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The Impact of Wind Power Projects on Residential Property Values in the United States: A Multi-Site Hedonic Analysis

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Environmental Energy Technologies Division

December 2009

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The Impact of Wind Power Projects on Residential Property Values in the United States: A Multi-Site Hedonic Analysis

Prepared for the

Office of Energy Efficiency and Renewable Energy
Wind & Hydropower Technologies Program
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Washington, D.C.

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Abstract

With wind energy expanding rapidly in the U.S. and abroad, and with an increasing number of communities considering wind power development nearby, there is an urgent need to empirically investigate common community concerns about wind project development. The concern that property values will be adversely affected by wind energy facilities is commonly put forth by stakeholders. Although this concern is not unreasonable, given property value impacts that have been found near high voltage transmission lines and other electric generation facilities, the impacts of wind energy facilities on residential property values had not previously been investigated thoroughly. The present research collected data on almost 7,500 sales of single-family homes situated within 10 miles of 24 existing wind facilities in nine different U.S. states. The conclusions of the study are drawn from eight different hedonic pricing models, as well as both repeat sales and sales volume models. The various analyses are strongly consistent in that none of the models uncovers conclusive evidence of the existence of any widespread property value impacts that might be present in communities surrounding wind energy facilities. Specifically, neither the view of the wind facilities nor the distance of the home to those facilities is found to have any consistent, measurable, and statistically significant effect on home sales prices. Although the analysis cannot dismiss the possibility that individual homes or small numbers of homes have been or could be negatively impacted, it finds that if these impacts do exist, they are either too small and/or too infrequent to result in any widespread, statistically observable impact.

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Executive Summary

Overview

Wind power development in the United States has expanded dramatically in recent years. If that growth is to continue it will require an ever-increasing number of wind power projects to be sited, permitted, and constructed. Most permitting processes in the U.S. require some form of environmental impact assessment as well as public involvement in the siting process. Though public opinion surveys generally show that acceptance towards wind energy is high, a variety of concerns with wind power development are often expressed on the local level during the siting and permitting process. One such concern is the potential impact of wind energy projects on the property values of nearby residences.

Concerns about the possible impact of wind power facilities on residential property values can take many forms, but can be divided into the following non-mutually exclusive categories:

- Area Stigma: A concern that the general area surrounding a wind energy facility will appear more developed, which may adversely affect home values in the local community regardless of whether any individual home has a view of the wind turbines.
- Scenic Vista Stigma: A concern that a home may be devalued because of the view of a wind energy facility, and the potential impact of that view on an otherwise scenic vista.
- Nuisance Stigma: A concern that factors that may occur in close proximity to wind turbines, such as sound and shadow flicker, will have a unique adverse influence on home values.

Although concerns about the possible impact of wind energy facilities on the property values of nearby homes are reasonably well established, the available literature[1] that has sought to quantify the impacts of wind projects on residential property values has a number of shortcomings:

1) Many studies have relied on surveys of homeowners or real estate professionals, rather than trying to quantify real price impacts based on market data;
2) Most studies have relied on simple statistical techniques that have limitations and that can be dramatically influenced by small numbers of sales transactions or survey respondents;
3) Most studies have used small datasets that are concentrated in only one wind project study area, making it difficult to reliably identify impacts that might apply in a variety of areas;
4) Many studies have not reported measurements of the statistical significance of their results, making it difficult to determine if those results are meaningful;
5) Many studies have concentrated on an investigation of the existence of Area Stigma, and have ignored Scenic Vista and/or Nuisance Stigmas;
6) Only a few studies included field visits to homes to determine wind turbine visibility and collect other important information about the home (e.g., the quality of the scenic vista); and
7) Only two studies have been published in peer-reviewed academic journals.

[1] This literature is briefly reviewed in Section 2 of the full report, and includes: Jordal-Jorgensen (1996); Jerabek (2001); Grover (2002); Jerabek (2002); Sterzinger et al. (2003); Beck (2004); Haughton et al. (2004); Khatri (2004); DeLacy (2005); Poletti (2005); Goldman (2006); Hoen (2006); Firestone et al. (2007); Poletti (2007); Sims and Dent (2007); Bond (2008); McCann (2008); Sims et al. (2008); and Kielisch (2009).

This report builds on the previous literature that has investigated the potential impact of wind projects on residential property values by using a hedonic pricing model and by avoiding many of the shortcomings enumerated above. The hedonic pricing model is one of the most prominent and reliable methods for identifying the marginal impacts of different housing and community characteristics on residential property values (see side bar). This approach dates to the seminal work of Rosen (1974) and Freeman (1979), and much of the available literature that has investigated the impacts of potential disamenities on property values has relied on this method.[2]

What Is a Hedonic Pricing Model?
Hedonic pricing models are frequently used by economists and real estate professionals to assess the impacts of house and community characteristics on property values by investigating the sales prices of homes. A house can be thought of as a bundle of characteristics (e.g., number of square feet, number of bathrooms). When a price is agreed upon by a buyer and seller there is an implicit understanding that those characteristics have value. When data from a large number of residential transactions are available, the individual marginal contribution to the sales price of each characteristic for an average home can be estimated with a hedonic regression model. Such a model can statistically estimate, for example, how much an additional bathroom adds to the sale price of an average home. A particularly useful application of the hedonic model is to value non-market goods – goods that do not have transparent and observable market prices. For this reason, the hedonic model is often used to derive value estimates of amenities such as wetlands or lake views, and disamenities such as proximity to and/or views of high-voltage transmission lines, roads, cell phone towers, and landfills. It should be emphasized that the hedonic model is not typically designed to appraise properties (i.e., to establish an estimate of the market value of a home at a specified point in time), as would be done with an automated valuation model. Instead, the typical goal of a hedonic model is to estimate the marginal contribution of individual house or community characteristics to sales prices.

To seed the hedonic model with appropriate market data, this analysis collects information on a large quantity of residential home sales (i.e., transactions) (n = 7,459) from ten communities surrounding 24 existing wind power facilities spread across multiple parts of the U.S. (e.g., nine states). Homes included in this sample are located from 800 ft to over five miles from the nearest wind energy facility, and were sold at any point from before wind facility announcement to over four years after the construction of the nearby wind project. Each of the homes that sold was visited to determine the degree to which the wind facility was likely to have been visible at the time of sale and to collect other essential data.

To assess the potential impacts of all three of the property value stigmas described earlier, a base hedonic model is applied as well as seven alternative hedonic models each designed to investigate the reliability of the results and to explore other aspects of the data (see Table ES - 1 below). In addition, a repeat sales model is analyzed, and an investigation of possible impacts on sales volumes is

[2] Many of these studies are summarized in the following reviews: Kroll and Priestley (1992); McCann (1999); Bateman et al. (2001); Boyle and Kiel (2001); Jackson (2001); Simons and Saginor (2006); and Leonard et al. (2008). For further discussion of the hedonic model and its application to the quantification of environmental stigmas see Jackson (2005) and Simons (2006a).

conducted. Though some limitations to the analysis approach and available data are acknowledged, the resulting product is the most comprehensive and data-rich analysis to date in the U.S. or abroad on the impacts of wind projects on nearby property values.

Analysis Findings

Table ES - 1 describes the ten resulting statistical models that are employed to investigate the effects of wind facilities on residential sales prices, and the specific stigmas that those models investigate. Though all models test some combination of the three possible stigmas, they do so in different ways. For instance, the Base Model asks the question, "All else being equal, do homes near wind facilities sell for prices different than for homes located farther away?", while the All Sales Model asks, "All else being equal, do homes near wind facilities that sell after the construction of the wind facility sell for prices different from similar homes that sold before the announcement and construction of the facility?" Each model is therefore designed to not only test for the reliability of the overall results, but also to explore the myriad of potential effects from a variety of perspectives. Table ES-2 summarizes the results from these models.

Table ES - 1: Description of Statistical Models

Statistical Model	Description
Base Hedonic Model	Using only "post-construction" transactions (those that occurred after the wind facility was built), this model investigates all three stigmas in a straightforward manner
Alternative Hedonic Models	
View Stability	Using only post-construction transactions, this model investigates whether the Scenic Vista Stigma results from the Base Model are independent of the Nuisance and Area Stigma results
Distance Stability	Using only post-construction transactions, this model investigates whether the Nuisance and Area Stigma results from the Base Model are independent of the Scenic Vista Stigma results
Continuous Distance	Using only post-construction transactions, this model investigates Area and Nuisance Stigmas by applying a continuous distance parameter as opposed to the categorical variables for distance used in the previous models
All Sales	Using all transactions, this model investigates whether the results for the three stigmas change if transactions that occurred before the announcement and construction of the wind facility are included in the sample
Temporal Aspects	Using all transactions, this model further investigates Area and Nuisance Stigmas and how they change for homes that sold more than two years pre-announcement through the period more than four years post-construction
Orientation	Using only post-construction transactions, this model investigates the degree to which a home's orientation to the view of wind turbines affects sales prices
Overlap	Using only post-construction transactions, this model investigates the degree to which the overlap between the view of a wind facility and a home's primary scenic vista affects sales prices
Repeat Sales Model	Using paired transactions of homes that sold once pre-announcement and again post-construction, this model investigates the three stigmas, using as a reference transactions of homes located outside of five miles of the nearest wind turbine and that have no view of the turbines
Sales Volume Model	Using both pre-announcement and post-construction transactions, this model investigates whether the rate of home sales (not the price of those sales) is affected by the presence of nearby wind facilities

Table ES-2: Impact of Wind Projects on Property Values: Summary of Key Results

Statistical Model	Is there statistical evidence of: Area Stigma?	Scenic Vista Stigma?	Nuisance Stigma?	Section Reference
Base Model	No	No	No	*Section 4*
View Stability	Not tested	No	Not tested	*Section 5.1*
Distance Stability	No	Not tested	No	*Section 5.1*
Continuous Distance	No	No	No	*Section 5.2*
All Sales	No	No	Limited	*Section 5.3*
Temporal Aspects	No	No	No	*Section 5.4*
Orientation	No	No	No	*Section 5.5*
Overlap	No	Limited	No	*Section 5.6*
Repeat Sales	No	Limited	No	*Section 6*
Sales Volume	No	Not tested	No	*Section 7*

"No"…….. No statistical evidence of a negative impact
"Yes"……. Strong statistical evidence of a negative impact
"Limited"…….. Limited and inconsistent statistical evidence of a negative impact
"Not tested"…… This model did not test for this stigma

Base Model Results

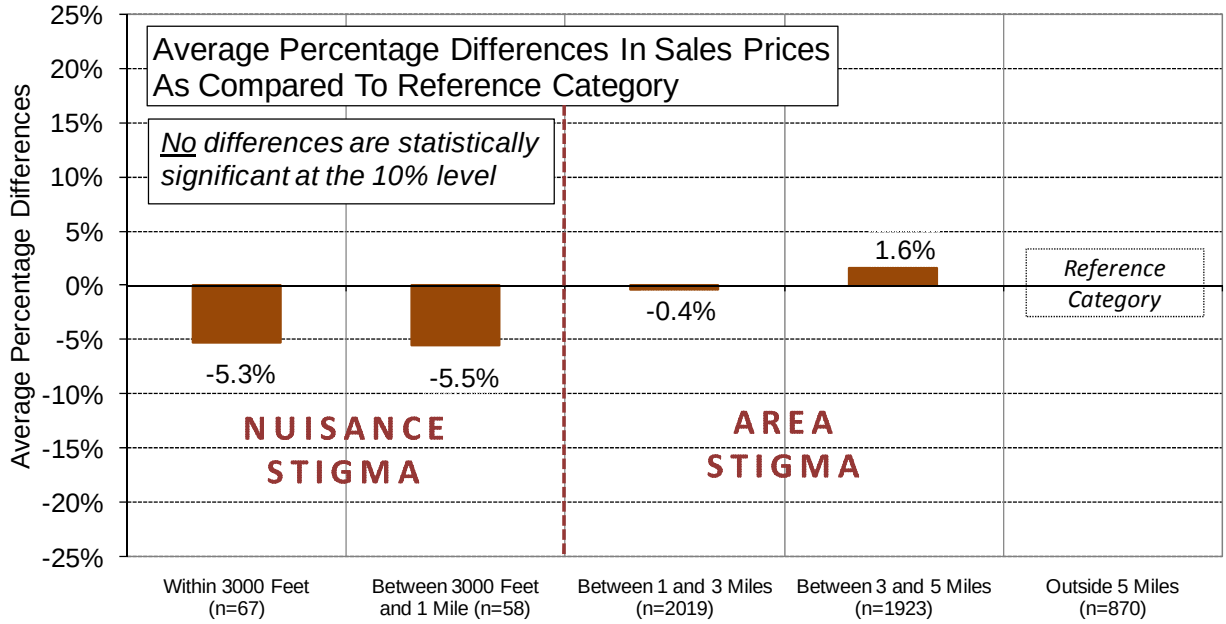
The Base Model serves as the primary model and allows all three stigmas to be explored. In sum, this model finds no persuasive evidence of any of the three potential stigmas: neither the view of the wind facilities nor the distance of the home to those facilities is found to have any consistent, measurable, and statistically significant effect on home sales prices.

- Area Stigma: To investigate Area Stigma, the model tests whether the sales prices of homes situated anywhere outside of one mile and inside of five miles of the nearest wind facility are measurably different from the sales price of those homes located outside of five miles. No statistically significant differences in sales prices between these homes are found (see Figure ES-1).
- Scenic Vista Stigma: For Scenic Vista Stigma, the model is first used to investigate whether the sales prices of homes with varying scenic vistas - absent the presence of the wind facility - are measurably different. The model results show dramatic and statistically significant differences in this instance (see Figure ES-2); not surprisingly, home buyers and sellers consider the scenic vista of a home when establishing the appropriate sales price. Nonetheless, when the model tests for whether homes with minor, moderate, substantial, or extreme views of wind turbines have measurably different sales prices, no statistically significant differences are apparent (see Figure ES-3).
- Nuisance Stigma: Finally, for Nuisance Stigma, the model is used to test whether the sales prices of homes situated inside of one mile of the nearest wind energy facility are measurably different from those homes located outside of five miles. Although sample size is somewhat limited in this case,[3] the model again finds no persuasive statistical evidence that wind

[3] 125 homes were located inside of one mile of the nearest wind facility and sold post-construction.

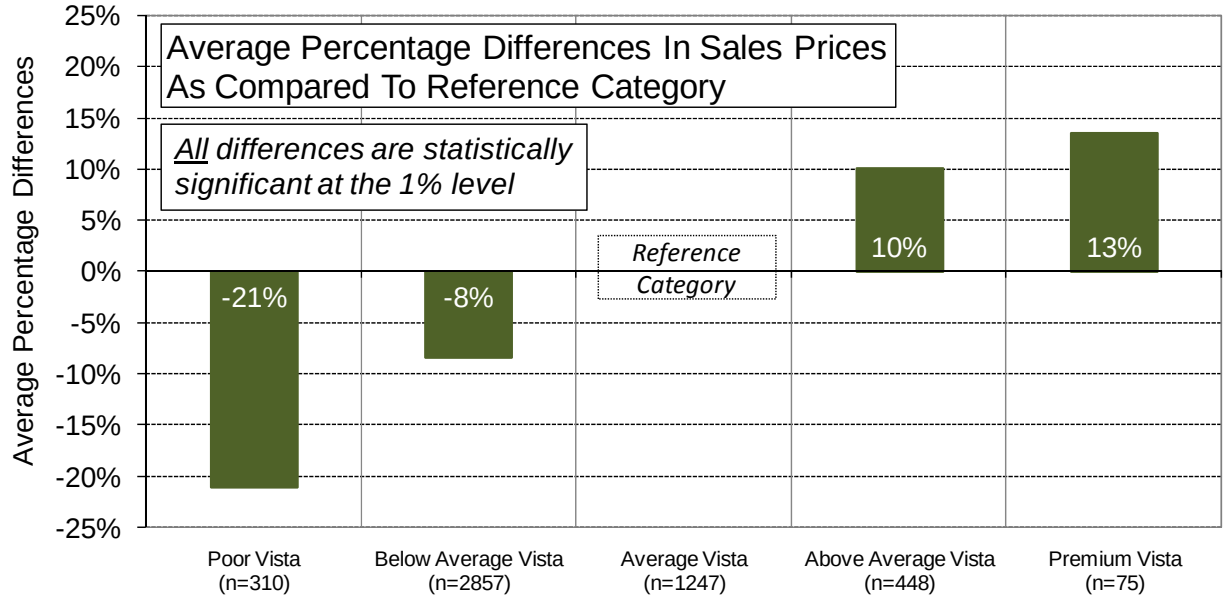
facilities measurably and broadly impact residential sales prices (see Figure ES-1 and later results).

Figure ES-1: Base Model Results: Area and Nuisance Stigma



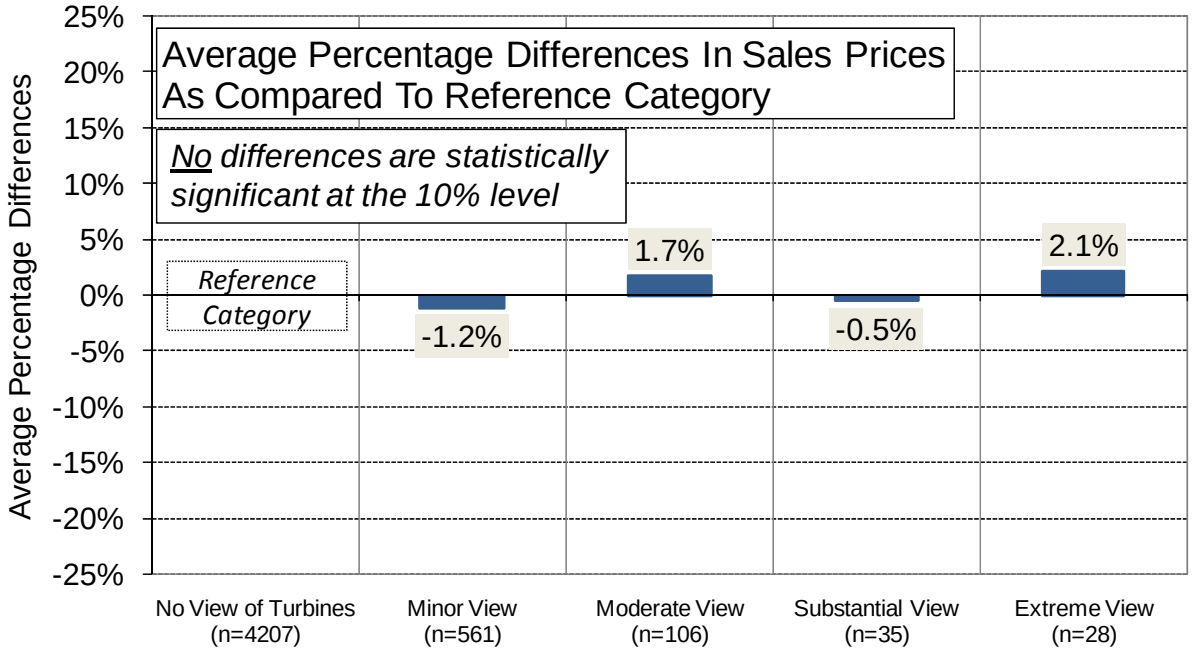
The reference category consists of transactions for homes situated more than five miles from the nearest turbine, and that occured after construction began on the wind facility

Figure ES-2: Base Model Results: Scenic Vista



The reference category consists of transactions for homes with an Average Vista, and that occured after construction began on the wind facility

Figure ES-3: Base Model Results: Scenic Vista Stigma



The reference category consists of transactions for homes without a view of the turbines, and that occured after construction began on the wind facility

The seven alternative hedonic models and the additional analysis contained in the Repeat Sales and Sales Volume Models (see Table ES-2) provide a fuller picture of the three stigmas and the robustness of the Base Model results.

Area Stigma: Other Model Results

Concentrating first on Area Stigma, the results from all of the models are similar: there is no statistical evidence of a widespread Area Stigma among the homes in this sample. Homes in the study areas analyzed here do not appear to be measurably stigmatized by the arrival of a wind facility, regardless of when those homes sold in the wind project development process and regardless of whether the homes are located one mile or five miles away from the nearest facility.

In the All Sales Model, for example, after adjusting for inflation,[4] homes that sold after wind facility construction and that had no view of the turbines are found to have transacted for higher prices - not lower - than those homes that sold prior to wind facility construction. Moreover, in the Temporal Aspects Model, homes that sold more than two years prior to the announcement of the wind facility and that were located more than five miles from where the turbines were eventually located are found to have transacted for lower prices - not higher - than homes situated closer to the turbines and that sold at any time after the announcement and construction of the wind facility (see Figure ES - 4). Further, in the Repeat Sales Model, homes located near the wind facilities that transacted more than once were found to have appreciated between those sales by an amount that was no different from that experienced by homes located in an area

[4] All sales prices in all models are adjusted for inflation, but because this model (and the Temporal Aspects Model) deals with time explicitly, it is mentioned specifically here.

many miles away from the wind facilities. Finally, as shown in Table ES-2, none of the other models identified evidence of a broadly negative and statistically significant Area Stigma.

Scenic Vista Stigma: Other Model Results

With respect to Scenic Vista Stigma, the seven alternative hedonic models and the additional analysis contained in the Repeat Sales Model find little consistent evidence of a broadly negative and statistically significant impact. Although there are 730 residential transactions in the sample that involve homes that had views of a wind facility at the time of sale, 160 of which had relatively significant views (i.e., a rating higher than Minor), none of the various models finds strong statistical evidence that the view of a nearby wind facility impacts sales prices in a significant and consistent manner.

When concentrating only on the view of the wind facilities from a home (and not testing for Area and Nuisance Stigmas simultaneously), for example, the results from the View Stability Model are very similar to those derived from the Base Model, with no evidence of a Scenic Vista Stigma. Similarly, the All Sales Model finds that homes that sold after wind facility construction and that had a view of the facility transacted for prices that are statistically indistinguishable from those homes that sold at any time prior to wind facility construction. The Orientation Model, meanwhile, fails to detect any difference between the sales prices of homes that had either a front, back, or side orientation to the view of the wind facility. As shown in Table ES-2, the Continuous Distance and Temporal Aspects models also do not uncover any evidence of a broadly negative and statistically significant Scenic Vista Stigma.

In the Repeat Sales Model, some limited evidence is found that a Scenic Vista Stigma may exist, but those effects are weak, fairly small, somewhat counter-intuitive, and are at odds with the results of other models. This finding is likely driven by the small number of sales pairs that are located within one mile of the wind turbines and that experience a dramatic view of those turbines. Finally, in the Overlap Model, where the degree to which a view of the wind facility overlaps the primary scenic vista from the home is accounted for, no statistically significant differences in sales prices are detected between homes with somewhat or strongly overlapping views when compared to those homes with wind turbine views that did not overlap the primary scenic vista. Though this model produces some weak evidence of a Scenic Vista Stigma among homes with Minor views of wind facilities, the same model finds that the sales prices of those homes with views that barely overlap the primary scenic vista are positively impacted by the presence of the wind facility. When these two results are combined, the overall impact is negligible, again demonstrating no persuasive evidence of a Scenic Vista Stigma.

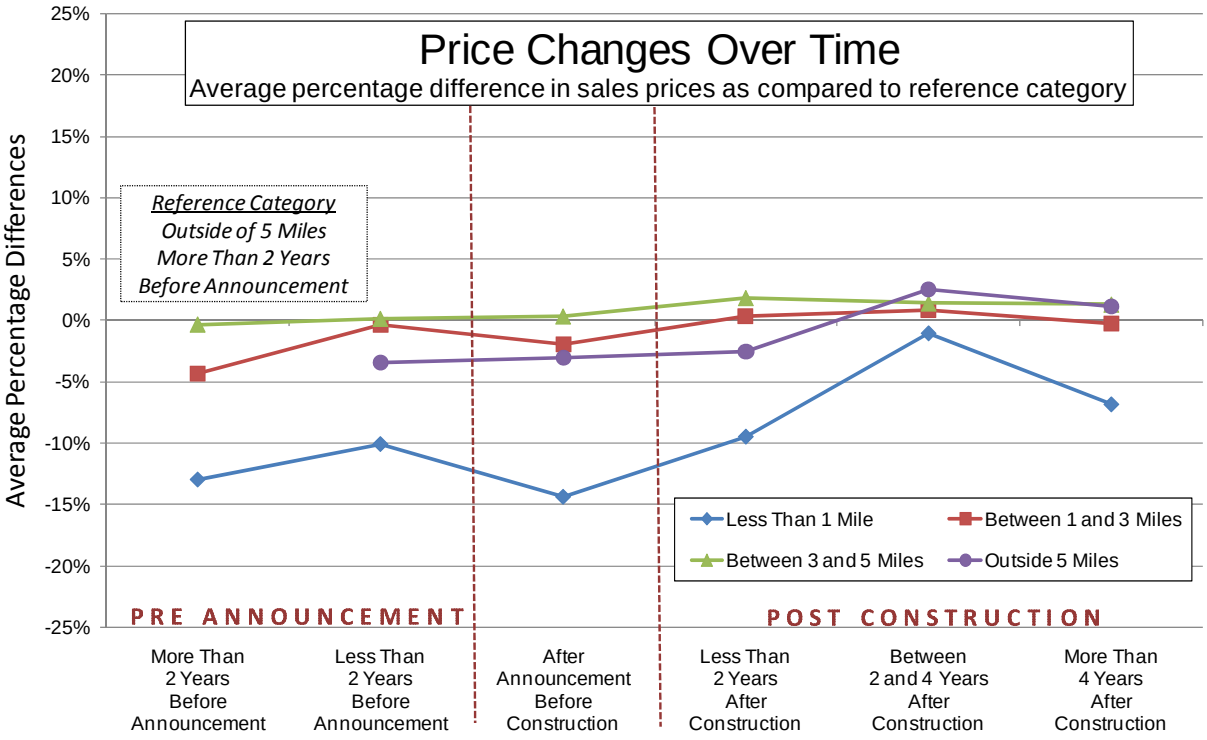
Nuisance Stigma: Other Model Results

Results for Nuisance Stigma from the seven alternative hedonic models and the additional analysis contained in the Repeat Sales and Sales Volume Models support the Base Model results. Taken together, these models present a consistent set of results: homes in this sample that are within a mile of the nearest wind facility, where various nuisance effects have been posited, have not been broadly and measurably affected by the presence of those wind facilities. These results imply that Nuisance Stigma effects are either not present in this sample, or are too small and/or infrequent to be statistically distinguished.

In the Distance Stability Model, for example, when concentrating only on the distance from homes to the nearest wind turbine (and not testing for Scenic Vista Stigma simultaneously), the results are very similar to those derived from the Base Model, with no statistical evidence of a Nuisance Stigma. These results are corroborated by the Continuous Distance, Orientation, Overlap, and Repeat Sales Models, none of which find a statistically significant relationship between distance and either sales prices or appreciation rates. Relatedly, the Sales Volume analysis finds no evidence that homes located within one mile of the nearest wind turbine are sold any more or less frequently than homes located farther away from the wind facilities.

In the All Sales Model, a weakly significant difference is found between the sales prices of homes located between 3000 feet and one mile of the nearest wind facility and the homes that sold before the announcement of the wind facility. This effect, however, is largely explained by the results of the Temporal Aspects Model, shown in Figure ES - 4. The Temporal Aspects Model finds that homes located within one mile of where the wind turbines would eventually be located sold for depressed prices well before the wind facility was even announced or constructed. In all time periods following the commencement of wind facility construction, however, inflation-adjusted sales prices increased - not decreased - relative to pre-announcement levels, demonstrating no statistical evidence of a Nuisance Stigma. The results from the All Sales Model (and, for that matter, the negative, albeit statistically insignificant coefficients inside of one mile in the Base Model, see Figure ES-1) are therefore an indication of sales price levels that preceded wind facility announcement construction, and that are not sustained after construction.

Figure ES - 4: Temporal Aspects Model Results: Area and Nuisance Stigma



The reference category consists of transactions of homes situated more than five miles from where the nearest turbine would eventually be located and that occurred more than two years before announcement of the facility

Conclusions and Further Research Needs

Though each of the analysis techniques used in this report has strengths and weaknesses, the results as a whole are strongly consistent in that none of the models uncovers conclusive evidence of the presence of any of the three property value stigmas that might be present in communities surrounding wind power facilities. Therefore, based on the data sample and analysis presented here, no evidence is found that home prices surrounding wind facilities are consistently, measurably, and significantly affected by either the view of wind facilities or the distance of the home to those facilities. Although the analysis cannot dismiss the possibility that individual homes or small numbers of homes have been or could be negatively impacted, it finds that if these impacts do exist, they are either too small and/or too infrequent to result in any widespread, statistically observable impact. Moreover, to the degree that homes and wind facilities in this sample are similar to homes and facilities in other areas of the United States, the results presented here are expected to be transferable to other areas.

This work builds on the existing literature in a number of respects, but there remain a number of areas for further research. The primary goal of subsequent research should be to concentrate on those homes located closest to wind facilities, where the data sample herein was the most limited. Additional research of the nature reported in this paper could be pursued, but with a greater number of transactions, especially for homes particularly close to wind facilities. A more detailed analysis of sales volume impacts may also be fruitful, as would an assessment of the potential impact of wind facilities on the length of time homes are on the market in advance of an eventual sale. Finally, it would be useful to conduct a survey of those homeowners living close to existing wind facilities, and especially those residents who have bought and sold homes in proximity to wind facilities after facility construction, to assess their opinions on the impacts of wind project development on their home purchase and sales decisions.

1. Introduction

Wind power development has expanded dramatically in recent years (GWEC, 2009). Although the percent of electricity supplied to the U.S. and globally from wind power projects installed through 2008 remains relatively low (1.9% and 1.5%, respectively) (Wiser and Bolinger, 2009), there are expectations that those percentages will rise and that wind energy could contribute a significant percentage of future electricity supply (GWEC, 2008; Wiser and Hand, 2010). Most recently, President Obama, in his 2009 State of the Union address, called for a doubling of renewable energy in three years (by 2012), and in 2008 the U.S. Department of Energy produced a report that analyzed the feasibility of meeting 20% of U.S. electricity demand with wind energy by 2030 (US DOE, 2008).

To meet these goals, a significant amount of wind project development activity would be required. The average size of wind power projects built in the U.S. in 2007 and 2008 was approximately 100 MW (Wiser and Bolinger, 2009) and the total amount of capacity required to reach 20% wind electricity is roughly 300,000 MW (US DOE, 2008). Therefore, to achieve 20% wind electricity by 2030, a total of 3,000 wind facilities may need to be sited and permitted. Most permitting processes in the U.S. require some form of environmental impact assessment, and some form of public involvement in the siting process. Though surveys show that public acceptance is high in general for wind energy (e.g., Wolsink, 2000; Firestone and Kempton, 2006), a variety of concerns are often expressed on the local level that can impact the length and outcome of the siting and permitting process. These concerns range from the potential impacts of wind projects on wildlife habitat and mortality, radar and communications systems, ground transportation and historic and cultural resources, to aesthetic and property value concerns as well as potential nuisance and health impacts. As a result, a variety of siting and permitting guidelines (AWEA, 2008) and impact assessments (NAS, 2007) have been completed.

Surveys of local communities considering wind facilities have consistently ranked adverse impacts on aesthetics and property values in the top tier of concerns (e.g., BBC R&C, 2005; Firestone and Kempton, 2006). Developers of wind energy echo this assessment: they ranked aesthetics and property values as two of the top concerns (first and third respectively) for individuals or communities opposed to wind power development (Paul, 2006). Local residents have even brought suit against a developer over property values (Dale Rankin v. FPL, 2008), and some developers have responded to these concerns by offering “neighbor agreements” that compensate nearby homeowners for the potential impacts of wind projects.

The two concerns of aesthetics and property values are intrinsically linked. It is well established that a home’s value will be increased if a high-quality scenic vista is enjoyed from the property (e.g., Seiler et al., 2001). Alternatively, it is reasonable to assume that if a home’s scenic vista overlaps with a view of a disamenity, the home might be devalued, as has been found for high-voltage transmission lines (HVTL) (Kroll and Priestley, 1992; Des-Rosiers, 2002). Whether a view of wind turbines similarly impacts home values is a key topic of debate in local siting decisions. Aesthetics alone, however, is not the only pathway through which wind projects might impact residential property values. Distance to the nearest wind turbine, for example, might also have an impact if various nuisance effects are prominent, such as turbine noise,

shadow flicker,[5] health or safety concerns, or other impacts, real or perceived. In this way, property values near wind turbines might be impacted in the same way as homes near roads might be devalued (Bateman et al., 2001). Additionally, there is evidence that proximity to a disamenity, even if that disamenity is not visible and is not so close as to have obvious nuisance effects, may still decrease a home's sales price, as has been found to be the case for landfills (Thayer et al., 1992).

Taken together, these general concerns about the possible impacts of wind projects on residential property values can be loosely categorized into three potential stigmas:

- Area Stigma: A concern that the general area surrounding a wind energy facility will appear more developed, which may adversely affect home values in the local community regardless of whether any individual home has a view of the wind turbines.
- Scenic Vista Stigma: A concern that a home may be devalued because of the view of a wind energy facility, and the potential impact of that view on an otherwise scenic vista.
- Nuisance Stigma: A concern that factors that may occur in close proximity to wind turbines, such as sound and shadow flicker, will have a unique adverse influence on home values.

These three potential stigmas are not mutually exclusive and could, in theory, be present in part or in combination for any single home. Consequently, all three potential impacts must be considered when analyzing the effects of wind facilities on residential sales prices.

Although concerns about the potential impact of wind projects on residential property values are often mentioned in siting cases, the state of the existing literature on this topic leaves much to be desired. To some extent, the growing body of research investigating this topic has come to opposing conclusions. The most recent and comprehensive of these studies have often concluded that no widespread impacts of wind projects on residential property values are apparent (Hoen, 2006; Sims and Dent, 2007; Sims et al., 2008). At the same time, pre-construction surveys of both homeowners and real estate experts have sometimes found an expectation of negative impacts (e.g. Haughton et al., 2004), and post-construction appraisals have sometimes come to similar conclusions (McCann, 2008; Kielisch, 2009). Given the state of the literature, it is not uncommon for local siting and permitting processes to involve contradicting testimony from experts, as occurred in 2004 when the Public Service Commission of Wisconsin heard opposing conclusions from two studies conducted by experienced home valuation experts (Poletti, 2005; Zarem, 2005).

This report contains the most comprehensive and data-rich analysis to date on the potential impacts of wind projects on nearby residential sales prices. Data from 7,459 residential transactions were collected from the surrounding communities of 24 individual wind projects in nine states and 14 counties in the United States.[6] Because of the large sample size, the diversity of wind projects included in the analysis, and the depth of information collected, a number of different analyses were possible. Specifically, this report relies heavily on a hedonic regression

[5] Shadow flicker occurs when the sun shines through the wind turbine blades when at a low angle to the horizon and shadows are cast on a window or interior wall of a residence (NAS, 2007).

[6] The majority of the analysis only includes homes that sold after wind facility construction began, totaling 4,937 transactions.

model[7] and uses various forms of that model to investigate potential effects and to confirm the robustness of the resulting findings. To further investigate the robustness of the results, a repeat sales model[8] and a sales volume model[9] are also utilized. In sum, this work builds and improves on the previous literature, and provides an in-depth assessment of the question of whether residential property values in the United States have been affected, in a statistically measurable way, by views of and proximity to wind power facilities.

The remainder of this report is structured as follows. The next section discusses the hedonic model in general, its application to environmental disamenities research, and some potentially analogous results drawn from these studies. This is followed by a summary of the existing literature that has investigated the effects of wind energy on residential property values. The report then turns to the data used in the analysis, a discussion of the primary (or "base") hedonic model, and an analysis of the results from that statistical model. Following that, a set of alternative hedonic models are estimated, as well as a repeat sales model and sales volume model, to test for the robustness of the "base" model results and to explore other aspects of the data. Taking into account the full set of results presented earlier, the report then discusses the three stigmas that may lead to wind projects impacting residential property values, and summarizes how the analysis informs the existence and magnitude of these potential effects. The report ends with a brief conclusion, and a discussion of future research possibilities. A number of appendices follow the conclusion, and contain detailed information on each wind project study area, the data collection instrument and qualitative rating systems used in the field research, the investigation of the best "base" model, the hedonic model assumptions and related tests, and full results from all of the additional statistical models estimated in the report.

[7] The hedonic regression model, which was briefly described in a sidebar in the Executive Summary, is described in detail in Section 2.1.

[8] A repeat sales model uses, as its dataset, only those homes that have sold more than once. By comparing annual appreciation rates of homes that sold once before facility announcement, and again after construction, it can be tested, in an alternative fashion, if home values are affected by the distance to or view of nearby wind turbines.

[9] Sales volume can be defined as the percentage of homes that fit a certain criteria (e.g. single family, on less than 25 acres, zoned residential, assessed for more than $10,000) that actually did sell. By comparing sales volumes at various distances to wind facilities, before and after the facility was built, a further robustness test is possible.

2. Previous Research

Hedonic pricing models are frequently used to assess the marginal impacts of house and community characteristics on sales prices and by extension on property values in general. Because the hedonic model is the primary statistical method used in this report, this section begins by describing the model in more detail and providing some relevant examples of its use. The section then reviews the existing literature on the effects of wind energy facilities on surrounding property values, highlights the shortcomings of that literature, and outlines how the present research addresses those shortcomings.

2.1. Hedonic Models and Environmental Disamenities

A house can be thought of as a bundle of characteristics (e.g., number of square feet, number of bathrooms, number of fireplaces, and amount of acreage). When a price is agreed upon between a buyer and seller there is an implicit understanding that those characteristics have value. When data from a number of sales transactions are available, the individual marginal contribution to the sales price of each characteristic can be estimated with a hedonic regression model (Rosen, 1974; Freeman, 1979). This relationship takes the basic form:

Sales price = *f* (house structural characteristics, other factors)

where "house structural characteristics" might include, but are not limited to, the number of square feet of living area, bathrooms, and fireplaces, the presence of central AC and the condition of the home, and "other factors" might include, but are not limited to, home site characteristics (e.g., number of acres), neighborhood characteristics (e.g., school district), market conditions at the time of sale (e.g., prevailing mortgage interest rates), and surrounding environmental conditions (e.g., proximity to a disamenity or amenity).

The relationship between the sales price of homes and the house characteristics and other factors can take various forms. The most common functional form is the semi-log construction where the dependent variable is the natural log of the inflation adjusted sales price, and the independent variables are unadjusted (not transformed) home characteristics and other factors. The usefulness of this form of hedonic model is well established (Malpezzi, 2003; Sirmans et al., 2005b; Simons and Saginor, 2006) assuming that certain threshold assumptions are met.[10] The model is used commonly by academics, real estate assessors, appraisers, and realtors when large datasets are available on past residential sales transactions, and when estimates of the marginal impact of certain house characteristics and other factors on sales prices are desired.[11]

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[10] These assumptions, which are discussed in greater detail in Section 4.2 and Appendix G, include absence of outliers and/or influencers, presence of homoskedastic variances, absence of spatial and temporal autocorrelation, and absence of collinearity between the variables of interest and other independent variables.

[11] It should be emphasized that a hedonic model is not designed to appraise properties (i.e., to establish an estimate of the market value of a home at a specified point in time), as would be done with an automated valuation model (AVM). Rather, hedonic models are designed to estimate the marginal contribution of individual house or community characteristics to sales prices, which requires hedonic models to rely upon large data sets with a sizable number of explanatory variables. Appraisal models, on the other hand, are generally based on small, localized data sets (i.e., "comps") and a limited number of explanatory variables that pertain to nearby properties. Due to their higher level of accuracy through the use of significantly more information (e.g., diverse spatial, temporal, and

A particularly useful application of the hedonic regression model is to value non-market goods – goods that do not have transparent and observable market prices. For this reason, the hedonic model is often used to derive value estimates of amenities such as wetlands (e.g., Mahan et al., 2000) or lake views (e.g., Seiler et al., 2001), and disamenities, such as proximity to and/or views of high-voltage transmission lines (HVTLs) (e.g. Des-Rosiers, 2002), fossil fuel power plants (Davis, 2008), roads (e.g. Bateman et al., 2001), cell phone towers (e.g. Bond and Wang, 2007), and landfills (e.g., Thayer et al., 1992; Ready and Abdalla, 2005).

There are a number of useful reviews that describe the application of hedonic models in these circumstances (Kroll and Priestley, 1992; Farber, 1998; McCann, 1999; Bateman et al., 2001; Boyle and Kiel, 2001; Jackson, 2001; Ready and Abdalla, 2005; Simons and Saginor, 2006; Simons, 2006b; Leonard et al., 2008).[12] The large number of studies covered in these reviews demonstrate that hedonic models are regularly used to investigate the interplay between home values and distance to potential disamenities, teasing out if and how sales prices are adversely affected depending on the distance of a typical home from a disamenity. For example, Carroll et al. (1996) use a hedonic model to estimate a devaluation of 16% for homes "close to" a chemical plant, with a 6.5% increase in sales price per mile away out to 2.5 miles, at which point effects fade entirely. Dale et al. (1999) find a maximum effect of -4% near a lead smelter, with sales prices increasing 2% for each mile away out to two miles, where effects again fade. Ready and Abdalla (2005) find maximum effects near landfills of -12.4%, which fade entirely outside 2,400 feet, and maximum effects near confined animal feeding operations of -6.4%, which fade entirely outside of 1,600 feet. Meanwhile, studies of other energy infrastructure, such as HVTLs, find maximum effects of -5.7% for homes adjacent to a HVTL tower, and an increase in prices of 0.018% per foot away from the tower out to 300 feet (Hamilton and Schwann, 1995), and maximum effects of -14% for homes within 50 feet of a HVTL, but no effect for similar homes at 150 feet (Des-Rosiers, 2002). Further, for fossil fuel power plants, Davis (2008) finds average adverse effects of between 3 and 5% inside of two miles but that those effects fade entirely outside of that distance range.

In addition to investigating how sales prices change with distance to a disamenity, hedonic models have been used to investigate how prices have changed over time. For instance, sales prices have sometimes been found to rebound after the removal of a disamenity, such as a lead smelter (Dale et al., 1999), or to fade over time, as with HVTLs (Kroll and Priestley, 1992) or spent fuel storage facilities (Clark and Allison, 1999). Finally, hedonic models have been used to estimate how views of a disamenity affect sales prices. Des-Rosiers (2002), for example, finds that homes adjacent to a power line and facing a HVTL tower sell for as much as 20% less than similar homes that are not facing a HVTL tower.

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characteristic information) and rigorous methodology, hedonic models can also be used as appraisal models. Automated valuation models cannot, however, be reliably used to measure marginal effects because they do not employ sufficient information to do so, and, more importantly, AVMs do not hold controlling characteristics constant, which could bias any resulting estimates of marginal effects.

[12] For further discussion of the hedonic model and its application to the quantification of environmental stigmas in comparison to other methods see Jackson (2005).

It is unclear how well the existing hedonic literature on other disamenities applies to wind turbines, but there are likely some similarities. For instance, in general, the existing literature seems to suggest that concerns about lasting health effects provide the largest diminution in sales prices, followed by concerns for one's enjoyment of the property, such as auditory and visual nuisances, and that all effects tend to fade with distance to the disamenity - as the perturbation becomes less annoying. This might indicate that property value effects from wind turbines are likely to be the most pronounced quite close to them, but fade quickly as their auditory and visual impacts fade. The existing hedonic literature also, in general, finds that effects fade with time as self-selecting buyers without prejudice towards the disamenity move into the area, or as the real or perceived risks of the disamenity are lessoned (Jackson, 2001). This implies that any stigmas related to wind turbines might also fade over time as local communities come to accept their presence.

2.2. Impacts of Wind Projects on Property Values

Turning to the literature that has investigated the potential property value effects from wind facilities directly, it deserves note that few studies have been academically peer-reviewed and published; in some cases, the work has been performed for a party on one side or the other of the permitting process (e.g., the wind developer or an opposition group). Nonetheless, at a minimum, a brief review of this existing literature will set the stage for and motivate the later discussion of the methods and results of the present work. The literature described below is summarized in Table 1. To frame this discussion, where possible, the three potential stigmas discussed earlier are used:

- Area Stigma: A concern that the general area surrounding a wind energy facility will appear more developed, which may adversely affect home values in the local community regardless of whether any individual home has a view of the wind turbines.
- Scenic Vista Stigma: A concern that a home may be devalued because of the view of a wind energy facility, and the potential impact of that view on an otherwise scenic vista.
- Nuisance Stigma: A concern that factors that may occur in close proximity to wind turbines, such as sound and shadow flicker, will have a unique adverse influence on home values.

In one of the most recent studies, Sims et al. (2008) used a hedonic model to investigate Scenic Vista Stigma using 199 residential transactions within ¼ of a mile of the 16-turbine Bears Down wind facility in Cornwall, UK. They found both large positive and smaller negative significant relationships between views of the turbines and sales prices depending on whether the view is seen from the front or rear of the home, respectively, but found no relationship between the number of wind turbines visible and sales prices. Previously, Sims and Dent (2007) used a hedonic model to investigate Nuisance and Scenic Vista Stigma with 919 transactions for homes within five miles of two wind facilities in the UK, finding only limited evidence of a relationship between proximity to and views of turbines and sales prices, which local real estate experts attributed to other causes. Hoen (2006) investigated Scenic Vista Stigma using a hedonic model to analyze 280 residential transactions occurring near a wind facility in Madison County, NY, and found no evidence that views of turbines significantly affects prices. Jordal-Jorgensen (1996) investigated Nuisance Stigma in Denmark, and found an adverse effect for homes located "close" to the turbines, but no statistical significance was reported.[13]

[13] A copy of this report could not be obtained and therefore its findings are reported based on other citations.

Using different statistical methods, Poletti (2005; 2007) used a *t*-Test to investigate Nuisance and Area Stigma by comparing the mean sales prices of 187 and 256 homes in Illinois and Wisconsin, respectively, located near wind facilities (target group) to those further away (control group).[14, 15] He split these target and control groups into respective smaller and more-homogenous sub-groups, such as large and small tracts, with and without homes, finding no statistical evidence that homes near the wind facilities sold for different prices than those farther away. Sterzinger et al. (2003) analyzed roughly 24,000 residential transactions, which were divided between those within five miles of a wind facility and those outside of five miles in an effort to assess Area Stigma. They compared residential appreciation rates over time, and found no apparent difference between those homes within and outside of five miles from a wind facility, but the statistical significance of this comparison was not reported.

Other authors have used smaller samples of residential transactions and a variety of simple statistical techniques, without reporting statistical significance, and have found a lack of evidence of effects from Nuisance Stigma (Jerabek, 2001; Jerabek, 2002; Beck, 2004) and Area Stigma (DeLacy, 2005; Goldman, 2006). These results, however, are somewhat contrary to what one appraiser has found. In his investigation of Nuisance Stigma around a wind facility in Lee County, IL, McCann (2008) found that two homes nearby a wind facility had lengthy selling periods that, he believes, also adversely affected transaction prices. Additionally, Kielisch (2009) investigated Nuisance Stigma by comparing twelve transactions of undeveloped land near two wind facilities in Wisconsin (Blue Sky Green Field and Forward) to undeveloped land transactions farther away. He found that land tracts near the wind facilities sold for dramatically lower prices ($/acre) than the comparable group, but the statistical significance of the comparison was not reported.

In addition to these revealed preference studies, a number of stated preference surveys (e.g., contingent valuation) and general opinion surveys have investigated the existence of potential effects.[16] A survey of <u>local residents</u>, conducted after the wind facilities were erected, found no evidence of Area Stigma (Goldman, 2006), while another found limited evidence of these stigmas (Bond, 2008).[17] Similarly, some surveys of <u>real estate experts</u> conducted after facility

[14] A *t*-Test is used to compare two sample means by discerning if one is significantly different from the other.

[15] The 2007 study used the data contained in the 2005 study in combination with new data consisting of transactions that occurred in the interim period.

[16] Contingent valuation is a survey based technique to value non-market goods (e.g., an environmental disamenity) that asks respondents what their "willingness to pay" (or "willingness to accept") is to have, for instance, a disamenity removed from (or to have it remain in) their neighborhood. This technique is distinct from a general opinion survey, which might ask whether respondents believe property values have been impacted by an environmental disamenity and, if so, "by how much." Although there are important distinctions between the two techniques, with the contingent valuation method often preferred by economic practitioners, for simplicity no distinction is made here between these two approaches. Finally, another subset of the survey literature focuses on public acceptance (i.e., opinion). Though these public acceptance surveys sometimes cover possible impacts on property values, those impacts are not quantified in economic terms. As a result, public acceptance survey results are not reported here.

[17] Bond (2008) asked respondents to declare if the wind facility, which is located roughly 7 miles away, would effect what they would be willing to pay for their house and 75% said either they would pay the same or more for their house, while the remainder would pay less. When those latter respondents were asked to estimate the percentage difference in value, their estimates averaged roughly 5%.

construction have found no evidence of Area or Nuisance Stigmas (Grover, 2002; Goldman, 2006). These results, however, are contrary to the expectations for Area, Scenic Vista, and Nuisance Stigma effects predicted by local residents (Haughton et al., 2004; Firestone et al., 2007) and real estate experts (Haughton et al., 2004; Khatri, 2004; Kielisch, 2009) prior to construction found elsewhere.[18] The difference between predicted and actual effects might be attributable, at least in part, to the fear of the unknown. For instance, Wolsink (1989) found that public attitudes toward wind power, on average, are at their lowest for local residents during the wind project planning stage, but return almost to pre-announcement levels after the facilities are built. This result is echoed by Exeter-Enterprises-Ltd. (1993) and Palmer (1997), whose post-construction surveys found higher approval than those conducted pre-construction. Others, however, have found that perceptions do not always improve, attributing the lack of improvement to the perceived "success" or lack therefore of the project, with strong disapproval forming if turbines sit idle (Thayer and Freeman, 1987) or are perceived as a waste of taxpayer dollars (Devine-Wright, 2004).

When this literature is looked at as a whole, it appears as if wind projects have been predicted to negatively impact residential property values when pre-construction surveys are conducted, but that sizable, widespread, and statistically significant negative impacts have largely failed to materialize post-construction when actual transaction data become available for analysis. The studies that have investigated Area Stigma with market data have failed to uncover any pervasive effect. Of the studies focused on Scenic Vista and Nuisance Stigmas, only one is known to have found statistically significant adverse effects, yet the authors contend that those effects are likely driven by variables omitted from their analysis (Sims and Dent, 2007). Other studies that have relied on market data have sometimes found the possibility of negative effects, but the statistical significance of those results have rarely been reported.

Despite these findings, the existing literature leaves much to be desired. First, many studies have relied on surveys of homeowners or real estate professionals, rather than trying to quantify real price impacts based on market data. Second, a number of studies conducted rather simplified analyses of the underlying data, potentially not controlling for the many drivers of residential sales prices. Third, many of the studies have relied upon a very limited number of residential sales transactions, and therefore may not have had an adequate sample to statistically discern any property value effects, even if effects did exist. Fourth, and perhaps as a result, many of the studies did not conduct, or at least have not published, the statistical significance of their results. Fifth, when analyzed, there has been some emphasis on Area Stigma, and none of the studies have investigated all three possible stigmas simultaneously. Sixth, only a few of the studies (Hoen, 2006; Sims and Dent, 2007; Sims et al., 2008; Kielisch, 2009) conducted field visits to the homes to assess the quality of the scenic vista from the home, and the degree to which the wind facility might impact that scenic vista. Finally, with two exceptions (Sims and Dent, 2007; Sims et al., 2008), none of the studies have been academically peer-reviewed and published.

[18] It should be noted that the samples used by both Khatri and Kielisch contained a subset of respondents who did have some familiarity with valuing homes near wind facilities.

Table 1: Summary of Existing Literature on Impacts of Wind Projects on Property Values

Document Type Author(s)	Year	Number of Transactions or Respondents	Before or After Wind Facility Construction Commenced	Area Stigma	Scenic Vista Stigma	Nuisance Stigma
Homeowner Survey						
Haughton et al.	2004	501	Before	- *	- *	
Goldman	2006	50	After	**none**		
Firestone et al.	2007	504	Before	- *	- *	
Bond	2008	~300	After		- ?	- ?
Expert Survey						
Grover	2002	13	After	**none**		**none**
Haughton et al.	2004	45	Before	- *	- *	
Khatri	2004	405	Before‡	- ?		- ?
Goldman	2006	50	After	**none**		**none**
Kielisch	2009	57	Before‡			- ?
Transaction Analysis - Simple Statistics						
Jerabek	2001	25	After			**none**
Jerabek	2002	7	After			**none**
Sterzinger et al.	2003	24,000	After	**none**		
Beck	2004	2	After			**none**
Poletti	2005	187	After	**none**		**none**
DeLacy	2005	21	Before†	**none**		
Goldman	2006	4	After	**none**		
Poletti	2007	256	After	**none**		**none**
McCann	2008	2	After			- ?
Kielisch	2009	103	After			- ?
Transaction Analysis - Hedonic Model						
Jordal-Jorgensen	1996	?	After			- ?
Hoen	2006	280	After		**none**	
Sims & Dent	2007	919	After			- *
Sims et al.	2008	199	After		-/+ *	

" none " indicates the majority of the respondents do not believe properties have been affected (for surveys) or that no effect was detected at 10% significance level (for transaction analysis)

"- ?" *indicates a negative effect without statistical significance provided*

"- *" *indicates statistically significant negative effect at 10% significance level*

"-/+ *" *indicates positive and negative statistically significant effects at 10% significance level*

† *Sales were collected after facility announcement but before construction*

‡ *Some respondents had experience with valuations near facilities while others did not*

3. Data Overview

The methods applied in the present work are intended to overcome many of the limitations of the existing literature. First, a large amount of data is collected from residential transactions within 10 miles of 24 different wind projects in the U.S., allowing for a robust statistical analysis across a pooled dataset that includes a diverse group of wind project sites. Second, all three potential stigmas are investigated by exploring the potential impact of wind projects on home values based both on the distance to and view of the projects from the homes. Third, field visits are made to every home in the sample, allowing for a solid assessment of the scenic vista enjoyed by each home and the degree to which the wind facility can be seen from the home, and to collect other value-influencing data from the field (e.g., if the home is situated on a cul-de-sac). Finally, a number of hedonic regression models are applied to the resulting dataset, as are repeat sales and sales volume analyses, in order to assess the robustness of the results.

Testing for the three potential stigmas requires a significant sample of residential transactions within close proximity to existing wind facilities. Unfortunately for the study, most wind power projects are not located near densely populated areas. As a result, finding a single wind project site with enough transaction data to rigorously analyze was not possible. Instead, the approach was to collect data from multiple wind project sites, with the resulting data then pooled together to allow for robust statistical analyses.[19] The remainder of this section describes the site selection process that is used, and provides a brief overview of both the selected study areas and the data that were collected from these areas. Also provided is a description of how scenic vista, views of turbines, and distances from turbines were quantified for use in the hedonic analysis, and a summary of the field data collection effort. The section ends with a brief summary of the resulting dataset.

3.1. Site Selection

For the purpose of this study, an ideal wind project area would:

1) Have a large number of residential transactions both before and, more importantly, after wind facility construction, and especially in close proximity (e.g., within 2 miles) of the facility;
2) Have comprehensive data on home characteristics, sales prices, and locations that are readily available in electronic form; and
3) Be reasonably representative of the types of wind power projects being installed in the United States.

To identify appropriate sites that met these criteria, and that also provided a diversity of locations, the authors obtained from Energy Velocity, LLC a set of Geographic Information System (GIS) coordinates representing 241 wind projects in the U.S. that each had a total nameplate capacity greater than 0.6 megawatts (MW) and had gone online before 2006.[20] Also provided were facility capacity, number of turbines, and announcement, construction, and operational dates. These data were cross-checked with a similar dataset provided by the American Wind Energy Association (AWEA), which also included some turbine hub-height information.

[19] A thorough discussion of this "pooled" approach is contained in Section 4.2 and in Appendix F.

[20] Energy Velocity, LLC was owned at the time by Global Energy Decisions, which was later purchased by Ventyx. The dataset is available as Velocity Suite 2008 from Ventyx.

By using a variety of different GIS sorting techniques involving nearby towns with populations greater than, for example, 2,500 people, using census tract population densities, and having discussions with wind energy stakeholders, a prospective list of 56 possible study areas was generated, which were then ranked using two scales: "highly desirable" to "least desirable," and "feasible" to "potentially unfeasible."[21] Then, through an iterative process that combined calls to county officials to discuss the number of residential transactions and data availability, with investigations using mapping software to find the location of individual wind turbines, and, in some cases, preliminary visits, a list of 17 prospective study areas were chosen as both "highly desirable" and "feasible." Ultimately, three of these proved to be "unfeasible" because of data availability issues and four "undesirable" because the study area was considered not representative. This effort ultimately resulted in a final set of ten study areas that encompass a total of 24 distinct wind facilities (see Figure 1 and Table 2).[22] A full description of each study area is provided in Appendix A.

[21] "Desirability" was a combination of a number of factors: the wind facility having more than one turbine; the study area having greater than 350 sales within 5 miles and within 10 years, 250 of which transacted following construction of the facility; having some transaction data old enough to pre-date facility announcement; having data on the core home and site characteristics (e.g., square feet, acres); and, where possible, having a concentration of sales within 1 mile of the facility. "Feasibility" was also a combination of factors: having home characteristic and sales data in electronic form; having GIS shapefiles of the parcel locations; and being granted ready access to this information.

[22] The "unfeasible" study areas were Cerro Gordo County, IA, Bennington County, VT, and Atlantic County, NJ. Cerro Gordo County, IA contained multiple wind projects totaling 140 MW. Although the data at this site were available in electronic form, the county only agreed to share data in paper form, which would have created an enormous data entry burden. Because another site in the sample was considered similar to the Cerro Gordo site (IABV), Cerro Gordo County was dropped from the prospective sites. Bennington County, VT contained the 11 turbine Searsburg Wind Project (6 MW) but had no electronic records. Atlantic County, NJ contained the five turbine Jersey Atlantic Wind Farm (7.5 MW), but had data in paper records only and the county was unresponsive to inquiries regarding the study. The "undesirable" study areas were Plymouth County, MA, Wood County, OH, Cascade County, MT, and Riverside County, CA. Although the data in Plymouth County, MA were more than adequate, this small, on-land, yet coastal Hull Wind facility (2 turbines, 2.5 MW) was not considered to be particularly representative of wind development across the US. Wood County's four turbine Bowling Green facility (7 MW) met the appropriate data requirements, but ultimately it was decided that this facility was too small and remote to be representative. Cascade County's six turbine Horseshoe Bend Wind Park (9 MW) did not have enough transactions to justify study. Riverside, CA, where roughly 2500 turbines are located, had less-than-desired home characteristic data, had transactions that came more than 10 years after large scale development began, and despite having homes that were within 1 mile of the turbines, those homes typically had limited views because of high subdivision walls.

Figure 1: Map of Study Areas and Potential Study Areas

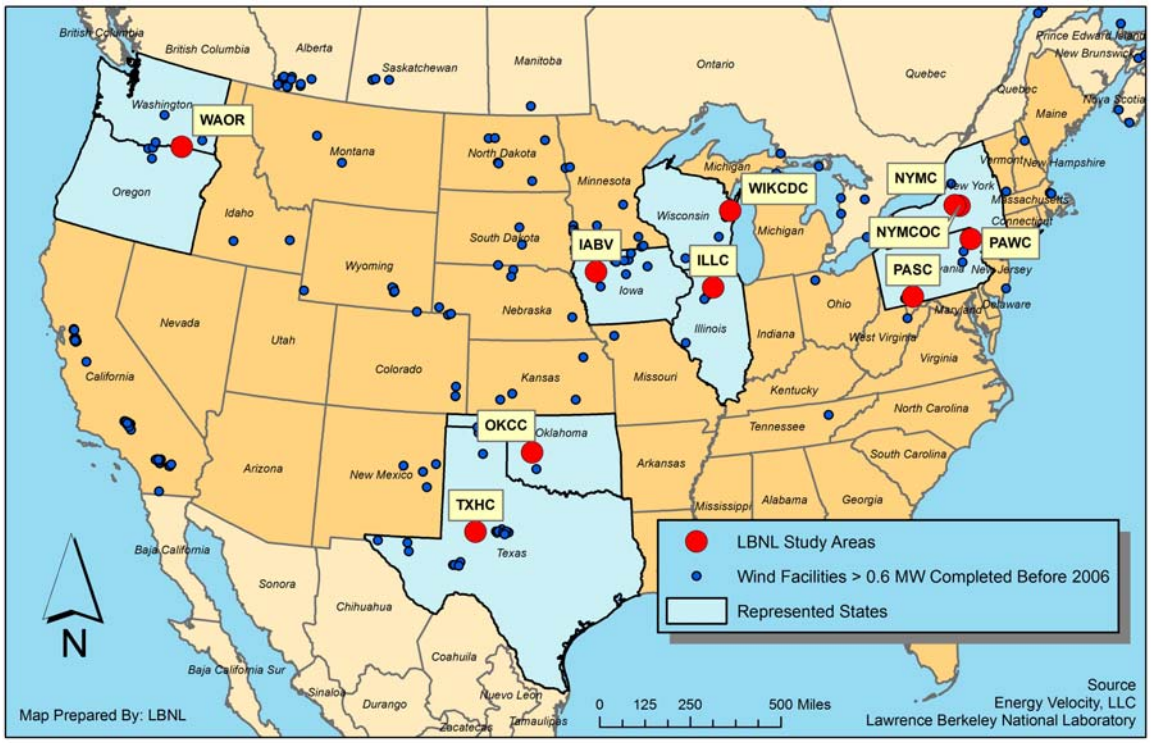

Table 2: Summary of Study Areas

Study Area Code	Study Area Counties, States	Facility Names	Number of Turbines	Number of MW	Max Hub Height (meters)	Max Hub Height (feet)
WAOR	Benton and Walla Walla Counties, WA and Umatilla County, OR	Vansycle Ridge, Stateline, Nine Canyon I & II, Combine Hills	582	429	60	197
TXHC	Howard County, TX	Big Spring I & II	46	34	80	262
OKCC	Custer County, OK	Weatherford I & II	98	147	80	262
IABV	Buena Vista County, IA	Storm Lake I & II, Waverly, Intrepid I & II	381	370	65	213
ILLC	Lee County, IL	Mendota Hills, GSG Wind	103	130	78	256
WIKCDC	Kewaunee and Door Counties, WI	Red River, Lincoln	31	20	65	213
PASC	Somerset County, PA	Green Mountain, Somerset, Meyersdale	34	49	80	262
PAWC	Wayne County, PA	Waymart	43	65	65	213
NYMCOC	Madison and Oneida Counties, NY	Madison	7	12	67	220
NYMC	Madison County, NY	Fenner	20	30	66	218
		TOTAL	**1345**	**1286**		

These 10 study areas and 24 projects are located in nine separate states, and include projects in the Pacific Northwest, upper Midwest, the Northeast, and the South Central region. The wind projects included in the sample total 1,286 MW, or roughly 13% of total U.S. wind power capacity installed at the time (the end of 2005). Turbine hub heights in the sample range from a

minimum of 164 feet (50 meters) in the Washington/Oregon (WAOR) study area, to a maximum of 262 (80 meters) (TXHC, OKCC and PASC), with nine of the ten study areas having hub heights of at least 213 feet (65 meters). The sites include a diverse variety of land types, including combinations of ridgeline (WAOR, PASC, and PAWC), rolling hills (ILLC, WIKCDC, NYMCOC, and NYMC), mesa (TXHC), and windswept plains (OKCC, IABV).[23]

3.2. Data Collection

In general, for each study area, residential transaction data in as close proximity to the wind turbines as possible was sought, from both before and after wind facility construction. To balance the cost and quantity of data collection in each study area with the desire to cover as many study areas as possible, the research effort sought to collect data on 400 to 1,250 transactions in each study area.[24] In some instances, this meant including all residential transactions within ten miles of the wind turbines. In others, only transactions within five miles were included. In some extreme instances, when the number of transactions inside of five miles far exceeded the 1,250 limit, all transactions in close proximity to the wind turbines (e.g., inside three miles) were included in combination with a random sample of transactions outside of that distance band (e.g., between three and five miles).[25] The data selection processes for each Study Area are contained in Appendix A.

Three primary sets of data are used in the analysis: tabular data, GIS data, and field data, each of which is discussed below. Following that, this subsection highlights the two qualitative variables that are essential to this analysis and that therefore require special attention, scenic vista and views of turbines, and then discusses the field data collection process.

3.2.1. Tabular Data

Berkeley Lab obtained tabular transaction data from participating counties[26] containing 7,459 "valid" [27] transactions of single family residential homes, on less than 25 acres,[28] which were

[23] Some areas, such as PASC, had both a ridgeline and rolling hills on which wind facilities were located.

[24] This range was chosen to ensure that a minimum of data were present in each study area to allow for a robust analysis, and yet not too much so as to make data collection (e.g., the visiting of each home) inordinately time and resource consuming in any individual study area.

[25] An alternative method would have been to collect data on every sale that occurred. Although in most cases this would be preferred, in ours it would not have added one additional transaction within close proximity or with dramatic views of wind turbine, the focus of the study. Rather, it would have added an overwhelming majority of transactions of homes without views and at distances outside of three miles from the turbines, all of which would have come at considerably cost and, more importantly, would not likely have influenced the results significantly while perhaps necessitating a reduction in the total number of study areas that could be included in the sample.

[26] In some cases, the county officials, themselves, extracted data from their database, and in some cases a company engaged to manage a county's data provided the necessary information. In either case the provider is referred to as "county." Detailed descriptions of the providers are presented in Appendix A.

[27] Validity was determined by each individual county data provider. A sale that is considered "valid" for county purposes would normally meet the minimum requirements of being arm's length; being a transfer of all rights and warrants associated with the real estate; containing an insignificant amount of personal property so as not to affect the price; demonstrating that neither party in the sale acting under duress or coercion; not being the result of a liquidation of assets or any other auction, a mortgage foreclosure, a tax sale, or a quit claim; and being appropriate for use in calculating the sales price to assessed value ratios that are reported to the state. Due to the formal requirements associated with this calculation, "validity" is often defined by a state's Department of Revenue, as shown, for example, here: http://www.orps.state.ny.us/assessor/manuals/vol6/rfv/index.htm. In addition, though the

sold for a price of more than $10,000,[29] which occurred after January 1, 1996,[30] and which had fully populated "core" home characteristics. These core characteristics are: number of square feet of the living area (not including finished basement), acres of land, bathrooms, and fireplaces, the year the home was built,[31] if the home had exterior wallsthatwere stone, a central air conditioning unit, and/or a finished basement, and the exterior condition of the home. The 7,459 residential transactions in the sample consist of 6,194 homes (a number of the homes in the sample sold more than once in the selected study period). Because each transaction had a corresponding set of the core home characteristic data, they could all be pooled into a single model. In addition to the home characteristic data, each county provided, at a minimum, the home's physical address and sales price. The counties often also provided data on homes in the study area that did not sell in the study period.[32] Finally, market-specific quarterly housing inflation indexes were obtained from Freddie Mac, which allowed nominal sales prices to be adjusted to 1996 dollars.[33]

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sample originally contained 7,498 sales, 34 homes sold twice in a 6 month period and, after discussions with local officials, these transactions were considered likely to have been "invalid" despite the county coding them to the contrary. Additionally, five transactions produced standardized residuals that were more than six standard deviations away from the mean, indicating that these sales were abnormal and likely not valid. Both of these sets of transactions, totaling 39, were removed from the final dataset. Of the 39 sales, 32 sold following construction, 10 were concentrated in IABV and nine in TXHC with the others spread between seven of the remaining eight study areas. One of the homes was inside of one mile from the turbines at the time of sale, and two had views of the turbines (both of which were MINOR). The home that was located within one mile was surrounded by a number of other homes – at similar distances from the turbines - that transacted both before and after the wind facilities were built and were included in the sample. A more thorough discussion of the screening techniques used to ensure the appropriateness of the final data set are presented in detail in Appendix G under "Outliers/Influencers." Finally, it should be noted that the authors are aware of four instances in the study areas when homes were sold to wind developers. In two cases the developer did not resell the home; in the other two, the developer resold the home at a lower price than which it was purchased. But, because the sales were to a related party, these transactions were not considered "valid' and are therefore not included here. One might, however, reasonably expect that the property values of these homes were impacted by the presence of the wind turbines.

[28] Single family residences on more than 25 acres were considered to be likely candidates for alternative uses, such as agricultural and recreational, which could have an influence on sales price that was outside of the capabilities of the model to estimate. Because all records were for parcels that contained a residence, the model did not contain any "land-only" transactions. Further, none of the transactions provided for this research were for parcels on which a turbine was located.

[29] A sales price of $10,000 was considered the absolute minimum amount an improved parcel (one containing a residential structure) would sell for in any of the study areas and study periods. This provided an additional screen over and above the "valid" screen that the counties performed.

[30] This provided a maximum of 12 years of data. Some counties did not have accessible data back to 1996 but in all cases these countries had data on transactions that occurred before the wind facilities were erected.

[31] "Year Built" was used to construct a variable for the age of the home at the time of the sale.

[32] These data were used to calculate the "Sales Volume" percentages referred to in Section 7.

[33] Freddie Mac Conventional Mortgage Home Price Index: municipal statistical area (MSA) series data are available from the following site: http://www.freddiemac.com/finance/cmhpi/. Because most of the study areas do not fall within the MSAs, a collection of local experts was relied upon, including real estate agents, assessors, and appraisers, to decide which MSA most-closely matched that of the local market. In all cases the experts had consensus as to the best MSA to use. In one case (NYMCOC) the sample was split between two MSAs. These indexes are adjusted quarterly, and span the entire sample period. Therefore, during the housing boom, insofar as a boom occurred in the sample areas, the indexes increased in value. Subsequently when the market began falling, the index retracted.

3.2.2. GIS Data

GIS data on parcel location and shape were also required, and were obtained from the counties. The counties also often provided GIS layers for roads, water courses, water bodies, wind turbines (in some cases), house locations, and school district and township/town/village delineations. GIS data on census tract and school district delineations were obtained from the U.S. Census Bureau, if not provided by the county.[34] GIS data were obtained on water courses, water bodies, land elevations, and satellite imagery, as was necessary, from the U.S. Department of Agriculture.[35] Combined, these data allowed each home to be identified in the field, the construction of a GIS layer of wind turbine locations for each facility, and the calculation of the distance from each home to the nearest wind turbine.[36] Determining the distance from each home to the nearest wind turbine was a somewhat involved process, and is discussed in detail in Appendix B. Suffice it to say that each transaction had a unique distance ("DISTANCE")[37] that was determined as the distance between the home and nearest wind turbine at the time of sale, and that these distances are grouped into five categories: inside of 3000 feet (0.57 miles), between 3000 feet and one mile, between one and three miles, between three and five miles, and outside of five miles.[38] Finally, the GIS data were used to discern if the home was situated on a cul-de-sac and had water frontage, both of which were corroborated in the field.

3.2.3. Field Data

Additional data had to be collected through field visits to all homes in the sample. Two qualitative measures in particular – for scenic vista and for view of the wind turbines – are worth discussing in detail because each is essential to the analysis and each required some amount of professional judgment in its creation.

The impact or severity of the view of wind turbines ("VIEW") [39] may be related to some combination of the number of turbines that are visible, the amount of each turbine that is visible (e.g., just the tips of the blades or all of the blades and the tower), the distance to the nearest turbines, the direction that the turbines are arrayed in relation to the viewer (e.g., parallel or perpendicular), the contrast of the turbines to their background, and the degree to which the turbine arrays are harmoniously placed into the landscape (Gipe, 2002). Recent efforts have made some progress in developing quantitative measures of the aesthetic impacts of wind turbines (Torres-Sibillea et al., 2009),[40] but, at the time this project began, few measures had

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[34] These data were sourced from the U.S. Census Bureau's Cartographic Boundary Files Webpage: http://www.census.gov/geo/www/cob/bdy_files.html.

[35] These data were sourced from the USDA Geospatial Data Gateway: http://datagateway.nrcs.usda.gov/GatewayHome.html.

[36] Although in some cases the county provided a GIS layer containing wind turbine points, often this was not available. A description of the turbine mapping process is provided in Appendix B.

[37] Distance measures are collectively and individually referred to as "DISTANCE" from this point forward.

[38] The minimum distance of "inside 3000 feet" was chosen because it was the closest cutoff that still provided an ample supply of data for analysis.

[39] View of turbines ratings are collectively and individually referred to as "VIEW" from this point forward.

[40] In addition to these possible field techniques, previous studies have attempted to use GIS to estimate wind turbine visibility using "line-of-sight" algorithms. For example, Hoen (2006) used these algorithms after adding ground cover to the underlying elevation layer. He found that the GIS method differed substantially from the data collected in the field. Seemingly, small inaccuracies in the underlying elevation model, errors in the software's algorithm, and the existence of ground cover not fully accounted for in the GIS, substantially biased GIS-based assessments of

been developed, and what had been developed was difficult to apply in the field (e.g., Bishop, 2002). As a result, the authors opted to develop an ordered qualitative VIEW rating system that consisted of placing the view of turbines into one of five possible categories: NO VIEW, MINOR, MODERATE, SUBSTANTIAL, and EXTREME. These ratings were developed to encompass considerations of distance, number of turbines visible, and viewing angle into one ordered categorical scale, and each rating is defined in Table 3:[41]

Table 3: Definition of VIEW Categories

NO VIEW	The turbines are not visible at all from this home.
MINOR VIEW	The turbines are visible, but the scope (viewing angle) is narrow, there are many obstructions, or the distance between the home and the facility is large.
MODERATE VIEW	The turbines are visible, but the scope is either narrow or medium, there might be some obstructions, and the distance between the home and the facility is most likely a few miles.
SUBSTANTIAL VIEW	The turbines are dramatically visible from the home. The turbines are likely visible in a wide scope and most likely the distance between the home and the facility is short.
EXTREME VIEW	This rating is reserved for sites that are unmistakably dominated by the presence of the wind facility. The turbines are dramatically visible from the home and there is a looming quality to their placement. The turbines are often visible in a wide scope or the distance to the facility is very small.

Photographic examples of each of the categories are contained in Appendix E.

visibility. This was corroborated elsewhere by Maloy and Dean (2001) and Riggs and Dean (2007). As a result of these findings, it was determined that field collection of VIEW data was essential.

[41]In addition to the qualitative rating system that was ultimately used in this study, a variety of quantitative data were collected that might describe the nature of the view of wind turbines, including the total number of turbines visible, the distance of the home to the nearest wind turbine, and the view scope/viewing angle (i.e., the degree to which the turbines spread out in front of the home: narrow, medium, or wide). To explore the validity of the qualitative rating scale two tests were conducted. First, a pre-study survey was conducted by showing 10 different off-site respondents 15 randomly selected photographs from the field representing the various rated VIEW categories. The higher VIEW ratings were oversampled to create a roughly equal distribution among the categories. The respondents rated the views into one of the qualitative categories. The on-site / field collected ratings matched the off-site responses 65% of the time, with 97% of the rankings differing by no more than one category. Ninety-eight percent of the on-site-ranked MINOR VIEWs and 89% of the EXTREME VIEWs were similarly ranked by off-site respondents. The on-site rankings were less than the off-site rankings 97% of the time; it is assumed that this is because on-site ratings took into account a greater portion of the panorama than were captured in the photos, which translated into a lower ranking. Secondly, a post hoc Multinomial Logistic Regression model was created that used the qualitative on-site VIEW ratings as the dependent variable and the quantitative measures of distance to nearest turbine, number of turbines visible, and view scope as the independent variables. This model produced high Pseudo R^2 statistics (Cox and Snell 0.88, Nagelkerke 0.95, and McFadden 0.79) and predicted values that were highly correlated with the actual qualitative rating (Pearson's 0.88). Therefore, both tests corroborated the appropriateness of the simpler qualitative VIEW rankings used herein.

In addition to the qualitative VIEW measurements, a rating for the quality of the scenic vista ("VISTA")[42] from each home, absent the existence of the wind facilities, was also collected in the field. An assessment of the quality of the VISTA from each home was needed because VIEW and VISTA are expected to be correlated; for example, homes with a PREMIUM VISTA are more likely to have a wide viewing angle in which wind turbines might also be seen. Therefore, to accurately measure the impacts of the VIEW of wind turbines on property values a concurrent control for VISTA (independent of any views of turbines) is required. Drawing heavily on the landscape-quality rating system developed by Buhyoff et al. (1994) and to a lesser degree on the systems described by others (Daniel and Boster, 1976; USDA, 1995), an ordered VISTA rating system consisting of five categories was developed: POOR, BELOW AVERAGE, AVERAGE, ABOVE AVERAGE, and PREMIUM, with each rating defined in Table 4:[43]

Table 4: Definition of VISTA Categories

POOR VISTA	These vistas are often dominated by visually discordant man-made alterations (not considering turbines), or are uncomfortable spaces for people, lack interest, or have virtually no recreational potential.
BELOW AVERAGE VISTA	These scenic vistas contain visually discordant man-made alterations (not considering turbines) but are not dominated by them. They are not inviting spaces for people, but are not uncomfortable. They have little interest or mystery and have minor recreational potential.
AVERAGE VISTA	These scenic vistas include interesting views that can be enjoyed often only in a narrow scope. These vistas may contain some visually discordant man-made alterations (not considering turbines), are moderately comfortable spaces for people, have some interest, and have minor recreational potential.
ABOVE AVERAGE VISTA	These scenic vistas include interesting views that often can be enjoyed in a medium to wide scope. They might contain some man-made alterations (not considering turbines), yet still possess significant interest and mystery, are moderately balanced and have some potential for recreation.
PREMIUM VISTA	These scenic vistas would include "picture postcard" views that can be enjoyed in a wide scope. They are often free or largely free of any discordant man made alterations (not considering turbines), possess significant interest, memorable qualities, and mystery and are well balanced and likely have a high potential for recreation.

Photographic examples of each of the categories are contained in Appendix D.

[42] Scenic vista ratings are individually and collectively referred to as "VISTA" from this point forward.

[43] The appropriateness of these rankings were tested in two ways. First, a set of 34 pictures taken on-site and representing various categories of VISTA were shown to 10 off-site respondents who were asked to rank them using the same categories, and then explain why they rated them as such. Although the off-site ratings matched the on-site ratings only 51% of the time, 94% of on- and off-site rankings differed by no more than one category, with 17% of the off-site rankings below the on-site and 26% ranked above. The descriptions of why the rankings where chosen by the off-site respondents illuminated the fact that off-site ratings did not take into account a number of aspects that were not adequately captured in the photos, but that were apparent in the field. This finding was borne out by a second test that had five individuals visit seven homes in the field to rank their scenic vistas. When all respondents were on-site, they similarly ranked the vista 72% of the time, with a rankingthat differed by no more than one category occurring one hundred percent of the time.

In addition to the VIEW and VISTA ratings, it was assumed that the orientation of the home to the view of turbines (e.g., front, back, or side) ("ORIENTATION"), and the degree to which the view of the turbines overlapped the primary scenic vista (e.g., not at all, barely, somewhat or strongly) ("OVERLAP"), might influence residential property values. As such, information on ORIENTATION and OVERLAP were also collected in the field.

3.2.4. Field Data Collection

Field data collection was conducted on a house-by-house basis. Each of the 6,194 homes was visited by the same individual to remove bias among field ratings. Data collection was conducted in the fall of 2006, and the spring, summer, and fall of 2007 and 2008. Each house was photographed and, when appropriate, so too were views of turbines and the prominent scenic vista.[44] Data on VIEW were collected only for those homes that sold after at least one wind power facility had been erected in the study area. When multiple wind facilities, with different construction dates, were visible from a home, field ratings for VIEW were made by taking into account which turbines had been erected at the time of sale. Additionally, if the season at the time of sale differed from that of data collection and, for example, if leaves were off the trees for one but on for the other, an effort was made to modulate the VIEW rating accordingly if necessary.[45]

Both VIEW and VISTA field ratings were arrived at through a Q-Sort method (Pitt and Zube, 1979), which is used to distinguish relatively similar rankings. For views of turbines, the rater first determined if the ranking was MINOR or EXTREME. If neither of these two rankings was appropriate, then only a choice between MODERATE and SUBSTANTIAL was required. Similarly, for VISTA rankings, first POOR and PREMIUM were distinguished from the others; if neither applied then BELOW AVERAGE or ABOVE AVERAGE could be selected. If neither of those were appropriate the VISTA, by default, was considered AVERAGE. In all cases, if wind turbines were visible from the home, the VISTA rankings were made as if those turbines did not exist.

3.3. Data Summary

The final dataset consists of 7,459 valid and screened residential transactions occurring between January 2, 1996 and June 30, 2007. Those transactions are arrayed across time and the ten wind project study areas as shown in Table 5. The sample of valid residential transactions ranges from 412 in Lee County, Illinois (ILLC) to 1,311 in Howard County, Texas (TXHC).[46] Of the total 7,459 transactions, 4,937 occurred after construction commenced on the relevant wind facilities. More specifically, 23% of the transactions (n=1,755) took place before any wind facility was announced and 10% occurred after announcement but before construction commenced (n=767),

[44] In many cases the prominent VISTA was homogenous across groups of home, for instance urban homes on the same road. In those cases a picture of the VISTA of one home was applied to all of the homes. All pictures were taken with a Canon EOS Rebel XTi Single Lens Reflex Camera with a 18-55mm lens. VIEW and VISTA pictures were taken with the lens set to 18mm, with the camera at head height, and with the center of the camera pointed at the center of the prominent VISTA or VIEW. Examples of the various VISTA and VIEW categories are contained in Appendices D and E respectively.

[45] This "modulation" occurred only for trees in the foreground, where, for instance, a single tree could obscure the view of turbines; this would not be the case for trees nearer the horizon.

[46] See description of "valid" in footnote 27 on page 13.

with the rest of the transactions occurring after construction commenced (66%, *n*=4,937).[47] Of that latter group, 17% (*n*=824, 11% of total) sold in the first year following the commencement of construction, 16% in the second year (*n*=811, 11% of total), and the remainder (67%) sold more than two years after construction commenced (*n*=3,302, 44% of total).

Table 5: Summary of Transactions across Study Areas and Development Periods

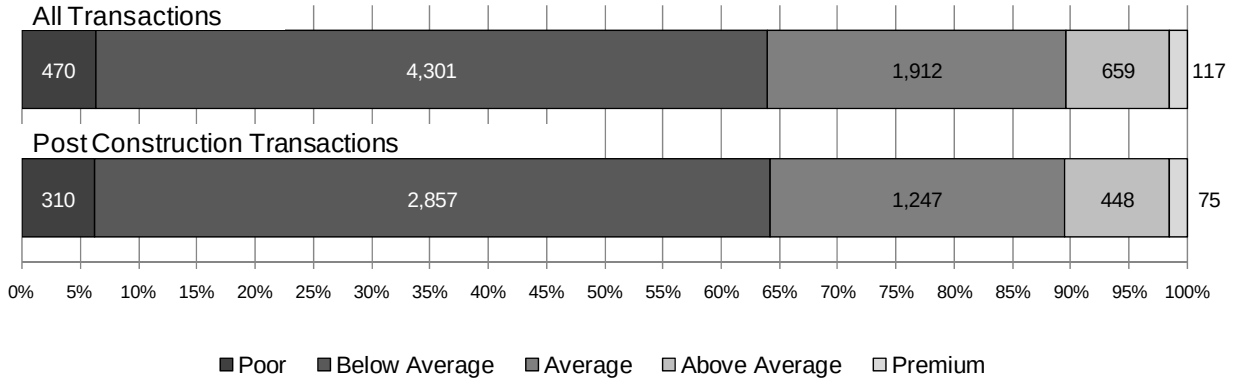
	Pre Announcement	Post Announcement Pre Construction	1st Year After Construction	2nd Year After Construction	2+ Years After Construction	Total
Benton/Walla Walla, WA & Umatilla, OR (WAOR)	226	45	76	59	384	**790**
Howard, TX (TXHC)	169	71	113	131	827	**1311**
Custer, OK (OKCC)	484	153	193	187	96	**1113**
Buena Vista, IA (IABV)	152	65	80	70	455	**822**
Lee, IL (ILLC)	115	84	62	71	80	**412**
Kewaunee/Door, WI (WIKCDC)	44	41	68	62	595	**810**
Somerset, PA (PASC)	175	28	46	60	185	**494**
Wayne, PA (PAWC)	223	106	64	71	87	**551**
Madison/Oneida, NY (MYMCOC)	108	9	48	30	268	**463**
Madison, NY (NYMC)	59	165	74	70	325	**693**
TOTAL	**1755**	**767**	**824**	**811**	**3302**	**7459**

A basic summary of the resulting dataset, including the many independent variables used in the hedonic models described later, is contained in Table 6 and Table 7. These tables present summary information for the full dataset (7,459 transactions) as well as the post-construction subset of that dataset (4,937 transactions); the latter is provided because much of the analysis that follows focuses on those homes that sold after wind facility construction. The mean nominal residential transaction price in the sample is $102,968, or $79,114 in 1996 dollars. The average house in the sample can be described as follows: it is 46 years old, has 1,620 square feet of finished living area above ground, is situated on 1.13 acres, has 1.74 bathrooms, and has a

[47] The announcement date (as well as construction and online dates) was provided by Energy Velocity with the GIS files as described in footnote 20 on page 10. The date corresponds to the first time the facility appears in the public record, which was often the permit application date. This constitutes the first well established date when the existing wind facility would have been likely known by the public, and therefore is appropriate to use for this analysis, but there remain a number of areas for potential bias in this date. First, the permit application date might be preceded by news reports of the impending application; alternatively, if the public record was not published online (that Energy Velocity used to establish their date), the "announcement" date – as used here - could, in fact, follow the permit application date. To address this, when possible, the authors had discussions with the developer of the facility. In most cases, the Energy Velocity dates were found to be accurate, and when they were not they were adjusted to reflect the dates provided by the developer. A second potential source of bias is the possibility that a different project was proposed but never built, but that influenced the residential market in the study area prior to the "announcement" date. Although this is likely rarer, we are aware of at least a few projects that fit that description in the study areas. A final source of bias might revolve around the likelihood that awareness of a project could occur even before the facility is formally announced. For example, a community member might know that a wind facility is being considered because they had been approached by the wind development company well ahead of a public announcement. In turn, they might have had private discussions regarding the facility with other members of the community. Taken together, it is appropriate to assume that there is some bias in the "announcement" date, and that awareness of the project might precede the date used in this analysis. How this bias might affect the results in this report is addressed further in Section 5.3 and footnote 74 on page 38.

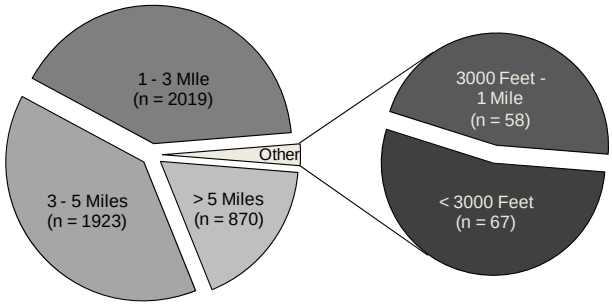
slightly better than average condition.[48] Within the full sample, 6% and 58% of homes had a poor or below average VISTA rating, respectively; 26% of homes received an average rating on this scale, with 9% above average and 2% experiencing premium vistas (see Figure 2).

Figure 2: Frequency of VISTA Ratings for All and Post-Construction Transactions



With respect to the variables of interest, among the post-construction subset of 4,937 transactions, the frequency of the DISTANCE categories is found to follow geometry with the smallest numbers of transactions occurring near the wind turbines and ever increasing numbers further away (see Figure 3). 67 transactions (1%) are situated inside of 3,000 feet (< 0.57 Miles), 58 (1%) are between 3,000 feet and one mile (0.57-1 mile), 2,019 (41%) occur outside of one mile but inside of three miles (1-3 miles), 1,923 (39%) occur between three and five miles (3-5 miles), and 870 (18%) occur outside of five miles (>5 miles).[49] In this same post-construction group, a total of 730 homes that sold (15%) have a view of the wind turbines (see Figure 4). A large majority of those homes have MINOR view ratings (n = 561, 11% of total), with 2% having MODERATE ratings (n=106) and the remaining transactions roughly split between SUBSTANTIAL and EXTREME ratings (n=35, 0.6%, and n=28, 0.5%, respectively). A full description of the variables of interest and how they are arrayed at the study area level is contained in Appendix A.

Figure 3: Frequency of DISTANCE Ratings for Post-Construction Transactions



[48] The variable for the condition of the home was not uniform across study areas because, in some cases, it took into account construction grade while in others it did not.

[49] These numbers and percentages are skewed slightly from the overall population of transactions because homes outside of three miles were often under-sampled to reduce field data collection burdens. Further, higher numbers of homes fall into each of the categories when the post-announcement-pre-construction transactions are included, as they are in some models. These additional transactions are described below in Table 7 under "All Sales."

Figure 4: Frequency of VIEW Ratings for Post-Construction Transactions

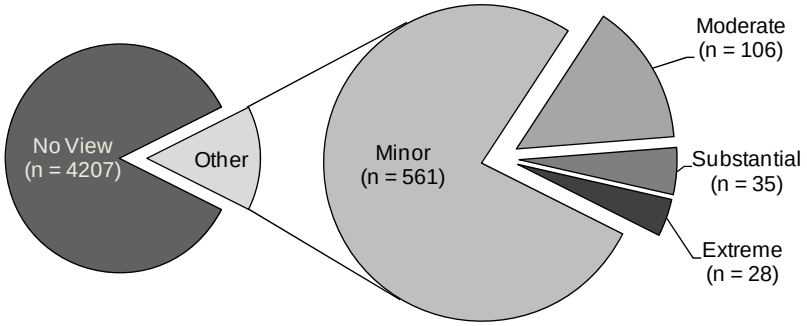


Table 6: Summary Statistics: All Sales and Post-Construction Sales

		All Sales			Post Construction Sales		
Variable Name	**Description**	**Freq. ***	**Mean**	**Std. Dev.**	**Freq. ***	**Mean**	**Std. Dev.**
SalePrice	The unadjusted sale price of the home (in US dollars)	7,459	102,968	64,293	4,937	110,166	69,422
SalePrice96	The sale price of the home adjusted to 1996 US dollars	7,459	79,114	47,257	4,937	80,156	48,906
LN_SalePrice96	The natural log transformation of the sale price of the home adjusted to 1996 US dollars	7,459	11.12	0.58	4,937	11.12	0.60
AgeatSale	The age of the home at the time of sale	7,459	46	37	4,937	47	36
AgeatSale_Sqrd	The age of the home at the time of sale squared	7,459	3,491	5,410	4,937	3,506	5,412
Sqft_1000	The number of square feet of above grade finished living area (in 1000s)	7,459	1.623	0.59	4,937	1.628	0.589
Acres	The number of Acres sold with the residence	7,459	1.13	2.42	4,937	1.10	2.40
Baths	The number of Bathrooms (Full Bath = 1, Half Bath = 0.5)	7,459	1.74	0.69	4,937	1.75	0.70
ExtWalls_Stone	If the home has exterior walls of stone, brick or stucco (Yes = 1, No = 0)	2,287	0.31	0.46	1,486	0.30	0.46
CentralAC	If the home has a Central AC unit (Yes = 1, No = 0)	3,785	0.51	0.50	2,575	0.52	0.50
Fireplace	The number of fireplace openings	2,708	0.39	0.55	1,834	0.40	0.55
Cul_De_Sac	If the home is situated on a cul-de-sac (Yes = 1, No = 0)	990	0.13	0.34	673	0.14	0.34
FinBsmt	If finished basement square feet is greater than 50% times first floor square feet (Yes = 1, No = 0)	1,472	0.20	0.40	992	0.20	0.40
Water_Front	If the home shares a property line with a body of water or river (Yes = 1, No = 0)	107	0.01	0.12	87	0.02	0.13
Cnd_Low	If the condition of the home is Poor (Yes = 1, No = 0)	101	0.01	0.12	69	0.01	0.12
Cnd_BAvg	If the condition of the home is Below Average (Yes = 1, No = 0)	519	0.07	0.25	359	0.07	0.26
Cnd_Avg	If the condition of the home is Average (Yes = 1, No = 0)	4,357	0.58	0.49	2,727	0.55	0.50
Cnd_AAvg	If the condition of the home is Above Average (Yes = 1, No = 0)	2,042	0.27	0.45	1,445	0.29	0.46
Cnd_High	If the condition of the home is High (Yes = 1, No = 0)	440	0.06	0.24	337	0.07	0.25
Vista_Poor	If the Scenic Vista from the home is Poor (Yes = 1, No = 0)	470	0.06	0.24	310	0.06	0.24
Vista_BAvg	If the Scenic Vista from the home is Below Average (Yes = 1, No = 0)	4,301	0.58	0.49	2,857	0.58	0.49
Vista_Avg	If the Scenic Vista from the home is Average (Yes = 1, No = 0)	1,912	0.26	0.44	1,247	0.25	0.44
Vista_AAvg	If the Scenic Vista from the home is Above Average (Yes = 1, No = 0)	659	0.09	0.28	448	0.09	0.29
Vista_Prem	If the Scenic Vista from the home is Premium (Yes = 1, No = 0)	117	0.02	0.12	75	0.02	0.12
SaleYear	The year the home was sold	7,459	2002	2.9	4,937	2004	2.3

** "Freq." applies to the number of cases the parameter's value is not zero*

Table 7: Summary of Variables of Interest: All Sales and Post-Construction Sales

		All Sales			Post Construction Sales		
Variable Name	**Description**	**Freq. ***	**Mean**	**Std. Dev.**	**Freq. ***	**Mean**	**Std. Dev.**
View_None	If the home sold after construction began and had no view of the turbines (Yes = 1, No = 0)	4,207	0.56	0.50	4,207	0.85	0.36
View_Minor	If the home sold after construction began and had a Minor View of the turbines (Yes = 1, No = 0)	561	0.08	0.26	561	0.11	0.32
View_Mod	If the home sold after construction began and had a Moderate View of the turbines (Yes = 1, No = 0)	106	0.01	0.12	106	0.02	0.15
View_Sub	If the home sold after construction began and had a Substantial View of the turbines (Yes = 1, No = 0)	35	-	0.07	35	0.01	0.08
View_Extrm	If the home sold after construction began and had a Extreme View of the turbines (Yes = 1, No = 0)	28	-	0.06	28	0.01	0.08
DISTANCE †	Distance to nearest turbine if the home sold after facility "announcement", otherwise 0	5,705	2.53	2.59	4,895	3.57	1.68
Mile_Less_0.57 †	If the home sold after facility "announcement" and was within 0.57 miles (3000 feet) of the turbines (Yes = 1, No = 0)	80	0.01	0.09	67	0.01	0.12
Mile_0.57to1 †	If the home sold after facility "announcement" and was between 0.57 miles (3000 feet) and 1 mile of the turbines (Yes = 1, No = 0)	65	0.01	0.09	58	0.01	0.11
Mile_1to3 †	If the home sold after facility "announcement" and was between 1 and 3 miles of the turbines (Yes = 1, No = 0)	2,359	0.27	0.44	2,019	0.41	0.49
Mile_3to5 †	If the home sold after facility "announcement" and was between 3 and 5 miles of the turbines (Yes = 1, No = 0)	2,200	0.26	0.44	1,923	0.39	0.49
Mile_Gtr5 †	If the home sold after facility "announcement" and was outside 5 miles of the turbines (Yes = 1, No = 0)	1,000	0.12	0.32	870	0.18	0.38

** "Freq." applies to the number of cases the parameter's value is not zero*

† "All Sales" freq., mean and standard deviation DISTANCE and DISTANCE fixed effects variables (e.g., Mile_1to3) include transactions that occurred after facility "announcement" and before "construction" as well as those that occured post-construction

4. Base Hedonic Model

This section uses the primary hedonic model ("Base Model") to assess whether residential sales prices are affected, in a statistically measurable way, by views of and proximity to wind power facilities. In so doing, it simultaneously tests for the presence of the three potential property value stigmas associated with wind power facilities: Area, Scenic Vista, and Nuisance. This section begins with a discussion of the dataset that is used and the form of the model that is estimated, and then turns to the results of the analysis. Various alternative hedonic models are discussed and estimated in Section 5, with Sections 6 and 7 providing a discussion of and results from the repeat sales and sales volume models.

4.1. Dataset

The data used for the Base Model were described in Section 3.3. A key threshold question is whether or not to include the residential transactions that pre-date the relevant wind facility. Specifically, though the complete dataset consists of 7,459 residential transactions, a number of these transactions (n = 2,522) occurred before the wind facility was constructed. Should these homes which, at the time of sale, would not have had any view of or distance to the wind facility, be included? Two approaches could be applied to address this issue. First, pre-construction transactions could be included in the hedonic model either as part of the reference category within which no wind-project property value impacts are assumed to exist, or instead by specifically identifying these pre-construction transactions through an indicator variable. Second, and alternatively, pre-construction transactions could simply be excluded from the analysis altogether.

For the purpose of the Base Model, the latter approach is used, therefore relying on only the post-construction subset of 4,937 residential transactions. This approach, as compared to the others, results in somewhat more intuitive findings because all homes have a distance greater than zero and have a possibility of some view of the turbines. More importantly, this approach minimizes the chance of inaccuracies that may otherwise exist due to inflation adjustment concerns or outdated home characteristics information.[50] Nonetheless, to test for the implications of this choice of datasets, alternative hedonic models that use the full dataset were estimated, and are discussed in detail in Sections 5.3 and 5.4.

[50] Home characteristics were obtained as of the last property assessment. The timing of that assessment relative to the timing of the home sale transaction dictates how representative the assessed home characteristics are of the subject home when it was sold. For example, if a home sold early in the study period but subsequently had significant improvements made that are reflected in the current assessment data used in the analysis, the model would assign value to these home characteristics at the time of sale when, in fact, those characteristics were inaccurate. Additionally, the inflation adjustment index used in this analysis to translate home values to real 1996 dollars came from the nearest or more appropriate municipal statistical area (MSA). Many of the wind projects in the analysis are located in relatively rural parts of the country, and the housing market in the nearest metropolitan area could be different than the market surrounding wind projects. Although these areas have – in many instances – recently begun to attract home buyers willing to commute back to the metropolitan areas on which the index is based, the older index adjustments are likely less accurate than the more recent adjustments. Using a subset of the data for the majority of the analyses that removes the older, pre-construction, homes minimizes both of these biases.

4.2. Model Form

A standard semi-log functional form is used for the hedonic models (as was discussed in Section 2.1), where the dependent variable (sales price in inflation-adjusted 1996 dollars) is transformed to its natural log form and the independent variables (e.g., square feet and acres) are not transformed. Using this form to examine the effect that views of, and distance to, wind facilities have on sales prices, the following basic model is estimated:

$$\ln(\mathrm{P}) = \beta_0 + \beta_1 \mathrm{N} + \sum_{\mathrm{s}} \beta_2 \mathrm{S} + \sum_{\mathrm{k}} \beta_3 \mathrm{X} + \sum_{\mathrm{v}} \beta_4 \mathrm{VIEW} + \sum_{\mathrm{d}} \beta_5 \mathrm{DISTANCE} + \varepsilon \qquad (1)$$

where
P represents the inflation-adjusted sales price,
N is the spatially weighted neighbors' predicted sales price,
S is the vector of *s* Study Area fixed effects variables (e.g., WAOR, OKCC, etc.),
X is a vector of *k* home and site characteristics (e.g., acres, square feet, number of bathrooms, condition of the home, age of home, VISTA, etc.),
VIEW is a vector of *v* categorical view of turbine variables (e.g., MINOR, MODERATE, etc.),
DISTANCE is a vector of *d* categorical distance to turbine variables (e.g., less than 3000 feet, between one and three miles, etc.),
β_0 is the constant or intercept across the full sample,
β_1 is a parameter estimate for the spatially weighted neighbor's predicted sales price,
β_2 is a vector of *s* parameter estimates for the study area fixed effects as compared to homes sold in the Washington/Oregon (WAOR) study area,
β_3 is a vector of *k* parameter estimates for the home and site characteristics,
β_4 is a vector of *v* parameter estimates for the VIEW variables as compared to homes sold with no view of the turbines,
β_5 is a vector of *d* parameter estimates for the DISTANCE variables as compared to homes sold situated outside of five miles, and
ε is a random disturbance term.

As such, this model, and all subsequent hedonic models, has four primary groups of parameters: variables of interest, spatial adjustments, study-area fixed effects, and home and site characteristics.

The variables of interest, VIEW and DISTANCE, are the focus of this study, and allow the investigation of the presence of Area, Scenic Vista, and Nuisance Stigmas. These variables were defined in Section 3, and are summarized in Table 8. Both VIEW and DISTANCE appear in the model together because a home's value may be affected in part by the magnitude of the view of the wind turbines, and in part by the distance from the home to those turbines, and both variables appear in the Base Model as ordered categorical values. The coefficients associated with these two vectors of variables (β_4 and β_5) represent the marginal impact of views of, and distances to, wind turbines on sales prices, as compared to a "reference" category of residential transactions, and should be ordered monotonically from low to high.[51] This form of variable was used to

[51] "Reference category" refers to the subset of the sample to which other observations are compared, and is pertinent when using categorical or "fixed effect" variables.

impose the least structure on the underlying data.[52] For the purpose of the Base Model, the reference category for the DISTANCE variables are those transactions of homes that were situated outside of five miles from the nearest wind turbine. The reference category for the VIEW variables are those transactions of homes that did not have a view of the wind facility upon sale. Among the post-construction sample of homes, these reference homes are considered the least likely to be affected by the presence of the wind facilities.[53]

Table 8: List of Variables of Interest Included in the Base Model

Variable Name	Description	Type	Expected Sign
View_None	If the home sold after construction began and had no view of the turbines (Yes = 1, No = 0)	Reference	n/a
View_Minor	If the home sold after construction began and had a Minor View of the turbines (Yes = 1, No = 0)	OC	-
View_Mod	If the home sold after construction began and had a Moderate View of the turbines (Yes = 1, No = 0)	OC	-
View_Sub	If the home sold after construction began and had a Substantial View of the turbines (Yes = 1, No = 0)	OC	-
View_Extrm	If the home sold after construction began and had an Extreme View of the turbines (Yes = 1, No = 0)	OC	-
Mile_Less_0.57	If the home sold after facility "construction" and was within 0.57 miles (3000 feet) of the turbines (Yes = 1, No = 0)	OC	-
Mile_0.57to1	If the home sold after facility "construction" and was between 0.57 miles (3000 feet) and 1 mile of the turbines (Yes = 1, No = 0)	OC	-
Mile_1to3	If the home sold after facility "construction" and was between 1 and 3 miles of the turbines (Yes = 1, No = 0)	OC	-
Mile_3to5	If the home sold after facility "construction" and was between 3 and 5 miles of the turbines (Yes = 1, No = 0)	OC	-
Mile_Gtr5	If the home sold after facility "construction" and was outside 5 miles of the turbines (Yes = 1, No = 0)	Reference	n/a

"OC" Ordered Categorical (1 = yes, 0 = no) values are interpreted in relation to the reference categorical case and are expected to have a monotonic order from low to high.

The three stigmas are investigated though these VIEW and DISTANCE variables. Scenic Vista Stigma is investigated through the VIEW variables. Area and Nuisance Stigmas, on the other hand, are investigated through the DISTANCE variables. To distinguish between Area and

[52] In place of the ordered categorical DISTANCE variables, practitioners often rely on a continuous DISTANCE form (e.g., Sims et al., 2008). Similar to ordered categorical variables, continuous variables have a natural ordering, either ascending or descending, but, unlike categorical variables, these "continuous" values are on a scale. Therefore, given any two of its values X_1 and X_2 and a specific functional form, the ratio "X_1/X_2" and the distance "$X_1 - X_2$" have a fixed meaning. Examples of continuous variables other than DISTANCE that are commonly used include the number of square feet of living area (in 1000s) in a home (SQFT_1000) or the acres in the parcel (ACRES). A continuous functional form of this nature "imposes structure" because practitioners must decide how price is related to the underlying variables through the selection of a specific functional relationship between the two. For instance, in the case of DISTANCE, is there a linear relationship (which would imply a similar marginal difference between two distances both near and far from the turbines), does it decay slowly as distance grows, or does it fade completely at some fixed distance? Because of the lack of literature in this area, no *a priori* expectations for which functional form is the best were established, and therefore unstructured categorical variables are used in the Base Model. Nonetheless, a continuous DISTANCE form is explored in Section 5.2.

[53] It is worth noting that these reference homes are situated in both rural and urban locales and therefore are not uniquely affected by influences from either setting. This further reinforces their worthiness as a reference category.

Nuisance Stigma, it is assumed that Nuisance effects are concentrated within one mile of the nearest wind turbine, while Area effects will be considered for those transactions outside of one mile. Any property value effects discovered outside of one mile and based on the DISTANCE variables are therefore assumed to indicate the presence of Area Stigma, while impacts within a mile may reflect the combination of Nuisance and Area Stigma.

The second set of variables in the Base Model - spatial adjustments - correct for the assumed presence of spatial autocorrelation in the error term (ε). It is well known that the sales price of a home can be systematically influenced by the sales prices of those homes that have sold nearby. Both the seller and the buyer use information from comparable surrounding sales to inform them of the appropriate transaction price, and nearby homes often experience similar amenities and disamenities. This lack of independence of home sale prices could bias hedonic regression results and, to help correct for this bias, a spatially (i.e., distance) weighted neighbors' sales price (N) is included in the model. Empirically, the neighbors' price has been found to be a strong (and sometimes even the strongest) predictor of home values (Leonard and Murdoch, forthcoming), and the coefficient β_1 is expected to be positive, indicating a positive correlation between the neighbors' and subject home's sales price. A more-detailed discussion of the importance of this variable, and how it was created, is contained in Appendix G.

The third group of variables in the Base Model - study area fixed effects - control for study area influences and the differences between them. The vector's parameters β_2 represent the marginal impact of being in any one of the study areas, as compared to a reference category. In this case, the reference category is the Washington/Oregon (WAOR) study area.[54] The estimated coefficients for this group of variables represent the combined effects of school districts, tax rates, crime, and other locational influences across an entire study area. Although this approach greatly simplifies the estimation of the model, because of the myriad of influences captured by these study-area fixed effects variables, interpreting the coefficient can be difficult. In general, though, the coefficients simply represent the mean difference in sales prices between the study areas and the reference study area (WAOR). These coefficients are expected to be strongly influential, indicating significant differences in sales prices across study areas.

The fourth group of variables in the Base Model are the core home and site characteristics (X), and include a range of continuous ("C"),[55] discrete ("D"),[56] binary ("B"),[57] and ordered categorical ("OC") variables. The specific home and site variables included in the Base Model are listed in Table 9 along with the direction of expected influence.[58] Variables included are age

[54] Because there is no intent to focus on the coefficients of the study area fixed effect variables, the reference case is arbitrary. Further, the results for the other variables in the model are completely independent of this choice.

[55] See discussion in footnote 52 on previous page.

[56] Discrete variables, similar to continuous variables, are ordered and the distance between the values, such as X_1 and X_2, have meaning, but for these variables, there are only a relatively small number of discrete values that the variable can take, for example, the number of bathrooms in a home (BATHROOMS).

[57] Binary variables have only two conditions: "on" or "off" (i.e., "1" or "0" respectively). Examples are whether the home has central air conditioning ("CENTRAL_AC") or if the home is situated on a cul-de-sac ("CUL_DE_SAC"). The coefficients for these variables are interpreted in relation to when the condition is "off."

[58] For those variables with a "+" sign it is expected that as the variable increases in value (or is valued at "1" as would be the case for fixed effects variables) the price of the home will increase, and the converse is true for the variables with a "-" sign. The expected signs of the variables all follow conventional wisdom (as discussed in

of the home, home and lot size, number of bathrooms and fireplaces, the condition of the home, the quality of the scenic vista from the home, if the home has central AC, a stone exterior, and/or a finished basement, and whether the home is located in a cul-de-sac and/or on a water way.[59]

Table 9: List of Home and Site Characteristics Included in the Base Model

Variable Name	Description	Type	Expected Sign
AgeatSale	The age of the home at the time of sale in years	C	-
AgeatSale_Sqrd	The age of the home at the time of sale squared	C	+
Sqft_1000	The number of square feet of above grade finished living area (in 1000s)	C	+
Acres	The number of Acres sold with the residence	C	+
Baths	The number of Bathrooms (Full Bath = 1, Half Bath = 0.5)	D	+
ExtWalls_Stone	If the home has exterior walls of stone, brick or stucco (Yes = 1, No = 0)	B	+
CentralAC	If the home has a Central AC unit (Yes = 1, No = 0)	B	+
Fireplace	The number of fireplace openings	D	+
Cul_De_Sac	If the home is situated on a cul-de-sac (Yes = 1, No = 0)	B	+
FinBsmt	If finished basement sqft > 50% times first floor sqft (Yes = 1, No = 0)	B	+
Water_Front	If the home shares a property line with a body of water or river (Yes = 1, No = 0)	B	+
Cnd_Low	If the condition of the home is Poor (Yes = 1, No = 0)	OC	-
Cnd_BAvg	If the condition of the home is Below Average (Yes = 1, No = 0)	OC	-
Cnd_Avg	If the condition of the home is Average (Yes = 1, No = 0)	Reference	n/a
Cnd_AAvg	If the condition of the home is Above Average (Yes = 1, No = 0)	OC	+
Cnd_High	If the condition of the home is High (Yes = 1, No = 0)	OC	+
Vista_Poor	If the Scenic Vista from the home is Poor (Yes = 1, No = 0)	OC	-
Vista_BAvg	If the Scenic Vista from the home is Below Average (Yes = 1, No = 0)	OC	-
Vista_Avg	If the Scenic Vista from the home is Average (Yes = 1, No = 0)	Reference	n/a
Vista_AAvg	If the Scenic Vista from the home is Above Average (Yes = 1, No = 0)	OC	+
Vista_Prem	If the Scenic Vista from the home is Premium (Yes = 1, No = 0)	OC	+

"C" Continuous, "D" Discrete, and "B" Binary (1 = yes, 0 = no) values are interpreted in relation to "No"

"OC" Ordered Categorical (1 = yes, 0 = no) values are interpreted in relation to the reference categorical case and are expected to have a monotonic order from low to high.

Sirmans et al., 2005a), save AgeatSale and AgeatSale_Sqrd, which are expected to be negative and positive, respectively. The magnitude of the coefficient of AgeatSale is expected to be larger than that of AgeatSale_Sqrd indicating an initial drop in value as a home increases in age, and then an increase in value as the home becomes considerably older and more "historic."

[59] Some characteristics, such as whether the home had a deck, a pool, or is located on a public sewer, are not available consistently across the dataset and therefore are not incorporated into the model. Other characteristics, such as the number of bedrooms, the number of stories, or if the home had a garage, are available but are omitted from the final model because they are highly correlated with characteristics already included in the model and therefore do not add significantly to the model's explanatory power. More importantly, and as discussed in Appendix G, when their inclusion or exclusion are tested, the results are stable with those derived from the Base Model.

It should be emphasized that in the Base Hedonic Model - equation (1) - and in all subsequent models presented in Section 5, all variables of interest, spatial adjustments, and home and site characteristics are pooled, and therefore their estimates represent the average across all study areas. Ideally, one would have enough data to estimate a model at the study area level - a fully unrestricted model - rather than pooled across all areas. This fully unrestricted model form, along with 15 other model forms (with some variables restricted and others not), are discussed in detail in Appendix F. In total, these 16 different models were estimated to explore which model was the most parsimonious (had the fewest parameters), performed the best (e.g., had the highest adjusted R^2 and the lowest Schwarz information criterion[60]), and had the most stable coefficients and standard errors. The basic pooled model described by equation (1) is found to fit that description, and that model is therefore chosen as the Base Model to which others are compared. By making this choice the effort concentrates on identifying the presence of potential property value impacts across all of the study areas in the sample as opposed to any single study area.[61]

Finally, to assure that the model produces the best linear unbiased parameter estimates, the underlying assumptions of Ordinary Least Squares (OLS) regression techniques must be verified:

1) Homoskedastic error term;
2) Absence of temporal serial correlation;
3) Reasonably limited multicollinearity; and
4) Appropriate controls for outliers and influencers.[62]

These assumptions, and the specific approaches that are used to address them, are discussed in detail in Appendix G.

4.3. Analysis of Results

Table 10 (on page 32) presents the results of the Base Model (equation 1).[63] The model performs well, with an adjusted R^2 of 0.77.[64] The spatial adjustment coefficient (β_1) of 0.29 (*p* value 0.00) indicates that a 10% increase in the spatially weighted neighbor's price increases the subject home's value by an average of 2.9%. The study-area fixed effects (β_2) variables are all significant at the one percent level, demonstrating important differences in home valuations

[60] The Schwarz information criterion measures relative parsimony between similar models (Schwarz, 1978).

[61] Because effects might vary between study areas, and the models estimate an average across all study areas, the full range of effects in individual study areas will go undetermined. That notwithstanding, there is no reason to suspect that effects will be completely "washed out." For that to occur, an effect in one study area would have to be positive while in another area it would have to be negative, and there is no reason to suspect that sales prices would increase because of the turbines in one community while decreasing in other communities.

[62] The absence of spatial autocorrelation is often included in the group of assumptions, but because it was discussed above (and in Appendix G), and is addressed directly by the variable (N_i) included in the model, it is not included in this list.

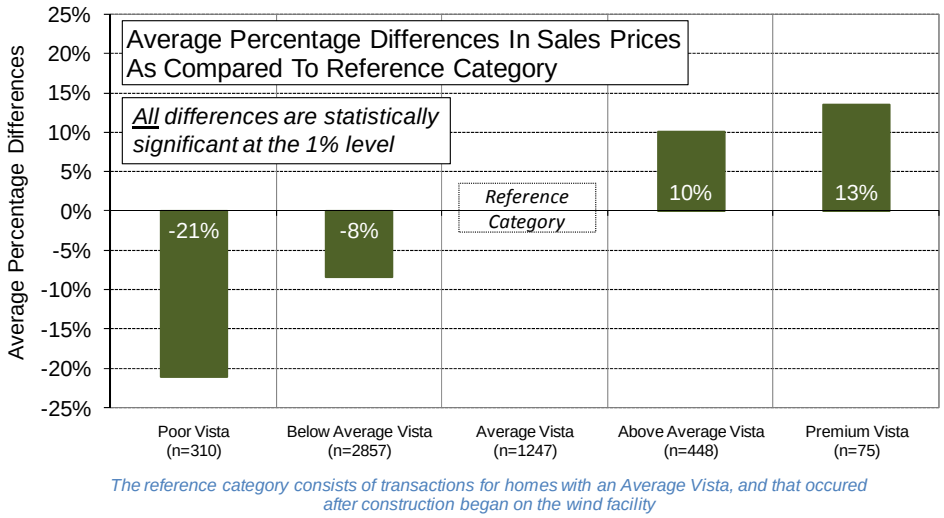
[63] This model and all subsequent models were estimated using the PROC REG procedure of SAS Version 9.2 TS1M0, which produces White's corrected standard errors.

[64] The appropriateness of the R^2 of 0.77 for this research is validated by the extensive hedonic literature that precedes it (see e.g., Kroll and Priestley, 1992; Boyle and Kiel, 2001; Simons, 2006b).

between the reference study area (WAOR) and the other nine study areas.[65] The sign and magnitudes of the home and site characteristics are all appropriate given the *a priori* expectations, and all are statistically significant at the one percent level.[66]

Of particular interest are the coefficient estimates for scenic vista (VISTA) as shown in Figure 5. Homes with a POOR vista rating are found, on average, to sell for 21% less (*p* value 0.00) than homes with an AVERAGE rating, while BELOW AVERAGE homes sell for 8% less (*p* value 0.00). Conversely, homes with an ABOVE AVERAGE vista are found to sell for 10% more (*p* value 0.00) than homes with an AVERAGE vista, while PREMIUM vista homes sell for 13% more than AVERAGE homes (*p* value 0.00). Based on these results, it is evident that home buyers and sellers capitalize the quality of the scenic vista in sales prices.[67]

Figure 5: Results from the Base Model for VISTA



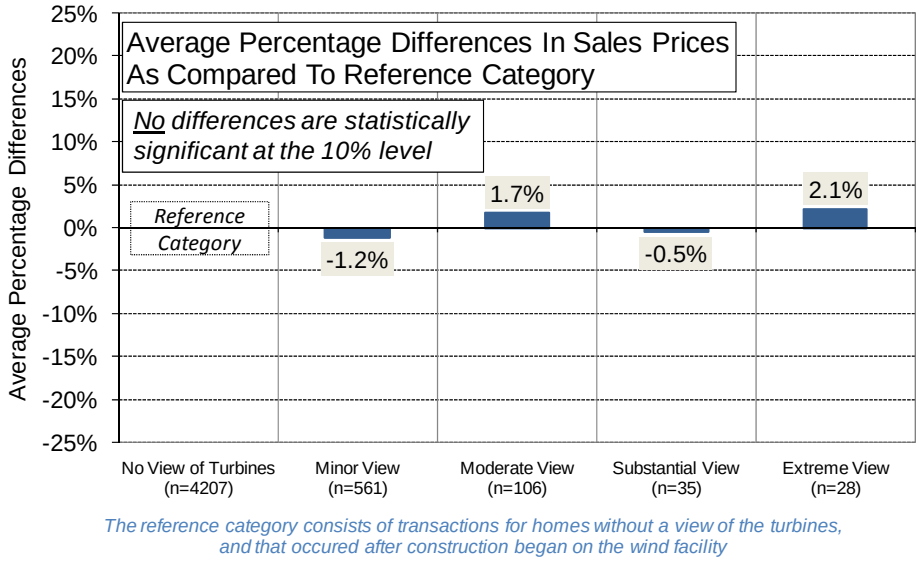
[65] The reference category WAOR study area has the highest mean and median house values in the sample (as shown in Appendix A) so the negative coefficients for all the study area fixed effect variables are appropriate.

[66] To benchmark the results against those of other practitioners the research by Sirmans et al. (2005a; 2005b) was consulted. They conducted a meta-analysis of 64 hedonic studies carried out in multiple locations in the U.S. during multiple time periods, and investigated the coefficients of ten commonly used characteristics, seven of which were included in the model. The similarities between their mean coefficients (i.e., the average across all 64 studies) and those estimated in the present Base Model are striking. The analysis presented here estimates the effect of square feet (in 1000s) on log of sales price at 0.28 and Sirmans et al. provide an estimate of 0.34, while ACRES was similarly estimated (0.02 to 0.03, Base Model and Sirmans et al., respectively). Further, AGEATSALE (age at the time of sale) (-0.006 to -0.009), BATHROOMS (0.09 to 0.09), CENTRALAC (0.09 to 0.08), and FIREPLACE (0.11 to 0.09) all similarly compare. As a group, the Base Model estimates differ from Sirmans et al. estimates in all cases by no more than a third of the Sirmans et al. mean estimate's standard deviation. This, taken with the relatively high adjusted R^2 of the Base Model, demonstrates the appropriateness of the model's specification.

[67] To benchmark these results they are compared to the few studies that have investigated the contribution of inland scenic vistas to sales prices. Benson et al. (2000) find that a mountain vista increases sales price by 8%, while Bourassa et al. (2004) find that wide inland vistas increase sales price by 7.6%. These both compare favorably to the 10% and 14% above average and premium rated VISTA estimates. Comparable studies for below average and poor VISTA were not found and therefore no benchmarking of those coefficients is conducted. Finally, it should again be noted that a home's scenic vista, as discussed in Section 3.2.3, was ranked without taking the presence of the wind turbines into consideration, even if those turbines were visible at the time of home sale.

Despite this finding for scenic vista, however, no statistically significant relationship is found between views of wind turbines and sales prices.[68] The coefficients for the VIEW parameters (β_4) are all relatively small, none are statistically significant, and they are not monotonically ordered (see Figure 6). Homes with EXTREME or SUBSTANTIAL view ratings, for which the Base Model is expected to find the largest differences, sell for, on average, 2.1% more (*p* value 0.80) and 0.5% less (*p* value 0.94) than NO VIEW homes that sold in the same post-construction period. Similarly, homes with MODERATE or MINOR view ratings sell, on average, for 1.7% more (*p* value 0.58) and 1.2% less (*p* value 0.40) than NO VIEW homes, respectively. None of these coefficients are sizable, and none are statistically different from zero. These results indicate that, among this sample at least, a statistically significant relationship between views of wind turbines and residential property values is not evident. In other words, there is an absence of evidence of a Scenic Vista Stigma in the Base Model.

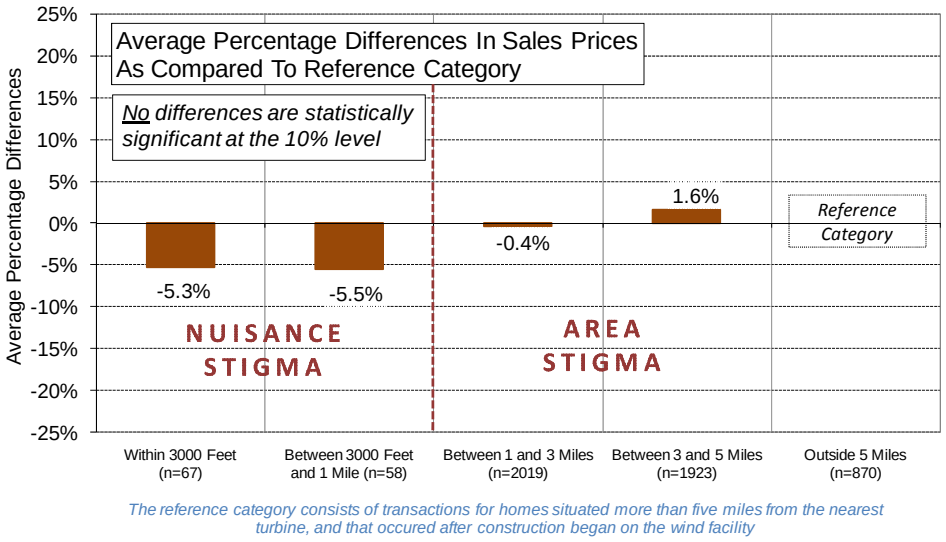
Figure 6: Results from the Base Model for VIEW



The coefficients for the DISTANCE parameters (β_5) are also all relatively small and none are statistically significant (see Figure 7). Homes that are situated within 3000 feet (0.57 miles) of the nearest wind turbine, at the time of sale, are found to sell for 5.3% less (*p* value 0.40), on average, than homes outside of 5 miles that sold in the same "post-construction" period. Meanwhile, homes between 3000 feet and 1 mile sold for 5.5% less (*p* value 0.30), on average, than homes more than 5 miles away. Homes that are within 1 to 3 miles of the nearest turbine, as compared to homes outside of 5 miles, sold for essentially the same, on average (coefficient = 0.004, *p* value 0.80), while homes between 3 and 5 miles sold for 1.6% more (*p* value 0.23).

[68] A significance level of 10% is used throughout this report, which corresponds to a *p*-value at or above 0.10. Although this is more liberal than the often used 5% (*p*-value at or above 0.05), it was chosen to give more opportunities for effects that might be fairly weak to be considered significant.

Figure 7: Results from the Base Model for DISTANCE



Looking at these results as a whole, a somewhat monotonic order from low to high is found as homes are situated further away from wind facilities, but all of the coefficients are relatively small and none are statistically different from zero. This suggests that, for homes in the sample at least, there is a lack of statistical evidence that the distance from a home to the nearest wind turbine impacts sales prices, and this is true regardless of the distance band.[69] As such, an absence of evidence of an Area or Nuisance Stigma is found in the Base Model. That notwithstanding, the -5% coefficients for homes that sold within one mile of the nearest wind turbine require further scrutiny. Even though the differences are not found to be statistically significant, they might point to effects that exist but are too small for the model to deem statistically significant due to the relatively small number of homes in the sample within 1 mile of the nearest turbine. Alternatively, these homes may simply have been devalued even before the wind facility was erected, and that devaluation may have carried over into the post construction period (the period investigated by the Base Model). To explore these possibilities, transactions that occurred well before the announcement of the wind facility to well after construction are investigated in the Temporal Aspects Model in the following "Alternative Models" section.

[69] It is worth noting that the number of cases in each of these categories (e.g., n = 67 for homes inside of 3000 feet and n = 58 between 3000 feet and one mile) are small, but are similar to the numbers of cases for other variables in the same model (e.g., LOW CONDITION, n = 69; PREMIUM VISTA, n = 75), the estimates of which were found to be significant above the 1% level.

Table 10: Results from the Base Model

	Coef.	SE	p Value	*n*
Intercept	7.62	0.18	0.00	
Nbr_LN_SalePrice96_hat	0.29	0.02	0.00	4,937
AgeatSale	-0.006	0.0004	0.00	4,937
AgeatSale_Sqrd	0.00002	0.000003	0.00	4,937
Sqft_1000	0.28	0.01	0.00	4,937
Acres	0.02	0.00	0.00	4,937
Baths	0.09	0.01	0.00	4,937
ExtWalls_Stone	0.21	0.02	0.00	1,486
CentralAC	0.09	0.01	0.00	2,575
Fireplace	0.11	0.01	0.00	1,834
FinBsmt	0.08	0.02	0.00	673
Cul_De_Sac	0.10	0.01	0.00	992
Water_Front	0.33	0.04	0.00	87
Cnd_Low	-0.45	0.05	0.00	69
Cnd_BAvg	-0.24	0.02	0.00	350
Cnd_Avg	Omitted	Omitted	Omitted	2,727
Cnd_AAvg	0.14	0.01	0.00	1,445
Cnd_High	0.23	0.02	0.00	337
Vista_Poor	-0.21	0.02	0.00	310
Vista_BAvg	-0.08	0.01	0.00	2,857
Vista_Avg	Omitted	Omitted	Omitted	1,247
Vista_AAvg	0.10	0.02	0.00	448
Vista_Prem	0.13	0.04	0.00	75
WAOR	Omitted	Omitted	Omitted	519
TXHC	-0.75	0.03	0.00	1,071
OKCC	-0.44	0.02	0.00	476
IABV	-0.24	0.02	0.00	605
ILLC	-0.09	0.03	0.00	213
WIKCDC	-0.14	0.02	0.00	725
PASC	-0.31	0.03	0.00	291
PAWC	-0.07	0.03	0.01	222
NYMCOC	-0.20	0.03	0.00	346
NYMC	-0.15	0.02	0.00	469
Post_Con_NoView	Omitted	Omitted	Omitted	4,207
View_Minor	-0.01	0.01	0.40	561
View_Mod	0.02	0.03	0.58	106
View_Sub	-0.01	0.07	0.94	35
View_Extrm	0.02	0.09	0.80	28
Mile_Less_0_57	-0.05	0.06	0.40	67
Mile_0_57to1	-0.05	0.05	0.30	58
Mile_1to3	0.00	0.02	0.80	2,019
Mile_3to5	0.02	0.01	0.23	1,923
Mile_Gtr5	Omitted	Omitted	Omitted	870

"Omitted" = reference category for fixed effects variables
"n" indicates number of cases in category when category = "1"

Model Information

Model Equation Number	**1**
Dependent Variable	**LN_SalePrice96**
Number of Cases	**4937**
Number of Predictors (k)	**37**
F Statistic	**442.8**
Adjusted R Squared	**0.77**

5. Alternative Hedonic Models

The Base Hedonic Model presented in Section 4 found that residential property values have, on average, not been measurably affected by the presence of nearby wind facilities. To test the robustness of this result and to test for other possible impacts from nearby wind projects, the report now turns to a number of other hedonic models. These Alternative Models were created to investigate different approaches to exploring the impact of the variables of interest (#1 and #2, below) and to assess the presence of impacts that are not otherwise fully captured by the Base Model (#3 through #6, below).

1) **View and Distance Stability Models:** Using only post-construction transactions (the same as the Base Model) these models investigate whether the Scenic Vista Stigma (as measured with VIEW) results are independent of the Nuisance and Area Stigma results (as measured by DISTANCE) and vice versa.[70]
2) **Continuous Distance Model:** Using only post-construction transactions, this model investigates Area and Nuisance Stigmas by applying a continuous distance parameter as opposed to the categorical variables for distance used in the previous models.
3) **All Sales Model:** Using all transactions, this model investigates whether the results for the three stigmas change if transactions that occurred before the announcement and construction of the wind facility are included in the sample.
4) **Temporal Aspects Model:** Using all transactions, this model further investigates Area and Nuisance Stigmas and how they change for homes that sold more than two years pre-announcement through the period more than four years post-construction.
5) **Home Orientation Model:** Using only post-construction transactions, this model investigates the degree to which a home's orientation to the view of wind turbines affects sales prices.
6) **View and Vista Overlap Model:** Using only post-construction transactions, this model investigates the degree to which the overlap between the view of a wind facility and a home's primary scenic vista affects sales prices.

Each of these models is described in more depth in the pages that follow. Results are shown for the variables of interest only; full results are contained in Appendix H.

5.1. View and Distance Stability Models

The Base Model (equation 1) presented in Section 4 includes both DISTANCE and VIEW variables because a home's value might be affected in part by the magnitude of the view of a nearby wind facility and in part by the distance from the home to that facility. These two variables may be related, however, in-so-far as homes that are located closer to a wind facility are likely to have a more-dominating view of that facility. To explore the degree to which these two sets of variables are independent of each other (i.e. not collinear) and to further test the robustness of the Base Model results two alternative hedonic models are run, each of which includes only one of the sets of parameters (DISTANCE or VIEW). Coefficients from these models are then compared to the Base Model results.

[70] Recall that the qualitative VIEW variable incorporated the visible distance to the nearest wind facility.

5.1.1. Dataset and Model Form

The same dataset is used as in the Base Model, focusing again on post-construction transactions (n = 4,937). To investigate DISTANCE effects alone the following model is estimated:

$$\ln(\mathrm{P}) = \beta_0 + \beta_1 \mathrm{N} + \sum_{\mathrm{s}} \beta_2 \mathrm{S} + \sum_{\mathrm{k}} \beta_3 \mathrm{X} + \sum_{\mathrm{d}} \beta_5 \mathrm{DISTANCE} + \varepsilon \tag{2}$$

where
P represents the inflation-adjusted sales price,
N is the spatially weighted neighbors' predicted sales price,
S is the vector of *s* Study Area fixed effects variables (e.g., WAOR, OKCC, etc.),
X is a vector of *k* home and site characteristics (e.g., acres, square feet, number of bathrooms, condition of the home, age of home, VISTA, etc.),
DISTANCE is a vector of *d* categorical distance variables (e.g., less than 3000 feet, between one and three miles, etc.),
β_0 is the constant or intercept across the full sample,
β_1 is a parameter estimate for the spatially weighted neighbor's predicted sales price,
β_2 is a vector of *s* parameter estimates for the study area fixed effects as compared to transactions of homes in the WAOR study area,
β_3 is a vector of *k* parameter estimates for the home and site characteristics,
β_5 is a vector of *d* parameter estimates for the DISTANCE variables as compared to transactions of homes situated outside of five miles, and
ε is a random disturbance term.

The parameters of primary interest are β_5, which represent the marginal differences between home values at various distances from the wind turbines as compared to the reference category of homes outside of five miles. These coefficients can then be compared to the same coefficients estimated from the Base Model.

Alternatively, to investigate the VIEW effects alone, the following model is estimated:

$$\ln(\mathrm{P}) = \beta_0 + \beta_1 \mathrm{N} + \sum_{\mathrm{s}} \beta_2 \mathrm{S} + \sum_{\mathrm{k}} \beta_3 \mathrm{X} + \sum_{\mathrm{v}} \beta_4 \mathrm{VIEW} + \varepsilon \tag{3}$$

where
VIEW is a vector of *v* categorical view variables (e.g., MINOR, MODERATE, etc.),
β_4 is a vector of *v* parameter estimates for the VIEW variables, and
all other components are as defined in equation (2).

The parameters of primary interest in this model are β_4, which represent the marginal differences between home values for homes with varying views of wind turbines at the time of sale as compared to the reference category of homes without a view of those turbines. Again, these coefficients can then be compared to the same coefficients estimated from the Base Model.

Our expectation for both of the models described here is that the results will not be dramatically different from the Base Model, given the distribution of VIEW values across the DISTANCE values, and vice versa, as shown in Table 11. Except for EXTREME view, which is

concentrated inside of 3000 feet, all view ratings are adequately distributed among the distance categories.

Table 11: Frequency Crosstab of VIEW and DISTANCE Parameters

	Inside 3000 Feet	Between 3000 Feet and 1 Mile	Between 1 and 3 Miles	Between 3 and 5 Miles	Outside 5 Miles	Total
No View	6	12	1653	1695	841	**4207**
Minor View	14	24	294	202	27	**561**
Moderate View	8	13	62	21	2	**106**
Substantial View	11	9	10	5	0	**35**
Extreme View	28	0	0	0	0	**28**
TOTAL	**67**	**58**	**2019**	**1923**	**870**	**4937**

5.1.2. Analysis of Results

Summarized results for the variables of interest from the Base Model and the two Alternative Stability Models are presented in Table 12. (For brevity, the full set of results for the models is not shown in Table 12, but is instead included in Appendix H.) The adjusted R^2 for the View and Distance Stability Models is the same as for the Base Model, 0.77. All study area, spatial adjustment, and home and site characteristics are significant at or above the one percent level and are similar in magnitude to the estimates presented earlier for the Base Model.

The DISTANCE and VIEW coefficients, β_5 and β_4, are stable, changing no more than 3%, with most (7 out of 8) not experiencing a change greater than 1%. In all cases, changes to coefficient estimates for the variables of interest are considerably less than the standard errors. Based on these results, there is confidence that the correlation between the VIEW and DISTANCE variables is not responsible for the findings and that these two variables are adequately independent to be included in the same hedonic model regression. As importantly, no evidence of Area, Scenic Vista, or Nuisance Stigma is found in the sample, as none of the VIEW or DISTANCE variables are found to be statistically different from zero.

Table 12: Results from Distance and View Stability Models

		Base Model			Distance Stability			View Stability		
Variables of Interest	***n***	**Coef**	**SE**	**p Value**	**Coef**	**SE**	**p Value**	**Coef**	**SE**	**p Value**
No View	4207	Omitted	Omitted	Omitted				Omitted	Omitted	Omitted
Minor View	561	-0.01	0.01	0.39				-0.02	0.01	0.24
Moderate View	106	0.02	0.03	0.57				0.00	0.03	0.90
Substantial View	35	-0.01	0.07	0.92				-0.04	0.06	0.45
Extreme View	28	0.02	0.09	0.77				-0.03	0.06	0.58
Inside 3000 Feet	67	-0.05	0.06	0.31	-0.04	0.04	0.25			
Between 3000 Feet and 1 Mile	58	-0.05	0.05	0.20	-0.06	0.05	0.17			
Between 1 and 3 Miles	2019	0.00	0.02	0.80	-0.01	0.02	0.71			
Between 3 and 5 Miles	1923	0.02	0.01	0.26	0.01	0.01	0.30			
Outside 5 Miles	870	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted			

"Omitted" = reference category for fixed effects variables. "n" indicates number of cases in category when category = "1"

Model Information

Model Equation Number	**1**	**2**	**3**
Dependent Variable	**LN_SalePrice96**	**LN_SalePrice96**	**LN_SalePrice96**
Number of Cases	**4937**	**4937**	**4937**
Number of Predictors (k)	**37**	**33**	**33**
F Statistic	**442.8**	**496.7**	**495.9**
Adjusted R Squared	**0.77**	**0.77**	**0.77**

5.2. Continuous Distance Model

The potential impact of wind facilities on residential property values based on Area and Nuisance effects was explored with the Base Model by using five ordered categorical DISTANCE variables. This approach was used in order to impose the least restriction on the functional relationship between distance and property values (as discussed in footnote 52 on page 25). The literature on environmental disamenities, however, more commonly uses a continuous distance form (e.g., Sims et al., 2008), which imposes more structure on this relationship. To be consistent with the literature and to test if a more rigid structural relationship might uncover an effect that is not otherwise apparent with the five distance categories used in the Base Model, a hedonic model that relies upon a continuous distance variable is presented here. One important benefit of this model is that a larger amount of data (e.g., n = 4,937) is used to estimate the continuous DISTANCE coefficient then was used to estimate any of the individual categorical estimates in the Base Model (e.g., n = 67 inside 3000 feet, n = 2019 between one and three miles). The Continuous Distance Model therefore provides an important robustness test to the Base Model results.

5.2.1. Dataset and Model Form

A number of different functional forms can be used for a continuous DISTANCE variable, including linear, inverse, cubic, quadratic, and logarithmic. Of the forms that are considered, an inverse function seemed most appropriate.[71] Inverse functions are used when it is assumed that any effect is most pronounced near the disamenity and that those effects fade asymptotically as distance increases. This form has been used previously in the literature (e.g., Leonard et al., 2008) to explore the impact of disamenities on home values, and is calculated as follows:

$$\text{InvDISTANCE} = 1/\text{DISTANCE} \tag{4}$$

where
DISTANCE is the distances to the nearest turbine from each home as calculated at the time of sale for homes that sold in the post-construction period.

For the purpose of the Continuous Distance Model, the same dataset is used as in the Base Model, focusing again on post-construction transactions (n = 4,937). InvDISTANCE has a maximum of 6.67 (corresponding to homes that were 0.15 miles, or roughly 800 feet, from the nearest wind turbine), a minimum of 0.09 (corresponding to a distance of roughly 11 miles), and a mean of 0.38 (corresponding to a distance of 2.6 miles). This function was then introduced into the hedonic model in place of the DISTANCE categorical variables as follows:

$$\ln(\text{P}) = \beta_0 + \beta_1\text{N} + \sum_{\text{s}}\beta_2\text{S} + \sum_{\text{k}}\beta_3\text{X} + \sum_{\text{v}}\beta_4\text{VIEW} + \beta_5\text{InvDISTANCE} + \varepsilon \tag{5}$$

where
InvDISTANCE_i is the inverse of the distance to the nearest turbine,
β_5 is a parameter estimate for the inverse of the distance to the nearest turbine, and

[71] The other distance functions (e.g., linear, quadratic, cubic & logarithmic) were also tested. Additionally, two-part functions with interactions between continuous forms (e.g., linear) and categorical (e.g., less than one mile) were investigated. Results from these models are briefly discussed below in footnote 72.

all other components are as defined in equation (1).

The coefficient of interest in this model is β_5, which, if effects exist, would be expected to be negative, indicating an adverse effect from proximity to the wind turbines.

5.2.2. Analysis of Results

Results for the variables of interest in the Continuous Distance Model and the Base Model are shown in Table 13. (For brevity, the full set of results for the model is not shown in Table 13, but is instead included in Appendix H.) The model performs well with an adjusted R^2 of 0.77. All study area, spatial adjustment, and home and site characteristics are significant at the one percent level. The coefficients for VIEW are similar to those found in the Base Model, demonstrating stability in results, and none are statistically significant. These results support the previous findings of a lack of evidence of a Scenic Vista Stigma.

Our focus variable InvDISTANCE produces a coefficient (β_5) that is slightly negative at -1%, but that is not statistically different from zero (*p* value 0.41), implying again that there is no statistical evidence of a Nuisance Stigma effect nor an Area Stigma effect and confirming the results obtained in the Base Model.[72]

Table 13: Results from Continuous Distance Model

	Base Model				Continuous Distance			
Variables of Interest	**Coef**	**SE**	**p Value**	***n***	**Coef**	**SE**	**p Value**	***n***
No View	Omitted	Omitted	Omitted	4,207	Omitted	Omitted	Omitted	4,207
Minor View	-0.01	0.01	0.39	561	-0.01	0.01	0.32	561
Moderate View	0.02	0.03	0.57	106	0.01	0.03	0.77	106
Substantial View	-0.01	0.07	0.92	35	-0.02	0.07	0.64	35
Extreme View	0.02	0.09	0.77	28	0.01	0.10	0.85	28
Inside 3000 Feet	-0.05	0.06	0.31	67				
Between 3000 Feet and 1 Mile	-0.05	0.05	0.20	58				
Between 1 and 3 Miles	0.00	0.02	0.80	2,019				
Between 3 and 5 Miles	0.02	0.01	0.26	1,923				
Outside 5 Miles	Omitted	Omitted	Omitted	870				
InvDISTANCE					-0.01	0.02	0.41	4,937

"Omitted" = reference category for fixed effects variables. "n" = number of cases in category when category = "1"

Model Information

Model Equation Number	**1**	**5**
Dependent Variable	**LN_SalePrice96**	**LN_SalePrice96**
Number of Cases	**4937**	**4937**
Number of Predictors (k)	**37**	**34**
F Statistic	**442.8**	**481.3**
Adjusted R Squared	**0.77**	**0.77**

5.3. All Sales Model

The Base Model presented earlier relied on only those transactions that occurred after the construction of the relevant wind facility. This approach, however, leaves open two key questions. First, it is possible that the property values of all of the post-construction homes in the

[72] As mentioned in footnote 71 on page 36, a number of alternative forms of the continuous distance function were also explored, including two-part functions, with no change in the results presented here. In all cases the resulting continuous distance function was not statistically significant.

sample have been affected by the presence of a wind facility, and therefore that the reference homes in the Base Model (i.e., those homes outside of five miles with no view of a wind turbine) are an inappropriate comparison group because they too have been impacted.[73] Using only those homes that sold before the announcement of the wind facility (pre-announcement) as the reference group would, arguably, make for a better comparison because the sales price of those homes are not plausibly impacted by the presence of the wind facility.[74] Second, the Base Model does not consider homes that sold in the post-announcement but pre-construction period, and previous research suggests that property value effects might be very strong during this period, during which an assessment of actual impacts is not possible and buyers and sellers may take a more-protective and conservative stance (Wolsink, 1989). This subsection therefore presents the results of a hedonic model that uses the full set of transactions in the dataset, pre- and post-construction.

5.3.1. Dataset and Model Form

Unlike the Base Model, in this instance the full set of 7,459 residential transactions is included. The following model is then estimated:

$$\ln(\mathrm{P}) = \beta_0 + \beta_1 \mathrm{N} + \sum_{\mathrm{s}} \beta_2 \mathrm{S} + \sum_{\mathrm{k}} \beta_3 \mathrm{X} + \sum_{\mathrm{v}} \beta_4 \mathrm{VIEW} + \sum_{\mathrm{d}} \beta_5 \mathrm{DISTANCE} + \varepsilon \tag{6}$$

where
VIEW is a vector of *v* categorical view variables (e.g., NONE, MINOR, MODERATE, etc.),
DISTANCE is a vector of *d* categorical distance variables (e.g., less than 3000 feet, between one and three miles, outside of five mile, etc.),
β_4 is a vector of *v* parameter estimates for the VIEW variables as compared to pre-construction transactions,
β_5 is a vector of *d* parameter estimates for the DISTANCE variables as compared to pre-announcement transactions, and
all other components are as defined in equation (1).

It is important to emphasize that the VIEW and DISTANCE parameters in equation (6) have different reference categories than they do in the Base Model - equation (1). In the Base Model, DISTANCE and VIEW are estimated in the post-construction period in reference to homes that sold outside of five miles and with no view of the turbines respectively.[75] In the All Sales Model, on the other hand, the coefficients for VIEW (β_4) are estimated in reference to all <u>pre-construction</u> transactions (spanning the pre-announcement and post-announcement-pre-construction periods) and the coefficients for DISTANCE (β_5) are estimated in reference to all <u>pre-announcement</u> transactions. In making a distinction between the reference categories for VIEW and DISTANCE, it is assumed that awareness of the view of turbines and awareness of

[73] This might be the case if there is an Area Stigma that includes the reference homes.

[74] As discussed in footnote 47 on page 19, it is conceivable that awareness might occur prior to the "announcement" date used for this analysis. If true, this bias is likely to be sporadic in nature and less of an issue in this model, when all pre-announcement transactions are pooled (e.g., both transactions near and far away from where the turbines were eventually located) than in models presented later (e.g., temporal aspects model). Nonetheless, if present, this bias may weakly draw down the pre-announcement reference category.

[75] See Section 4.1 and also footnote 51 on page 24 for more information on why the post-construction dataset and five-mile-no-view homes reference category are used in the Base Model.

the distance from them might not occur at the same point in the development process. Specifically, it is assumed that VIEW effects largely occur after the turbines are erected, in the post-construction period, but that DISTANCE effects might occur in the post-announcement-pre-construction timeframe. For example, after a wind facility is announced, it is not atypical for a map of the expected locations of the turbines to be circulated in the community, allowing home buyers and sellers to assess the distance of the planned facility from homes. Because of this assumed difference in when awareness begins for VIEW and DISTANCE, the DISTANCE variable is populated for transactions occurring in the post-announcement-pre-construction period as well as the post-construction period (see Table 14 below), but the VIEW variable is populated only for transactions in the post-construction period – as they were in the Base Model.[76]

Table 14: Frequency Summary for DISTANCE in All Sales Model

	< 0.57 Miles	0.57 - 1 Miles	1 - 3 Miles	3 - 5 Miles	> 5 Miles	Total
Post-Construction	67	58	2019	1923	870	**4937**
Post-Announcement-Pre-Construction	13	7	340	277	130	**767**
TOTAL	**80**	**65**	**2359**	**2200**	**1000**	**5704**

One beneficial consequence of the differences in reference categories for the VIEW and DISTANCE variables in this model, as opposed to the Base Model, is that this model can accommodate all of the possible VIEW and DISTANCE categories, including NO VIEW transactions and transactions of homes outside of five miles. Because of the inclusion of these VIEW and DISTANCE categories, the tests to investigate Area, Scenic Vista, and Nuisance Stigmas are slightly different in this model than in the Base Model. For Area Stigma, for example, how homes with no view of the turbines fared can now be tested; if they are adversely affected by the presence of the wind facility, then this would imply a pervasive Area Stigma impact. For Scenic Vista Stigma, the VIEW coefficients (MINOR, MODERATE, etc.) can be compared (using a *t*-Test) to the NO VIEW results; if they are significantly different, a Scenic Vista Stigma would be an obvious culprit. Finally, for Nuisance Stigma, the DISTANCE coefficients inside of one mile can be compared (using a *t*-Test) to those outside of five miles; if there is a significant difference between these two categories of homes, then homes are likely affected by their proximity to the wind facility.

5.3.2. Analysis of Results

Results for the variables of interest for this hedonic model are summarized in Table 15, and Base Model results are shown for comparison purposes. (For brevity, the full set of results for the model is not shown in Table 15, but is instead included in Appendix H.) The adjusted R^2 for the model is 0.75, down slightly from 0.77 for the Base Model, and indicating that this model has slightly more difficulty (i.e. less explanatory power) modeling transactions that occurred pre-

[76] It is conceivable that VIEW effects could occur before the turbines are constructed. In some cases, for example, developers will simulate what the project will look like after construction during the post-announcement but pre-construction timeframe. In these situations, home buyers and sellers might adjust home values accordingly based on the expected views of turbines. It is assumed, however, that such adjustments are likely to be reasonably rare, and VIEW effects are therefore estimated using only post-construction sales.

construction.[77] All study area, spatial adjustment, and home and site characteristics are significant at or above the one percent level and are similar in sign and magnitude to the estimates derived from the post-construction Base Model.

The VIEW coefficients (β_4) are clearly affected by the change in reference category. All of the VIEW parameter estimates are higher than the Base Model estimates for the same categories. Of particular interest is the NO VIEW coefficient, which represents the values of homes without a view of the turbines and that sold in the post-construction period, as compared to the mean value of homes that sold in the pre-construction period, all else being equal. These homes, on average, are estimated to sell for 2% (*p* value 0.08) more than similar pre-construction homes. If an Area Stigma existed, a negative coefficient for these NO VIEW homes would be expected. Instead, a positive and statistically significant coefficient is found.[78] It is outside the ability of this study to determine whether the increase is directly related to the wind turbines, or whether some other factor is impacting these results, but in either instance, no evidence of a pervasive Area Stigma associated with the presence of the wind facilities is found.

To test for the possibility of Scenic Vista Stigma, the coefficients for MINOR, MODERATE, SUBSTANTIAL, and EXTREME views can be compared to the NO VIEW coefficient using a simple *t*-Test. Table 16 presents these results. As shown, no significant difference is found for any of the VIEW coefficients when compared to NO VIEW transactions. This reinforces the findings earlier that, within the sample at least, there is no evidence of a Scenic Vista Stigma.

The DISTANCE parameter estimates (β_5) are also found to be affected by the change in reference category, and all are lower than the Base Model estimates for the same categories. This result likely indicates that the inflation-adjusted mean value of homes in the pre-announcement period is slightly higher, on average, than for those homes sold outside of five miles in the post-construction period. This difference could be attributed to the inaccuracy of the inflation index, a pervasive effect from the wind turbines, or to some other cause. Because the coefficients are not systematically statistically significant, however, this result is not pursued further. What is of interest, however, is the negative 8% estimate for homes located between 3000 feet and one mile of the nearest wind turbine (*p* value 0.03). To correctly interpret this result, and to compare it to the Base Model, one needs to discern if this coefficient is significantly different from the estimate for homes located outside of five miles, using a *t*-Test.

The results of this *t*-Test are shown in Table 17. The coefficient differences are found to be somewhat monotonically ordered. Moving from homes within 3000 feet (-0.06, *p* value 0.22), and between 3000 feet and one mile (-0.08, *p* value 0.04), to between one and three miles (0.00, *p* value 0.93) and between three and five miles (0.01, *p* value 0.32) the DISTANCE coefficients are found to generally increase. Nonetheless, none of these coefficients are statistically significant except one, homes that sold between 3000 feet and one mile. The latter finding suggests the possibility of Nuisance Stigma. It is somewhat unclear why an effect would be found in this model, however, when one was not evident in the Base Model. The most likely

[77] This slight change in performance is likely due to the inaccuracies of home and site characteristics and the inflation adjustment for homes that sold in the early part of the study period. This is discussed in more detail in footnote 50 on page 23.

[78] For more on the significance level used for this report, see footnote 68 on page 30.

explanation is that the additional homes that are included in this model, specifically those homes that sold post-announcement but pre-construction, are driving the results. A thorough investigation of these "temporal" issues is provided in the next subsection.

In summation, no evidence is found of an Area or Scenic Vista Stigma in this alternative hedonic model, but some limited not-conclusive evidence of a Nuisance Stigma is detected. To further explore the reliability of this latter result, the analysis now turns to the Temporal Aspects Model.

Table 15: Results from All Sales Model

	Base Model				All Sales			
Variables of Interest	**Coef**	**SE**	**p Value**	***n***	**Coef**	**SE**	**p Value**	***n***
Pre-Construction Sales	n/a	n/a	n/a	n/a	Omitted	Omitted	Omitted	2,522
No View	Omitted	Omitted	Omitted	4,207	0.02	0.01	0.08	4,207
Minor View	-0.01	0.01	0.39	561	0.00	0.02	0.77	561
Moderate View	0.02	0.03	0.57	106	0.03	0.03	0.41	106
Substantial View	-0.01	0.07	0.92	35	0.03	0.07	0.53	35
Extreme View	0.02	0.09	0.77	28	0.06	0.08	0.38	28
Inside 3000 Feet	-0.05	0.06	0.31	67	-0.06	0.05	0.18	80
Between 3000 Feet and 1 Mile	-0.05	0.05	0.20	58	-0.08	0.05	0.03	65
Between 1 and 3 Miles	0.00	0.02	0.80	2,019	0.00	0.01	0.80	2,359
Between 3 and 5 Miles	0.02	0.01	0.26	1,923	0.01	0.01	0.59	2,200
Outside 5 Miles	Omitted	Omitted	Omitted	870	0.00	0.02	0.78	1,000
Pre-Announcement Sales	n/a	n/a	n/a	n/a	Omitted	Omitted	Omitted	1,755

"Omitted" = reference category for fixed effects variables. "n" = number of cases in category when category = "1"

Model Information

Model Equation Number	**1**	**6**
Dependent Variable	**LN_SalePrice96**	**LN_SalePrice96**
Number of Cases	**4937**	**7459**
Number of Predictors (k)	**37**	**39**
F Statistic	**442.8**	**579.9**
Adjusted R Squared	**0.77**	**0.75**

Table 16: Results from Equality Test of VIEW Coefficients in the All Sales Model

	No View	**Minor View**	**Moderate View**	**Substantial View**	**Extreme View**
n	4,207	561	106	35	28
Coefficient	0.02	0.00	0.03	0.03	0.06
Coefficient Difference *	Reference	-0.02	0.00	0.01	0.04
Variance	0.0001	0.0003	0.0009	0.0030	0.0050
Covariance	n/a	0.00011	0.00010	0.00009	0.00008
Df	n/a	7419	7419	7419	7419
***t*-Test**	n/a	-1.20	0.17	0.23	0.58
Significance	n/a	0.23	0.87	0.82	0.57

** Differences are rounded to the nearest second decimal place.*
"n" = number of cases in category when category = "1"

Table 17: Results from Equality Test of DISTANCE Coefficients in the All Sales Model

	Inside 3000 Feet	Between 3000 Feet and 1 Mile	Between 1 and 3 Miles	Between 3 and 5 Miles	Outside 5 Miles
n	80	65	2,359	2,200	1,000
Coefficient	-0.06	-0.08	0.00	0.01	0.00
Coefficient Difference *	-0.05	-0.08	0.00	0.01	Reference
Variance	0.0019	0.0015	0.0002	0.0002	0.0003
Covariance	0.00010	0.00013	0.00013	0.00015	n/a
Df	7419	7419	7419	7419	n/a
***t* Test**	-1.23	-2.06	0.09	1.00	n/a
Significance	0.22	0.04	0.93	0.32	n/a

** Differences are rounded to the nearest second decimal place.*
"n" = number of cases in category when category = "1"

5.4. Temporal Aspects Model

Based on the results of the All Sales Model, a more thorough investigation of how Nuisance and Area Stigma effects might change throughout the wind project development period is warranted. As discussed previously, there is some evidence that property value impacts may be particularly strong after the announcement of a disamenity, but then may fade with time as the community adjusts to the presence of that disamenity (e.g., Wolsink, 1989). The Temporal Aspects Model presented here allows for an investigation of how the different periods of the wind project development process affect estimates for the impact of DISTANCE on sales prices.

5.4.1. Dataset and Model Form

Here the full set of 7,459 residential transactions is used, allowing an exploration of potential property value impacts (focusing on the DISTANCE variable) throughout time, including in the pre-construction period. The following model is then estimated:

$$\ln(\mathrm{P}) = \beta_0 + \beta_1 \mathrm{N} + \sum_{\mathrm{s}} \beta_2 \mathrm{S} + \sum_{\mathrm{k}} \beta_3 \mathrm{X} + \sum_{\mathrm{v}} \beta_4 \mathrm{VIEW} + \sum_{\mathrm{y}} \beta_5 (\mathrm{DISTANCE} \cdot \mathrm{PERIOD}) + \varepsilon \qquad (7)$$

where
DISTANCE is a vector of categorical distance variables (e.g., less than one mile, between one and three miles, etc.),
PERIOD is a vector of categorical development period variables (e.g., after announcement and before construction, etc.),
β_5 is a vector of *y* parameter estimates for each DISTANCE and PERIOD category as compared to the transactions more than two years before announcement and outside of five miles, and all other components are as defined in equation (1).

The PERIOD variable contains six different options:
1) More than two years before announcement;
2) Less than two years before announcement;
3) After announcement but before construction;
4) Less than two years after construction;
5) Between two and four years after construction; and

6) More than four years after construction.

In contrast to the Base Model, the two DISTANCE categories inside of one mile are collapsed into a single "less than one mile" group. This approach increases the number of transactions in each crossed subcategory of data, and therefore enhances the stability of the parameter estimates and decreases the size of the standard errors, thus providing an increased opportunity to discover statistically significant effects. Therefore, in this model the DISTANCE variable contains four different options:

1) Less than one mile;
2) Between one and three miles;
3) Between three and five miles; and
4) Outside of five miles.[79]

The number of transactions in each of the DISTANCE and PERIOD categories is presented in Table 18.

The coefficients of interest are β_5, which represent the vector of marginal differences between homes sold at various distances from the wind facility (DISTANCE) during various periods of the development process (PERIOD) as compared to the reference group. The reference group in this model consists of transactions that occurred more than two years before the facility was announced for homes that were situated more than five miles from where the turbines were ultimately constructed. It is assumed that the value of these homes would not be affected by the future presence of the wind facility. The VIEW parameters, although included in the model, are not interacted with PERIOD and therefore are treated as controlling variables.[80]

Although the comparisons of these categorical variables <u>between</u> different DISTANCE and PERIOD categories is be interesting, it is the comparison of coefficients <u>within</u> each PERIOD and DISTANCE category that is the focus of this section. Such comparisons, for example, allow one to compare how the average value of homes inside of one mile that sold two years before announcement compare to the average value of homes inside of one mile that sold in the post-announcement-pre-construction period. For this comparison, a *t*-Test similar to that in the All Sales Model is used.

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[79] For homes that sold in the pre-construction time frame, no turbines yet existed, and therefore DISTANCE is created using a proxy: the Euclidian distance to where the turbines were eventually constructed. This approach introduces some bias when there is more than one facility in the study area. Conceivably, a home that sold in the post-announcement-pre-construction period of one wind facility could also be assigned to the pre-announcement period of another facility in the same area. For this type of sale, it is not entirely clear which PERIOD and DISTANCE is most appropriate, but every effort was made to apply the sale to the wind facility that was most likely to have an impact. In most cases this meant choosing the closest facility, but in some cases, when development periods were separated by many years, simply the earliest facility was chosen. In general, any bias created by these judgments is expected to be minimal because, in the large majority of cases, the development process in each study area was more-or-less continuous and focused in a specific area rather then being spread widely apart.

[80] As discussed earlier, the VIEW variable was considered most relevant for the post-construction period, so delineations based on development periods that extended into the pre-construction phase were unnecessary. It is conceivable, however, that VIEW effects vary in periods following construction, such as in the first two years or after that. Although this is an interesting question, the numbers of cases for the SUBSTANTIAL and EXTREME ratings – even if combined – when divided into the temporal periods were too small to be fruitful for analysis.

Table 18: Frequency Crosstab of DISTANCE and PERIOD

	More Than 2 Years Before Announcement	Less Than 2 Years Before Announcement	After Announcement Before Construction	Less Than 2 Years After Construction	Between 2 and 4 Years After Construction	More Than 4 Years After Construction	Total
Less Than 1 Mile	38	40	20	39	45	43	**225**
Between 1 and 3 Miles	283	592	340	806	502	709	**3,232**
Between 3 and 5 Miles	157	380	277	572	594	757	**2,737**
Outside of 5 Miles	132	133	130	218	227	425	**1,265**
TOTAL	**610**	**1,145**	**767**	**1,635**	**1,368**	**1,934**	**7,459**

5.4.2. Analysis of Results

Results for the variables of interest for this hedonic model are presented in Table 19; as with previous models, the full set of results is contained in Appendix H. Similar to the All Sales Model discussed in the previous section, the adjusted R^2 for the model is 0.75, down slightly from 0.77 for the Base Model, and indicating that this model has slightly more difficulty (i.e., less explanatory power) modeling transactions that occurred before wind facility construction. All study area, spatial adjustment, and home and site characteristics are significant at or above the one percent level, are of the appropriate sign, and are similar in magnitude to the estimates derived from the post-construction Base Model.

All of the DISTANCE / PERIOD interaction coefficients for distances outside of one mile are relatively small ($-0.04 < \beta_5 < 0.02$) and none are statistically significant. This implies that there are no statistically significant differences in property values between the reference category homes – homes sold more than two years before announcement that were situated outside of five miles from where turbines were eventually erected – and any of the categories of homes that sold outside of one mile at any other period in the wind project development process. These comparisons demonstrate, arguably more directly than any other model presented in this report that Area Stigma effects likely do not exist in the sample.

The possible presence of a Nuisance Stigma is somewhat harder to discern. For homes that sold inside of one mile of the nearest wind turbine, in three of the six periods there are statistically significant negative differences between average property values when compared to the reference category. Transactions completed more than two years before facility announcement are estimated to be valued at 13% less (*p* value 0.02) than the reference category, transactions less than two years before announcement are 10% lower (*p* value 0.06), and transactions after announcement but before construction are 14% lower (*p* value 0.04). For other periods, however, these marginal differences are considerably smaller and are not statistically different from the reference category. Sales prices in the first two years after construction are, on average, 9% less (*p* value 0.15), those occurring between three and four years following construction are, on average, 1% less (*p* value 0.86), and those occurring more than four years after construction are, on average, 7% less (*p* value 0.37).

Table 19: Results from Temporal Aspects Model

Variables of Interest		Temporal Aspects			
		Coef	**SE**	**p Value**	***n***
Inside 1 Mile	**More Than 2 Years Before Announcement**	-0.13	0.06	0.02	38
	Less Than 2 Years Before Announcement	-0.10	0.05	0.06	40
	After Announcement Before Construction	-0.14	0.06	0.04	21
	2 Years After Construction	-0.09	0.07	0.11	39
	Between 2 and 4 Years After Construction	-0.01	0.06	0.85	44
	More Than 4 Years After Construction	-0.07	0.08	0.22	42
Between 1-3 Miles	**More Than 2 Years Before Announcement**	-0.04	0.03	0.18	283
	Less Than 2 Years Before Announcement	0.00	0.03	0.91	592
	After Announcement Before Construction	-0.02	0.03	0.54	342
	2 Years After Construction	0.00	0.03	0.90	807
	Between 2 and 4 Years After Construction	0.01	0.03	0.78	503
	More Than 4 Years After Construction	0.00	0.03	0.93	710
Between 3-5 Miles	**More Than 2 Years Before Announcement**	0.00	0.04	0.92	157
	Less Than 2 Years Before Announcement	0.00	0.03	0.97	380
	After Announcement Before Construction	0.00	0.03	0.93	299
	2 Years After Construction	0.02	0.03	0.55	574
	Between 2 and 4 Years After Construction	0.01	0.03	0.65	594
	More Than 4 Years After Construction	0.01	0.03	0.67	758
Outside 5 Miles	**More Than 2 Years Before Announcement**	Omitted	Omitted	Omitted	132
	Less Than 2 Years Before Announcement	-0.03	0.04	0.33	133
	After Announcement Before Construction	-0.03	0.03	0.39	105
	2 Years After Construction	-0.03	0.03	0.44	215
	Between 2 and 4 Years After Construction	0.03	0.03	0.44	227
	More Than 4 Years After Construction	0.01	0.03	0.73	424

"Omitted" = reference category for fixed effects variables.
"n" indicates number of cases in category when category = "1"

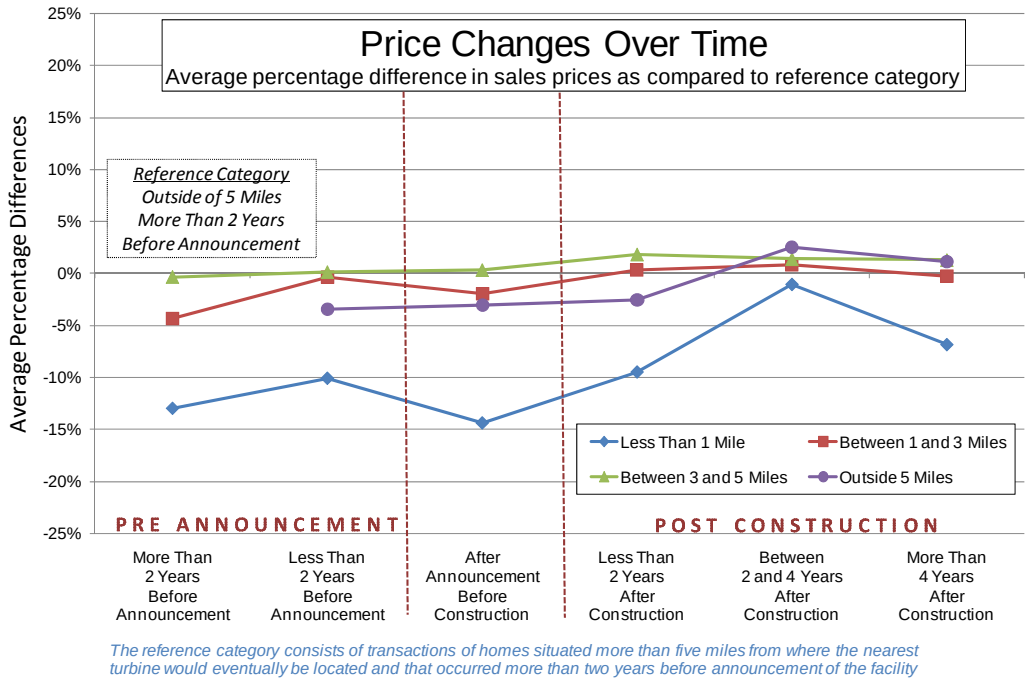
Model Information

Model Equation Number	**7**
Dependent Variable	**LN_SalePrice96**
Number of Cases	**7459**
Number of Predictors (k)	**56**
F Statistic	**404.5**
Adjusted R Squared	**0.75**

What these results suggest (as shown in Figure 8) is that homes inside of one mile in the sample, on average, were depressed in value (in relation to the reference category) before and after the announcement of the wind facility and up to the point that construction began, but that those values rebounded somewhat after construction commenced.[81] This conclusion also likely explains why a significant and negative effect for homes that sold between 3000 feet and one mile is found in the All Sales Model presented in Section 5.3: homes within this distance range that sold prior to facility construction were depressed in value and most likely drove the results for homes that sold after announcement. Regardless, these results are not suggestive of a pervasive Nuisance Stigma.

[81] As discussed in footnotes 47 (on page 19) and 74 (on page 38), the "announcement date" often refers to the first time the proposed facility appeared in the press. "Awareness" of the project in the community may precede this date, however, and therefore transactions occurring in the period "less than two years before announcement" could conceivably have been influenced by the prospective wind project, but it is considerably less likely that those in the period more than two years before announcement would have been influenced.

Figure 8: Results from the Temporal Aspects Model



To explore Nuisance Stigma further, the analysis again turns to the *t*-Test and compares the coefficients for transactions that occurred more than two years before wind facility announcement (during which time the future wind facility is not expected to have any impact on sales prices) to the estimates for the DISTANCE coefficients in the periods that follow. These results are shown in Table 20. Focusing on those transactions inside of one mile, it is found that all coefficients are greater in magnitude than the reference category except during the post-announcement-pre-construction period (which is 1% less and is not statistically significant; *p* value 0.90), indicating, on average, that home values are increasing or staying stable from the pre-announcement reference period onward. These increases, however, are not statistically significant except in the period of two to four years after construction (0.12, *p* value 0.08). With respect to Nuisance Stigma, the more important result is that, relative to homes that sold well before the wind facility was announced, no statistically significant adverse effect is found in any period within a one mile radius of the wind facility. Therefore, the -5% (albeit not statistically significant) average difference that is found in the Base Model, and the -8% (statistically significant) result that is found in the All Sales Model (for homes between 3000 feet and one mile) appear to both be a reflection of depressed home prices that preceded the construction of the relevant wind facilities. If construction of the wind facilities were downwardly influencing the sales prices of these homes, as might be deduced from the Base or All Sales Models alone, a diminution in the inflation adjusted price would be seen as compared to pre-announcement levels. Instead, an increase is seen. As such, no persuasive evidence of a Nuisance Stigma is evident among this sample of transactions.[82]

[82] It should be noted that the numbers of study areas represented for homes situated inside of one mile but in the periods "more than two years before announcement" and "more than four years after construction" are fewer ($n = 5$) than in the other temporal categories ($n = 8$). Further, the "more than two years before announcement – inside of one mile" category is dominated by transactions from one study area (OKCC). For these reasons, there is less

Turning to the coefficient differences for distances greater than one mile in Table 20, again, no statistical evidence of significant adverse impacts on home values is uncovered. Where statistically significant differences are identified, the coefficients are greater than the reference category. These findings corroborate the earlier Area Stigma results, and re-affirm the lack of evidence for such an effect among the sample of residential transactions included in this analysis.

Table 20: Results from Equality Test of Temporal Aspects Model Coefficients

	More Than 2 Years Before Announcement	Less Than 2 Years Before Announcement	After Announcement Before Construction	Less Than 2 Years After Construction	Between 2 and 4 Years After Construction	More Than 4 Years After Construction
Less Than 1 Mile	Reference	0.03 (0.45)	-0.01 (-0.13)	0.04 (0.56)	0.12 (1.74)*	0.06 (0.88)
Between 1 and 3 Miles	Reference	0.04 (1.92)*	0.02 (0.86)	0.05 (2.47)**	0.05 (2.27)**	0.04 (1.82)*
Between 3 and 5 Miles	Reference	0.01 (0.37)	0.01 (0.34)	0.02 (0.77)	0.02 (0.78)	0.02 (0.79)
Outside of 5 Miles †	Reference	-0.04 (-0.86)	-0.03 (-0.91)	-0.03 (-0.77)	0.03 (0.81)	0.01 (0.36)

*Numbers in parenthesis are t-Test statistics. Significance = *** 1% level, ** 5% level, * 10% level, <blank> below the 10% level.*

† For homes outside of 5 miles, the coefficient differences are equal to the coefficients in the Temporal Aspects Model, and therefore the t-values were produced via the OLS.

5.5. Orientation Model

All of the hedonic models presented to this point use a VIEW variable that effectively assumes that the impact of a view of wind turbines on property values will not vary based on the orientation of the home to that view; the impact will be the same whether the view is seen from the side of the home or from the back or front. Other literature, however, has found that the impact of wind projects on property values may be orientation-dependent (Sims et al., 2008). To investigate this possibility further a parameter for orientation is included in the model.

5.5.1. Dataset and Model Form

The same dataset is used as in the Base Model, focusing on post-construction transactions (*n* = 4,937). To investigate whether the orientation of a home to the turbines (ORIENTATION) has a marginal impact on residential property values, over and above that of the VIEW impacts alone, the following hedonic model is estimated:[83]

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confidence in these two estimates (-13% and -7% respectively) than for the estimates for other temporal periods inside of one mile. Based on additional sensitivity analysis not included here, it is believed that if they are biased, both of these estimates are likely biased downward. Further, as discussed in footnote 47 on page 19, there is a potential for bias in the "announcement" date in that awareness of a project may precede the date that a project enters the public record (i.e., the "announcement" date used for this analysis). Taken together, these two issues might imply that the curve shown in Figure 8 for "less than one mile" transactions, instead of having a flat and then increasing shape, may have a more of an inverse parabolic (e.g., "U") shape. This would imply that a relative minimum in sales prices is reached in the period after awareness began of the facility but before construction commenced, and then, following construction, prices recovered to levels similar to those prior to announcement (and awareness). These results would be consistent with previous studies (e.g., Wolsink, 1989; Devine-Wright, 2004) but cannot be confirmed without the presence of more data. Further research on this issue is warranted. In either case, such results would not change the conclusion here of an absence of evidence of a pervasive Nuisance Stigma in the post-construction period.

[83] The various possible orientations of the home to the view of turbines will be, individually and collectively, referred to as "ORIENTATION" in this report.

$$\ln(\mathrm{P}) = \beta_0 + \beta_1 \mathrm{N} + \sum_{\mathrm{s}} \beta_2 \mathrm{S} + \sum_{\mathrm{k}} \beta_3 \mathrm{X} + \sum_{\mathrm{v}} \beta_4 \mathrm{VIEW} + \sum_{\mathrm{d}} \beta_5 \mathrm{DISTANCE} + \sum_{\mathrm{o}} \beta_6 \mathrm{ORIENTATION} + \varepsilon \tag{8}$$

where
ORIENTATION is a vector of *o* ORIENTATION variables (e.g., SIDE, FRONT, and BACK),
β_6 is a vector of *o* parameter estimates for ORIENTATION variables, and
all other components are as defined in equation (1).[84]

The ORIENTATION categories include FRONT, BACK, and SIDE, and are defined as follows:

- SIDE: The orientation of the home to the view of the turbines is from the side.
- FRONT: The orientation of the home to the view of the turbines is from the front.
- BACK: The orientation of the home to the view of the turbines is from the back.

The orientation of the home to the view of the wind facilities was determined in the course of the field visits to each home. If more than one orientation to the turbines best described the home (e.g., back and side, or front, back, and side) they were coded as such (e.g., turbines visible from back and side: SIDE = 1; BACK = 1; FRONT = 0).[85]

Not surprisingly, ORIENTATION is related to VIEW. Table 21 and Table 22 provide frequency and percentage crosstabs of ORIENTATION and VIEW. As shown, those homes with more dramatic views of the turbines generally have more ORIENTATION ratings applied to them. For instance, 25 out of 28 EXTREME VIEW homes have all three ORIENTATION ratings (i.e., FRONT, BACK, and SIDE). Virtually all of the MINOR VIEW homes, on the other hand, have only one ORIENTATION. Further, MINOR VIEW homes have roughly evenly spread orientations to the turbines across the various possible categories of FRONT, BACK, and SIDE. Conversely, a majority of the MODERATE and SUBSTANTIAL VIEW ratings coincide with an ORIENTATION from the back of the house.[86]

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[84] Ideally, one would enter ORIENTATION in the model through an interaction with VIEW. There are two ways that could be accomplished: either with the construction of multiple fixed effects ("dummy") variables, which capture each sub-category of VIEW and ORIENTATION, or through a semi-continuous interaction variable, which would be created by multiplying the ordered categorical variable VIEW by an ordered categorical variable ORIENTATION. Both interaction scenarios are problematic, the former because it requires increasingly small subsets of data, which create unstable coefficient estimates, and the latter because there are no *a priori* expectations for the ordering of an ordered categorical ORIENTATION variable and therefore none could be created and used for the interaction. As a result, no interaction between the two variables is reported here.

[85] An "Angle" orientation was also possible, which was defined as being between Front and Side or Back and Side. An Angle orientation was also possible in combination with Back or Front (e.g., Back-Angle or Front-Angle). In this latter case, the orientation was coded as one of the two prominent orientations (e.g., Back or Front). An Angle orientation, not in combination with Front or Back, was coded as Side.

[86] The prevalence of BACK orientations for MODERATE and SUBSTANTIAL VIEW homes may be because BACK views might more-frequently be kept without obstruction, relative to SIDE views.

Table 21: Frequency Crosstab of VIEW and ORIENTATION

		VIEW				
		Minor	**Moderate**	**Substantial**	**Extreme**	**Total**
ORIENTATION	**Front**	217	33	17	27	**294**
	Back	164	67	24	25	**280**
	Side	194	17	15	27	**253**
	Total	**561**	**106**	**35**	**28**	**730**

Note: Total of ORIENTATION does not sum to 730 because multiple orientations are possible for each VIEW.

Table 22: Percentage Crosstab of VIEW and ORIENTATION

		VIEW				
		Minor	**Moderate**	**Substantial**	**Extreme**	**Total**
ORIENTATION	**Front**	39%	31%	49%	96%	**40%**
	Back	29%	63%	69%	89%	**38%**
	Side	35%	16%	43%	96%	**35%**

Note: Percentages are calculated as a portion of the total for each VIEW ratings (e.g., 24 of the 35 SUBSTANTIAL rated homes have a BACK ORIENTATION = 69%). Columns do not sum to 100% because multiple orientations are possible for each VIEW.

The parameter estimates of interest in this hedonic model are those for ORIENTATION (β_6) and VIEW (β_4). β_6 represent the marginal impact on home value, over and above that of VIEW alone, of having a particular orientation to the turbines. In the Base Model the VIEW coefficients effectively absorb the effects of ORIENTATION, but in this model they are estimated separately. Because a home's surrounding environment is typically viewed from the front or back of the house, one would expect that, to the extent that wind facility VIEW impacts property values, that impact would be especially severe for homes that have FRONT or BACK orientations to those turbines. If this were the case, the coefficients for these categories would be negative, while the coefficient for SIDE would be to be close to zero indicating little to no incremental impact from a SIDE ORIENTATION.

5.5.2. Analysis of Results

Results for the variables of interest for this hedonic model are shown in Table 23; as with previous models, the full set of results is contained in Appendix H. The model performs well with an adjusted R^2 of 0.77. All study area, spatial adjustment, and home and site characteristics are significant at or above the one percent level, are of the appropriate sign, and are similar in magnitude to the estimates derived from the post-construction Base Model. The coefficients for DISTANCE and VIEW are stable, in sign and magnitude, when compared to the Base Model results, and none of the marginal effects are statistically significant.

The coefficients for the variables of interest (β_6) do not meet the *a priori* expectations. The estimated effect for SIDE ORIENTATION, instead of being close to zero, is -3% (*p* value 0.36), while BACK and FRONT, instead of being negative and larger, are estimated at 3% (*p* value 0.37) and -1% (*p* value 0.72), respectively. None of these variables are found to be even marginally statistically significant, however, and based on these results, it is concluded that there is no evidence that a home's orientation to a wind facility affects property values in a measurable way. Further, as with previous models, no statistical evidence of a Scenic Vista Stigma is found among this sample of sales transactions.

Table 23: Results from Orientation Model

	Base Model				Orientation Model			
Variables of Interest	**Coef**	**SE**	**p Value**	***n***	**Coef**	**SE**	**p Value**	***n***
No View	Omitted	Omitted	Omitted	4207	Omitted	Omitted	Omitted	4207
Minor View	-0.01	0.01	0.39	561	-0.01	0.06	0.88	561
Moderate View	0.02	0.03	0.57	106	0.00	0.06	0.96	106
Substantial View	-0.01	0.07	0.92	35	-0.01	0.09	0.85	35
Extreme View	0.02	0.09	0.77	28	0.02	0.17	0.84	28
Inside 3000 Feet	-0.05	0.06	0.31	67	-0.04	0.07	0.46	67
Between 3000 Feet and 1 Mile	-0.05	0.05	0.20	58	-0.05	0.05	0.26	58
Between 1 and 3 Miles	0.00	0.02	0.80	2019	0.00	0.02	0.83	2019
Between 3 and 5 Miles	0.02	0.01	0.26	1923	0.02	0.01	0.26	1923
Outside 5 Miles	Omitted	Omitted	Omitted	870	Omitted	Omitted	Omitted	870
Front Orientation					-0.01	0.06	0.72	294
Back Orientation					0.03	0.06	0.37	280
Side Orientation					-0.03	0.06	0.36	253

"Omitted" = reference category for fixed effects variables. "n" = number of cases in category when category = "1"

Model Information

Model Equation Number	**1**	**8**
Dependent Variable	**LN_SalePrice96**	**LN_SalePrice96**
Number of Cases	**4937**	**4937**
Number of Predictors (k)	**37**	**40**
F Statistic	**442.8**	**410.0**
Adjusted R Squared	**0.77**	**0.77**

5.6. Overlap Model

The Orientation Model, presented above, investigated, to some degree, how the potential effects of wind turbines might be impacted by how a home is oriented to the surrounding environment. In so doing, this model began to peel back the relationship between VIEW and VISTA, but stopped short of looking at the relationship directly. It would be quite useful, though, to understand the explicit relationship between the VISTA and VIEW variables. In particular, one might expect that views of wind turbines would have a particularly significant impact on residential property values when those views strongly overlap ("OVERLAP") the prominent scenic vista from a home. To investigate this possibility directly, and, in general, the relationship between VIEW and VISTA, a parameter for OVERLAP is included in the model.

5.6.1. Dataset and Model Form

Data on the degree to which the view of wind turbines overlaps with the prominent scenic vista from the home (OVERLAP) were collected in the course of the field visits to each home.[87] The categories for OVERLAP included NONE, BARELY, SOMEWHAT, and STRONGLY, and are described in Table 24: [88]

Table 24: Definition of OVERLAP Categories

OVERLAP - NONE	The scenic vista does not contain any view of the turbines.
OVERLAP - BARELY	A small portion (~ 0 - 20%) of the scenic vista is overlapped by the view of turbines, and might contain a view of a few turbines, only a few of which can be seen entirely.
OVERLAP - SOMEWHAT	A moderate portion (~20-50%) of the scenic vista contains turbines, and likely contains a view of more than one turbine, some of which are likely to be seen entirely.
OVERLAP - STRONGLY	A large portion (~50-100%) of the scenic vista contains a view of turbines, many of which likely can be seen entirely.

A crosstab describing the OVERLAP designations and the VIEW categories is shown in Table 25. As would be expected, the more dramatic views of wind turbines, where the turbines occupy more of the panorama, are coincident with the OVERLAP categories of SOMEWHAT or STRONGLY. Nonetheless, STRONGLY are common for all VIEW categories. Similarly, SOMEWHAT is well distributed across the MINOR and MODERATE rated views, while BARELY is concentrated in the MINOR rated views.

The same dataset is used as in the Base Model, focusing on post-construction transactions (*n* = 4,937). To investigate whether the overlap of VIEW and VISTA has a marginal impact on residential property values, over and above that of the VIEW and VISTA impacts alone, the following hedonic model is estimated:[89]

$$\ln(\mathrm{P}) = \beta_0 + \beta_1 \mathrm{N} + \sum_{\mathrm{s}} \beta_2 \mathrm{S} + \sum_{\mathrm{k}} \beta_3 \mathrm{X} + \sum_{\mathrm{v}} \beta_4 \mathrm{VIEW} + \sum_{\mathrm{d}} \beta_5 \mathrm{DISTANCE} + \sum_{\mathrm{t}} \beta_6 \mathrm{VISTA} + \sum_{\mathrm{p}} \beta_7 \mathrm{OVERLAP} + \varepsilon \tag{9}$$

where
VIEW is a vector of *v* categorical view variables (e.g., MINOR, MODERATE, etc.),
VISTA is a vector of *t* categorical scenic vista variables (e.g., POOR, BELOW-AVERAGE, etc.),
OVERLAP is a vector of *p* categorical overlap variables (e.g., BARELY, SOMEWHAT, etc.),

[87] Scenic vista was rated while taking into account the entire panorama surrounding a home. But, for each home, there usually was a prominent direction that offered a preferred scenic vista. Often, but not always, the home was orientated to enjoy that prominent scenic vista. Overlap is defined as the degree to which the view of the wind facility overlaps with this prominent scenic vista.

[88] "…can be seen entirely" refers to being able to see a turbine from the top of the sweep of its blade tips to below the nacelle of the turbine where the sweep of the tips intersects the tower.

[89] Although VISTA appears in all models, and is usually included in the vector of home and site characteristics represented by X, it is shown separately here so that it can be discussed directly in the text that follows.

β_4 is a vector of *v* parameter estimates for VIEW fixed effects variables as compared to transactions of homes without a view of the turbines,
β_6 is a vector of *t* parameter estimates for VISTA fixed effect variables as compared to transactions of homes with an AVERAGE scenic vista,
β_7 is a vector of *o* parameter estimates for OVERLAP fixed effect variables as compared to transactions of homes where the view of the turbines had no overlap with the scenic vista, and all other components are as defined in equation (1).

The variables of interest in this model are VIEW, VISTA and OVERLAP, and the coefficients β_4, β_6, and β_7 are therefore the primary focus. Theory would predict that the VISTA coefficients in this model would be roughly similar to those derived in the Base Model, but that the VIEW coefficients may be somewhat more positive as the OVERLAP variables explain a portion of any negative impact that wind projects have on residential sales prices. In that instance, the OVERLAP coefficients would be negative, indicating a decrease in sales price when compared to those homes that experience no overlap between the view of wind turbines and the primary scenic vista.

Table 25: Frequency Crosstab of OVERLAP and VIEW

		VIEW					
		None	**Minor**	**Moderate**	**Substantial**	**Extreme**	**Total**
OVERLAP	**None**	4,207	317	3	0	0	**4,527**
	Barely	0	139	10	1	0	**150**
	Somewhat	0	81	42	7	2	**132**
	Strongly	0	24	51	27	26	**128**
	Total	**4,207**	**561**	**106**	**35**	**28**	**4,937**

5.6.2. Analysis of Results

Results for the variables of interest for this hedonic model are shown in Table 26; as with previous models, the full set of results is contained in Appendix H. The model performs well with an adjusted R^2 of 0.77. All study area, spatial adjustment, and home and site characteristics are significant at or above the one percent level, are of the appropriate sign, and are similar in magnitude to the estimates derived from the post-construction Base Model.

As expected from theory, the VISTA parameters are stable across models with no change in coefficient sign, magnitude, or significance. Counter to expectations, however, the VIEW coefficients, on average, decrease in value. MINOR VIEW is now estimated to adversely affect a home's sale price by 3% (*p* value 0.10) and is weakly significant, but none of the other VIEW categories are found to be statistically significant. Oddly, the OVERLAP rating of BARELY is found to significantly <u>increase</u> home values by 5% (*p* value 0.08), while none of the other OVERLAP ratings are found to have a statistically significant impact.

Taken at face value, these results are counterintuitive. For instance, absent any overlap of view with the scenic vista (NONE), a home with a MINOR view sells for 3% less than a home with no view of the turbines. If, alternatively, a home with a MINOR view BARELY overlaps the prominent scenic vista, it not only enjoys a 2% <u>increase</u> in value over a home with NO VIEW of the turbines but a 5% <u>increase</u> in value over homes with views of the turbines that do not overlap

with the scenic vista. In other words, the sales price increases when views of turbines overlap the prominent scenic vista, at least in the BARELY category. A more likely explanation for these results are that the relatively high correlation (0.68) between the VIEW and OVERLAP parameters is spuriously driving one set of parameters up and the other down. More importantly, when the parameters are combined, they offer a similar result as was found in the Base Model. Therefore, it seems that the degree to which the view of turbines overlaps the scenic vista has a negligible effect on sales prices among the sample of sales transactions analyzed here.[90]

Despite these somewhat peculiar results, other than MINOR, none of the VIEW categories are found to have statistically significant impacts, even after accounting for the degree to which those views overlap the scenic vista. Similarly, none of the OVERLAP variables are simultaneously negative and statistically significant. This implies, once again, that a Scenic Vista Stigma is unlikely to be present in the sample. Additionally, none of the DISTANCE coefficients are statistically significant, and those coefficients remain largely unchanged from the Base Model, reaffirming previous results in which no significant evidence of either an Area or a Nuisance Stigma was found.

[90] An alternative approach to this model was also considered, one that includes an interaction term between VIEW and VISTA. For this model it is assumed that homes with higher rated scenic vistas might have higher rated views of turbines, and that these views of turbines would decrease the values of the scenic vista. To construct the interaction, VISTA, which can be between one and five (e.g., POOR=1,…PREMIUM=5), was multiplied by VIEW, which can be between zero and four (e.g. NO VIEW=0, MINOR=1,…EXTREME=4). The resulting interaction (VIEW*VISTA) therefore was between zero and sixteen (there were no PREMIUM VISTA homes with an EXTREME VIEW), with zero representing homes without a view of the turbines, one representing homes with a POOR VISTA and a MINOR VIEW, and sixteen representing homes with either a PREMIUM VISTA and a SUBSTANTIAL VIEW or an ABOVE AVERAGE VISTA and an EXTREME VIEW. The interaction term, when included in the model, was relatively small (-0.013) and weakly significant (*p* value 0.10 – not White's corrected). The VISTA estimates were unchanged and the VIEW parameters were considerably larger and positive. For instance, EXTREME was 2% in the Base Model and 16% in this "interaction" model. Similarly, SUBSTANTIAL was -1% in the Base Model and 13% in this model. Therefore, although the interaction term is negative and weakly significant, the resulting VIEW estimates, to which it would need to be added, fully offset this negative effect. These results support the idea that the degree to which a VIEW overlaps VISTA has a likely negligible effect on sales prices, while also confirming that there is a high correlation between the interaction term and VIEW variables.

Table 26: Results from Overlap Model

Variables of Interest	Base Model				Overlap Model			
	Coef	**SE**	**p Value**	***n***	**Coef**	**SE**	**p Value**	***n***
No View	Omitted	Omitted	Omitted	4,207	Omitted	Omitted	Omitted	4,207
Minor View	-0.01	0.01	0.39	561	-0.03	0.02	0.10	561
Moderate View	0.02	0.03	0.57	106	-0.02	0.04	0.65	106
Substantial View	-0.01	0.07	0.92	35	-0.05	0.09	0.43	35
Extreme View	0.02	0.09	0.77	28	-0.03	0.10	0.73	28
Inside 3000 Feet	-0.05	0.06	0.31	67	-0.05	0.06	0.32	67
Between 3000 Feet and 1 Mile	-0.05	0.05	0.20	58	-0.05	0.05	0.27	58
Between 1 and 3 Miles	0.00	0.02	0.80	2,019	0.00	0.02	0.82	2,019
Between 3 and 5 Miles	0.02	0.01	0.26	1,923	0.02	0.01	0.26	1,923
Outside 5 Miles	Omitted	Omitted	Omitted	870	Omitted	Omitted	Omitted	870
Poor Vista	-0.21	0.02	0.00	310	-0.21	0.02	0.00	310
Below Average Vista	-0.08	0.01	0.00	2,857	-0.08	0.01	0.00	2,857
Average Vista	Omitted	Omitted	Omitted	1,247	Omitted	Omitted	Omitted	1,247
Above Average Vista	0.10	0.02	0.00	448	0.10	0.02	0.00	448
Premium Vista	0.13	0.04	0.00	75	0.13	0.04	0.00	75
View Does Not Overlap Vista					Omitted	Omitted	Omitted	320
View Barely Overlaps Vista					0.05	0.03	0.08	150
View Somewhat Overlaps Vista					0.01	0.03	0.66	132
View Strongly Overlaps Vista					0.05	0.05	0.23	128

"Omitted" = reference category for fixed effects variables. "n" = number of cases in category when category = "1"

Model Information

Model Equation Number	**1**	**9**
Dependent Variable	**LN_SalePrice96**	**LN_SalePrice96**
Number of Cases	**4937**	**4937**
Number of Predictors (k)	**37**	**40**
F Statistic	**442.8**	**409.7**
Adjusted R Squared	**0.77**	**0.77**

6. Repeat Sales Analysis

In general, the Base and Alternative Hedonic Models presented in previous sections come to the same basic conclusion: wind power facilities in this sample have no demonstrable, widespread, sizable, and statistically significant affect on residential property values. These hedonic models contain 29 or more controlling variables (e.g., house and site characteristics) to account for differences in home values across the sample. Although these models perform well and explain nearly 80% of the variation in sales prices among homes in the sample, it is always possible that variables not included in (i.e., "omitted from") the hedonic models could be correlated with the variables of interest, therefore biasing the results.

A common method used to control for omitted variable bias in the home assessment literature is to estimate a repeat sales model (Palmquist, 1982). This technique focuses on just those homes that have sold on more than one occasion, preferably once before and once after the introduction of a possible disamenity, and investigates whether the price appreciation between these transactions is affected by the presence of that disamenity. In this section a repeat sales analysis is applied to the dataset, investigating in a different way the presence of the three possible property value stigmas associated with wind facilities, and therefore providing an important cross-check to the hedonic model results. The section begins with a brief discussion of the general form of the Repeat Sales Model and a summary of the literature that has employed this approach to investigate environmental disamenities. The dataset and model used in the analysis is then described, followed by a summary of the results from that analysis.

6.1. Repeat Sales Models and Environmental Disamenities Literature

Repeat sales models use the annual sales-price appreciation rates of homes as the dependent variable. Because house, home site, and neighborhood characteristics are relatively stable over time for any individual home, many of those characteristics need not be included in the repeat sales model, thereby increasing the degrees of freedom and allowing sample size requirements to be significantly lower and coefficient estimates to be more efficient (Crone and Voith, 1992). A repeat sales analysis is not necessarily preferred over a traditional hedonic model, but is rather an alternative analysis approach that can be used to test the robustness of the earlier results (for further discussion see Jackson, 2003). The repeat sales model takes the basic form:

Annual Appreciation Rate (AAR) = *f* (TYPE OF HOUSE, OTHER FACTORS)

where
TYPE OF HOUSE provides an indication of the segment of the market in which the house is situated (e.g., high end vs. low end), and
OTHER FACTORS include, but are not limited to, changes to the environment (e.g., proximity to a disamenity).

The dependent variable is the adjusted annual appreciation rate and is defined as follows:

$$\mathrm{AAR} = \exp\left[\frac{\ln\left(P_1 / P_2\right)}{t_1 - t_2}\right] - 1 \qquad (10)$$

where

P_1 is the adjusted sales price at the first sale (in 1996 dollars),
P_2 is the adjusted sales price at the second sale (in 1996 dollars),
t_1 is the date of the first sale,
t_2 is the date of the second sale, and
$(t_1 - t_2)$ is determined by calculating the number of days that separate the sale dates and dividing by 365.

As with the hedonic regression model, the usefulness of the repeat sales model is well established in the literature when investigating possible disamenities. For example, a repeat sales analysis was used to estimate spatial and temporal sales price effects from incinerators by Kiel and McClain (1995), who found that appreciation rates, on average, are not sensitive to distance from the facility during the construction phase but are during the operation phase. Similarly, McCluskey and Rausser (2003) used a repeat sales model to investigate effects surrounding a hazardous waste site. They found that appreciation rates are not sensitive to the home's distance from the disamenity before that disamenity is identified by the EPA as hazardous, but that home values are impacted by distance after the EPA's identification is made.

6.2. Dataset

The 7,459 residential sales transactions in the dataset contain a total of 1,253 transactions that involve homes that sold on more than one occasion (i.e., a "pair" of sales of the same home). For the purposes of this analysis, however, the key sample consists of homes that sold once before the announcement of the wind facility, and that subsequently sold again after the construction of that facility. Therefore any homes that sold twice in either the pre-announcement or post-construction periods were not used in the repeat sales sample.[91] These were excluded because either they occurred before the effect would be present (for pre-announcement pairs) or after (for post-announcement pairs). This left a total of 368 pairs for the analysis, which was subsequently reduced to 354 usable pairs.[92]

The mean AAR for the sample is 1.0% per year, with a low of -10.5% and a high of 13.4%. Table 27 summarizes some of the characteristics of the homes used in the repeat sales model. The average house in the sample has 1,580 square feet of above-ground finished living area, sits on a parcel of 0.67 acres, and originally sold for $70,483 (real 1996 dollars). When it sold a second time, the average home in the sample was located 2.96 miles from the nearest wind turbine (14 homes were within one mile, 199 between one and three miles, 116 between three and five miles, and 25 outside of five miles). Of the 354 homes, 14% (n = 49) had some view of the facility (35 were rated MINOR, five MODERATE, and nine either SUBSTANTIAL or EXTREME). Because of the restriction to those homes that experienced repeat sales, the sample is relatively small for those homes in close proximity to and with dramatic views of wind facilities.

[91] 752 pairs occurred after construction began, whereas 133 pairs occurred before announcement.

[92] Of the 368 pairs, 14 were found to have an AAR that was either significantly above or below the mean for the sample (mean +/- 2 standard deviations). These pairs were considered highly likely to be associated with homes that were either renovated or left to deteriorate between sales, and therefore were removed from the repeat sales model dataset. Only two of these 14 homes had views of the wind turbines, both of which were MINOR. All 14 of the homes were situated either between one and three miles from the nearest turbine (n = 8) or between three and five miles away (n = 6).

Table 27: List of Variables Included in the Repeat Sales Model

Variable Name	Description	Type	Sign	Freq.	Mean	Std. Dev.	Min.	Max.
SalePrice96_Pre	The Sale Price (adjusted for inflation into 1996 dollars) of the home as of the first time it had sold	C	+	354	$ 70,483	$ 37,798	$ 13,411	$ 291,499
SalePrice96_Pre_Sqr	SalePrice96_Pre Squared (shown in millions)	C	–	354	$ 6,393	$ 8,258	$ 180	$ 84,972
Acres	Number of Acres that sold with the residence	C	+	354	0.67	1.34	0.07	10.96
Sqft_1000	Number of square feet of finished above ground living area (in 1000s)	C	+	354	1.58	0.56	0.59	4.06
No View	If the home had no view of the turbines when it sold for the second time (Yes = 1, No = 0)	Omitted	n/a	305	0.86	0.35	0	1
Minor View	If the home had a Minor View of the turbines when it sold for the second time (Yes = 1, No = 0)	OC	–	35	0.10	0.30	0	1
Moderate View	If the home had a Moderate View of the turbines when it sold for the second time (Yes = 1, No = 0)	OC	–	5	0.01	0.12	0	1
Substantial/Extreme View	If the home had a Substantial or Extreme View of the turbines when it sold for the second time (Yes = 1, No = 0)	OC	–	9	0.03	0.12	0	1
Less than 1 Mile	If the home was within 1 mile (5280 feet) of the turbines when it sold for the second time (Yes = 1, No = 0)	OC	–	14	0.02	0.13	0	1
Between 1 and 3 Miles	If the home was between 1 and 3 miles of the turbines when it sold for the second time (Yes = 1, No = 0)	OC	–	199	0.56	0.50	0	1
Between 3 and 5 Miles	If the home was between 3 and 5 miles of the turbines when it sold for the second time (Yes = 1, No = 0)	OC	–	116	0.33	0.47	0	1
Outside 5 Miles	If the home was outside 5 miles of the turbines when it sold for the second time (Yes = 1, No = 0)	Omitted	n/a	25	0.07	0.26	0	1

"C" Continuous, "OC" Ordered Categorical (1 = yes, 0 = no) values are interpreted in relation to the "Omitted" category. This table does not include the study area fixed effects variables that are included in the model (e.g., WAOR, TXHC, NYMC). The reference case for these variables is the WAOR study area.

6.3. Model Form

To investigate the presence of Area, Scenic Vista, and Nuisance Stigmas, the adjusted annual appreciation rate (AAR) is calculated for the 354 sales pairs in the manner described in equation (10), using inflation adjusted sales prices. The following model is then estimated:

$$\text{AAR} = \beta_0 + \sum_{s} \beta_1 \text{S} + \sum_{k} \beta_2 \text{X} + \sum_{v} \beta_3 \text{VIEW} + \sum_{d} \beta_4 \text{DISTANCE} + \varepsilon \qquad (11)$$

where

AAR represents the inflation-adjusted Annual Appreciation Rate for repeat sales,

S is the vector of *s* Study Area fixed effects variables (e.g., WAOR, OKCC, etc.),

X is a vector of *k* home, site and sale characteristics (e.g., acres, square feet, original sales price),

VIEW is a vector of *v* categorical view variables (e.g., MINOR, MODERATE, etc.),

DISTANCE is a vector of *d* categorical distance variables (e.g., less than one mile, between one and three miles, etc.),

β_0 is the constant or intercept across the full sample,

β_1 is a vector of *s* parameter estimates for the study area fixed effects as compared to sales that occurred in the WAOR study area,

β_2 is a vector of *k* parameter estimates for the home, site, and sale characteristics,

β_3 is a vector of *v* parameter estimates for the VIEW variables as compared to transactions of homes with no view of the turbines,

β_4 is a vector of *d* parameter estimates for the DISTANCE variables as compared to transactions of homes outside of five miles, and

ε is a random disturbance term.

Effectively, this model seeks to identify reasons that AARs vary among those sales pairs in the sample. Reasons for such differences in AARs might include variations in home and site characteristics, the study area in which the sale occurs, or the degree to which the home is in proximity to or has a dramatic view of a wind facility. As such, the model as shown by equation (11) has three primary groups of parameters: variables of interest; home, site, and sale characteristics; and study area fixed effects.

The variables of interest are VIEW and DISTANCE, and the coefficients β_3 and β_4 are therefore the primary focus of this analysis. Because of the small numbers of homes in the sample situated inside of 3000 feet and between 3000 feet and one mile, they are collapsed into a single category (inside one mile). For the same reason, homes with SUBSTANTIAL or EXTREME VIEWS are collapsed into a single category (SUBSTANTIAL/EXTREME). In this model, therefore, the influence on appreciation rates of the following variables of interest is estimated: MINOR, MODERATE, and SUBSTANTIAL/EXTREME VIEWS, and less than one mile, between one and three mile, and between three and five mile DISTANCES. For the VIEW fixed-effects variables, the reference category is NO VIEW; for DISTANCE, it is homes outside of five miles. As with previous models, if effects exist, it is expected that all of the coefficients would be negative and monotonically ordered.

The number of home, site, and sale characteristics included in a repeat sales model is typically substantially lower than in a hedonic model. This is to be expected because, as discussed earlier, the repeat sales model explores variations in AARs for sales pairs from individual homes, and home and site characteristics are relatively stable over time for any individual home. Nonetheless, various characteristics have been found by others (e.g., Kiel and McClain, 1995; McCluskey and Rausser, 2003) to affect appreciation rates. For the purposes of the Repeat Sales Model, these include the number of square feet of living space (SQFT_1000), the number of acres (ACRES), the inflation-adjusted price of the home at the first sale (SalePrice96_Pre), and that sales price squared (SalePrice96_Pre_Sqr). Of those characteristics, the SQFT_1000 and ACRES coefficients are expected to be positive indicating that, all else being equal, an increase in living area and lot size increases the relative appreciation rate. Conversely, it is expected that the combined estimated effect of the initial sales prices (SalePrice96_Pre and SalePrice96_Pre_Sqr) will trend downward, implying that as the initial sales price of the house increases the appreciation rate decreases. These expectations are in line with the previous literature (Kiel and McClain, 1995; McCluskey and Rausser, 2003).

Finally, the study-area fixed effects variables (β_1) are included in this model to account for differences in inflation adjusted appreciation rates that may exist across study areas (e.g., WAOR, TXHC, NYMC). The WAOR study area is the reference category, and all study-area coefficients therefore represent the marginal change in AARs compared to WAOR (the intercept represents the marginal change in AAR for WAOR by itself). These study area parameters provide a unique look into Area Stigma effects. Recall that the appreciation rates used in this model are adjusted for inflation by using an inflation index from the nearby municipal statistical area (MSA). These MSAs are sometimes quite far away (as much as 20 miles) and therefore would be unaffected by the wind facility. As such, any variation in the study area parameters (and the intercept) would be the result of local influences not otherwise captured in the inflation

adjustment, and represent another test for Area Stigma; if effects exist, it is expected that the β_0 and β_1 coefficients will be negative.

As with the hedonic models presented earlier, the assumptions of homoskedasticity, absence of spatial autocorrelation, reasonably little multicollinearity, and appropriate controls for outliers are addressed as described in the associated footnote and in Appendix G.[93]

6.4. Analysis of Results

The results from the Repeat Sales Model are presented in Table 28. The model performs relatively poorly overall, with an Adjusted R^2 of just 0.19 (and an *F*-test statistic of 5.2). Other similar analyses in the literature have produced higher performance statistics but have done so with samples that are considerably larger or more homogenous than ours.[94] The low R^2 found here should not be cause for undue concern, however, given the relatively small sample spread across ten different study areas. Moreover, many of the home and site characteristics are found to be statistically significant, and of the appropriate sign. The coefficient for the adjusted initial sales price (SalePrice96_Pre), for example, is statistically significant, small, and negative (-0.000001, *p* value 0.00), while the coefficient for the adjusted initial sales price squared (SalePrice96_Pre_Sqr) is also statistically significant and considerably smaller (<0.000000, *p* value 0.00). These results imply, consistent with the prior literature, that for those homes in the sample, an increase in initial adjusted sales price decreases the average percentage appreciation rate. ACRES (0.002, *p* value 0.10) and SQFT_1000 (0.02, *p* value 0.00) are both positive, as expected, and statistically significant.

Of particular interest are the intercept term and the associated study-area fixed effect coefficients, and what they collectively say about Area Stigma. The coefficient for the intercept (β_0) is 0.005 (*p* value 0.81), which is both extremely small and not statistically significant. Likewise, the study-area fixed effects are all relatively small (less than 0.03 in absolute terms) and none are statistically significant. As discussed above, if a pervasive Area Stigma existed, it would be expected to be represented in these coefficients. Because all are small and statistically insignificant, it can again be concluded that there is no persuasive evidence of an Area Stigma among this sample of home transactions.

[93] All results are produced using White's corrected standard errors to control for heteroskedasticity. Spatial autocorrelation, with this small sample, is impossible to control. Because of the small sample, an even smaller number of neighboring sales exist, which are required to construct the spatial matrix. As such, spatial autocorrelation is not addressed in the repeat sales model. As with the hedonic models, some multicollinearity might exist, but that multicollinearity is unlikely to be correlated with the variables of interest. Outliers are investigated and dealt with as discussed in footnote 91 on page 56.

[94] McCluskey and Rausser (2003) had a sample of over 30,000 repeat sales and had an *F*-test statistic of 105; Kiel and McClain (1995) produced an R^2 that ranged from 0.40 to 0.63 with samples ranging from 53 to 145, but all sales took place in North Andover, MA.

Table 28: Results from Repeat Sales Model

	Coef.	SE	p Value	*n*
Intercept	0.005	0.02	0.81	354
WAOR	Omitted	Omitted	Omitted	6
TXHC	-0.01	0.02	0.63	57
OKCC	0.03	0.02	0.11	102
IABV	0.02	0.02	0.14	59
ILLC	-0.01	0.02	0.38	18
WIKCDC	0.02	0.03	0.50	8
PASC	-0.01	0.02	0.67	32
PAWC	0.02	0.02	0.16	35
NYMCOC	0.02	0.02	0.23	24
NYMC	0.03	0.02	0.13	13
SalePrice96_Pre	-0.000001	0.0000002	0.00	354
SalePrice96_Pre_Sqr	0.0000000	0.0000000	0.00	354
Acres	0.002	0.001	0.10	354
Sqft_1000	0.02	0.01	0.00	354
No View	Omitted	Omitted	Omitted	305
Minor View	-0.02	0.01	0.02	35
Moderate View	0.03	0.03	0.29	5
Substantial/Extreme View	-0.02	0.01	0.09	9
Less than 1 Mile	0.03	0.01	0.01	14
Between 1 and 3 Miles	0.01	0.01	0.59	199
Between 3 and 5 Miles	0.01	0.01	0.53	116
Outside 5 Miles	Omitted	Omitted	Omitted	25

"Omitted" = reference category for fixed effects variables
"n" indicates number of cases in category when category = "1"

Model Information

Model Equation Number	**11**
Dependent Variable	**SalePrice96_AAR**
Number of Cases	**354**
Number of Predictors (k)	**19**
F Statistic	**5.2**
Adjusted R2	**0.19**

Turning to the variables of interest, mixed results (see Figure 9 and Figure 10) are found. For homes with MINOR or SUBSTANTIAL/EXTREME VIEWS, despite small sample sizes, appreciation rates after adjusting for inflation are found to decrease by roughly 2% annually (*p* values of 0.02 and 0.09, respectively) compared to homes with NO VIEW. Though these findings initially seem to suggest the presence of Scenic Vista Stigma, the coefficients are not monotonically ordered, counter to what one might expect: homes with a MODERATE rated view appreciated on average 3% annually (*p* value 0.29) compared to homes with NO VIEW. Adding to the suspicion of these VIEW results, the DISTANCE coefficient for homes situated inside of one mile, where eight out of the nine SUBSTANTIAL/EXTREME rated homes are located, is positive and statistically significant (0.03, *p* value 0.01). If interpreted literally, these results suggest that a home inside of one mile with a SUBSTANTIAL/EXTREME rated view would experience a decrease in annual appreciation of 2% compared to homes with no views of turbines, but simultaneously would experience an increase of 3% in appreciation compared to homes outside of five miles. Therefore, when compared to those homes outside of five miles and with no view of the wind facilities, these homes would experience an overall increase in AAR by 1%. These results are counterintuitive and are likely driven by the small number of sales pairs

that are located within one mile of the wind turbines and experience a dramatic view of those turbines.

Figure 9: Repeat Sales Model Results for VIEW

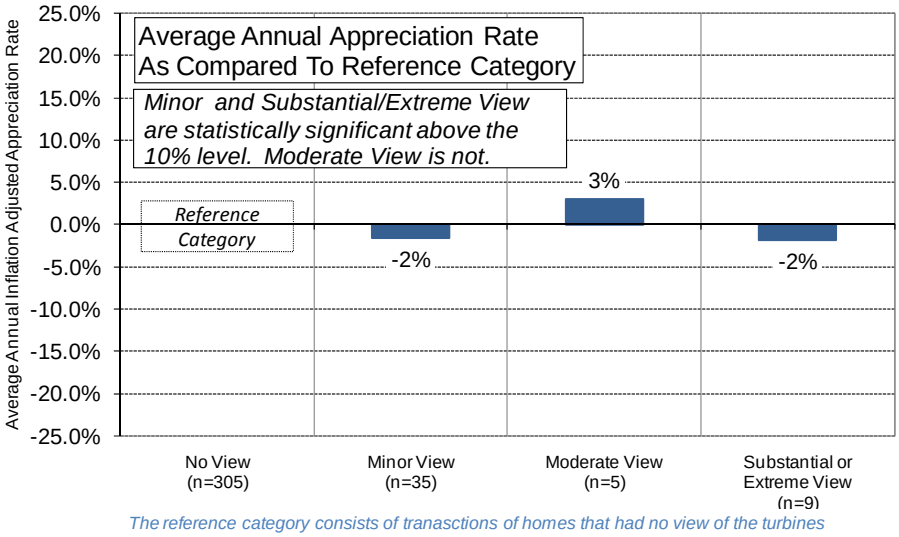
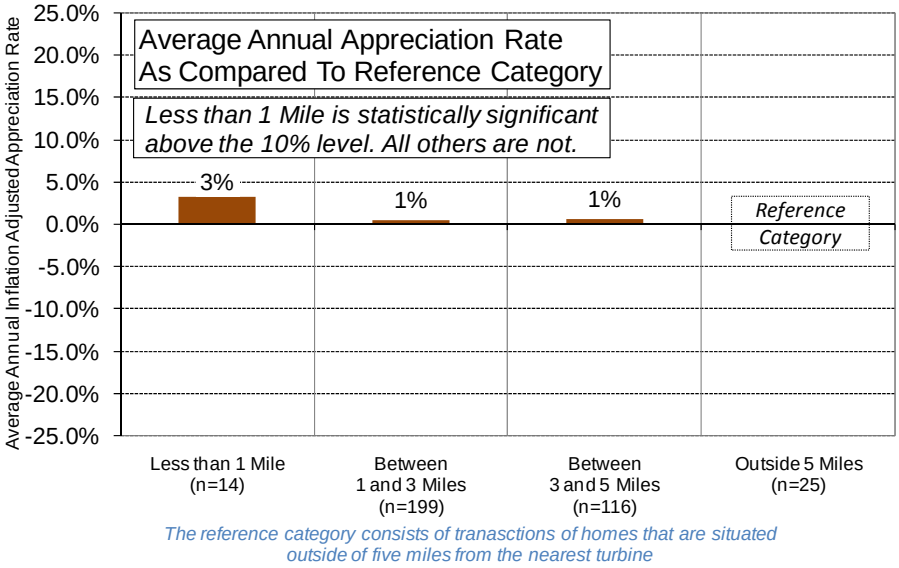


Figure 10: Repeat Sales Model Results for DISTANCE



Regardless of the reason for this result, again no persuasive evidence of consistent and widespread adverse effects is found from the presence of the wind facilities in the sample, reinforcing the findings from the previous hedonic analysis. Specifically, there is no evidence that an Area Stigma exists in that homes outside of one mile and inside of five miles do not appreciate differently than homes farther away. Similarly, there is no evidence of a Nuisance Stigma. Appreciation rates for homes inside of one mile are not adversely affected; in fact, significantly higher appreciation rates are found for these homes than for those homes located outside of five miles from the nearest wind facility. Finally, though some evidence is found that a Scenic Vista Stigma may exist in the sample of repeat sales, it is weak, fairly small, and

somewhat counter-intuitive. This result is likely driven by the small number of sales pairs that are located within one mile of the wind turbines and that experience a dramatic view of those turbines.

7. Sales Volume Analysis

The analysis findings to this point suggest that, among the sample of sales transactions analyzed in this report, wind facilities have had no widespread and statistically identifiable impact on residential property values. A related concern that has not yet been addressed is that of sales volume: does the presence of wind facilities either increase or decrease the rate of home sales transactions? On the one hand, a decrease in sales volumes might be expected. This might occur if homeowners expect that their property values will be impacted by the presence of the wind facility, and therefore simply choose not to sell their homes as a result, or if they try to sell but are not easily able to find willing buyers. Alternatively, an increase in sales volume might be expected if homeowners that are located near to or have a dominating view of wind turbines are uncomfortable with the presence of those turbines. Though those homes may sell at a market value that is not impacted by the presence of the wind facilities, self-selection may lead to accelerated transaction volumes shortly after facility announcement or construction as homeowners who view the turbines unfavorably sell their homes to individuals who are not so stigmatized. To address the question of whether and how sales volumes are impacted by nearby wind facilities, sales volumes are analyzed for those homes located at various distances from the wind facilities in the sample, during different facility development periods.

7.1. Dataset

To investigate whether sales volumes are affected by the presence of wind facilities two sets of data are assembled: (1) the number of homes available to sell annually within each study area, and (2) the number of homes that actually did sell annually in those areas. Homes potentially "available to sell" are defined as all single family residences within five miles of the nearest turbine that are located on a parcel of land less than 25 acres in size, that have only one residential structure, and that had a market value (for land and improvements) above $10,000.[95] Homes that "did sell" are defined as every valid sale of a single family residence within five miles of the nearest turbine that are located on a parcel of land less than 25 acres in size, that have only one residential structure, and that sold for more than $10,000.

The sales data used for this analysis are slightly different from those used in the hedonic analysis reported earlier. As mentioned in Section 3.3, a number of study areas were randomly sampled to limit the transactions outside of 3 miles if the total number of transactions were to exceed that which could efficiently be visited in the field (n ~1,250). For the sales volume analysis, however, field data collection was not required, and all relevant transactions could therefore be used. Secondly, two study areas did not provide the data necessary for the sales volume analysis (WAOR and OKCC), and are therefore excluded from the sample. Finally, data for some homes that were "available to sell" were not complete, and rather than including only a small selection of these homes, these subsets of data were simply excluded from the analysis. These excluded homes include those located outside of five miles of the nearest wind turbine, and those available to sell or that did sell more than three years before wind facility announcement.[96] The resulting

[95] "Market value" is the estimated price at which a home would sell as of a given point in time.

[96] For instance, some providers supplied sales data out to ten miles, but only provided homes available to sell out to five miles. As well, data on homes that did sell were not consistently available for periods many years before announcement.

dataset spans the period starting three years prior to facility announcement and ending four years after construction. All homes in this dataset are situated inside of five miles, and each is located in one of the eight represented study areas.[97]

The final set of homes potentially "available to sell" and that actually "did sell" are then segmented into three distance categories: inside of one mile, between one and three miles, and between three and five miles. For each of these three distance categories, in each of the eight study areas, and for each of the three years prior to announcement, the period between announcement and construction, and each of the four years following construction, the number of homes that sold as a percentage of those available to sell is calculated.[98] This results in a total of 24 separate sales volume calculations in each study area, for a total of 192 calculations across all study areas. Finally, these sales volumes are averaged across all study areas into four development period categories: less than three years before announcement, after announcement but before construction, less than two years after construction, and between two and four years after construction.[99] The resulting average annual sales volumes, by distance band and development period, are shown in Table 29 and Figure 11.

Table 29: Sales Volumes by PERIOD and DISTANCE

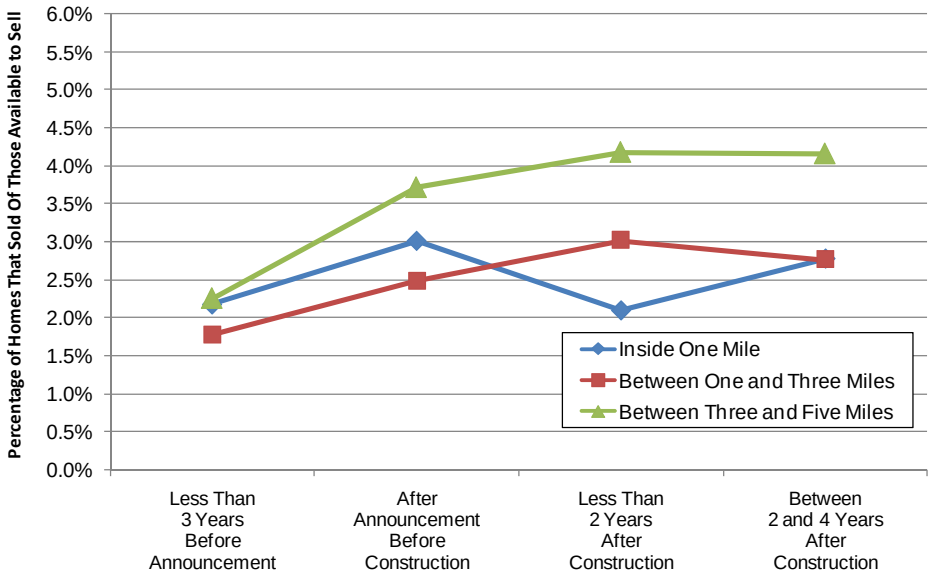
	Inside 1 Mile	**Between 1 and 3 Miles**	**Between 3 and 5 Miles**
Less Than 3 Years Before Announcement	2.2%	1.8%	2.3%
After Announcement Before Construction	3.0%	2.5%	3.7%
Less Than 2 Years After Construction	2.1%	3.0%	4.2%
Between 2 and 4 Years After Construction	2.8%	2.8%	4.2%

[97] The number of homes "available to sell" is constructed for each year after 1996 based on the year the homes in each study area were built. For many homes in the sample, the year built occurred more than three years before wind facility announcement, and therefore those homes are "available to sell" in all subsequent periods. For some homes, however, the home was built during the wind facility development process, and therefore becomes "available" some time after the first period of interest. For those homes, the build year is matched to the development dates so that it becomes "available" during the appropriate period. For this reason, the number of homes "available to sell" increases in later periods.

[98] For the period after announcement and before construction, which in all study areas was not exactly 12 months, the sales volume numbers are adjusted so that they corresponded to an average over a 12 month period.

[99] These temporal groupings are slightly different from those used in the hedonic Temporal Aspects Model. Namely, the period before announcement is not divided into two parts – more than two years before announcement and less than two years before announcement – but rather only one – less than three years before announcement. This simplification is made to allow each of the interaction categories to have enough data to be meaningful.

Figure 11: Sales Volumes by PERIOD and DISTANCE



7.2. Model Form

To investigate whether the rate of sales transactions is measurably affected by the wind facilities, the various resulting sales volumes shown above in Table 29 and Figure 11 are compared using a *t*-Test, as follows:

$$t = \frac{(\bar{x}_1 - \bar{x}_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \tag{12}$$

where

$\bar{x}_1$ and $\bar{x}_2$ are the mean sales volumes from the two categories being compared,

s_1^2 and s_2^2 are variances of the sales volumes from the two categories being compared, and

n_1 and n_2 are numbers of representative volumes in the two categories.[100]

The degrees of freedom used to calculate the *p*-value of the *t* statistic equals the lower of $(n_1 - 1)$ or $(n_2 - 1)$.

Three sets of *t*-Tests are conducted. First, to test whether sales volumes have changed with time and are correlated with wind facility construction, the volumes for each DISTANCE group in later periods (x_1) are compared to the volume in that same group in the pre-announcement period (x_2). Second, to test whether sales volumes are impacted by distance to the nearest wind turbine, the volumes for each PERIOD group at distances closer to the turbines (x_1) are compared to the volume in that same group in the three to five mile distance band (x_2). Finally, for reasons that will become obvious later, the sales volumes for each PERIOD group at distances within one

[100] The number of representative volumes could differ between the two categories. For instance, the "less than three years before announcement" category represents three years – and therefore three volumes – for each study area for each distance band, while the "less than two years after construction" category represents two years – and therefore two volumes – for each study area for each distance band.

mile and outside of three miles of the turbines (x_1) are compared to the sales volume in that same group in the one to three mile distance band (x_2). These three tests help to evaluate whether sales volumes are significantly different after wind facilities are announced and constructed, and whether sales volumes near the turbines are affected differently than for those homes located farther away.[101]

7.3. Analysis of Results

Table 29 and Figure 11 above show the sales volumes in each PERIOD and DISTANCE category, and can be interpreted as the percentage of homes that are available to sell that did sell in each category, on an annual average basis. The sales volume between one and three miles and before facility announcement is the lowest, at 1.8%, whereas the sales volumes for homes located between three and five miles in both periods following construction are the highest, at 4.2%.

The difference between these two sales volumes can be explained, in part, by two distinct trends that are immediately noticeable from the data presented in Figure 11. First, sales volumes <u>in all periods</u> are highest for those homes located in the three to five mile distance band. Second, sales volumes <u>at virtually all distances</u> are higher after wind facility announcement than they were before announcement.[102]

To test whether these apparent trends are borne out statistically the three sets of *t*-Tests described earlier are performed, the results of which are shown in Table 30, Table 31, and Table 32. In each table, the difference between the subject volume (x_1) and the reference volume (x_2) is listed first, followed by the *t* statistic, and whether the statistic is significant at or above the 90% level ("*").

Table 30 shows that mean sales volumes in the post-announcement periods are consistently greater than those in the pre-announcement period, and that those differences are statistically significant in four out of the nine categories. For example, the post-construction sales volumes for homes in the three to five mile distance band in the period less than two years after construction (4.2%) and between three and four years after construction (4.2%) are significantly greater than the pre-announcement volume of 2.3% (1.9%, $t = 2.40$; 1.9%, $t = 2.31$). Similarly, the post-construction sales volumes between one and three miles are significantly greater than the pre-announcement volume. These statistically significant differences, it should be noted, could be as much related to the low reference volume (i.e., sales volume in the period less than

[101] An alternative method to this model would be to pool the homes that "did sell" with the homes "available to sell" and construct a Discrete Choice Model where the dependent variable is zero (for "no sale") or one (for "sale") and the independent variables would include various home characteristics and the categorical distance variables. This would allow one to estimate the probability that a home sells dependent on distance from the wind facility. Because home characteristics data for the homes "available to sell," was not systematically collected it was not possible to apply this method to the dataset.

[102] It is not entirely clear why these trends exist. Volumes may be influenced upward in areas farther from the wind turbines, where homes, in general, might be more densely sited and homogenous, both of which might be correlated with greater home sales transactions. The converse might be true in more rural areas, nearer the wind turbines, where homes may be more unique or homeowners less prone to move. The increasing sales volumes seen in periods following construction, across all distance bands, may be driven by the housing bubble, when more transactions were occurring in general.

three years before announcement), as they are to the sales volumes to which the reference category is compared. Finally, when comparing post-construction volumes inside of a mile, none are statistically different than the 2.2% pre-announcement level.

Table 30: Equality Test of Sales Volumes between PERIODS

	Inside 1 Mile	Between 1 and 3 Miles	Between 3 and 5 Miles
Less Than 3 Years Before Announcement	Reference	Reference	Reference
After Announcement Before Construction	0.8% (0.72)	0.7% (0.99)	1.5% (1.49)
Less Than 2 Years After Construction	-0.1% (-0.09)	1.2% (2.45) *	1.9% (2.4) *
Between 2 and 4 Years After Construction	0.6% (0.54)	1% (2.24) *	1.9% (2.31) *

Numbers in parenthesis represent t-Test statistics. "" = significantly different at or below the 10% level*

Turning to sales volumes in the same development period but between the different distance bands, consistent but less statistically significant results are uncovered (see Table 31). Although all sales volumes inside of three miles, for each period, are less than their peers outside of three miles, those differences are statistically significant in only two out of eight instances. Potentially more important, when one compares the sales volumes inside of one mile to those between one and three miles (see Table 32), small differences are found, none of which are statistically significant. In fact, on average, the sales volumes for homes inside of one mile are greater or equal to the volumes of those homes located between one and three miles in two of the three post-announcement periods. Finally, it should be noted that the volumes for the inside one mile band, in the period immediately following construction, are less than those in the one to three mile band in the same period. Although not statistically significant, this difference might imply an initial slowing of sales activity that, in later periods, returns to more normal levels. This possibility is worth investigating further and is therefore recommended for future research.

Table 31: Equality Test of Volumes between DISTANCES using 3-5 Mile Reference

	Inside 1 Mile	Between 1 and 3 Miles	Between 3 and 5 Miles
Less Than 3 Years Before Announcement	-0.1% (-0.09)	-0.5% (-0.88)	Reference
After Announcement Before Construction	-0.7% (-0.56)	-1.2% (-1.13)	Reference
Less Than 2 Years After Construction	-2.1% (-2.41) *	-1.2% (-1.48)	Reference
Between 2 and 4 Years After Construction	-1.4% (-1.27)	-1.4% (-1.82) *	Reference

Numbers in parenthesis represent t-Test statistics. "" = significantly different at or below the 10% level*

Table 32: Equality Test of Sales Volumes between DISTANCES using 1-3 Mile Reference

	Inside 1 Mile	Between 1 and 3 Miles	Between 3 and 5 Miles
Less Than 3 Years Before Announcement	0.4% (0.49)	Reference	0.5% (0.88)
After Announcement Before Construction	0.5% (0.47)	Reference	1.2% (1.13)
Less Than 2 Years After Construction	-0.9% (-1.38)	Reference	1.2% (1.48)
Between 2 and 4 Years After Construction	0% (0.01)	Reference	1.4% (1.82) *

Numbers in parenthesis represent t-Test statistics. "" = significantly different at or below the 10% level*

Taken together, these results suggest that sales volumes are not conclusively affected by the announcement and presence of the wind facilities analyzed in this report. At least among this sample, sales volumes increased in all distance bands after the announcement and construction of the wind facilities. If this result was driven by the presence of the wind facilities, however, one would expect that such impacts would be particularly severe for those homes in close proximity to wind facilities. In other words, sales volumes would be the most affected inside of one mile, where views of the turbines are more frequent and where other potential nuisances are more noticeable than in areas farther away. This is not borne out in the data - no statistically significant differences are found for sales volumes inside of one mile as compared to those between one and three miles, and sales volumes outside of three miles are higher still. Therefore, on the whole, this analysis is unable to find persuasive evidence that wind facilities have a widespread and identifiable impact on overall residential sales volumes. It is again concluded that neither Area nor Nuisance Stigma are in evidence in this analysis.

8. Wind Projects and Property Values: Summary of Key Results

This report has extensively investigated the potential impacts of wind power facilities on the value (i.e., sales prices) of residential properties that are in proximity to and/or that have a view of those wind facilities. In so doing, three different potential impacts of wind projects on property values have been identified and analyzed: Area Stigma, Scenic Vista Stigma, and Nuisance Stigma. To assess these potential impacts, a primary (Base) hedonic model has been applied, seven alternative hedonic models have been explored, a repeat sales analysis has been conducted, and possible impacts on sales volumes have been evaluated. Table 33 outlines the resulting ten tests conducted in this report, identifies which of the three potential stigmas those tests were designed to investigate, and summarizes the results of those investigations. This section synthesizes these key results, organized around the three potential stigmas.

Table 33: Impact of Wind Projects on Property Values: Summary of Key Results

	Is there statistical evidence of:			
Statistical Model	**Area Stigma?**	**Scenic Vista Stigma?**	**Nuisance Stigma?**	**Section Reference**
Base Model	No	No	No	*Section 4*
View Stability	Not tested	No	Not tested	*Section 5.1*
Distance Stability	No	Not tested	No	*Section 5.1*
Continuous Distance	No	No	No	*Section 5.2*
All Sales	No	No	Limited	*Section 5.3*
Temporal Aspects	No	No	No	*Section 5.4*
Orientation	No	No	No	*Section 5.5*
Overlap	No	Limited	No	*Section 5.6*
Repeat Sales	No	Limited	No	*Section 6*
Sales Volume	No	Not tested	No	*Section 7*

"No"…….. No statistical evidence of a negative impact
"Yes"……. Strong statistical evidence of a negative impact
"Limited"…….. Limited and inconsistent statistical evidence of a negative impact
"Not tested"…… This model did not test for this stigma

8.1. Area Stigma

Area Stigma is defined as a concern that the general area surrounding a wind energy facility will appear more developed, which may adversely affect home values in the local community regardless of whether any individual home has a view of the wind turbines. Though these impacts might be expected to be especially severe at close range to the turbines, the impacts could conceivably extend for a number of miles around a wind facility. Modern wind turbines are visible from well outside of five miles in many cases, so if an Area Stigma exists, it is possible that all of the homes in the study areas inside of five miles would be affected.

As summarized in Table 33, Area Stigma is investigated with the Base, Distance Stability, Continuous Distance, All Sales, Temporal Aspects, Orientation, and Overlap hedonic models. It is also tested, somewhat differently, with the Repeat Sales and Sales Volume analyses. In each case, if an Area Stigma exists, it is expected that the sales prices (and/or sales volume) of homes

located near wind facilities would be broadly affected by the presence of those facilities, with effects decreasing with distance.

The Base Model finds little evidence of an Area Stigma, as the coefficients for the DISTANCE variables are all relatively small and none are statistically different from zero. For homes in this sample, at least, there is no statistical evidence from the Base Model that the distance from a home to the nearest wind turbine impacts sales prices, regardless of the distance band. Perhaps a more direct test of Area Stigma, however, comes from the Temporal Aspects Model. In this model, homes in all distance bands that sold after wind facility announcement are found to sell, on average, for prices that are not statistically different from those for homes that sold more than two years prior to wind facility announcement. Again, no persuasive evidence of an Area Stigma is evident.

The Repeat Sales and Sales Volume Models also investigate Area Stigma. The Repeat Sales Model's 354 homes, each of which sold once before facility announcement and again after construction, show average inflation-adjusted annual appreciation rates that are small and not statistically different from zero. If homes in all study areas were subject to an Area Stigma, one would expect a negative and statistically significant intercept term. Similarly, if homes in any individual study area experienced an Area Stigma, the fixed effect terms would be negative and statistically significant. Neither of these expectations is borne out in the results. The Sales Volume Model tells a similar story, finding that the rate of residential transactions is either not significantly different between the pre- and post-announcement periods, or is greater in later periods, implying, in concert with the other tests, that increased levels of transactions do not signify a rush to sell, and therefore lower prices, but rather an increase in the level of transactions with no appreciable difference in the value of those homes.

The All Sales, Distance Stability, Continuous Distance, Orientation, and Overlap Models corroborate these basic findings. In the All Sales and Distance Stability Models, for example, the DISTANCE coefficients for homes that sold outside of one mile but within five miles, compared to those that sold outside of five miles, are very similar: they differ by no more than 2%, and this small disparity is not statistically different from zero. The same basic findings resulted from the Orientation and Overlap Models. Further, homes with No View as estimated in the All Sales Model are found to appreciate in value, after adjusting for inflation, when compared to homes that sold before wind facility construction (0.02, p value 0.06); an Area Stigma effect should be reflected as a negative coefficient for this parameter. Finally, despite using all 4,937 cases in a single distance variable and therefore having a correspondingly small standard error, the Continuous Distance Model discovers no measurable relationship between distance from the nearest turbine and the value of residential properties.

Taken together, the results from these models are strikingly similar: there is no evidence of a widespread and statistically significant Area Stigma among the homes in this sample. Homes in these study areas are not, on average, demonstrably and measurably stigmatized by the arrival of a wind facility, regardless of when they sold in the wind project development process and regardless of whether those homes are located one mile or five miles away from the nearest wind facility.

Drawing from the previous literature on environmental disamenities discussed in Section 2.1, one likely explanation for this result is simply that any effects that might exist may have faded to a level indistinguishable from zero at distances outside of a mile from the wind facilities. For other disamenities, some of which would seemingly be more likely to raise concerns, effects have been found to fade quickly with distance. For example, property value effects near a chemical plant have been found to fade outside of two and a half miles (Carroll et al., 1996), near a lead smelter (Dale et al., 1999) and fossil fuel plants (Davis, 2008) outside of two miles, and near landfills and confined animal feeding operations outside of 2,400 feet and 1,600 feet, respectively (Ready and Abdalla, 2005). Further, homes outside of 300 feet (Hamilton and Schwann, 1995) or even as little as 150 feet (Des-Rosiers, 2002) from a high voltage transmission line have been found to be unaffected. A second possible explanation for these results could be related to the view of the turbines. In the sample used for this analysis, a large majority of the homes outside of one mile (n = 4,812) that sold after wind-facility construction commenced cannot see the turbines (n = 4,189, 87%), and a considerably larger portion have – at worst – a minor view of the turbines (n = 4,712, 98%). Others have found that the sales prices for homes situated at similar distances from a disamenity (e.g., HVTL) depend, in part, on the , view of that disamenity (Des-Rosiers, 2002). Similarly, research has sometimes found that annoyance with a wind facility decreases when the turbines cannot be seen (Pedersen and Waye, 2004). Therefore, for the overwhelming majority of homes outside of a mile that have either a minor rated view or no view at all of the turbines, the turbines may simply be out of sight, and therefore, out of mind.

8.2. Scenic Vista Stigma

Scenic Vista Stigma is defined as concern that a home may be devalued because of the view of a wind energy facility, and the potential impact of that view on an otherwise scenic vista. It has as its basis an admission that home values are, to some degree, derived from the quality of what can be seen from the property and that if those vistas are altered, sales prices might be measurably affected. The Base, View Stability, Continuous Distance, All Sales, Temporal Aspects, Orientation, Overlap, and Repeat Sales Models each test whether Scenic Vista Stigma is present in the sample.

The Base Model, as well as subsequent Alternative Hedonic Models, demonstrates persuasively that the quality of the scenic vista – absent wind turbines – impacts sales prices. Specifically, compared to homes with an AVERAGE VISTA, those having a POOR or a BELOW AVERAGE rating are estimated to sell for 21% (p value 0.00) and 8% (p value 0.00) less, on average. Similarly, homes with an ABOVE AVERAGE or PREMIUM rating are estimated to sell for 10% (p value 0.00) and 13% (p value 0.00) more than homes with an AVERAGE vista rating. Along the same lines, homes in the sample with water frontage or situated on a cul-de-sac sell for 33% (p value 0.00) and 10% (p value 0.00) more, on average, than those homes that lack these characteristics. Taken together, these results demonstrate that home buyers and sellers consistently take into account what can be seen from the home when sales prices are established, and that the models presented in this report are able to clearly identify those impacts.[103]

[103] Of course, cul-de-sacs and water frontage bestow other benefits to the home owner beyond the quality of the scenic vista, such as safety and privacy in the case of a cul-de-sac, and recreational potential and privacy in the case of water frontage.

Despite this finding, those same hedonic models are unable to identify a consistent and statistically significant Scenic Vista Stigma associated with wind facilities. Home buyers and sellers, at least among this sample, do not appear to be affected in a measurable way by the visual presence of wind facilities. Regardless of which model was estimated, the value of homes with views of turbines that were rated MODERATE, SUBSTANTIAL, or EXTREME are found to be statistically indistinguishable from the prices of homes with no view of the turbines. Specifically, the 25 homes with EXTREME views in the sample, where the home site is "unmistakably dominated by the [visual] presence of the turbines," are not found to have measurably different property values, and neither are the 31 homes with a SUBSTANTIAL view, where "the turbines are dramatically visible from the home."[104] The same finding holds for the 106 homes that were rated as having MODERATE views of the wind turbines. Moreover, the Orientation and Overlap Models show that neither the orientation of the home with respect to the view of wind turbines, nor the overlap of that view with the prominent scenic vista, have measurable impacts on home prices.

The All Sales Model compares homes with views of the turbines (in the post-construction period) to homes that sold before construction (when no views were possible), and finds no statistical evidence of adverse effects within any VIEW category. Moreover, when a *t*-Test is performed to compare the NO VIEW coefficient to the others, none of the coefficients for the VIEW ratings are found to be statistically different from the NO VIEW homes. The Repeat Sales Model comes to a similar result, with homes with MODERATE views appreciating at a rate that was not measurably different from that of homes with no views (0.03, *p* value 0.29). The same model also finds that homes with SUBSTANTIAL/EXTREME views appreciate at a rate 2% slower per year (*p* value 0.09) than their NO VIEW peers. Homes situated inside of one mile, however, are found to appreciate at a rate 3% more (*p* value 0.01) than reference homes located outside of five miles. Eight of the nine homes situated inside of one mile had either a SUBSTANTIAL or EXTREME view. Therefore, to correctly interpret these results, one would add the two coefficients for these homes, resulting in a combined 1% increase in appreciation as compared to the reference homes situated outside of five miles with no view of turbines, and again yielding no evidence of a Scenic Vista Stigma.

Although these results are consistent across most of the models, there are some individual coefficients from some models that differ. Specifically, homes with MINOR rated views in the Overlap and Repeat Sales Models are estimated to sell for 3% less (*p* value 0.10) and appreciate at a rate 2% less (*p* value 0.02) than NO VIEW homes. Taken at face value, these MINOR VIEW findings imply that homes where "turbines are visible, but, either the scope is narrow, there are many obstructions, or the distance between the home and the facility is large" are systematically impacted in a modest but measurable way. Homes with more dramatic views of a wind facility in the same models, on the other hand, are found to not be measurably affected. Because of the counterintuitive nature of this result, and because it is contradicted in the results of other models presented earlier, it is more likely that there is some aspect of these homes that was not modeled appropriately in the Overlap and Repeat Sales Models, and that the analysis is picking up the effect of omitted variable(s) rather than a systematic causal effect from the wind facilities.

[104] See Section 3.2.3 and Appendix C for full description of VIEW ratings.

Taken together, the results from all of the models and all of the VIEW ratings support, to a large degree, the Base Model findings of no evidence of a Scenic Vista Stigma. Although there are 160 residential transactions in the sample with more dramatic views than MINOR, none of the model specifications is able to find any evidence that those views of wind turbines measurably impacted average sales prices, despite the fact that those same models consistently find that home buyers and sellers place value on the quality of the scenic vista.

8.3. Nuisance Stigma

Nuisance Stigma is defined as a concern that factors that may occur in close proximity to wind turbines, such as sound and shadow flicker, will have a unique adverse influence on home values. If these factors impact residential sales prices, those impacts are likely to be concentrated within a mile of the wind facilities. The Base, Distance Stability, Continuous Distance, All Sales, Temporal Aspects, Orientation, Overlap, Repeat Sales, and Sales Volume Models all investigate the possible presence of a Nuisance Stigma.

The Base Model finds that those homes within 3000 feet and those between 3000 feet and one mile of the nearest wind turbine sold for roughly 5% less than similar homes located more than five miles away, but that these differences are not statistically significant (*p* values of 0.40 and 0.30, respectively). These results remain unchanged in the Distance Stability Model, as well as in the Orientation and Overlap Models. Somewhat similarly, in the All Sales Model, when all transactions occurring after wind facility announcement are assumed to potentially be impacted (rather than just those occurring after construction, as in the Base Model), and a comparison is made to the average of all transactions occurring pre-announcement (rather than the average of all transactions outside of five miles, as in the Base Model), these same coefficients grow to -6% (*p* value 0.23) and -8% (*p* value 0.08) respectively. Although only one of these coefficients was statistically significant, they are large enough to warrant further scrutiny.

The Temporal Aspects Model provides a clearer picture of these findings. It finds that homes that sold prior to wind facility announcement and that were situated within one mile of where the turbines were eventually located sold, on average, for between 10% and 13% less than homes located more than five miles away and that sold in the same period. Therefore, the homes nearest the wind facility's eventual location were already depressed in value before the announcement of the facility. Most telling, however, is what occurred after construction. Homes inside of one mile are found to have inflation-adjusted sales prices that were either statistically undistinguishable from, or in some cases greater than, pre-announcement levels. Homes sold in the first two years after construction, for example, have higher prices (0.07, *p* value 0.32), as do those homes that sold between two and four years after construction (0.13, *p* value 0.06) and more than four years after construction (0.08, *p* value 0.24). In other words, there is no indication that these homes experienced a decrease in sales prices after wind facility construction began. Not only does this result fail to support the existence of a Nuisance Stigma, but it also indicates that the relatively large negative coefficients estimated in the Base and All Sales Models are likely caused by conditions that existed prior to wind facility construction and potentially prior to facility announcement.[105]

[105] See footnote 82 on page 46 for a discussion of possible alternative explanations to this scenario.

These results are corroborated by the Continuous Distance Model, which finds no statistically significant relationship between an inverse DISTANCE function and sales prices (-0.01, sig 0.46). Similarly, in the Repeat Sales Model, homes within one mile of the nearest turbine are not found to be adversely affected; somewhat counter-intuitively, they are found to appreciate faster (0.03, *p* value 0.01) than their peers outside of five miles. Finally, the Sales Volume analysis does not find significant and consistent results that would suggest that the ability to sell one's home within one mile of a wind facility is substantially impacted by the presence of that facility.

Taken together, these models present a consistent set of results: the sales prices of homes in this sample that are within a mile of wind turbines, where various nuisance effects have been posited, are not measurably affected compared to those homes that are located more than five miles away from the facilities or that sold well before the wind projects were announced. These results imply that widespread Nuisance Stigma effects are either not present in the sample, or are too small or sporadic to be statistically identifiable.

Though these results may appear counterintuitive, it may simply be that property value impacts fade rapidly with distance, and that few of the homes in the sample are close enough to the subject wind facilities to be substantially impacted. As discussed earlier, studies of the property value impacts of high voltage transmission lines often find that effects fade towards zero at as little distance as 200 feet (see, e.g., Gallimore and Jayne, 1999; Watson, 2005). None of the homes in the present sample are closer than 800 feet to the nearest wind turbine, and all but eight homes are located outside of 1000 feet of the nearest turbine. It is therefore possible that, if any effects do exist, they exist at very close range to the turbines, and that those effects are simply not noticeable outside of 800 feet. Additionally, almost half of the homes in the sample that are located within a mile of the nearest turbine have either no view or a minor rated view of the wind facilities, and some high voltage transmission line (HVTL) studies have found a decrease in adverse effects if the towers are <u>not</u> visible (Des-Rosiers, 2002) and, similarly, decreases in annoyance with wind facility sounds if turbines cannot be seen (Pedersen and Waye, 2004). Finally, effects that existed soon after the announcement or construction of the wind facilities might have faded over time. More than half of the homes in the sample sold more than three years after the commencement of construction, while studies of HVTLs have repeatedly found that effects fade over time (Kroll and Priestley, 1992) and studies of attitudes towards wind turbines have found that such attitudes often improve after facility construction (Wolsink, 1989). Regardless of the explanation, the fact remains that, in this sizable sample of residential transactions, no persuasive evidence of a widespread Nuisance Stigma is found, and if these impacts do exist, they are either too small or too infrequent to result in any widespread and consistent statistically observable impact.

9. Conclusions

Though surveys generally show that public acceptance towards wind energy is high, a variety of concerns with wind development are often expressed at the local level. One such concern that is often raised in local siting and permitting processes is related to the potential impact of wind projects on the property values of nearby residences.

This report has investigated the potential impacts of wind power facilities on the sales prices of residential properties that are in proximity to and/or that have a view of those wind facilities. It builds and improve on the previous literature that has investigated these potential effects by collecting a large quantity of residential transaction data from communities surrounding a wide variety of wind power facilities, spread across multiple parts of the U.S. Each of the homes included in this analysis was visited to clearly determine the degree to which the wind facility was visible at the time of home sale and to collect other essential data. To frame the analysis, three potentially distinct impacts of wind facilities on property values are considered: Area, Scenic Vista, and Nuisance Stigma. To assess these potential impacts, the authors applied a base hedonic model, explored seven alternative hedonic models, conducted a repeat sales analysis, and evaluated possible impacts on sales volumes. The result is the most comprehensive and data-rich analysis to date on the potential impacts of wind projects on nearby property values.

Although each of the analysis techniques used in this report has strengths and weaknesses, the results are strongly consistent in that each model fails to uncover conclusive evidence of the presence of any of the three property value stigmas. Based on the data and analysis presented in this report, no evidence is found that home prices surrounding wind facilities are consistently, measurably, and significantly affected by either the view of wind facilities or the distance of the home to those facilities. Although the analysis cannot dismiss the possibility that individual or small numbers of homes have been or could be negatively impacted, if these impacts do exist, they are either too small and/or too infrequent to result in any widespread and consistent statistically observable impact. Moreover, to the degree that homes in the present sample are similar to homes in other areas where wind development is occurring, the results herein are expected to be transferable.

Finally, although this work builds on the existing literature in a number of respects, there remain a number of areas for further research. The primary goal of subsequent research should be to concentrate on those homes located closest to wind facilities, where the least amount of data are available. Additional research of the nature reported in this paper could be pursued, but with a greater number of transactions, especially for homes particularly close to wind facilities. Further, it is conceivable that cumulative impacts might exist whereby communities that have seen repetitive development are affected uniquely, and these cumulative effects may be worth investigating. A more detailed analysis of sales volume impacts may also be fruitful, as would an assessment of the potential impact of wind facilities on the length of time homes are on the market in advance of an eventual sale. Finally, it would be useful to conduct a survey of those homeowners living close to existing wind facilities, and especially those residents who have bought and sold homes in proximity to wind facilities after facility construction, to assess their opinions on the impacts of wind project development on their home purchase and sales decisions.

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Appendix A: Study Area Descriptions

The analysis reported in the body of the report used data from ten different wind-project study areas, across nine different states and 14 counties, and surrounding 24 different wind facilities. Each of the study areas is unique, but as a group they provide a good representation of the range of wind facility sizes, hub heights, and locations of recent wind development activity in the U.S. (see Figure A - 1 and Table A - 1). This appendix describes each of the ten study areas, and provides the following information: a map of the study area; a description of the area; how the data were collected; statistics on home sales prices in the sample and census-reported home values for the towns, county, and state that encompass the area; data on the wind facilities contained within the study area; and frequency tables for the variables of interest (i.e., views of turbines, distance to nearest turbine ,and development period).

Figure A - 1: Map of Study Areas

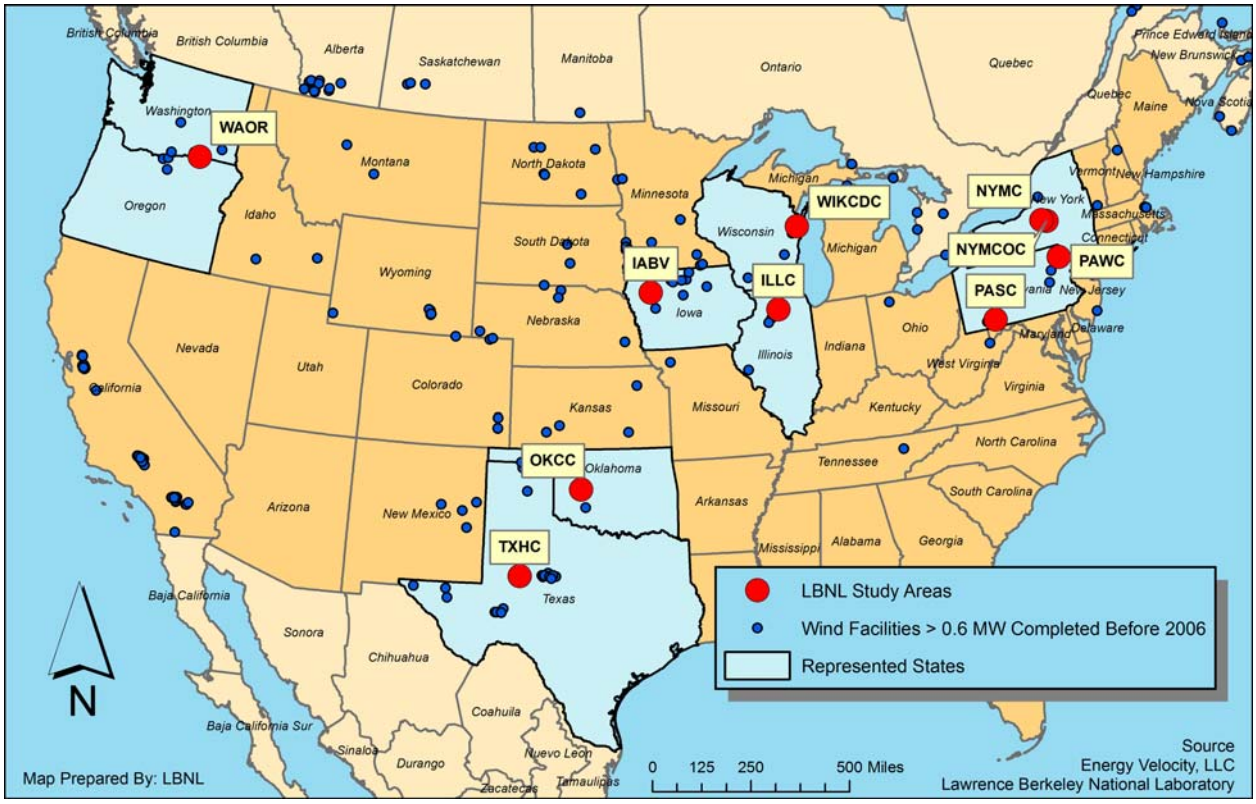
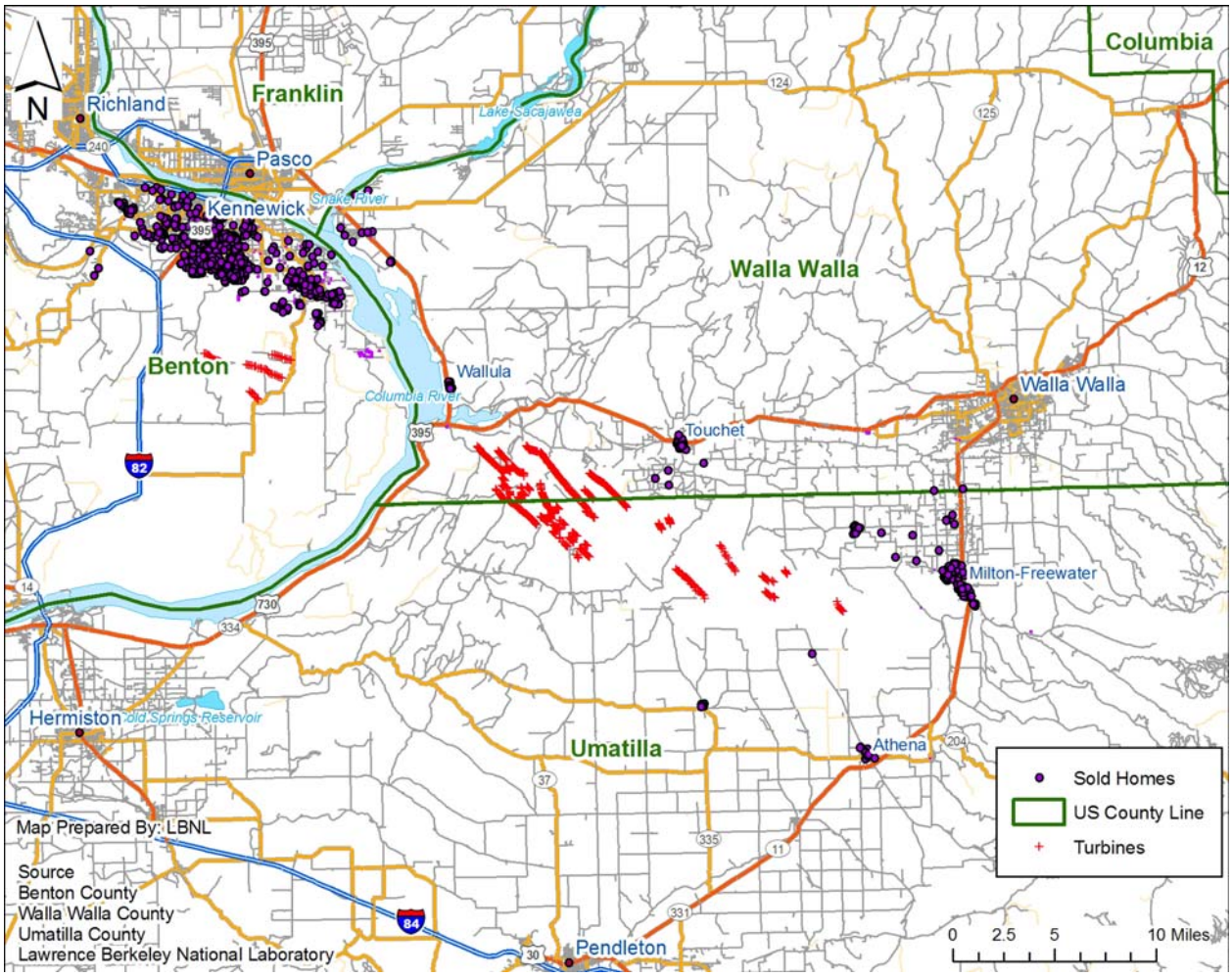


Table A - 1: Summary of Study Areas

Study Area Code	Study Area Counties, States	Facility Names	Number of Turbines	Number of MW	Max Hub Height (meters)	Max Hub Height (feet)
WAOR	Benton and Walla Walla Counties, WA and Umatilla County, OR	Vansycle Ridge, Stateline, Nine Canyon I & II, Combine Hills	582	429	60	197
TXHC	Howard County, TX	Big Spring I & II	46	34	80	262
OKCC	Custer County, OK	Weatherford I & II	98	147	80	262
IABV	Buena Vista County, IA	Storm Lake I & II, Waverly, Intrepid I & II	381	370	65	213
ILLC	Lee County, IL	Mendota Hills, GSG Wind	103	130	78	256
WIKCDC	Kewaunee and Door Counties, WI	Red River, Lincoln	31	20	65	213
PASC	Somerset County, PA	Green Mountain, Somerset, Meyersdale	34	49	80	262
PAWC	Wayne County, PA	Waymart	43	65	65	213
NYMCOC	Madison and Oneida Counties, NY	Madison	7	12	67	220
NYMC	Madison County, NY	Fenner	20	30	66	218
		TOTAL	**1345**	**1286**		

A.1 WAOR Study Area: Benton and Walla Walla Counties (Washington), and Umatilla County (Oregon)

Figure A - 2: Map of WAOR Study Area



Note: "Sold Homes" include all sold homes both before and after construction.

Area Description

This study area combines data from the three counties - Benton and Walla Walla in Washington, and Umatilla in Oregon - that surround the Vansycle Ridge, Stateline, Combine Hills, and Nine Canyon wind projects. Wind development began in this area in 1997 and, within the sample of wind projects, continued through 2003. In total, the wind facilities in this study area include 582 turbines and 429 MW of nameplate capacity, with hub heights that range from 164 feet to almost 200 feet. The wind facilities are situated on an East-West ridge that straddles the Columbia River, as it briefly turns South. The area consists of undeveloped highland/plateau grassland, agricultural tracks for winter fruit, and three towns: Kennewick (Benton County), Milton-Freewater (Umatilla County), and Walla Walla (Walla Walla County). Only the first two of these towns are represented in the dataset because Walla Walla is situated more than 10 miles from the nearest wind turbine. Also in the area are Touchet and Wallula, WA, and Athena, OR,

all very small communities with little to no services. Much of the area to the North and South of the ridge, and outside of the urban areas, is farmland, with homes situated on small parcels adjoining larger agricultural tracts.

Data Collection and Summary

Data for this study area were collected from a myriad of sources. For Benton County, sales and home characteristic data and GIS parcel shapefiles were collected with the assistance of county officials Eric Beswick, Harriet Mercer, and Florinda Paez, while state official Deb Mandeville (Washington Department of State) provided information on the validity of the sales. In Walla Walla County, county officials Bill Vollendorff and Tiffany Laposi provided sales, house characteristic, and GIS data. In Umatilla County, county officials Jason Nielsen, Tracie Diehl, and Tim McElrath provided sales, house characteristic, and GIS data.

Based on the data collection, more than 8,500 homes are found to have sold within ten miles of the wind turbines in this study area from January 1996 to June 2007. Completing field visits to this number of homes would have been overly burdensome; as a result, only a sample of these home sales was used for the study. Specifically, all valid sales within three miles of the nearest turbine are used, and a random sample of those homes outside of three miles but inside of five miles in Benton County and inside ten miles in Walla Walla and Umatilla Counties. This approach resulted in a total of 790 sales, with prices that ranged from $25,000 to $647,500, and a mean of $134,244. Of those 790 sales, 519 occurred after wind facility construction commenced, and 110 could see the turbines at the time of sale, though all but four of these homes had MINOR views. No homes within this sample were located within one mile of the nearest wind turbine, with the majority occurring outside of three miles.

Area Statistics

Study Period Begin	Study Period End	Number of Sales	Median Price	Mean Price	Minimum Price	Maximum Price
1/23/1996	6/29/2007	790	$ 125,803	$ 134,244	$ 25,000	$ 647,500

Facility Statistics

Facility Name	Number of MW	Number of Turbines	Announce Date	Construction Begin Date	Completion Date	Turbine Maker	Hub Height (Meters)
Vansycle Ridge	25	38	Aug-97	Feb-98	Aug-98	Vestas	50
Stateline Wind Project, Phase I (OR)	83	126	Jun-00	Sep-01	Dec-01	Vestas	50
Stateline Wind Project, Phase I (WA)	177	268	Jun-00	Feb-01	Dec-01	Vestas	50
Stateline Wind Project, Phase II	40	60	Jan-02	Sep-02	Dec-02	Vestas	50
Nine Canyon Wind Farm	48	37	Jun-01	Mar-02	Sep-02	Bonus	60
Combine Hills Turbine Ranch I	41	41	Apr-02	Aug-03	Dec-03	Mitsubishi	55
Nine Canyon Wind Farm II	16	12	Jun-01	Jun-03	Dec-03	Bonus	60

Source: AWEA & Ventyx Inc.

Variables of Interest Statistics

Development Period	Pre Announcement	Post Announcement Pre Construction	1st Year After Construction	2nd Year After Construction	2+ Years After Construction	Total
Benton/Walla Walla, WA & Umatilla, OR (WAOR)	226	45	76	59	384	790

View of Turbines	Pre Construction	None	Minor	Moderate	Substantial	Extreme	Total
Benton/Walla Walla, WA & Umatilla, OR (WAOR)	271	409	106	4	0	0	790

Distance to Nearest Turbine	Pre Construction	< 0.57 Miles	0.57 - 1 Miles	1 - 3 Miles	3 - 5 Miles	> 5 Miles	Total
Benton/Walla Walla, WA & Umatilla, OR (WAOR)	271	0	0	20	277	222	790

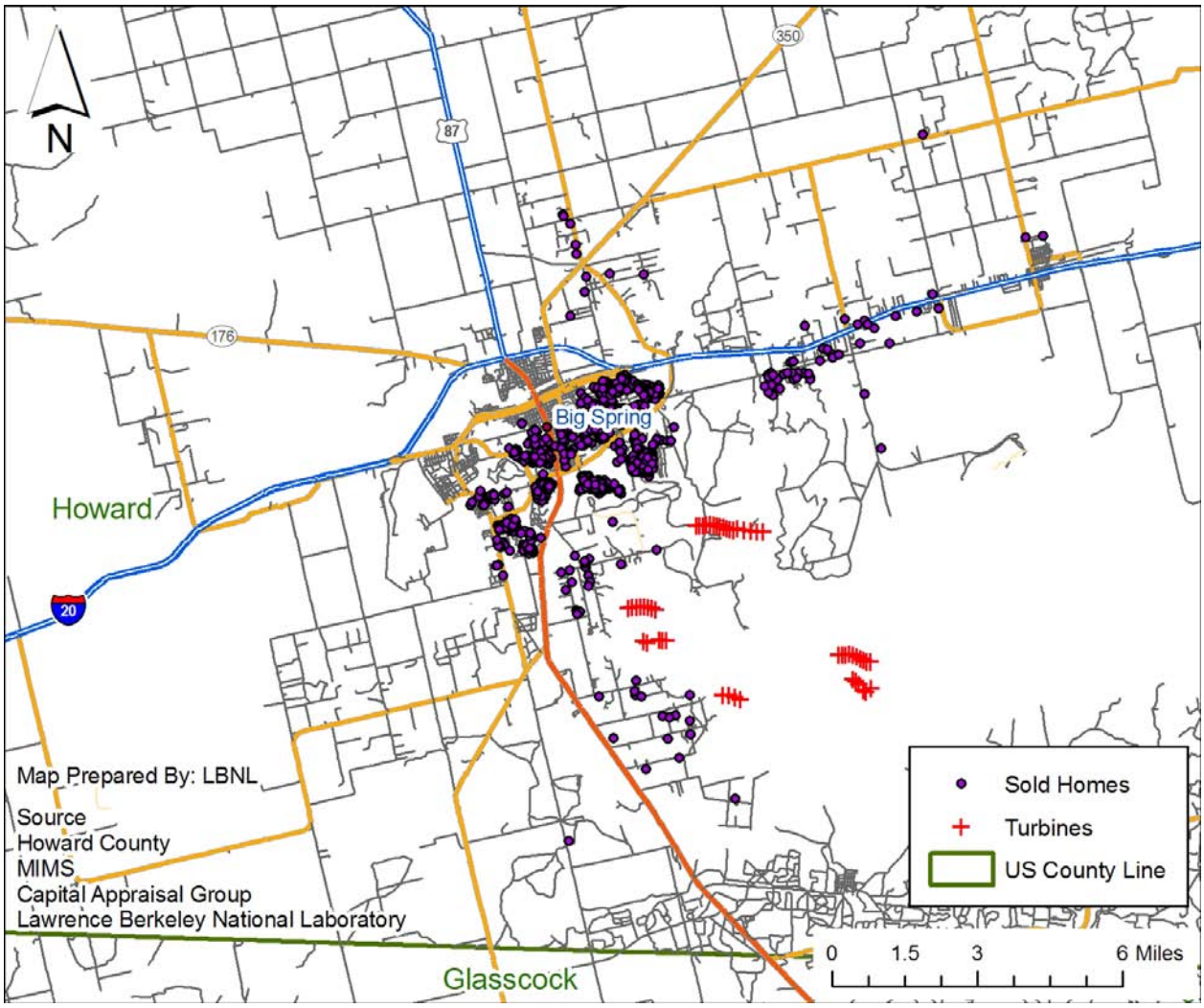
Census Statistics

Name	Type	2007 Population	% Change Since 2000	Population Per Mile^2	Median Age	Median Income	Median House 2007	% Change Since 2000
Kennewich, WA	City	62,182	12.5%	2,711	32.3	$ 45,085	$ 155,531	46%
Walla Walla, WA	City	30,794	4.0%	2,847	33.8	$ 38,391	$ 185,706	91%
Milton Freewater, OR	Town	6,335	-2.0%	3,362	31.7	$ 30,229	$ 113,647	47%
Touchet, WA	Town	413	n/a	340	33.6	$ 47,268	$ 163,790	81%
Benton	County	159,414	3.6%	94	34.4	$ 51,464	$ 162,700	46%
Walla Walla	County	57,709	1.0%	45	34.9	$ 43,597	$ 206,631	89%
Umatilla	County	73,491	0.6%	23	34.6	$ 38,631	$ 138,200	47%
Washington	State	6,488,000	10.1%	89	35.3	$ 55,591	$ 300,800	79%
Oregon	State	3,747,455	9.5%	36	36.3	$ 48,730	$ 257,300	69%
US	Country	301,139,947	6.8%	86	37.9	$ 50,233	$ 243,742	46%

Source: City-Data.com & Wikipedia. "% Change Since 2000" refers to the percentage change between 2000 and 2007 for the figures in the column to the left (population or median house price). "Town" signifies any municipality with less than 10,000 inhabitants. "n/a" signifies data not available.

A.2 TXHC Study Area: Howard County (Texas)

Figure A - 3: Map of TXHC Study Area



Note: "Sold Homes" include all sold homes both before and after construction.

Area Description

This study area is entirely contained within Howard County, Texas, and includes the city of Big Spring, which is situated roughly 100 miles South of Lubbock and 275 miles West of Dallas in West Texas. On top of the Northern end of the Edwards Plateau, which runs from the Southeast to the Northwest, sits the 46 turbine (34 MW) Big Spring wind facility, which was constructed in 1998 and 1999. Most of the wind turbines in this project have a hub height of 213 feet, but four are taller, at 262 feet. The plateau and the wind facility overlook the city of Big Spring which, when including its suburbs, wraps around the plateau to the South and East. Surrounding the town are modest farming tracks and arid, undeveloped land. These lands, primarily to the South of the facility towards Forsan (not shown on map), are dotted with small oil rigs. Many of the homes in Big Spring do not have a view of the wind facility, but others to the South and East do have such views.

Data Collection and Summary

County officials Brett McKibben, Sally Munoz, and Sheri Proctor were extremely helpful in answering questions about the data required for this project, and the data were provided by two firms that manage it for the county. Specifically, Erin Welch of the Capital Appraisal Group provided the sales and house characteristic data and Paul Brandt of MIMS provided the GIS data.

All valid single-family home sales transactions within five miles of the nearest turbine and occurring between January 1996 and March 2007 were included in the dataset, resulting in 1,311 sales.[106] These sales ranged in price from $10,492 to $490,000, with a mean of $74,092. Because of the age of the wind facility, many of the sales in the sample occurred after wind facility construction had commenced (*n* = 1,071). Of those, 104 had views of the turbines, with 27 having views more dramatic than MINOR. Four homes sold within a mile of the facility, with the rest falling between one and three miles (*n* = 584), three to five miles (*n* = 467), and outside of five miles (*n* = 16).

Area Statistics

Study Period Begin	Study Period End	Number of Sales	Median Price	Mean Price	Minimum Price	Maximum Price
1/2/1996	3/30/2007	1,311	$66,500	$74,092	$10,492	$490,000

Facility Statistics

Facility Name	Number of MW	Number of Turbines	Announce Date	Construction Begin Date	Completion Date	Turbine Maker	Hub Height (Meters)
Big Spring I	27.7	42	Jan-98	Jul-98	Jun-99	Vestas	65
Big Spring II	6.6	4	Jan-98	Jul-98	Jun-99	Vestas	80

Source: AWEA & Ventyx Inc.

Variables of Interest Statistics

Development Period	Pre Announcement	Post Announcement Pre Construction	1st Year After Construction	2nd Year After Construction	2+ Years After Construction	Total
Howard, TX (TXHC)	169	71	113	131	827	1311

View of Turbines	Pre Construction	None	Minor	Moderate	Substantial	Extreme	Total
Howard, TX (TXHC)	240	967	77	22	5	0	1311

Distance to Nearest Turbine	Pre Construction	< 0.57 Miles	0.57 - 1 Miles	1 - 3 Miles	3 - 5 Miles	> 5 Miles	Total
Howard, TX (TXHC)	240	0	4	584	467	16	1311

[106] If parcels intersected the five mile boundary, they were included in the sample, but were coded as being outside of five miles.

Census Statistics

Name	Type	2007 Population	% Change Since 2000	Population Per Mile^2	Median Age	Median Income	Median House 2007	% Change Since 2000
Big Spring	City	24,075	-5.4%	1,260	35.1	$ 32,470	$ 54,442	50%
Forsan	Town	220	-4.0%	758	36.8	$ 50,219	$ 64,277	84%
Howard	County	32,295	-1.9%	36	36.4	$ 36,684	$ 60,658	58%
Texas	State	23,904,380	14.6%	80	32.3	$ 47,548	$ 120,900	47%
US	Country	301,139,947	6.8%	86	37.9	$ 50,233	$ 243,742	46%

Source: City-Data.com & Wikipedia. "% Change Since 2000" refers to the percentage change between 2000 and 2007 for the figures in the column to the left (population or median house price). "Town" signifies any municipality with less than 10,000 inhabitants.

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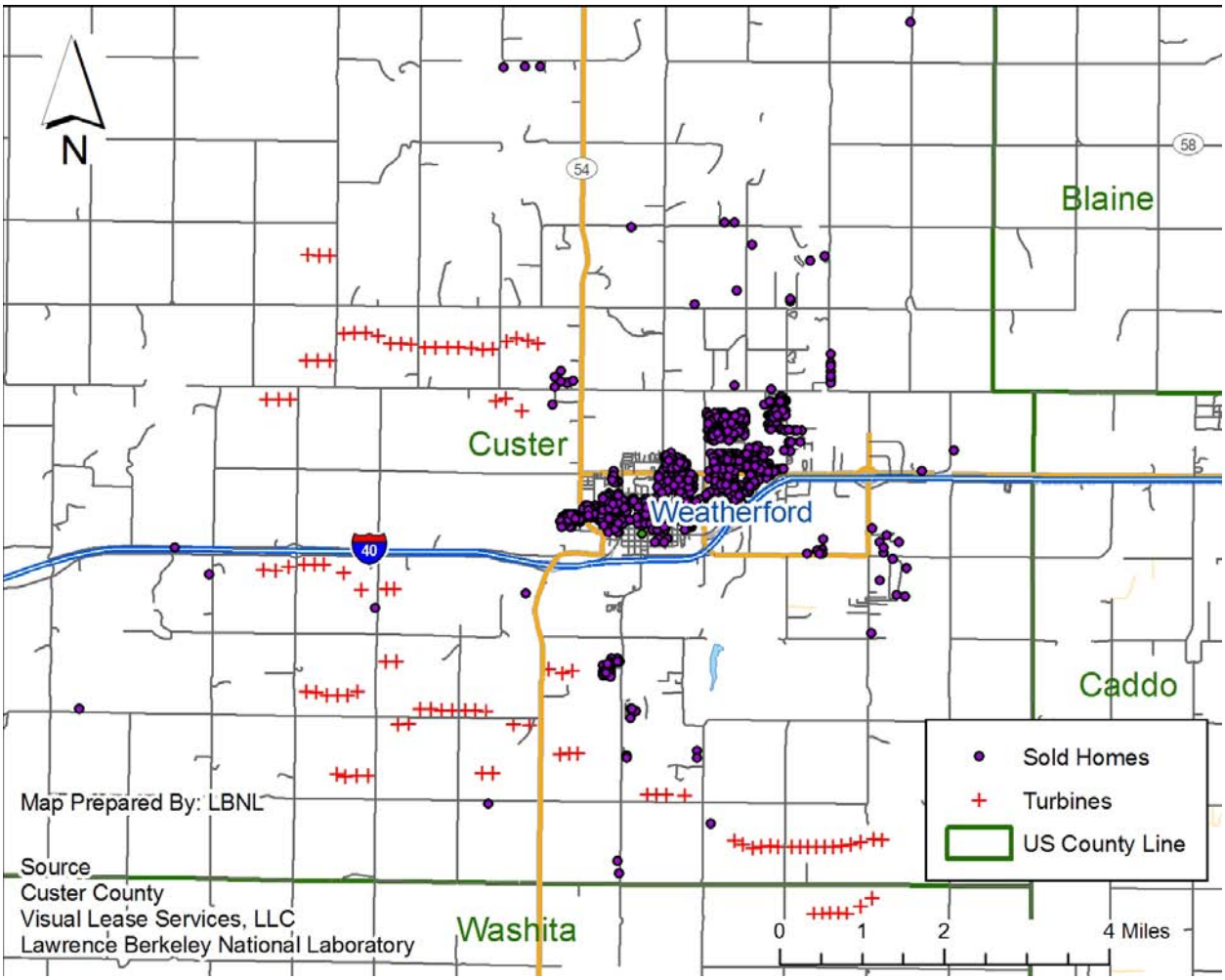
A.3 OKCC Study Area: Custer County (Oklahoma)

Figure A - 4: Map of OKCC Study Area



Note: "Sold Homes" include all sold homes both before and after construction.

Area Description

This study area is entirely contained within Custer County, Texas, and includes the Weatherford wind facility, which is situated near the city of Weatherford, 70 miles due west of Oklahoma City and near the western edge of the state. The 98 turbine (147 MW) Weatherford wind facility straddles Highway 40, which runs East-West, and U.S. County Route 54, which runs North-South, creating an "L" shape that is more than six miles long and six miles wide. Development began in 2004, and was completed in two phases ending in 2006. The turbines are some of the largest in the sample, with a hub height of 262 feet. The topography of the study area is mostly flat plateau, allowing the turbines to be visible from many parts of the town and the surrounding rural lands. There are a number of smaller groupings of homes that are situated to the North and South of the city, many of which are extremely close to the turbines and have dramatic views of them.

Data Collection and Summary

County Assessor Debbie Collins and mapping specialist Karen Owen were extremely helpful in gathering data and answering questions at the county level. Data were obtained directly from the county and from Visual Lease Services, Inc and OKAssessor, where representatives Chris Mask, Terry Wood, Tracy Leniger, and Heather Brown helped with the request.

All valid single-family residential transactions within five miles of the nearest wind turbine and occurring between July 1996 and June 2007 were included in the dataset, resulting in 1,113 sales.[107] These sales ranged in price from $11,000 to $468,000, with a mean of $100,445. Because of the relatively recent construction of the facility, 58% of the sales (n = 637) occurred before construction, leaving 476 sales with possible views of the turbines. Of those 476 sales, 25 had more-dramatic view ratings than MINOR and 17 sales occurred inside of one mile.

Area Statistics

Study Period Begin	Study Period End	Number of Sales	Median Price	Mean Price	Minimum Price	Maximum Price
7/7/1996	6/29/2007	1,113	$91,000	$100,445	$11,000	$468,000

Facility Statistics

Facility Name	Number of MW	Number of Turbines	Announce Date	Construction Begin Date	Completion Date	Turbine Maker	Hub Height (Meters)
Weatherford Wind Energy Center	106.5	71	Mar-04	Dec-04	May-05	GE Wind	80
Weatherford Wind Energy Center Expansion	40.5	27	May-05	Oct-05	Jan-06	GE Wind	80

Source: AWEA & Ventyx Inc.

Variables of Interest Statistics

Development Period	Pre Announcement	Post Announcement Pre Construction	1st Year After Construction	2nd Year After Construction	2+ Years After Construction	Total
Custer, OK (OKCC)	**484**	**153**	**193**	**187**	**96**	**1113**

View of Turbines	Pre Construction	None	Minor	Moderate	Substantial	Extreme	Total
Custer, OK (OKCC)	**637**	**375**	**76**	**6**	**7**	**12**	**1113**

Distance to Nearest Turbine	Pre Construction	< 0.57 Miles	0.57 - 1 Miles	1 - 3 Miles	3 - 5 Miles	> 5 Miles	Total
Custer, OK (OKCC)	**637**	**16**	**1**	**408**	**50**	**1**	**1113**

[107] Portions of the town of Weatherford, both North and South of the town center, were not included in the sample due to lack of available data. The homes that were mapped, and for which electronic data were provided, however, were situated on all sides of these unmapped areas and were similar in character to those that were omitted. None of the unmapped homes were within a mile of the nearest wind turbine.

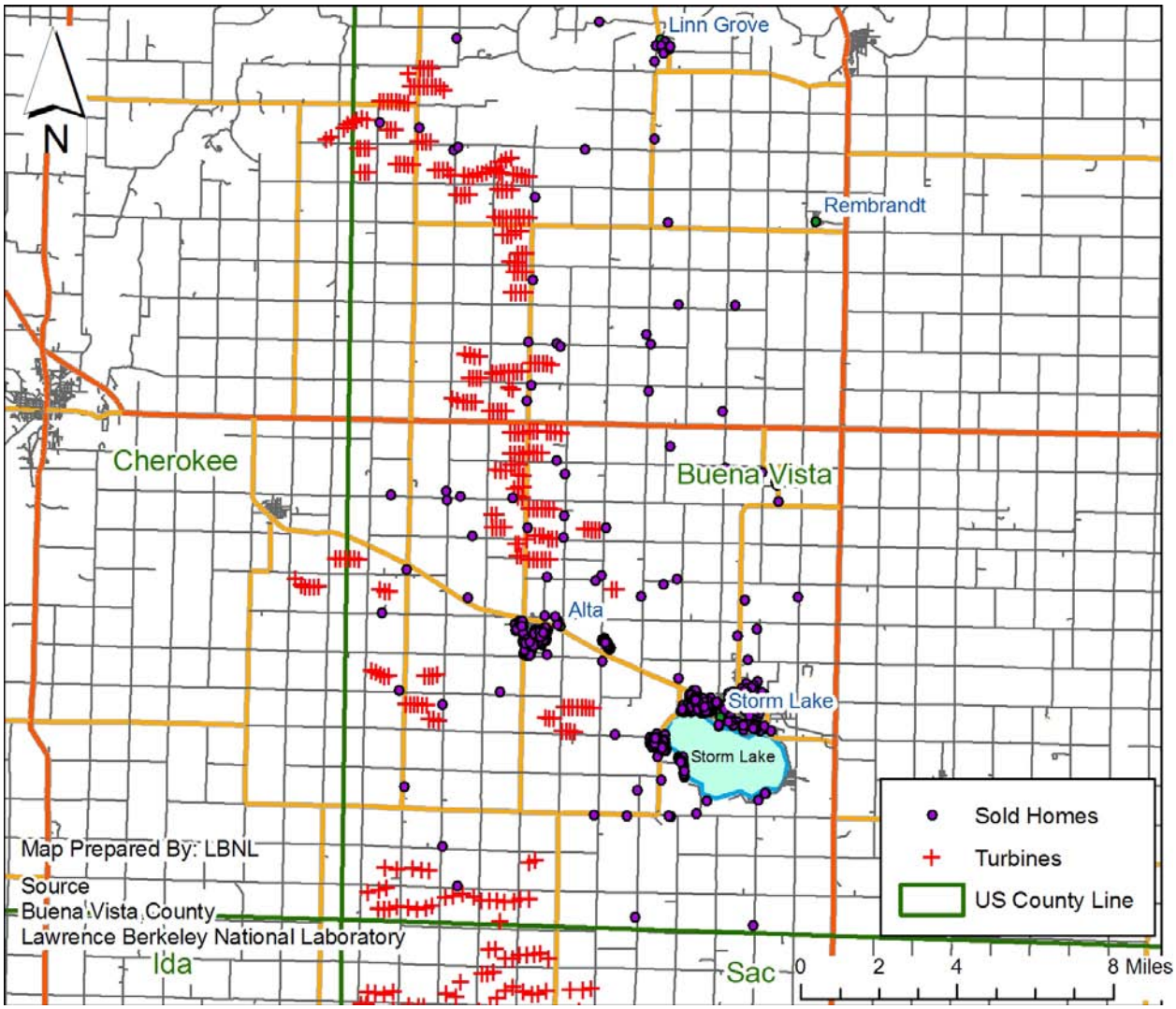
Census Statistics

Name	Type	2007 Population	% Change Since 2000	Population Per Mile^2	Median Age	Median Income	Median House 2007	% Change Since 2000
Weatherford	City	10,097	1.2%	1,740	24.1	$ 32,543	$ 113,996	45%
Hydro	Town	1,013	-3.7%	1,675	39.2	$ 35,958	$ 66,365	68%
Custer	County	26,111	3.6%	26	32.7	$ 35,498	$ 98,949	52%
Oklahoma	State	3,617,316	4.8%	53	35.5	$ 41,567	$ 103,000	46%
US	Country	301,139,947	6.8%	86	37.9	$ 50,233	$ 243,742	46%

Source: City-Data.com & Wikipedia. "% Change Since 2000" refers to the percentage change between 2000 and 2007 for the figures in the column to the left (population or median house price). "Town" signifies any municipality with less than 10,000 inhabitants.

A.4 IABV Study Area: Buena Vista County (Iowa)

Figure A - 5: Map of IABV Study Area



Note: "Sold Homes" include all sold homes both before and after construction.

Area Description

This study area includes the sizable Storm Lake and Intrepid wind facilities, which are mostly situated in Buena Vista County, located in Northwestern Iowa, 75 miles East of Sioux City. The facilities also stretch into Sac County to the South and Cherokee County to the West. The facilities total 381 turbines (370 MW) and are more than 30 miles long North to South and eight miles wide East to West. Development began on the first Storm Lake facility in 1998 and the last of the Intrepid development was completed in 2006. The largest turbines have a hub height of 213 feet at the hub, but most are slightly smaller at 207 feet. The majority of the homes in the sample surround Storm Lake (the body of water), but a large number of homes are situated on small residential plots located outside of the town and nearer to the wind facility. Additionally, a number of sales occurred in Alta - a small town to the East of Storm Lake -thatis straddled by the

wind facilities and therefore provides dramatic views of the turbines. In general, except for the depression in which Storm Lake sits, the topography is very flat, largely made up corn fields, and the turbines are therefore visible from quite far away. The housing market is driven, to some extent, by the water body, Storm Lake, which is a popular recreational tourist destination, and therefore development is occurring to the East and South of the lake. Some development is also occurring, to a lesser degree, to the East of Alta.

Data Collection and Summary

County Assessor Kathy A. Croker and Deputy Assessor Kim Carnine were both extremely helpful in answering questions and providing GIS data. Sales and home characteristic data were provided by Vanguard Appraisals, Inc., facilitated by the county officials. David Healy from MidAmerican provided some of the necessary turbine location GIS files.

The county provided data on valid single-family residential transactions between 1996 and 2007 for 1,743 homes inside of five miles of the nearest wind turbine. This sample exceeded the number for which field data could reasonably be collected; as a result, only a sample of these homes sales was used for the study. Specifically, all transactions that occurred within three miles of the nearest turbine were used, in combination with a random sample (totaling roughly 10%) of those homes between three and five miles. This approach resulted in 822 sales, with prices that ranged from $12,000 to $525,000, and a mean of $94,713. Development of the wind facilities in this area occurred relatively early in the sample period, and therefore roughly 75% of the sales (*n* = 605) occurred after project construction had commenced. Of those 605 sales, 105 had views of the turbines, 37 of which were ranked with a view rating more dramatic than MINOR, and 30 sales occurred within one mile of the nearest wind turbine.

Area Statistics

Study Period Begin	Study Period End	Number of Sales	Median Price	Mean Price	Minimum Price	Maximum Price
1/2/1996	3/30/2007	822	$79,000	$94,713	$12,000	$525,000

Facility Statistics

Facility Name	Number of MW	Number of Turbines	Announce Date	Construction Begin Date	Completion Date	Turbine Maker	Hub Height (Meters)
Storm Lake I	112.5	150	Feb-98	Oct-98	Jun-99	Enron	63
Storm Lake II	80.3	107	Feb-98	Oct-98	Apr-99	Enron	63
Waverly	1.5	2	Feb-98	Oct-98	Jun-99	Enron	65
Intrepid	160.5	107	Mar-03	Oct-04	Dec-04	GE Wind	65
Intrepid Expansion	15.0	15	Jan-05	Apr-05	Dec-05	Mitsubishi	65

Source: AWEA & Ventyx Inc.

Variables of Interest Statistics

Development Period	Pre Announcement	Post Announcement Pre Construction	1st Year After Construction	2nd Year After Construction	2+ Years After Construction	Total
Buena Vista, IA (IABV)	**152**	**65**	**80**	**70**	**455**	**822**

View of Turbines	Pre Construction	None	Minor	Moderate	Substantial	Extreme	Total
Buena Vista, IA (IABV)	**217**	**500**	**68**	**18**	**8**	**11**	**822**

Distance to Nearest Turbine	Pre Construction	< 0.57 Miles	0.57 - 1 Miles	1 - 3 Miles	3 - 5 Miles	> 5 Miles	Total
Buena Vista, IA (IABV)	**217**	**22**	**8**	**472**	**101**	**2**	**822**

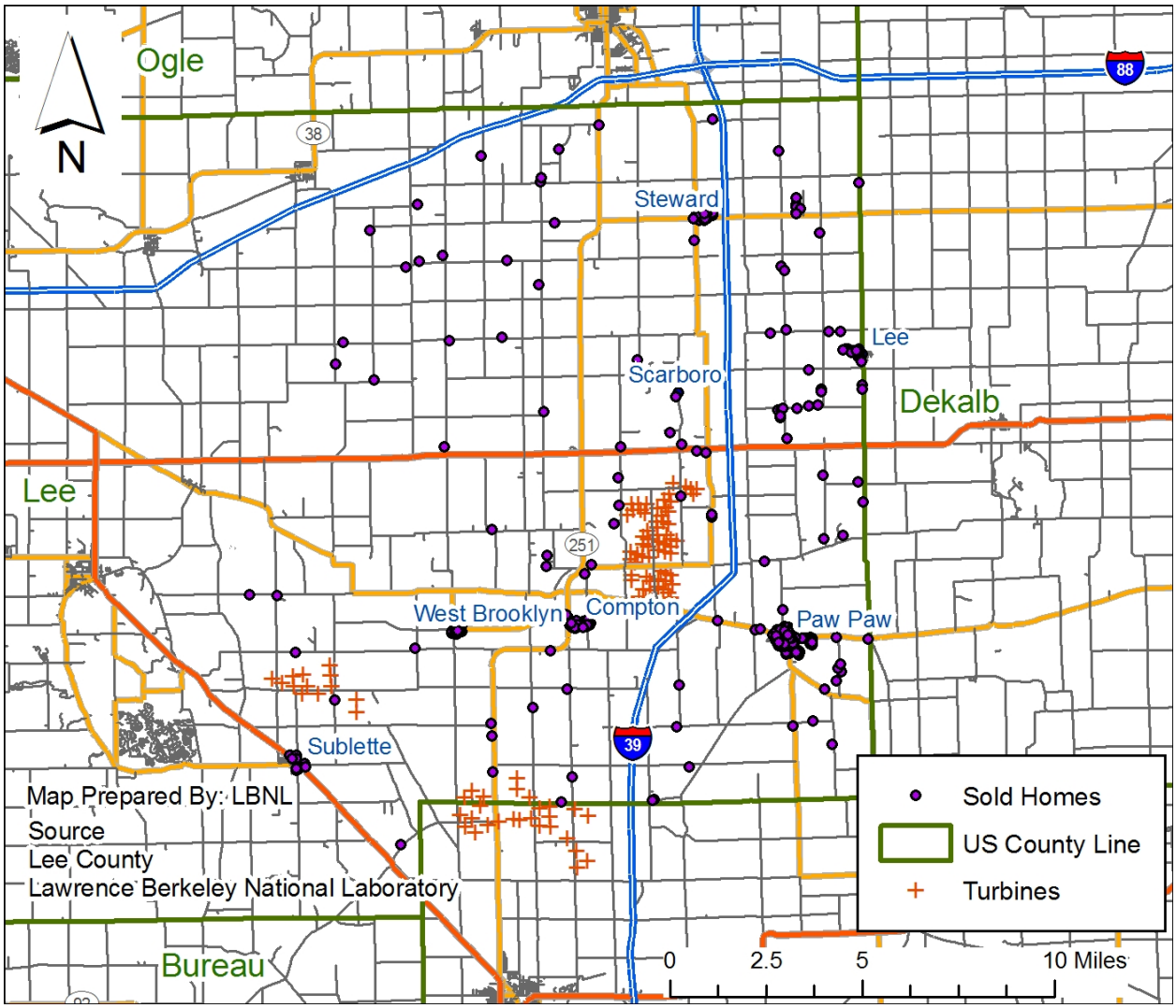
Census Statistics

Name	Type	2007 Population	% Change Since 2000	Population Per Mile^2	Median Age	Median Income	Median House 2007	% Change Since 2000
Storm Lake	City	9,706	-3.9%	2,429	31.7	$ 39,937	$ 99,312	41%
Alta	Town	1,850	-1.0%	1,766	35.1	$ 40,939	$ 98,843	48%
Buena Vista	County	19,776	-3.1%	36	36.4	$ 42,296	$ 95,437	45%
Iowa	State	3,002,555	2.6%	52	36.6	$ 47,292	$ 117,900	43%
US	Country	301,139,947	6.8%	86	37.9	$ 50,233	$ 243,742	46%

Source: City-Data.com & Wikipedia. "% Change Since 2000" refers to the percentage change between 2000 and 2007 for the figures in the column to the left (population or median house price). "Town" signifies any municipality with less than 10,000 inhabitants.

A.5 ILLC Study Area: Lee County (Illinois)

Figure A - 6: Map of ILLC Study Area



Note: "Sold Homes" include all sold homes both before and after construction.

Area Description

This study area is situated roughly 80 miles due West of Chicago, in Lee County, Illinois, and includes two wind facilities. The 63 turbine (53 MW) Mendota Hills Wind Project sits just West of North-South Highway 39, and 10 miles South of East-West Highway 88. Development began on the facility in 2001 and was completed in 2003. The second facility, the 40 turbine (80 MW) GSG Wind Farm is South and West of the Mendota Hills facility, and is broken into two parts: roughly one third of the turbines are situated two miles due north of the small town of Sublette, with the remainder located roughly six miles to the southeast and spanning the line separating Lee from La Salle County. Development began on this project in the fall of 2006 and was completed in April of the following year. The town of Paw Paw, which is East of Highway 38 and both facilities, is the largest urban area in the study area, but is further away from the

facilities than the towns of Compton, West Brooklyn, Scarboro, and Sublette. Also, to the North of the facilities are the towns of Lee, to the East of Highway 38, and Steward, just to the West. Although many home sales occurred in these towns, a significant number of additional sales occurred on small residential tracts in more-rural areas or in small developments. The topography of the area is largely flat, but falls away slightly to the East towards Paw Paw. The area enjoyed significant development during the real estate boom led by commuters from the Chicago metropolitan area, which was focused in the Paw Paw area but was also seen in semi-rural subdivisions to the Southwest and North of the wind facility.

Data Collection and Summary

County Supervisor Wendy Ryerson was enormously helpful in answering questions and providing data, as were Carmen Bollman and GIS Director, Brant Scheidecker, who also work in the county office. Wendy and Carmen facilitated the sales and home characteristic data request and Brant provided the GIS data. Additionally, real estate brokers Neva Grevengoed of LNG Realtor, Alisa Stewart of AC Corner Stone, and Beth Einsely of Einsely Real Estate were helpful in understanding the local market.

The county provided information on 412 valid single-family transactions that occurred between 1998 and 2007 within 10 miles of the nearest wind turbine, all of which were included in the sample.[108] These sales ranged in price from $14,500 to $554,148, with a mean of $128,301. Of those sales, 213 occurred after construction commenced on the wind facility and, of those, 36 had views of the turbines – nine of which were rated more dramatically than MINOR. Only two sales occurred within one mile of the nearest wind turbine.

Area Statistics

Study Period Begin	Study Period End	Number of Sales	Median Price	Mean Price	Minimum Price	Maximum Price
5/1/1998	3/2/2007	412	$113,250	$128,301	$14,500	$554,148

Facility Statistics

Facility Name	Number of MW	Number of Turbines	Announce Date	Construction Begin Date	Completion Date	Turbine Maker	Hub Height (Meters)
Mendota Hills	50.4	63	Nov-01	Aug-03	Nov-03	Gamesa	65
GSG Wind Farm	80	40	Dec-05	Sep-06	Apr-07	Gamesa	78

Source: AWEA & Ventyx Inc.

[108] This county was not able to provide data electronically back to 1996, as would have been preferred, but because wind project development did not occur until 2001, there was ample time in the study period to establish pre-announcement sale price levels.

Variables of Interest Statistics

Development Period	Pre Announcement	Post Announcement Pre Construction	1st Year After Construction	2nd Year After Construction	2+ Years After Construction	Total
Lee, IL (ILLC)	115	84	62	71	80	412

View of Turbines	Pre Construction	None	Minor	Moderate	Substantial	Extreme	Total
Lee, IL (ILLC)	199	177	27	7	1	1	412

Distance to Nearest Turbine	Pre Construction	< 0.57 Miles	0.57 - 1 Miles	1 - 3 Miles	3 - 5 Miles	> 5 Miles	Total
Lee, IL (ILLC)	199	1	1	85	69	57	412

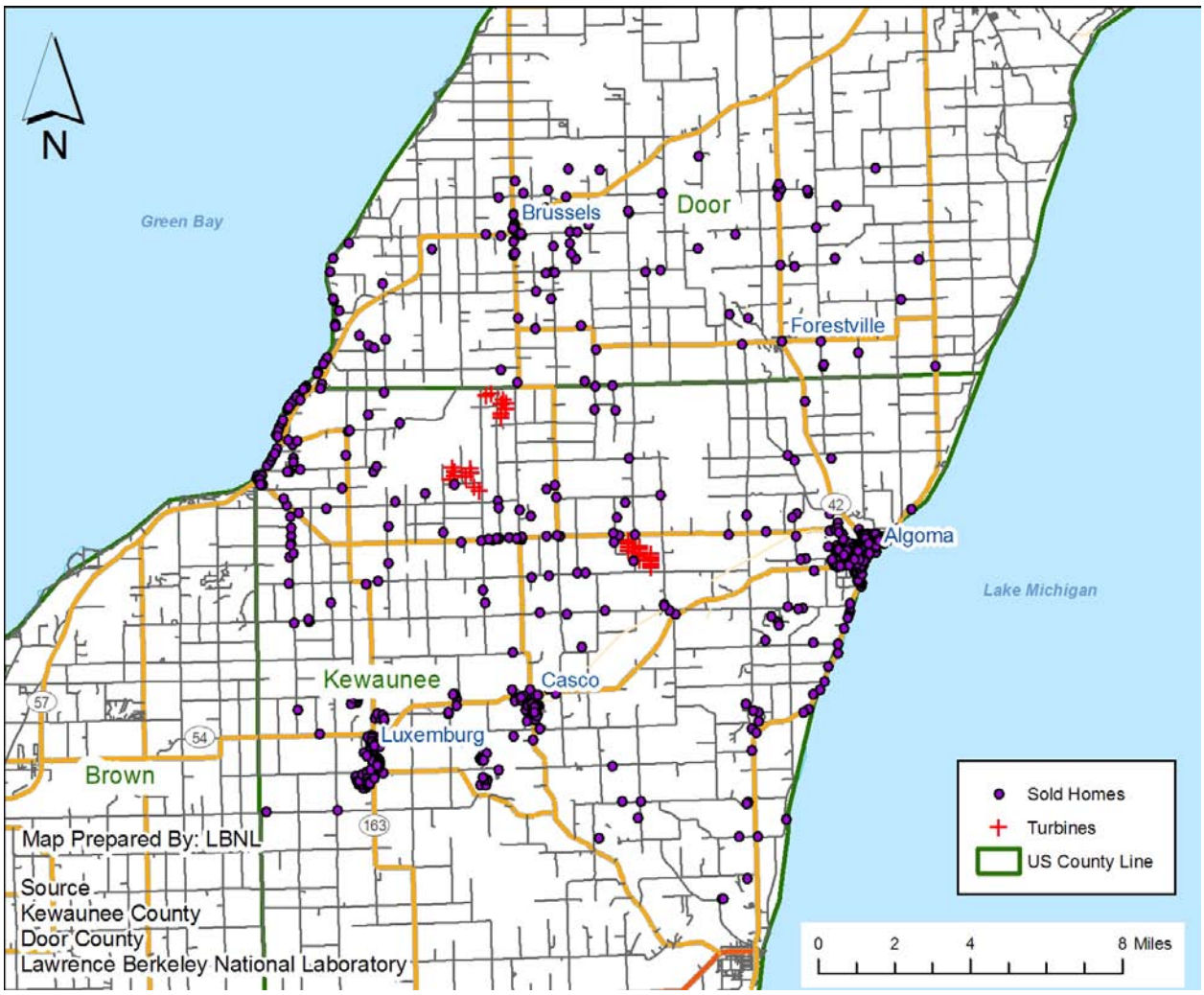
Census Statistics

Name	Type	2007 Population	% Change Since 2000	Population Per Mile^2	Median Age	Median Income	Median House 2007	% Change Since 2000
Paw Paw	Town	884	2.6%	1,563	38.0	$ 48,399	$ 151,954	n/a
Compton	Town	337	-2.9%	2,032	32.8	$ 44,023	$ 114,374	n/a
Steward	Town	263	-3.0%	2,116	35.2	$ 59,361	$ 151,791	n/a
Sublette	Town	445	-2.4%	1,272	37.7	$ 55,910	$ 133,328	n/a
Lee	County	35,450	-1.7%	49	37.9	$ 47,591	$ 136,778	64%
Illinois	State	12,852,548	3.5%	223	34.7	$ 54,124	$ 208,800	60%
US	Country	301,139,947	7.0%	86	37.9	$ 50,233	$ 243,742	46%

Source: City-Data.com & Wikipedia. "% Change Since 2000" refers to the percentage change between 2000 and 2007 for the figures in the column to the left (population or median house price). "Town" signifies any municipality with less than 10,000 inhabitants. "n/a" signifies data not available.

A.6 WIKCDC Study Area: Kewaunee and Door Counties (Wisconsin)

Figure A - 7: Map of WIKCDC Study Area



Note: "Sold Homes" include all sold homes both before and after construction.

Area Description

This study area includes the Red River (17 turbines, 14 MW) and Lincoln (14 turbines, 9 MW) wind facilities. It is situated on the "thumb" jutting into Lake Michigan, Northeast of Green Bay, Wisconsin, and spans two counties, Kewaunee and Door. There is a mix of agricultural, small rural residential, waterfront, and urban land use in this area. The three largest towns are Algoma to the East of the facilities and on the lake, Casco, which is six miles due South of the turbines, and Luxemburg, four miles West of Casco. There is a smaller village, Brussels, to the North in Door County. The remainder of the homes is situated on the water or in small rural residential parcels between the towns. Topographically, the "thumb" is relatively flat except for a slight crown in the middle, and then drifting lower to the edges. The East edge of the "thumb" ends in bluffs over the water, and the western edge drops off more gradually, allowing those parcels to

enjoy small beaches and easy boat access. There is some undulation of the land, occasionally allowing for relatively distant views of the wind turbines, which stand at a hub height of 213 feet.

Data Collection and Summary

Kewaunee and Door Counties did not have a countywide system of electronic data storage for either sales or home characteristic data. Therefore, in many cases, data had to be collected directly from the town or city assessor. In Kewaunee County, Joseph A. Jerabek of the town of Lincoln, Gary Taicher of the town of Red River, Melissa Daron of the towns of Casco, Pierce, and West Kewaunee, Michael Muelver of the town of Ahnapee and the city of Algoma, William Gerrits of the town of Casco, Joseph Griesbach Jr. of the town of Luxemburg, and David Dorschner of the city of Kewaunee all provided information. In Door County, Scott Tennessen of the town of Union and Gary Maccoux of the town of Brussels were similarly very helpful in providing information. Additionally, Andy Pelkey of Impact Consultants, Inc., John Holton of Associated Appraisal Consultants, Andy Bayliss of Dash Development Group, and Lue Van Asten of Action Appraisers & Consultants all assisted in extracting data from the myriad of storage systems used at the town and city level. The State of Wisconsin provided additional information on older sales and sales validity, with Mary Gawryleski, James Bender, and Patrick Strabala from the Wisconsin Department of Revenue being extremely helpful. GIS data were obtained from Steve Hanson from Kewaunee County and Tom Haight from Door County.

After collecting data from each municipality, a total of 810 valid single-family home sales transactions were available for analysis, ranging in time from 1996 to 2007. These sales ranged in price from $20,000 to $780,000, with a mean of $116,698. Because development of the wind facilities occurred relatively early in the study period, a large majority of the sales transactions, 75% (n = 725), occurred after project construction had commenced. Of those, 64 had views of the turbines, 14 of which had more dramatic than MINOR views, and 11 sales occurred within one mile.

Area Statistics

Study Period Begin	Study Period End	Number of Sales	Median Price	Mean Price	Minimum Price	Maximum Price
2/2/1996	6/30/2007	810	$98,000	$116,698	$20,000	$780,000

Facility Statistics

Facility Name	Number of MW	Number of Turbines	Announce Date	Construction Begin Date	Completion Date	Turbine Maker	Hub Height (Meters)
Red River	11.2	17	Apr-98	Jan-99	Jun-99	Vestas	65
Lincoln	9.2	14	Aug-98	Jan-99	Jun-99	Vestas	65

Source: AWEA & Ventyx Inc.

Variables of Interest Statistics

Development Period	Pre Announcement	Post Announcement Pre Construction	1st Year After Construction	2nd Year After Construction	2+ Years After Construction	Total
Kewaunee/Door, WI (WIKCDC)	44	41	68	62	595	810

View of Turbines	Pre Construction	None	Minor	Moderate	Substantial	Extreme	Total
Kewaunee/Door, WI (WIKCDC)	85	661	50	9	2	3	810

Distance to Nearest Turbine	Pre Construction	< 0.57 Miles	0.57 - 1 Miles	1 - 3 Miles	3 - 5 Miles	> 5 Miles	Total
Kewaunee/Door, WI (WIKCDC)	85	7	4	63	213	438	810

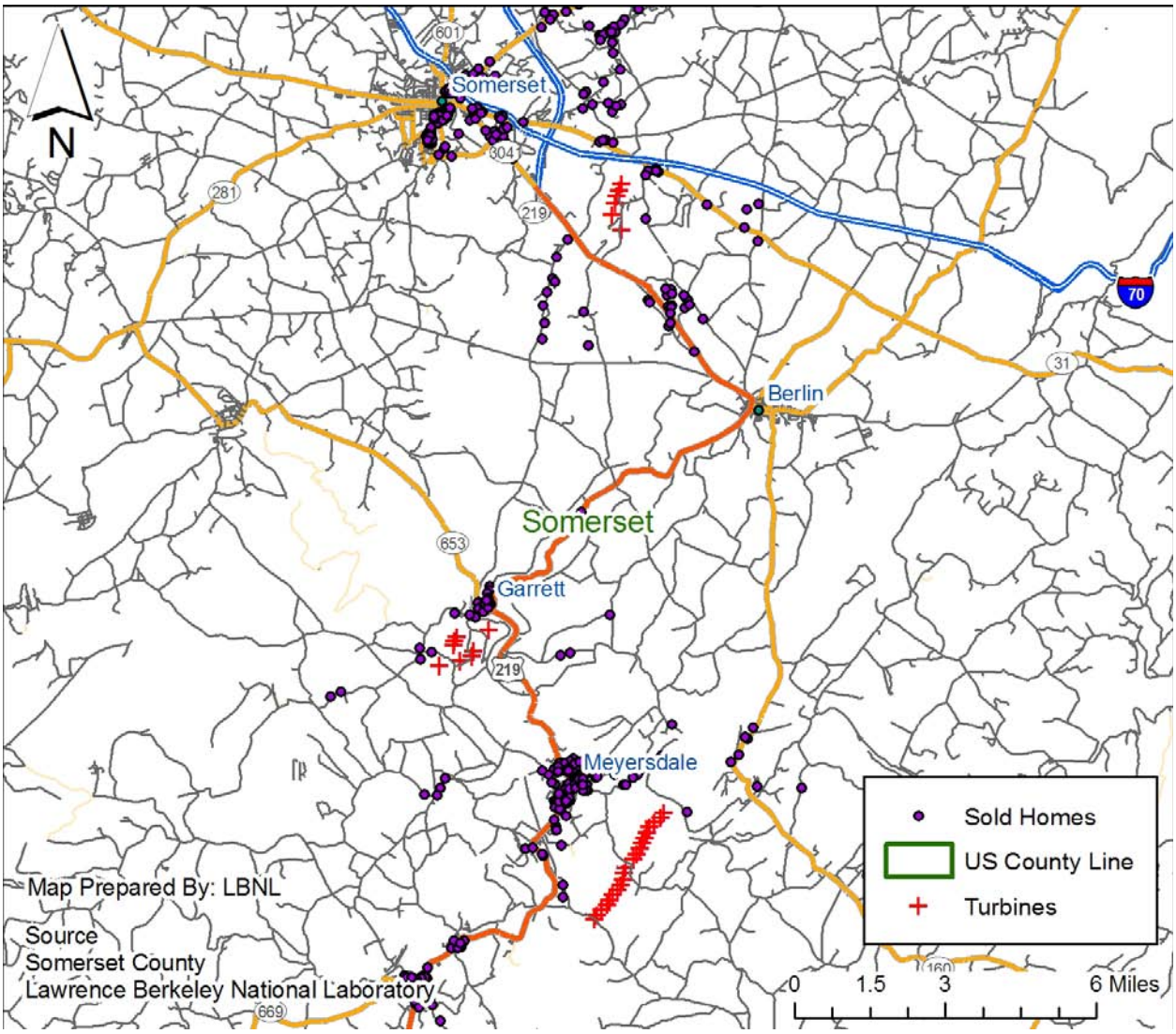
Census Statistics

Name	Type	2007 Population	% Change Since 2000	Population Per Mile^2	Median Age	Median Income	Median House 2007	% Change Since 2000
Algoma	Town	3,186	-4.7%	1,305	41.8	$ 39,344	$ 112,295	51%
Casco	Town	551	-2.8%	985	35.6	$ 53,406	$ 141,281	n/a
Luxemburg	Town	2,224	15.3%	1,076	32.0	$ 53,906	$ 167,403	n/a
Kewaunee	County	20,533	1.4%	60	37.5	$ 50,616	$ 148,344	57%
Door	County	27,811	2.4%	58	42.9	$ 44,828	$ 193,540	57%
Wisconsin	State	5,601,640	0.3%	103	36.0	$ 50,578	$ 168,800	50%
US	Country	301,139,947	6.8%	86	37.9	$ 50,233	$ 243,742	46%

Source: City-Data.com & Wikipedia. "% Change Since 2000" refers to the percentage change between 2000 and 2007 for the figures in the column to the left (population or median house price). "Town" signifies any municipality with less than 10,000 inhabitants. "n/a" signifies data not available.

A.7 PASC Study Area: Somerset County (Pennsylvania)

Figure A - 8: Map of PASC Study Area



Note: "Sold Homes" include all sold homes both before and after construction.

Area Description

This study area includes three wind facilities, Somerset (6 turbines, 9 MW, 210 ft hub height) to the North, Meyersdale (20 turbines, 30 MW, 262 ft hub height) to the South, and Green Mountain (8 turbines, 10 MW, 197 ft hub height) between them. All of the projects are located in Somerset County, roughly 75 miles southeast of Pittsburg in the Southwest section of Pennsylvania. None of the three facilities are separated by more than 10 miles, so all were included in one study area. To the North of the facilities is East-West U.S. Highway 70, which flanks the city of Somerset. Connecting Somerset with points South is County Route 219, which zigzags Southeast out of Somerset to the smaller towns of Berlin (not included in the data), Garret to the Southwest, and Meyersdale, which is Southeast of Garret. These towns are flanked by two ridges that run from the Southwest to the Northeast. Because of these ridges and the

relatively high elevations of all of the towns, this area enjoys winter recreation, though the coal industry, which once dominated the area, is still an integral part of the community with mining occurring in many places up and down the ridges. Although many of the home sales in the sample occurred in the towns, a number of the sales are for homes situated outside of town corresponding to either rural, rural residential, or suburban land uses.

Data Collection and Summary

The County Assessor, Jane Risso, was extremely helpful, and assisted in providing sales and home characteristic data. Glen Wagner, the IT director, worked with Gary Zigler, the county GIS specialist, to extract both GIS and assessment data from the county records. Both Gary and Jane were extremely helpful in fielding questions and providing additional information as needs arose.

The county provided a total of 742 valid residential single-family home sales transactions within four miles of the nearest wind turbine. All of the sales within three miles were used (n = 296), and a random sample (~ 44%) of those between three and four miles were used, yielding a total of 494 sales that occurred between May 1997 and March 2007. These sales ranged in price from $12,000 to $360,000, with a mean of $69,770. 291 sales (~ 60% of the 494) occurred after construction commenced on the nearest wind facility. Of these 291 sales, 73 have views of the turbines, 18 of which are more dramatic than MINOR, and 35 sales occurred within one mile.[109]

Area Statistics

Study Period Begin	Study Period End	Number of Sales	Median Price	Mean Price	Minimum Price	Maximum Price
5/1/1997	3/1/2007	494	$62,000	$69,770	$12,000	$360,000

Facility Statistics

Facility Name	Number of MW	Number of Turbines	Announce Date	Construction Begin Date	Completion Date	Turbine Maker	Hub Height (Meters)
GreenMountain Wind Farm	10.4	8	Jun-99	Dec-99	May-00	Nordex	60
Somerset	9.0	6	Apr-01	Jun-01	Oct-01	Enron	64
Meyersdale	30.0	20	Jan-03	Sep-03	Dec-03	NEG Micon	80

Source: AWEA & Ventyx Inc.

[109] This study area was one of the earliest to have field work completed, and therefore the field data collection process was slower resulting in a lower number of transactions than many other study areas.

Variables of Interest Statistics

Development Period	Pre Announcement	Post Announcement Pre Construction	1st Year After Construction	2nd Year After Construction	2+ Years After Construction	Total
Somerset, PA (PASC)	**175**	**28**	**46**	**60**	**185**	**494**

View of Turbines	Pre Construction	None	Minor	Moderate	Substantial	Extreme	Total
Somerset, PA (PASC)	**203**	**218**	**55**	**15**	**2**	**1**	**494**

Distance to Nearest Turbine	Pre Construction	< 0.57 Miles	0.57 - 1 Miles	1 - 3 Miles	3 - 5 Miles	> 5 Miles	Total
Somerset, PA (PASC)	**203**	**17**	**18**	**132**	**124**	**0**	**494**

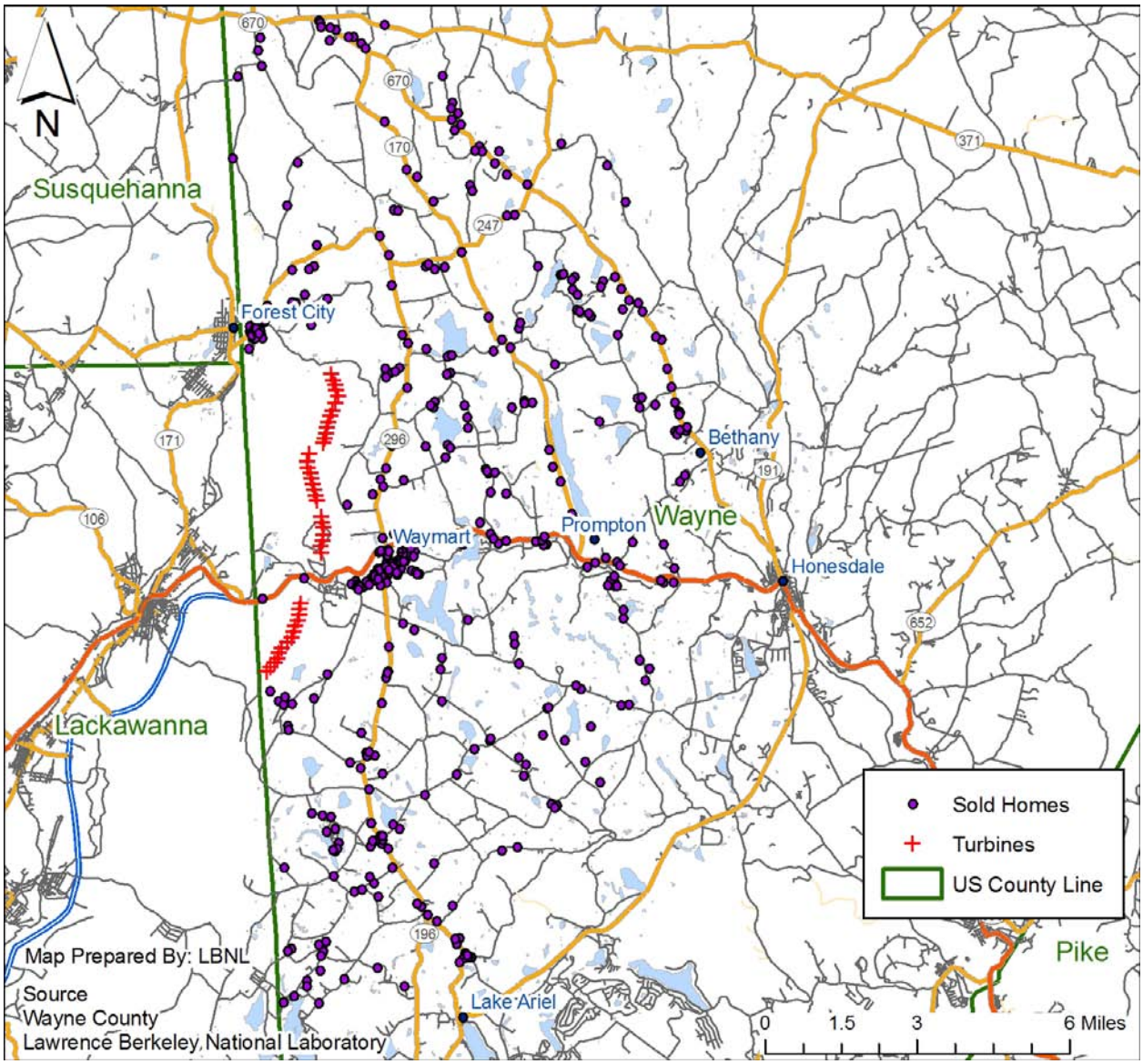
Census Statistics

Name	Type	2007 Population	% Change Since 2000	Population Per Mile^2	Median Age	Median Income	Median House 2007	% Change Since 2000
Somerset	Town	6,398	-4.8%	2,333	40.2	$ 35,293	$ 123,175	n/a
Berlin	Town	2,092	-4.0%	2,310	41.1	$ 35,498	$ 101,704	n/a
Garrett	Town	425	-4.7%	574	34.5	$ 29,898	$ 54,525	n/a
Meyersdale	Town	2,296	-6.6%	2,739	40.9	$ 29,950	$ 79,386	n/a
Somerset Cou	County	77,861	-2.7%	72	40.2	$ 35,293	$ 94,500	41%
Pennsylvania	State	12,440,621	1.3%	277	38.0	$ 48,576	$ 155,000	60%
US	Country	301,139,947	6.8%	86	37.9	$ 50,233	$ 243,742	46%

Source: City-Data.com & Wikipedia. "% Change Since 2000" refers to the percentage change between 2000 and 2007 for the figures in the column to the left (population or median house price). "Town" signifies any municipality with less than 10,000 inhabitants. "n/a" signifies data not available.

A.8 PAWC Study Area: Wayne County (Pennsylvania)

Figure A - 9: Map of PAWC Study Area



Note: "Sold Homes" include all sold homes both before and after construction.

Area Description

This study area includes the Waymart wind facility, which sits atop the North-South ridge running along the line separating Wayne County from Lackawanna and Susquehanna Counties in Northeast Pennsylvania. The 43 turbine (65 MW, 213 ft hub height) facility was erected in 2003, and can be seen from many locations in the study area and especially from the towns of Waymart, which sits East of the facility, and Forest City, which straddles Wayne and Susquehanna Counties North of the facility. The study area is dominated topographically by the ridgeline on which the wind turbines are located, but contains rolling hills and many streams, lakes, and natural ponds. Because of the undulating landscape, views of the wind facility can be

maintained from long distances, while some homes relatively near the turbines have no view of the turbines whatsoever. The area enjoys a substantial amount of second home ownership because of the bucolic scenic vistas, the high frequency of lakes and ponds, and the proximity to larger metropolitan areas such as Scranton, roughly 25 miles to the Southwest, and Wilkes-Barre a further 15 miles Southwest.

Data Collection and Summary

John Nolan, the County Chief Assessor, was very helpful in overseeing the extraction of the data from county records. GIS specialist Aeron Lankford provided the GIS parcel data as well as other mapping layers, and Bruce Grandjean, the IT and Data Specialist, provided the sales and home characteristic data as well as fielding countless questions as they arose. Additionally, real estate brokers Dotti Korpics of Bethany, Kent Swartz of Re Max, and Tom Cush of Choice #1 Country Real Estate were instrumental providing context for understanding the local market.

The county provided data on 551 valid single-family transactions that occurred between 1996 and 2007, all of which were included in the sample. These sales ranged in price from $20,000 to $444,500, with a mean of $111,522. Because of the relatively recent development of the wind facility, only 40% (n = 222) of the sales transaction occurred after the construction of the facility had commenced. Of those sales, 43 (19%) had views of the turbines, ten of which had more dramatic than MINOR views, and 11 were situated within one mile.

Area Statistics

Study Period Begin	Study Period End	Number of Sales	Median Price	Mean Price	Minimum Price	Maximum Price
7/12/1996	9/25/2006	551	$96,000	$111,522	$20,000	$444,500

Facility Statistics

Facility Name	Number of MW	Number of Turbines	Announce Date	Construction Begin Date	Completion Date	Turbine Maker	Hub Height (Meters)
Waymart Wind Farm	64.5	43	Feb-01	Jun-03	Oct-03	GE Wind	65

Source: AWEA & Ventyx Inc.

Variables of Interest Statistics

Development Period	Pre Announcement	Post Announcement Pre Construction	1st Year After Construction	2nd Year After Construction	2+ Years After Construction	Total
Wayne, PA (PAWC)	223	106	64	71	87	551

View of Turbines	Pre Construction	None	Minor	Moderate	Substantial	Extreme	Total
Wayne, PA (PAWC)	329	179	33	8	2	0	551

Distance to Nearest Turbine	Pre Construction	< 0.57 Miles	0.57 - 1 Miles	1 - 3 Miles	3 - 5 Miles	> 5 Miles	Total
Wayne, PA (PAWC)	329	1	10	95	55	61	551

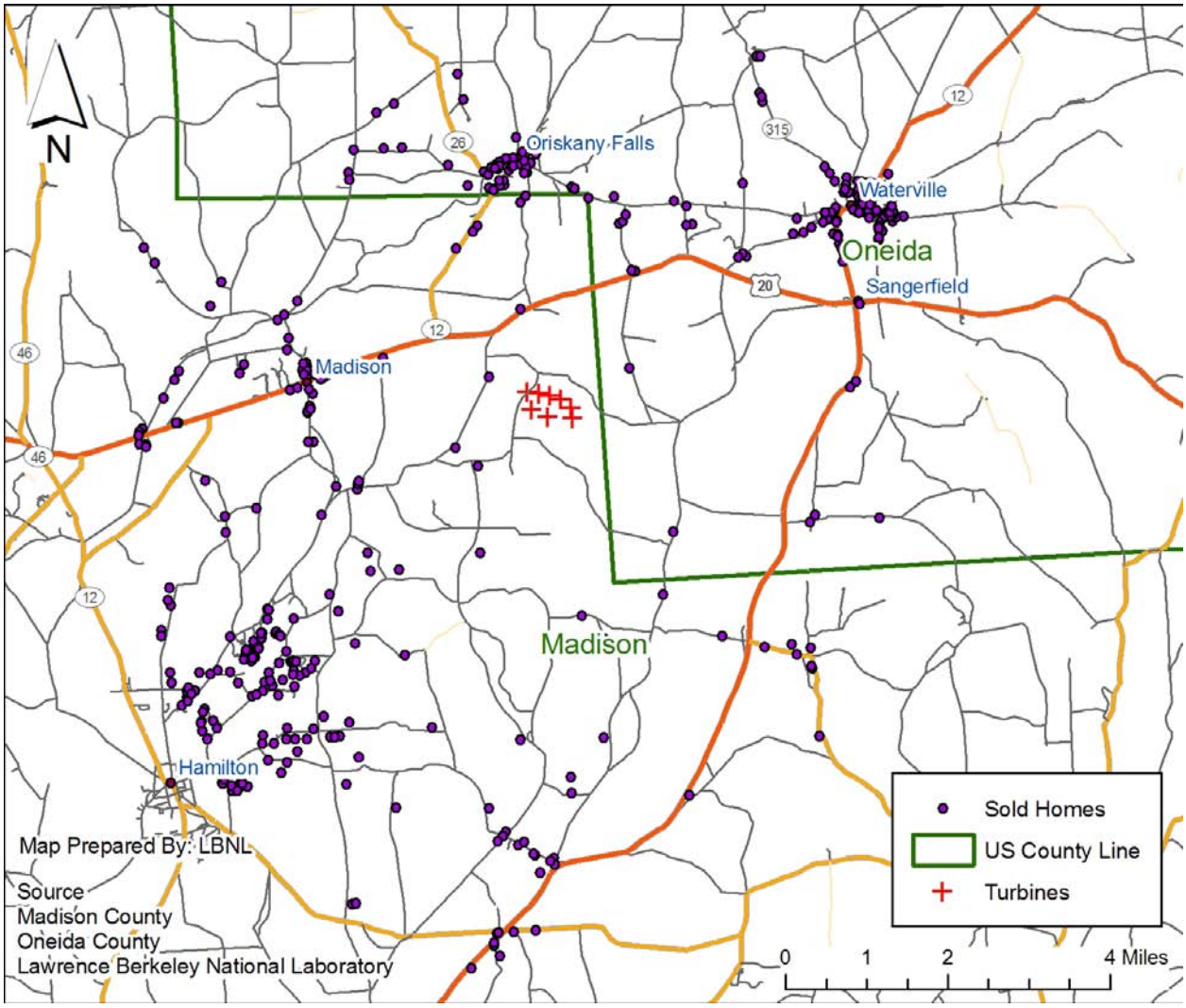
Census Statistics

Name	Type	2007 Population	% Change Since 2000	Population Per Mile^2	Median Age	Median Income	Median House 2007	% Change Since 2000
Waymart	Town	3,075	116.0%	1,111	41.7	$ 43,797	$ 134,651	56%
Forest City	Town	1,743	-5.2%	1,929	45.6	$ 32,039	$ 98,937	67%
Prompton	Town	237	-1.6%	149	41.9	$ 30,322	$ 162,547	56%
Wayne	County	51,708	5.9%	71	40.8	$ 41,279	$ 163,060	57%
Lackawanna	County	209,330	-1.9%	456	40.3	$ 41,596	$ 134,400	48%
Pennsylvania	State	12,440,621	1.3%	277	38.0	$ 48,576	$ 155,000	60%
US	Country	301,139,947	6.8%	86	37.9	$ 50,233	$ 243,742	46%

Source: City-Data.com & Wikipedia. "% Change Since 2000" refers to the percentage change between 2000 and 2007 for the figures in the column to the left (population or median house price). "Town" signifies any municipality with less than 10,000 inhabitants.

A.9 NYMCOC Study Area: Madison and Oneida Counties (New York)

Figure A - 10: Map of NYMCOC Study Area



Note: "Sold Homes" include all sold homes both before and after construction.

Area Description

This study area surrounds the seven turbine (12 MW, 220 ft hub height) Madison wind facility, which sits atop an upland rise in Madison County, New York. The area is roughly 20 miles Southwest of Utica and 40 miles Southeast of Syracuse. The facility is flanked by the towns moving from the Southwest, clockwise around the rise, from Hamilton and Madison in Madison County, NY, to Oriskany Falls, Waterville, and Sangerfield in Oneida County, NY. Hamilton is the home of Colgate University, whose staff lives throughout the area around Hamilton and stretching up into the town of Madison. Accordingly, some development is occurring near the college. To the Northeast, in Oneida County, the housing market is more depressed and less development is apparent. The study area in total is a mix of residential, rural residential, and

rural landscapes, with the largest portion being residential homes in the towns or immediately on their outskirts. The topography, although falling away from the location of the wind facility, does not do so dramatically, so small obstructions can obscure the views of the facility.

Data Collection and Summary

Data were obtained from both Madison and Oneida Counties for this study area. In Madison County, Kevin Orr, Mike Ellis, and Carol Brophy, all of County's Real Property Tax Services Department, were extremely helpful in obtaining the sales, home characteristic, and GIS data. In Oneida County, Jeff Quackenbush and Richard Reichert in the Planning Department were very helpful in obtaining the county data. Additionally, discussions with real estate brokers Susanne Martin of Martin Real Estate, Nancy Proctor of Prudential, and Joel Arsenault of Century 21 helped explain the housing market and the differences between Madison and Oneida Counties.

Data on 463 valid sales transactions of single family residential homes that occurred between 1996 and 2006 were obtained, all of which were located within seven miles of the wind facility. These sales ranged in price from $13,000 to $380,000, with a mean of $98,420. Roughly 75% (*n* = 346) of these sales occurred after construction commenced on the wind facility, of which 20 could see the turbines, all of which were rated as having MINOR views, except one which had a MODERATE rating; only two sales involved homes that were situated inside of one mile.

Area Statistics

Study Period Begin	Study Period End	Number of Sales	Median Price	Mean Price	Minimum Price	Maximum Price
1/6/1996	12/26/2006	463	$77,500	$98,420	$13,000	$380,000

Facility Statistics

Facility Name	Number of MW	Number of Turbines	Announce Date	Construction Begin Date	Completion Date	Turbine Maker	Hub Height (Meters)
Madison Windpower	11.6	7	Jan-00	May-00	Sep-00	Vestas	67

Source: AWEA & Ventyx Inc.

Variables of Interest Statistics

Development Period	Pre Announcement	Post Announcement Pre Construction	1st Year After Construction	2nd Year After Construction	2+ Years After Construction	Total
Madison/Oneida, NY (MYMCOC)	108	9	48	30	268	463

View of Turbines	Pre Construction	None	Minor	Moderate	Substantial	Extreme	Total
Madison/Oneida, NY (MYMCOC)	117	326	19	1	0	0	463

Distance to Nearest Turbine	Pre Construction	< 0.57 Miles	0.57 - 1 Miles	1 - 3 Miles	3 - 5 Miles	> 5 Miles	Total
Madison/Oneida, NY (MYMCOC)	117	1	1	80	193	71	463

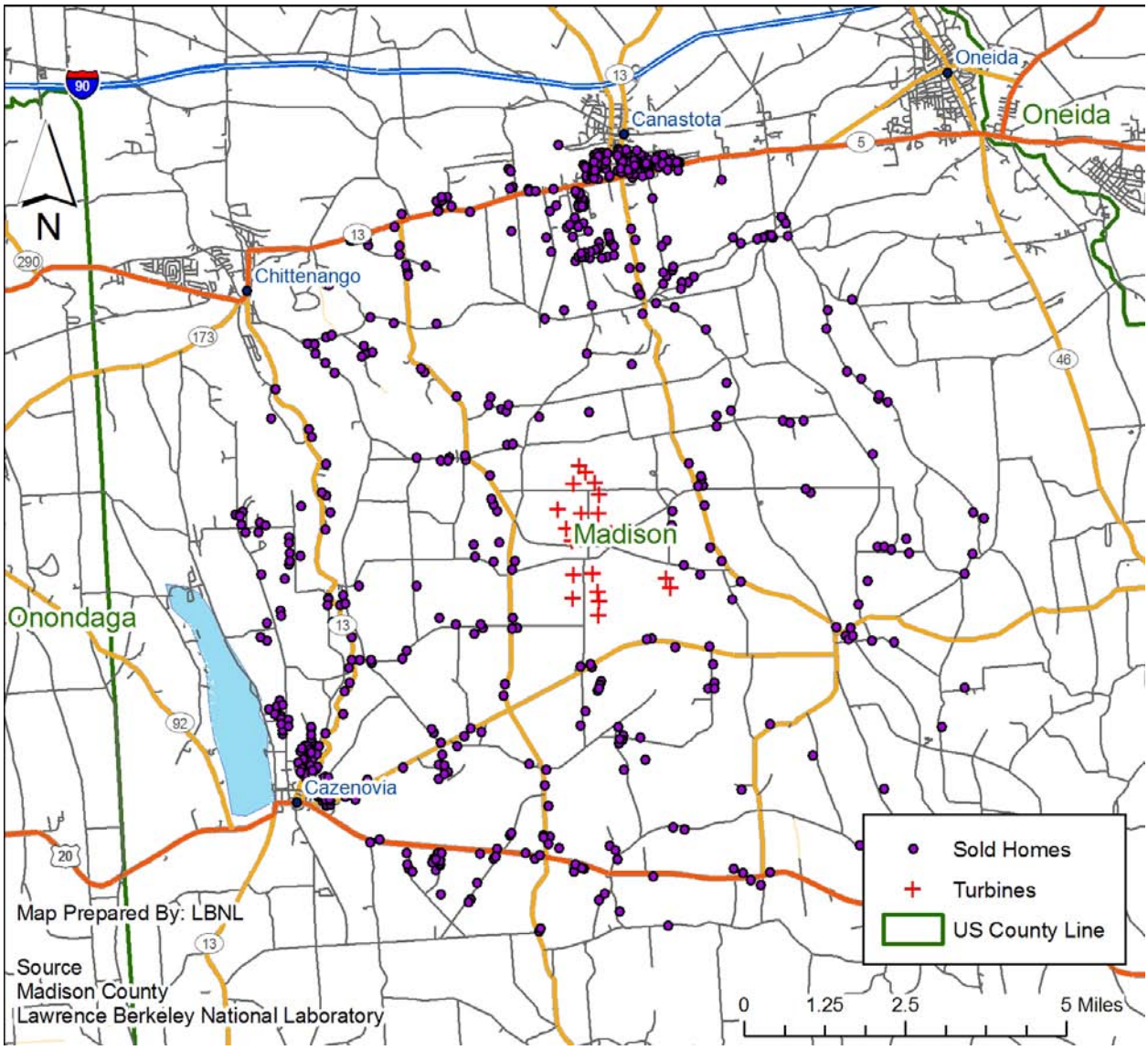
Census Statistics

Name	Type	2007 Population	% Change Since 2000	Population Per Mile^2	Median Age	Median Income	Median House 2007	% Change Since 2000
Madison	Town	304	-2.9%	605	38.1	$ 36,348	$ 94,734	n/a
Hamilton	Town	3,781	7.9%	1,608	20.8	$ 48,798	$ 144,872	n/a
Orinkany Fal	Town	1,413	-2.9%	1,703	40.8	$ 47,689	$ 105,934	n/a
Waterville	Town	1,735	-3.2%	1,308	37.8	$ 46,692	$ 104,816	n/a
Sangerfield	Town	2,626	-1.4%	85	37.6	$ 47,563	$ 106,213	n/a
Madison	County	69,829	0.6%	106	36.1	$ 53,600	$ 109,000	39%
Oneida	County	232,304	-1.3%	192	38.2	$ 44,636	$ 102,300	40%
New York	State	19,297,729	1.7%	408	35.9	$ 53,514	$ 311,000	109%
US	Country	301,139,947	6.8%	86	37.9	$ 50,233	$ 243,742	46%

Source: City-Data.com & Wikipedia. "% Change Since 2000" refers to the percentage change between 2000 and 2007 for the figures in the column to the left (population or median house price). "Town" signifies any municipality with less than 10,000 inhabitants. "n/a" signifies data not available.

A.10 NYMC Study Area: Madison County (New York)

Figure A - 11: Map of NYMC Study Area



Note: "Sold Homes" include all sold homes both before and after construction.

Area Description

This study area surrounds the 20 turbine (30 MW, 218 ft hub height) Fenner wind facility in Madison County, New York, roughly 20 miles East of Syracuse and 40 miles West of Utica in the middle of New York. The study area is dominated by two roughly parallel ridges. One, on which the Fenner facility is located, runs Southeast to Northwest and falls away towards the town of Canastota. The second ridge runs roughly North from Cazenovia, and falls away just South of the town of Chittenango. Surrounding these ridges is an undulating landscape with many water features, including the Chittenango Falls and Lake Cazenovia. A number of high-priced homes are situated along the ridge to the North of Cazenovia, some of which are afforded

views of the lake and areas to the West, others with views to the East over the wind facility, and a few having significant panoramic views. The west side of the study area has a number of drivers to its real estate economy: it serves as a bedroom community for Syracuse, is the home to Cazenovia College, and enjoys a thriving summer recreational population. Canastota to the North, and Oneida to the East, are older industrial towns, both of which now serve as feeder communities for Syracuse because of easy access to Highway 90. Between the towns of Cazenovia and Canastota are many rural residential properties, some of which have been recently developed, but most of which are homes at least a half century old.

Data Collection and Summary

Data were obtained from the Madison County Real Property Tax Services department directed by Carol Brophy. As the first study area that was investigated, IT and mapping specialists Kevin Orr and Mike Ellis were subjected to a large number of questions from the study team and were enormously helpful in helping shape what became the blueprint for other study areas. Additionally, real estate brokers Nancy Proctor of Prudential, Joel Arsenault of Century 21, Don Kinsley of Kingsley Real Estate, and Steve Harris of Cazenovia Real Estate were extremely helpful in understanding the local market.

Data on 693 valid sales transactions of single family residential structures that occurred between 1996 and 2006 were obtained, most of which were within five miles of the wind facility. These sales ranged in price from $26,000 to $575,000, with a mean of $124,575. Roughly 68% of these sales (n = 469) occurred after construction commenced on the wind facility, 13 of which were inside of one mile, and 74 of which had views of the turbines. Of that latter group, 24 have more dramatic than MINOR views of the turbines.

Area Statistics

Study Period Begin	Study Period End	Number of Sales	Median Price	Mean Price	Minimum Price	Maximum Price
1/31/1996	9/29/2006	693	$109,900	$124,575	$26,000	$575,000

Facility Statistics

Facility Name	Number of MW	Number of Turbines	Announce Date	Construction Begin Date	Completion Date	Turbine Maker	Hub Height (Meters)
Fenner Wind Power Project	30	20	Dec-98	Mar-01	Nov-01	Enron	66

Source: AWEA & Ventyx Inc.

Variables of Interest Statistics

Development Period	Pre Announcement	Post Announcement Pre Construction	1st Year After Construction	2nd Year After Construction	2+ Years After Construction	Total
Madison, NY (NYMC)	**59**	**165**	**74**	**70**	**325**	**693**

View of Turbines	Pre Construction	None	Minor	Moderate	Substantial	Extreme	Total
Madison, NY (NYMC)	**224**	**395**	**50**	**16**	**8**	**0**	**693**

Distance to Nearest Turbine	Pre Construction	< 0.57 Miles	0.57 - 1 Miles	1 - 3 Miles	3 - 5 Miles	> 5 Miles	Total
Madison, NY (NYMC)	**224**	**2**	**11**	**80**	**374**	**2**	**693**

Census Statistics

Name	Type	2007 Population	% Change Since 2000	Population Per Mile^2	Median Age	Median Income	Median House 2007	% Change Since 2000
Cazenovia	Town	2,835	8.6%	1,801	32.3	$ 58,172	$ 159,553	n/a
Chittenango	Town	4,883	-0.5%	2,000	36.0	$ 58,358	$ 104,845	n/a
Canastota	Town	4,339	-1.7%	1,306	37.3	$ 45,559	$ 93,349	n/a
Oneida	City	10,791	-1.7%	490	36.9	$ 47,173	$ 99,305	n/a
Morrisville	Town	2,155	0.6%	1,869	20.4	$ 45,852	$ 102,352	n/a
Madison	County	69,829	0.6%	106	36.1	$ 53,600	$ 109,000	39%
New York	State	19,297,729	1.7%	408	35.9	$ 53,514	$ 311,000	109%
US	Country	301,139,947	6.8%	86	37.9	$ 50,233	$ 243,742	46%

Source: City-Data.com & Wikipedia. "% Change Since 2000" refers to the percentage change between 2000 and 2007 for the figures in the column to the left (population or median house price). "Town" signifies any municipality with less than 10,000 inhabitants. "n/a" signifies data not available.

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Appendix B: Methodology for Calculating Distances with GIS

For each of the homes in the dataset, accurate measurements of the distance to the nearest wind turbine at the time of sale were needed, and therefore the exact locations of both the turbines and the homes was required. Neither of these locations was available from a single source, but through a combination of techniques, turbine and home locations were derived. This section describes the data and techniques used to establish accurate turbine and home locations, and the process for then calculating distances between the two.

There were a number of possible starting points for mapping accurate wind turbine locations. First, the Energy Velocity data, which covered all study areas, provided a point estimate for project location, but did not provide individual turbine locations. The Federal Aviation Administration (FAA), because of permitting and aviation maps, maintains data on turbine locations, but at the time of this study, that data source did not cover all locations, contained data on structures that no longer exist, and was difficult to use.[110] Finally, in some cases, the counties had mapped the wind turbines into GIS.

In the end, because no single dataset was readily available to serve all study areas, instead the variety of data sources described above was used to map and/or confirm the location of every turbine in the 10 study areas. The process began with high-resolution geocoded satellite and aerial ortho imagery that the United States Department of Agriculture (USDA) collects and maintains under its National Agriculture Imagery Program (NAIP), and which covers virtually all of the areas in this investigation. Where needed, older ortho imagery from the USDA was used. Combining these data with the Energy Velocity data, and discussions with local officials, and maps provided by the county or the developer, locating and mapping all of the turbines in each study area was possible.

Home locations were provided directly by some counties; in other cases, a parcel centroid was created as a proxy.[111] In some situations, the centroid did not correspond to the actual house location, and therefore required further refinement. This refinement was only required and conducted if the parcel was near the wind turbines, where the difference of a few hundred feet, for example, could alter its distance rating in a meaningful fashion, or when the parcel included a considerable amount of acreage, where inaccuracy in home location could be considerable. Therefore, parcels inside of 1.5 miles of the nearest wind turbine and of any size, and parcels outside of 1.5 miles and larger than 5 acres, were both examined using the USDA NAIP imagery to determine the exact home location. In cases where the parcel centroid was not centered over the home, the location was adjusted, using the ortho image as a guide, to the actual house location.

With both turbine and home locations identified, the next step was to determine distances between the two. To do so, the date when each transaction in the sample occurred was taken into

[110] A newer FAA database is now available that clears up many of these earlier concerns.

[111] A "parcel centroid" is the mathematical center point of a polygon, and was determined by XTools Pro (www.xtoolspro.com).

account, combined with the determination of which turbines were in existence at what time.[112] This required breaking the transactions in the sample into three categories: 1) those occurring before any wind facility was announced in the study area, 2) those occurring after the first wind facility was announced in the area but before all development was complete in the area, and 3) those occurring after all wind development in the area was complete. Any sale that occurred before wind development was announced in the study area was coded with a distance to the nearest turbine derived from the actual turbine locations after all wind development had occurred.[113] Homes that sold after all wind development had occurred were treated similarly, with distances derived from the set of turbines in place after all development had taken place. The final set of homes - those that sold after announcement of the first facility, but before the construction of the last - had to be treated, essentially, on a case by case basis. Some homes were located within five miles of one wind facility but more than five miles from another wind facility in the same study area (e.g., many homes in PASC). In this case the distance to that closer facility could be applied in a similar fashion as would be the case if only one facility was erected (e.g., NYMC or PAWC). Another group of homes, those that sold during the development of the first facility in the study area, were given the distance to that facility, regardless of distance to the other facilities in the study area. The final and most complicated group of homes consisted of those that were within five miles of multiple wind facilities, and that sold after the first facility had been erected. In those cases, the exact configuration of turbines was determined for each stage of the development process. In study areas with multiple facilities that were developed over multiple periods, there might be as many as six possible configurations (e.g., IABV). In this final scenario, the distance to the closest turbine was used, assuming it had been "announced" at the time of sale.

Once the above process was complete, the mechanics of calculating distances from the turbines to the homes was straightforward. After establishing the location of a set of turbines, for instance those constructed in the first development in the area, a euclidian distance raster was derived that encompassed every home in the study area.[114] The calculations were made using a 50-foot resolution state-plane projection and North American Datum from 1983 (NAD83). As discussed above, similar rasters were created for each period in the development cycle for each study area, depending on the turbine configuration at that time. Ultimately, a home's sale date was matched to the appropriate raster, and the underlying distance was extracted. Taking everything into account discussed above, it is expected that these measurements are accurate to

[112] It is recognized that the formal date of sale will follow the date at which pricing decisions were made. It is also recognized, as mentioned in Section 3, that wind facility announcement and construction dates are likely to be preceded by "under the radar" discussions in the community. Taken together, these two factors might have the effect, in the model, of creating some apparent lag in when effects are shown, compared to the earlier period in which effects may begin to occur. For this to bias the results, however, effects would have to disappear or dramatically lesson with time (e.g., less than one year after construction) such that the effects would not be uncovered with the models in later periods. Based on evidence from other potentially analogous infrastructure (e.g., HVTL), any fading of effects would likely occur over many years, so it is assumed that any bias is likely minimal.

[113] These distances were used to compare homes sold, for instance, within 1 mile of where the turbines were eventually erected with similar homes sold after the turbines were erected (see, for example, the Temporal Aspects Model).

[114] A "Raster" is a grid of, in this case, 50 feet by 50 feet squares, each of which contains a number representing the number of feet from the center of the square to the nearest turbine.

within roughly 150 feet inside of 1.5 miles and within a maximum of roughly 1150 feet outside of 1.5 miles.[115]

[115] The resolution of the raster is 50 feet, so the hypotenuse is 70 feet. If the home is situated in the top left of a raster cell and the turbine is situated in the bottom right of a diagonally adjacent cell, they could be separated by as much as 140 feet, yet the raster distance would only be 50 feet, a difference of 90 feet. Moreover, the resolution of the Ortho image is 40 feet so that location could additionally be off by another 55 feet along the diagonal. These two uncertainties total to roughly 150 feet for homes inside of 1.5 miles. Outside of 1.5 miles the variation between centroid and house location for parcels smaller than 5 acres could be larger still. If a 4.9 acre parcel had a highly irregular rectangular shape of 102 by 2100 feet, for instance, the centroid could be as much as 1050 feet from the property line. If the home was situated 50 feet from the property line then the actual house location could be off by as much as 1000 feet. Adding this to the 150 feet from above leads to a total discrepancy of 1150 feet (0.22 miles) for homes outside of 1.5 miles on parcels smaller than 5 acres. Of course, these extreme scenarios are highly unlikely to be prevalent.

Appendix C: Field Data Collection Instrument

Figure A - 12: Field Data Collection Instrument

House # (Control/ Key #)			County		
House Address					
Home Characteristics			**House Photo Number(s)**		
Cul-De-Sac?	No(0) / Yes(1)		Waterfront?		No(0) / Yes(1)
Scenic Vista Characteristics			**Vista Photo Numbers**		
Overall Quality of Scenic Vista: Poor (1), Below Average (2), Average (3), Above Average (4), Premium (5)					
View of Turbines Characteristics			**View Photo Numbers**		
Total # of Turbines visible			Orientation of Home to View: See Below		
# of Turbines- blade tips only visible			Side (S), Front (F), Back (B), Angled (A)		
# of Turbines- nacelle/hub visible					
# of Turbines- tower visible			View Scope: Narrow(1), Medium(2), Wide(3)		
The Degree to which the View of Turbines Dominate the Site? Non-Existent (0), Minor (1), Moderate (2), Substantial (3), Extreme (4)					
Degree to which the Turbines Overlap the Prominent Scenic Vista? Not at all (0), Barely (1), Somewhat (2), Strongly (3), Entirely (4)					
Notes:					

Figure A - 13: Field Data Collection Instrument - Instructions - Page 1

Home Characteristics

Cul-De-Sac? No(0)/Yes(1)	Is the home situated on a cul-de-sac?
Waterfront? No(0)/Yes(1)	Is the home situated on the waterfront?

"Vista" Characteristics

Overall Quality of Scenic Vista: Poor (1)	This rating is reserved for vistas of unmistakably poor quality. These vistas are often dominated by visually discordant man-made alterations (not considering turbines), or are uncomfortable spaces for people, lack interest, or have virtually no recreational potential.
Overall Quality of Scenic Vista: Below Average (2)	The home's vista is of the below average quality. These vistas contain visually discordant man-made alterations (not considering turbines) but are not dominated by them. They are not inviting spaces for people, but are not uncomfortable. They have little interest, mystery and have minor recreational potential.
Overall Quality of Scenic Vista: Average (3)	The home's vista is of the average quality. These vistas include interesting views which can be enjoyed often only a narrow scope. These vistas may contain some visually discordant man-made alterations (not considering turbines), are moderately comfortable spaces for people, have some interest, and have minor recreational potential.
Overall Quality of Scenic Vista: Above Average (4)	The vista from the home is of above average quality. These vistas include interesting views which often can be enjoyed in a medium to wide scope. They might contain some man made alterations (not considering turbines), yet still possess significant interest and mystery, are moderately balanced and have some potential for recreation.
Overall Quality of Scenic Vista: Premium (5)	This rating is reserved for vistas of unmistakably premium quality. These vistas would include "picture post card" views which can be enjoyed in a wide scope. They are often free or largely free of any discordant man made alterations (not considering turbines), possess significant interest, memorable qualities, mystery and are well balanced and likely have a high potential for recreation.
Degree Turbines Overlap Prominent Vista? Not at all (0))	The vista does not contain any view of the turbines.
Degree Turbines Overlap Prominent Vista? Barely (1)	A small portion (~ 0 - 20%) of the vista is overlapped by the view of turbines therefore the vista might contain a view of a few turbines, only a few of which can be seen entirely (from below the sweep of the blades to the top of their tips).
Degree Turbines Overlap Prominent Vista? Somewhat (2)	A moderate portion (~20-50%) of the vista contains turbines, and likely contains a view of more than one turbine, some of which are likely to be seen entirely (from below the sweep of the blades to the top of their tips).
Degree Turbines Overlap Prominent Vista? Strongly (3)	A large portion (~50-80%) of the vista contains a view of turbines, many of which likely can be seen entirely (from below the sweep of the blades to the top of their tips).
Degree Turbines Overlap Prominent Vista? Entirely (4)	This rating is reserved for situations where the turbines overlap virtually the entire (~80-100%) vista from the home. The vista likely contains a view of many turbines, virtually all of which can be seen entirely (from below the sweep of the blades to the top of their tips).

Figure A - 14: Field Data Collection Instrument - Instructions - Page 2

View of Turbines Characterist

House Orientation to View of Turbines: Side (S)	Orientation of home to the view of the turbines is from the side.
House Orientation to View of Turbines: Front (F)	Orientation of home to the view of the turbines is from the front.
House Orientation to Vista of Turbines: Back (B)	Orientation of home to the view of the turbines is from the back.
House Orientation to Vista of Turbines: Angled (A)	Orientation of home to the view of the turbines is from an angle.
View of Turbines Scope: Narrow(1)	The view of the turbines is largely blocked by trees, large shrubs or man made features in the foreground (0-300 feet) allowing 0 - 30 degrees of view of the wind facility
View of Turbines Scope: Medium(2)	The view of turbines is partially blocked by trees, large shrubs or man made features in the foreground (0-300 feet) allowing only 30-90 degrees of view of the wind facility.
View of Turbines Scope: Wide(3)	The view of the turbines is free or almost free from blockages by trees, large shrubs or man made features in the foreground (0-300 feet) allowing at least 90 degrees of view of the wind facility.
Degree to which View of Turbines Dominates the Site? None (0)	The turbines are not visible at all frrom this home.
Degree to which View of Turbines Dominates the Site? Minor (1)	The turbines are visible but either the scope is narrow, there are many obstructions, or the distance between the home and the facility is large.
Degree to which View of Turbines Dominates the Site? Moderate (2)	The turbines are visible but the scope is either narrow or medium, there might be some obstructions, and the distance between the home and the facility is most likely a few miles.
Degree to which View of Turbines Dominates the Site? Substantial (3)	The turbines are dramatically visible from the home. The turbines are likely visible in a wide scope, and most likely the distance between the home and the facility is short.
Degree to which View of Turbines Dominates the Site? Extreme (4)	This rating is reserved for sites that are unmistakably dominated by the presence of the windfarm. The turbines are dramatically visible from the home and there is a looming quality to their placement. The turbines are often visible in a wide scope, or the distance to the facility is very small.

Appendix D: Vista Ratings with Photos

POOR VISTA

BELOW AVERAGE VISTA

AVERAGE VISTA

ABOVE AVERAGE VISTA

PREMIUM VISTA

Appendix E: View Ratings with Photos

MINOR VIEW

3 turbines visible from front orientation, nearest 1.4 miles (TXHC)

5 turbines visible from front orientation, nearest 0.9 miles (NYMC)

MODERATE VIEW

18 turbines visible from back orientation, nearest 1.6 miles (ILLC)

6 turbines visible from back orientation, nearest 0.8 miles (PASC)

SUBSTANTIAL VIEW

90 turbines visible from all orientations, nearest 0.6 miles (IABV)

27 turbines visible from multiple orientations, nearest 0.6 miles (TXHC)

EXTREME VIEW

6 turbines visible from multiple orientations, nearest 0.2 miles (WIKCDC)

212 turbines visible from all orientations, nearest 0.4 miles (IABV)

Appendix F: Selecting the Primary ("Base") Hedonic Model

Equation (1) as described in Section 4.2 is presented in this report as the primary (or "Base") model to which all other models are compared. As noted earlier, in the Base Hedonic Model and in all subsequent models presented in Section 5 all variables of interest, spatial adjustments, and home and site characteristics are pooled, and therefore their estimates represent the average across all study areas. Ideally, one would have enough data to estimate a model at the study area level - a fully unrestricted model - rather than pooled across all areas. In this appendix, alternative model forms are presented that unrestrict these variables at the level of study areas. As shown here, these investigations ultimately encouraged the selection of the somewhat simpler pooled Base Model as the primary model, and to continue to use restricted or pooled models in the alternative hedonic analyses.

F.1 Discussion of Fully Unrestricted Model Form

The Base Model described by equation (1) has variables that are pooled, and the coefficients for these variables therefore represent the average across all study areas (after accounting for study area fixed effects). An alternative (and arguably superior) approach would be to estimate coefficients at the level of each study area, thereby allowing coefficient values to vary among study areas.[116] This fully interacted – or unrestricted – model would take the following form:

$$\ln(\mathrm{P}) = \beta_0 + \sum_{\mathrm{s}} \beta_1 \left(\mathrm{N} \cdot \mathrm{S}\right) + \sum_{\mathrm{c}} \beta_2 \left(\mathrm{Y}\right) + \sum_{\mathrm{k}} \beta_3 \left(\mathrm{X} \cdot \mathrm{S}\right) + \sum_{\mathrm{v}} \beta_4 (\mathrm{VIEW} \cdot \mathrm{S}) + \sum_{\mathrm{d}} \beta_5 (\mathrm{DISTANCE} \cdot \mathrm{S}) + \varepsilon \tag{F13}$$

where

P represents the inflation-adjusted sale price,
N is the spatially weighted neighbors' predicted sale price,
S is a vector of *s* study areas (e.g., WAOR, OKCC, etc.),
Y is a vector of *c* study area locational characteristics (e.g., census tract, school district, etc.),
X is a vector of k home and site characteristics (e.g., acres, square feet, number of bathrooms, condition of the home, age of home, VISTA, etc.),
VIEW is a vector of v categorical view of turbine variables (e.g., MINOR, MODERATE, etc.),
DISTANCE is a vector of d categorical distance to turbine variables (e.g., less than 3000 feet, between one and three miles, etc.),
β_0 is the constant or intercept across the full sample,
β_1 is a vector of *s* parameter estimates for the spatially weighted neighbor's predicted sale price for S study areas,
β_2 is a vector of *c* parameter estimates for the study area locational fixed effect variables,
β_3 is a vector of *k* parameter estimates for the home and site characteristics for S study areas,
β_4 is a vector of *v* parameter estimates for the VIEW variables as compared to homes sold with no view of the turbines for S study areas,

[116] For instance, the marginal contribution of Acres (the number of acres) to the selling price would be estimated for each study area (i.e., Acres_WAOR, Acres_TXHC etc.), as would the variables of interest: VIEW and DISTANCE.

β_5 is a vector of *d* parameter estimates for the DISTANCE variables as compared to homes sold situated outside of five miles for S study areas, and
ε is a random disturbance term.

To refresh, the fully restricted equation (1) takes the following form:

$$\ln(\mathrm{P}) = \beta_0 + \beta_1 \mathrm{N} + \sum_{\mathrm{s}} \beta_2 \mathrm{S} + \sum_{\mathrm{k}} \beta_3 \mathrm{X} + \sum_{\mathrm{v}} \beta_4 \mathrm{VIEW} + \sum_{\mathrm{d}} \beta_5 \mathrm{DISTANCE} + \varepsilon \qquad (1)$$

where
P represents the inflation-adjusted sale price,
N is the spatially weighted neighbors' predicted sale price,
S is the vector of *s* Study Area fixed effects variables (e.g., WAOR, OKCC, etc.),
X is a vector of *k* home and site characteristics (e.g., acres, square feet, number of bathrooms, condition of the home, age of home, VISTA, etc.),
VIEW is a vector of *v* categorical view of turbine variables (e.g., MINOR, MODERATE, etc.),
DISTANCE is a vector of *d* categorical distance to turbine variables (e.g., less than 3000 feet, between one and three miles, etc.),
β_0 is the constant or intercept across the full sample,
β_1 is a parameter estimate for the spatially weighted neighbor's predicted sale price,
β_2 is a vector of *s* parameter estimates for the study area fixed effects as compared to homes sold in the Washington/Oregon (WAOR) study area,
β_3 is a vector of *k* parameter estimates for the home and site characteristics,
β_4 is a vector of *v* parameter estimates for the VIEW variables as compared to homes sold with no view of the turbines,
β_5 is a vector of *d* parameter estimates for the DISTANCE variables as compared to homes sold situated outside of five miles, and
ε is a random disturbance term.

The significant change between equations (1) and (F13) is that each of the primary groups of variables in equation (F13) is interacted with the study areas (S) so that parameters can be estimated at the study area level. For example, whereas ACRES is estimated in equation (1) across all study areas, in equation (F13) it is estimated for each study area (i.e., Acres_WAOR, Acres_TXHC, etc).[117] Similarly, when considering the possible impact of wind facilities on residential sales prices, equation (1) seeks average effects that exist over the entire sample, while equation (F13) instead looks for differential effects in each individual study area. Additionally, in equation (F13), instead of estimating fixed effects using inter-study area parameters alone (e.g., WAOR, TXHC), a set of intra-study area effects (Y) - school district and census tract delineations - are added.[118] These latter coefficients represent not only effects that are presumed

[117] This change is made because, theoretically, the contribution to sales prices of home or site characteristics may differ between study areas – for instance Central_AC in Texas vs. New York – and therefore estimating them at the study area level may increase the explanatory power of the model.

[118] In the evaluation and selection of the best model to use as the "Base Model" a set of census tract and school district delineations were used instead of the study area fixed effects. These more-granular fixed effects were extracted from GIS using house locations and census tract and school district polygons. Often, the school district and census tract delineations were not mutually exclusive. For example, in Wisconsin the WIKCDC study area contains four school districts and six census tracts, none of which completely overlap. Alternatively, in some study

to exist over each entire study area (inter-study area effects), but also intra-study area effects such as differences in home valuation due to school districts, distances to amenities, and other locationally bound influences. As with the inter-study area coefficients, because of the myriad influences captured by these variables, interpretation of any single coefficient can be difficult. However, it is expected that such coefficients would be influential, indicating significant differences in value between homes in each study area and across study areas due to school district quality and factors that differ between census tracts (e.g., crime rates).

Although the fully unrestricted model described by equation (F13) is arguably superior to the fully restricted model described in equation (1) because of its ability to resolve differences between and within study areas that are not captured by the Base Model, there are three potential drawbacks:

- Model parsimony and performance;
- Standard error magnitudes; and
- Parameter estimate stability.

Each of these potential drawbacks is discussed in turn below:

Model parsimony and performance: In general, econometricians prefer a simpler, more parsimonious statistical model. In this instance, variables should be added to a model only if their addition is strongly supported by theory and if the performance of the model is substantially improved by their inclusion. As such, if a model with a relatively small number of parameters performs well, it should be preferred to a model with more parameters unless the simple model can be "proven to be inadequate" (Newman, 1956). To prove the inadequacy of a simpler model requires a significant increase in performance to be exhibited from the more complex model. In this case, as presented later, performance is measured using the combination of Adjusted R^2, Modified R^2, and the Schwarz information criterion (see footnote 119 on page 127).

Standard error magnitudes: The magnitude of the standard errors for the variables of interest, as well as the other controlling variables, are likely to increase in the unrestricted model form because the number of cases for each variable will decrease when they are estimated at the study area level. Within each study area, there are a limited number of home transactions that meet the criteria for inclusion in the model, but even more limiting is the number of home transactions within each study area that have the characteristics of interest. For example, in Lee County, IL (ILLC), there are 205 post-construction home sales, while in Wayne County, PA (PAWC) there are 222. More importantly, in those areas, the data include a total of one and eleven sales inside of one mile, respectively, and a total of one and two homes with either EXTREME or SUBSTANTIAL rated views of turbines. With so few observations, there is increased likelihood that a single or small group of observations will strongly influence the sample mean of an independent variable. Since the standard error is derived from the variance of the parameter estimate, which in turn is derived from the summed deviation of each observation's actual level relative to its sample mean, this standard error is more likely to be larger than if a larger sample were considered. If the presence of wind facilities does have a detrimental effect on property

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areas the school district and census tracts perfectly overlapped, and in those cases either both were omitted as the reference category or one was included and the other withdrawn from the model to prevent perfect collinearity.

values, that effect seems likely to be relatively small, at least outside of the immediate vicinity of the wind turbines. The smaller sample sizes for the independent variables that come with the unrestricted model, which may decrease statistical precision by producing larger standard errors, would likely decrease the ability to accurately identify these possible effects statistically. To explore the magnitude of this concern, the difference in standard errors of the variables of interest is investigated among the restricted and unrestricted models.

Parameter estimate stability: In an unrestricted model, parameter estimates are more likely to be unstable because the sample of home transactions with any particular characteristic may be small and thus not representative of the population as a whole. As mentioned above, there are a limited number of transactions within each study area that have the characteristics of interest. Restricting the sample size by using an unrestricted model increases the likelihood that a limited number of observations, which in the population as a whole represent a very small segment, will drive the results in one direction or another, thereby leading to erroneous conclusions. The difference in parameter estimates is investigated by comparing the coefficients for the unrestricted variables of interest to those for the restricted variables of interest. Additionally, the sign of any significant variables will be investigated for the unrestricted models, which might help uncover potentially spurious results.

F.2 Analysis of Alterative Model Forms

Here the spectrum of alternative models is explored, from the fully restricted equation (1) to the fully unrestricted equation (F13). To do so, not only are these two ends of the spectrum estimated, but also 14 intermediate models are estimated that consist of every combination of restriction of the four variable groups (i.e., variables of interest, spatial adjustments, study area delineations, and home and site characteristics). This produces a total of 16 models over which to assess model parsimony and performance, standard error size, and coefficient stability. This process allows for an understanding of model performance but, more importantly, to ultimately define a "Base Model" that is parsimonious (i.e., has the fewest parameters), robust (i.e., high adjusted R^2), and best fits the purpose of investigating wind facility impacts on home sales prices.

Table A - 2 presents the performance statistics for each of the 16 models defined above, moving from the fully restricted model equation (1) ("Model 1") to the fully unrestricted model equation (F13) ("Model 16"). In columns 2 – 5 of the table, the "R" represents a restriction for this variable group (i.e., not crossed with the study areas) and the "U" represents the case when the variable group is unrestricted (i.e., crossed with the study areas). Also shown are summary model statistics (i.e., Adjusted R^2, Modified R^2, and Schwarz information criterion - "SIC"), as well as the number of estimated parameters (*k*). [119] All models were run using the post-construction data subset of the sample of home sales transactions (*n* = 4,937).

[119] Goldberger (1991), as cited by Gujarati (2003), suggests using a Modified $R^2 = (1 - k/n) * R^2$ to adjust for added parameters. For example, Models 1 and 14 have Modified R^2 of 0.76, yet Adjusted R^2 of 0.77 and 0.78 respectively. Therefore the Modified R^2 penalizes their measure of explanatory power more than the Adjusted R^2 when taking into account the degrees of freedom. Similarly, the Schwarz information criterion penalizes the models for increased numbers of parameters (Schwarz, 1978). More importantly, practitioners often rely on the Schwarz criterion – over the Modified or Adjusted R^2 statistics - to rank models with the same dependent variable by their relative parsimony (Gujarati, 2003). Therefore it will be used for that purpose here.

Model Parsimony and Performance

Overall, the fully restricted model (1) performs well with only 37 independent variables, producing an Adjusted R^2 of 0.77. Despite the limited number of explanatory variables, the model explains ~77% of the variation in home prices in the sample. When the fully unrestricted model 16 (equation F13) is estimated, which lies at the other end of the spectrum, it performs only slightly better, with an Adjusted R^2 of 0.81, but with an additional 285 explanatory variables. It is therefore not surprising that the Modified R^2 is 0.76 for Model 1 and is only 0.77 for Model 16. Similarly, the Schwarz information criterion (SIC) increases from 0.088 to 0.110 when moving from model 1 to model 16 indicating relatively less parsimony. Combined, these metrics show that the improvement in the explanatory power of model 16 over model 1 is not enough to overcome the lack of parsimony. Turning to the 14 models that lie between Models 1 and 16, in general, little improvement in performance is found over Model 1, and considerably less parsimony, providing little initial justification to pursue a more complex specification than equation (1).

Table A - 2: Summarized Results of Restricted and Unrestricted Model Forms

Model [1]	Study Area [2]	Spatial Adjustment	Home and Site Characteristics	Variables of Interest	Adj R^2	Modified R^2	SIC	*k* †
1	R	R	R	R	0.77	0.76	0.088	37
2	U	R	R	R	0.74	0.73	0.110	111
3	R	U	R	R	0.77	0.76	0.088	46
4	R	R	U	R	0.80	0.78	0.095	188
5	R	R	R	U	0.77	0.76	0.093	88
6	U	U	R	R	0.78	0.76	0.094	120
7	R	U	U	R	0.80	0.77	0.096	197
8	R	R	U	U	0.80	0.77	0.101	239
9	U	R	U	R	0.80	0.77	0.107	262
10	U	R	R	U	0.76	0.75	0.107	162
11	R	U	R	U	0.77	0.76	0.094	97
12	U	U	U	R	0.81	0.77	0.103	271
13	R	U	U	U	0.80	0.77	0.103	248
14	U	U	R	U	0.78	0.76	0.100	171
15	U	R	U	U	0.80	0.76	0.113	313
16	U	U	U	U	0.81	0.77	0.110	322

"R" indicates parameters are pooled ("restricted") across the study areas.
"U" indicates parameters are not pooled ("unrestricted"), and are instead estimated at the study area level.
1 - *Model numbers do not correspond to equation numbers listed in the report; equation (1) is Model 1, and equation (F1) is Model 16.*
2 - *In its restricted form "Study Area" includes only inter-study area delineations, while unrestricted "Study Area" includes intra-study area delineations of school district and census tract.*
† - *Numbers of parameters do not include intercept or omitted variables.*

The individual contributions to model performance from unrestricting each of the variable groups in turn (as shown in Models 2-5) further emphasizes the small performance gains that are earned despite the sizable increases in the number of parameters. As a single group, the

unrestricted Home and Site Characteristics model (Model 4) makes the largest impact on model performance, at least with respect to the Adjusted R^2 (0.80), but this comes with the addition of 151 estimated parameters a slight improvement in the Modified R^2 (0.78) and a worsening SIC (0.095). Adding unrestricted Study Area delineations (Model 2), on the other hand, adversely affects performance (Adj. R^2 = 0.74, Modified R^2 = 0.73) and adds 74 estimated parameters (SIC = 0.110). Similarly, unrestricting the Spatial Adjustments (Model 3) offers little improvement in performance (Adj. R^2 = 0.77, Modified R^2 = 0.76) despite adding nine additional variables (SIC = 0.088). Finally, unrestricting the Variables of Interest (Model 5) does not increase model performance (Adj. R^2 = 0.77, Modified R^2 = 0.76) and adds 51 variables to the model (SIC = 0.093). This pattern of little model improvement yet considerable increases in the number of estimated parameters (i.e., less parsimony) continues when pairs or trios of variable groups are unrestricted. With an Adjusted R^2 of 0.77, the fully restricted equation (1) performs more than adequately, and is, by far, the most parsimonious.

Standard Error Magnitudes

Table A - 3 summarizes the standard errors for the variables of interest for all of the 16 models, grouped into restricted and unrestricted model categories. The table specifically compares the medians, minimums, and maximums of the standard errors for the models with restricted variables of interest (1, 2, 3, 4, 6, 7, 9 and 12) to those with unrestricted variables of interest (5, 8, 10, 11, 13, 14, 15 and 16).[120] The table demonstrates that the unrestricted standard errors for the variables of interest are significantly larger than the restricted standard errors. In fact, the minimum standard errors in the unrestricted models are often higher than the maximum standard errors produced in the restricted models. For example, the maximum standard error for an EXTREME VIEW in the restricted models is 0.09, yet the minimum in the unrestricted models is 0.12, with a maximum of 0.34. To put this result in a different light, a median standard error for the unrestricted EXTREME VIEW variable of 0.25 would require an effect on house prices larger than 50% to be considered statistically significant at the 90% level. Clearly, the statistical power of the unrestricted models is weak.[121] Based on other disamenities, as discussed in Section 2.1, an effect of this magnitude is very unlikely. Therefore, based on these standard errors, there is no apparent reason to unrestrict the variables of interest.

[120] For the restricted models, the medians, minimums, and maximums are derived across all eight models for each variable of interest. For the unrestricted models, they are derived across all study areas and all eight models for each variable of interest.

[121] At 90% confidence a standard error of 0.25 would produce a confidence interval of roughly +/- 0.42 (0.25 * 1.67). An effect of this magnitude represents a 52% change in sales prices because sales price is in a natural log form (*e* ^ 0.42-1 = 0.52).

Table A - 3: Summary of VOI Standard Errors for Restricted and Unrestricted Models

Standard Errors	Restricted Models			Unrestricted Models		
	Standard Errors			Standard Errors		
	Median	Min	Max	Median	Min	Max
Minor View	0.01	0.01	0.02	0.05	0.03	0.07
Moderate View	0.03	0.03	0.03	0.10	0.06	0.18
Substantial View	0.05	0.05	0.06	0.19	0.10	0.29
Extreme View	0.08	0.08	0.09	0.25	0.12	0.34
Inside 3000 Feet	0.05	0.05	0.06	0.21	0.09	0.33
Between 3000 Feet and 1 Mile	0.04	0.04	0.05	0.13	0.08	0.40
Between 1 and 3 Miles	0.02	0.02	0.02	0.05	0.02	0.11
Between 3 and 5 Miles	0.01	0.01	0.02	0.05	0.02	0.10

Parameter Estimate Stability

Table A - 4 summarizes the coefficient estimates for the variables of interest for all of the 16 models. The table specifically compares the medians, minimums, and maximums of the coefficients for the models with restricted variables of interest (1, 2, 3, 4, 6, 7, 9 and 12) to those with unrestricted variables of interest (5, 8, 10, 11, 13, 14, 15 and 16). As shown, the coefficients in the unrestricted models diverge significantly from those in the restricted models. For example, in the restricted models, the median coefficient for homes inside of 3000 feet is -0.03, with a minimum of -0.06 and a maximum of -0.01, yet in the unrestricted models the median coefficient is 0.06, with a minimum of -0.38 and a maximum of 0.32. Similarly, a MODERATE VIEW in the restricted models has a median of 0.00, with a minimum of -0.01 and a maximum of 0.03, whereas the unrestricted models produce coefficients with a median of -0.05 and with a minimum of -0.25 and a maximum of 0.35.

Table A - 4: Summary of VOI Coefficients for Restricted and Unrestricted Models

Parameters	Restricted Models			Unrestricted Models		
	Coefficients			Coefficients		
	Median	Min	Max	Median	Min	Max
Minor View	-0.02	-0.03	0.00	-0.02	-0.16	0.24
Moderate View	0.00	-0.01	0.03	-0.05	-0.25	0.35
Substantial View	-0.01	-0.04	0.02	-0.08	-0.31	0.13
Extreme View	0.03	0.02	0.05	-0.03	-0.23	0.09
Inside 3000 Feet	-0.03	-0.06	-0.01	0.06	-0.38	0.32
Between 3000 Feet and 1 Mile	-0.04	-0.06	-0.01	-0.10	-0.44	0.52
Between 1 and 3 Miles	-0.01	-0.03	0.02	0.00	-0.23	0.40
Between 3 and 5 Miles	0.02	0.01	0.04	0.05	-0.05	0.32

Turning from the levels of the coefficients to the stability of their statistical significance and sign across models more reasons for concern are found. Table A - 5 summarizes the results of the unrestricted models, and presents the number of statistically significant variables of interest as a percent of the total estimated. The table also breaks these results down into two groups, those

with coefficients above zero and those with coefficients below zero.[122] It should be emphasized here that it is the *a priori* expectation that, if effects exist, all of these coefficients would be less than zero, indicating an adverse effect on home prices from proximity to and views of wind turbines. Despite that expectation, when the variables of interest are unrestricted it is found that they are as likely to be above zero as they are below.[123] In effect, the small numbers of cases available for analysis at the study area level produce unstable results, likely because the estimates are being unduly influenced by either study area specific effects that are not captured by the model or by a limited number of observations that represents a larger fraction of the overall sample in that model.[124]

Table A - 5: Summary of Significant VOI Above and Below Zero in Unrestricted Models

Significant Variables	Unrestricted Models		
	Total	Below Zero	Above Zero
Minor View	32%	14%	18%
Moderate View	23%	11%	13%
Substantial View	4%	4%	0%
Extreme View	0%	0%	0%
Inside 3000 Feet	23%	15%	8%
Between 3000 Feet and 1 Mile	30%	14%	16%
Between 1 and 3 Miles	56%	32%	24%
Between 3 and 5 Miles	45%	3%	43%

F.3 Selecting a Base Model

To conclude, it was found that all three concerns related to the estimation and use of an unrestricted model form are borne out in practice. Despite experimenting with 16 different combinations of interactions, little overall improvement in performance is discovered. Where performance gains are found they are at the expense of parsimony as reflected in the lack of increase in the Modified R^2 and the relatively higher Schwartz information criterion. Further, divergent and spurious coefficients of interest and large standard errors are associated with those coefficients. Therefore the fully restricted model, equation (1), is used in this report as the "Base Model".

[122] The "Total" percentage of significant coefficients is calculated by counting the total number of significant coefficients across all 8 unrestricted models for each variable of interest, and dividing this total by the total number of coefficients. Therefore, a study area that did not have any homes in a group (for example, homes with EXTREME VIEWS) was not counted in the "total number of coefficients" sum. Any differences between the sum of "above" and "below" zero groups from the total are due to rounding errors.

[123] The relatively larger number of significant variables for the MINOR rated view, MODERATE rated view, Mile 1 to 3, and Mile 3 to 5 parameters are likely related to the smaller standard errors for those categories, which result from larger numbers of cases.

[124] Another possible explanation for spurious results in general is measurement error, when parameters do not appropriately represent what one is testing for. In this case though, the VIEW variables have been adequately "ground truthed" during the development of the measurement scale, and are similar to the VISTA variables, which were found to be very stable across study areas. DISTANCE, or for that matter, distance to any disamenity, has been repeatedly found to be an appropriate proxy for the size of effects. As a result, it is not believed that measurement error is a likely explanation for the results presented here.

Appendix G: OLS Assumptions, and Tests for the Base Model

A number of criteria must be met to ensure that the Base Model and Alternative Hedonic Models produce unbiased coefficient estimates and standard errors: 1) appropriate controls for outliers and influencers; 2) homoskedasticity; 3) absence of serial or spatial autocorrelation; and 4) reasonably limited multicollinearity. Each of these criteria, and how they are addressed, is discussed below.

Outliers and Influencers: Home sale prices that are well away from the mean, also called outliers and influencers, can cause undue influence on parameter estimates. A number of formal tests are available to identify these cases, the most common being Mahalanobis' Distance ("M Distance") (Mahalanobis, 1936) and standardized residual screening. M Distance measures the degree to which individual observations influence the mean of the residuals. If any single observation has a strong influence on the residuals, it should be inspected and potentially removed. An auxiliary, but more informal, test for identifying these potentially influential observations is to see when the standardized absolute value of the residual exceeds some threshold. Both the Base Model and the All Sales Model were run using the original dataset of 7,464 transactions and the 4,940 transactions which occurred post-construction respectively. For both models the standardized residuals and the M Distance statistics were saved.[125] The histograms of these two sets of statistics from the two regressions are shown in Figure A - 15 through Figure A - 18.

[125] For the M Distance statistics all variables of interest were removed from the model. If they were left in the M-Distance statistics could be influenced by the small numbers of cases in the variables of interest. If these parameters were strongly influenced by a certain case, it could drive the results upward. Inspecting the controlling variables in the model, and how well they predicted the sale prices of the transactions in the sample, was of paramount importance therefore the variables of interest were not included.

Figure A - 15: Histogram of Standardized Residuals for Base Model

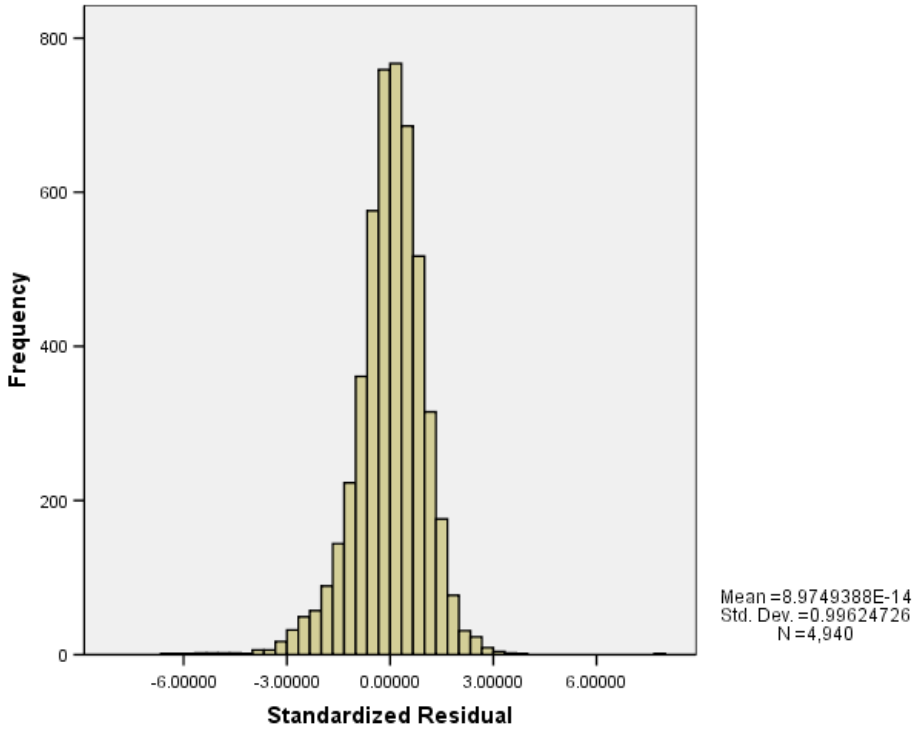


Figure A - 16: Histogram of Mahalanobis Distance Statistics for Base Model

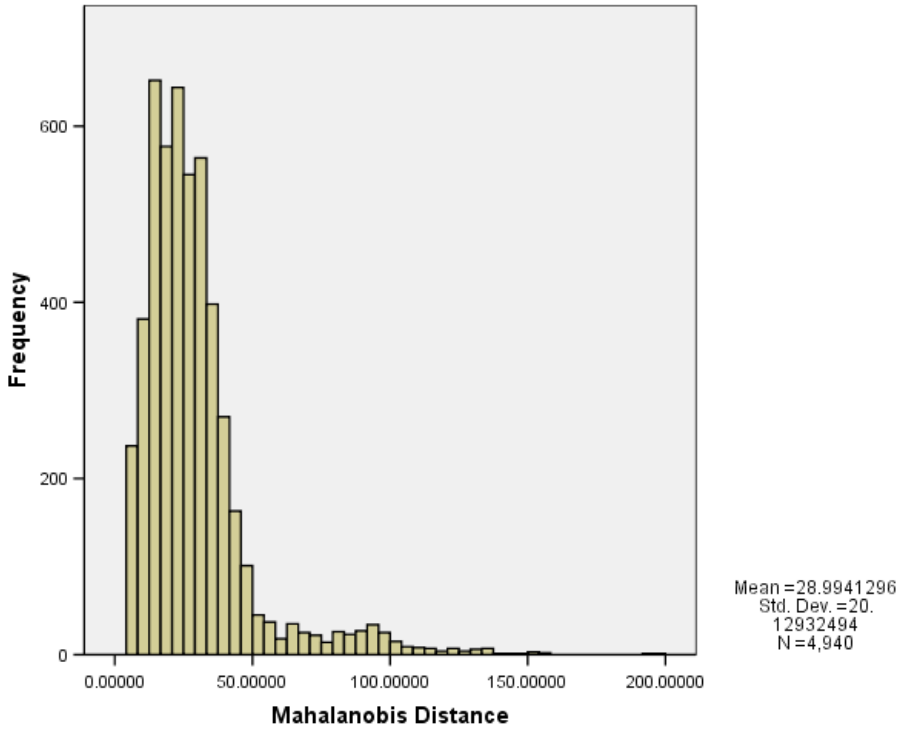


Figure A - 17: Histogram of Standardized Residuals for All Sales Model

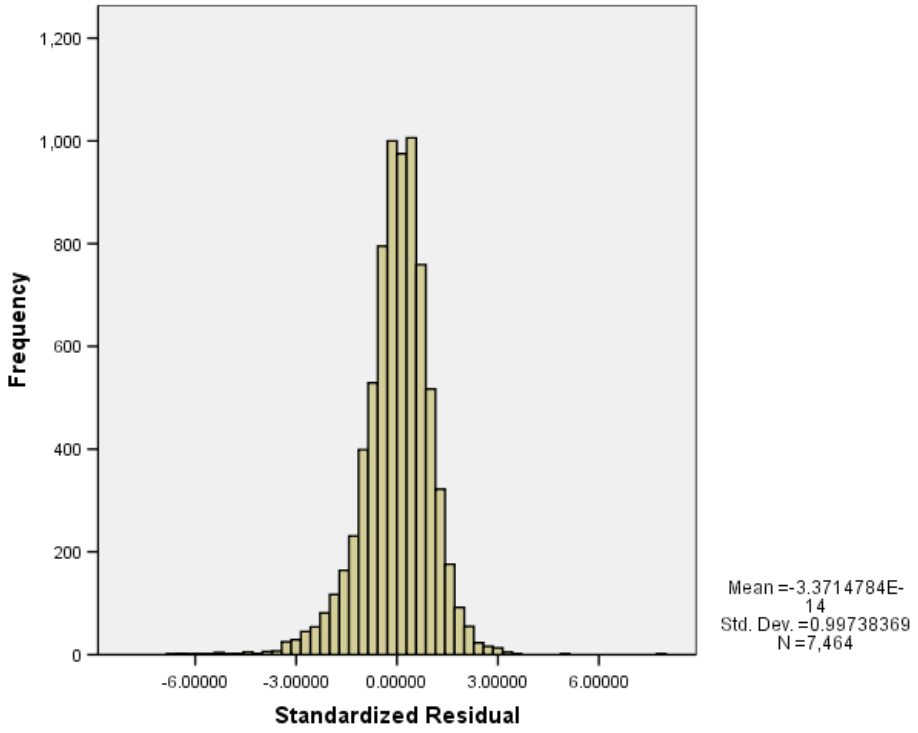
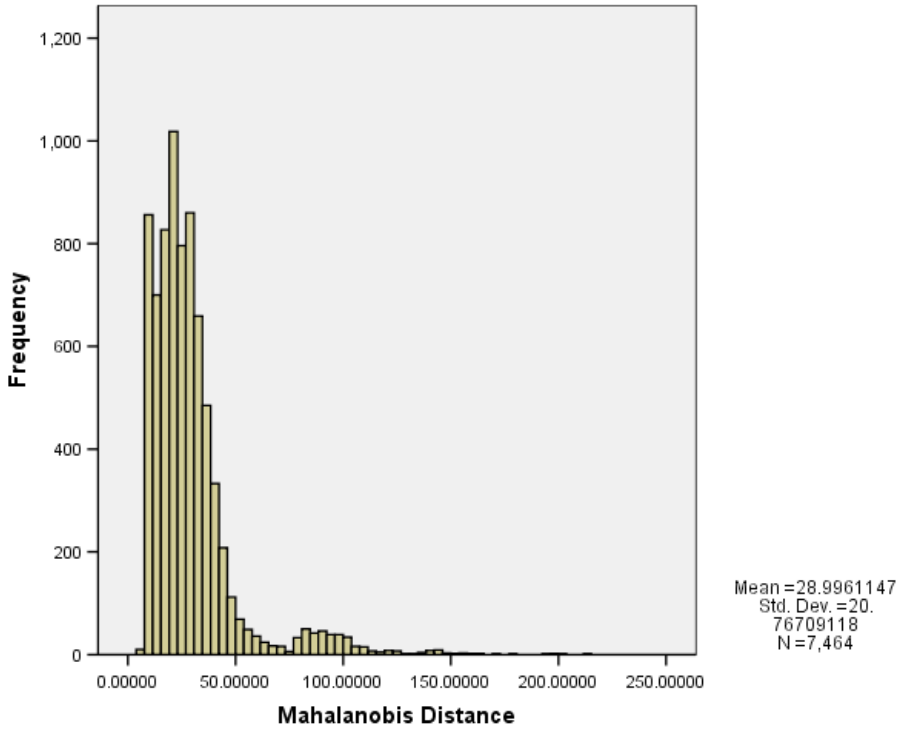


Figure A - 18: Histogram of Mahalanobis Distance Statistics for All Sales Model



The M Distance histograms suggested that a cutoff of 150 may be appropriate, which would exclude 15 cases from the All Sales Model and seven cases from the Base Model (all of the latter of which were among the 15 outliers in the All Sales Model). The Standardized Residual histograms suggested a cutoff of 4, 5, or 6, which would exclude 13, 8, and 3 cases from the Base Model, and 22, 12, and 5 cases from the All Sales Model. A case-by-case investigation of each of these sales transactions was then conducted by comparing their home characteristics (e.g., square feet, baths, age, etc.) against their study area and panel model cohorts to ensure that none had been inappropriately coded. None of the M Distance flagged cases seemed to be inappropriately coded, and none of those cases were removed from the final dataset as a result. Five cases that were flagged from the All Sales Model (which corresponded to three cases in the Base Model) with a Standardized Residual greater than six, however, were clearly outliers. One had a sale price that was more than $200,000 more than any other transaction in the model, and the other four had exceptionally low prices, yet high numbers of corresponding characteristics that would suggest higher home sales prices (such as over 2000 square feet – all four cases – or more than two bathrooms – three cases).

As a result of these investigations, these five cases were removed from the model. One of the five cases occurred prior to announcement, one occurred after announcement and before construction, and the other three occurred after construction began. None were within three miles of the nearest wind turbine except one, which was 0.6 miles from the nearest turbine and had a MINOR view of the wind facility. The other two had no views of the turbines. Although there was hesitancy in removing any cases from the model, these transactions were considered appropriately influential and keeping them in the model would bias the results inappropriately. Further, the one home that was situated inside of one mile was surrounded by five other transactions in the same study area that also occurred after construction began and were a similar distance from the turbines, but that were not flagged by the outliers screen. Therefore, its removal was considered appropriate given that other homes in the sample would likely experience similar effects.

After removing these five cases, the sensitivity of the model results were tested to the inclusion or exclusion of the “greater than five” and “greater than four” Standardized Residuals observations and the cases flagged by the M Distance screen, finding that parameter estimates for the variables of interest moved slightly with these cases removed but not enough to change the results significantly. Because they did not show a unique grouping across the variables of interest, nor any unusual potentially inappropriate coding, and, more importantly, did not substantially influence the results, no substantive reason was found to remove any additional transactions from the sample. Therefore, the final dataset included a total of 7,459 cases, of which 4,937 occurred post-construction.

Homoskedasticity: A standard formal test for the presence of homoskedastic error terms is the White's statistic (White, 1980). However, the requirements to perform this test were overly burdensome for the computing power available. Instead, an informal test was applied, which plots the regression errors against predicted values and various independent variables to observe whether a "heteroskedastic pattern" is in evidence (Gujarati, 2003). Although no evidence of heteroskedasticity was found using this method, to be conservative, nonetheless all models were

run with White's heteroskedasticity correction to the parameter estimates' standard errors (which will not adversely influence the errors if they are homoskedastic).

Serial Autocorrelation: A standard formal test for the presence of serial autocorrelation in the error term is the Durbin-Watson statistic (Durbin and Watson, 1951). Applying this test as proposed by Durbin and Watson to the full panel dataset was problematic because the test looks at the error structure based on the order that observations are included in the statistical regression model. Any ordering choice over the entire panel data set invariably involves mixing home transactions from various study areas. Ideally, one would segment the data by study area for purposes of calculating this test, but that method was not easily implemented with the statistical software package used for this analysis (i.e., SAS). Instead, study area specific regression models were run with the data chronologically ordered in each to produce twelve different Durbin-Watson statistics, one for each study area specific model. The Durbin-Watson test statistics ranged from 1.98–2.16, which are all within the acceptable range.[126] Given that serial autocorrelation was not found to be a significant concern for each study area specific model, it is assumed that the same holds for the full dataset used in the analysis presented in this report.

Spatial Autocorrelation: It is well known that the sales price of a home can be systematically influenced by the sales prices of those homes that have sold nearby (Dubin, 1998; LeSage, 1999). Both the seller and the buyer use information from comparable surrounding sales to inform them of the appropriate transaction price, and nearby homes often experience similar amenities and disamenities. Therefore, the price for any single home is likely to be weakly dependent of the prices of homes in close temporal and spatial proximity. This lack of independence of home sale prices could bias the hedonic results (Dubin, 1998; LeSage, 1999), if not adequately addressed. A number of techniques are available to address this concern (Case et al., 2004; Espey et al., 2007), but because of the large sample and computing limits, a variation of the Spatial Auto Regressive Model (SAR) was chosen (Espey et al., 2007).

Specifically, an independent variable is included in the models: the predicted values of the weighted nearest neighbor's natural log of sales price in 1996 dollars.[127] To construct this vector of predicted prices, an auxiliary regression is developed using the spatially weighted average natural log of sales price in 1996 dollars as the independent variable and the spatially weighted average set of home characteristics as the dependent variables. This regression was used to produce the <u>predicted</u> weighted nearest neighbor's natural log of sales price in 1996 dollars that is then included in the Base and Alternative Models. This process required the following steps:

1) Selecting the neighbors for inclusion in the calculation;
2) Calculating a weighted sales price from these neighbors' transactions;
3) Selecting and calculating the weighted neighbors home characteristics; and
4) Forecasting the weighted average neighbor's sales price.

- **Selecting the neighbors**: To select the neighbors whose home transactions would most likely have affected the sales price of the subject home under review, all of the homes that

[126] The critical values for the models were between 1.89 and 2.53, assuming 5% significance, greater than 20 variables, and more than 200 cases (Gujarati, 2003).

[127] The predicted value was used, instead of the actual value, to help correct for simultaneity or endogeneity problems that might otherwise exist.

sold within the preceding six months of a subject home's sale date in the same study area are identified and, from those, the five nearest neighbors based on Euclidian distance are selected. The inverse of each selected nearest neighbors' distance (in quarter miles) to the subject home was then calculated. Each of these values was then divided by the sum of the five nearest neighbor's inverse distance values to create a neighbor's distance weight (NDW) for each of the five nearest neighbors.[128]

- **Creating the weighted sales price**: Each of the neighbor's natural log of sales price in 1996 dollars (LN_Saleprice96) is multiplied by its distance weight (NDW). Then, each weighted neighbor's LN_Saleprice96 is summed to create a weighted nearest neighbor LN_Saleprice96 (Nbr_LN_Saleprice96).

- **Selecting and calculating the weighted neighbors home characteristics**: Nine independent variables are used from each of the neighbor's homes: square feet, age of the home at the time of sale, age of the home at the time of sale squared, acres, number of full baths, and condition (1-5, with Poor = 1, Below Average = 2, etc.). A weighted average is created of each of the characteristics by multiplying each of the neighbor's individual characteristics by their NDW, and then summing those values across the five neighbors to create the weighted average nearest neighbors' home characteristic.[129] Then each of the independent variables is interacted with the study area to allow each one to be independently estimated for each study area.

- **Forecasting the weighted average neighbors sales price**: To create the final predicted neighbor's price, the weighted nearest neighbor LN_Saleprice96 is regressed on the weighted average nearest neighbors' home characteristics to produce a predicted weighted nearest neighbor LN_Saleprice96 (Nbr_LN_SalePrice96_hat). These predicted values are then included in the Base and Alternative Models as independent variables to account for the spatial and temporal influence of the neighbors' home transactions.

In all models, the coefficient for this spatial adjustment parameter meets the expectations for sign and magnitude and is significant well above the 99% level, indicating both the presence of spatial autocorrelation and the appropriateness of the control for it.

Multicollinearity: There are several standard formal tests for detecting multicollinearity within the independent variables of a regression model. The Variance-Inflation Factor and Condition Index is applied to test for this violation of OLS assumptions. Specifically, a Variance-Inflation Factor (VIF) greater than 4 and/or a Condition Index of greater than 30 (Kleinbaum et al., 1988) are strong indicators that multicollinearity may exist. Multicollinearity is found in the model using both tests. Such a result is not uncommon in hedonic models because a number of characteristics, such as square feet or age of a home, are often correlated with other characteristics, such as the number of acres, bathrooms, and fireplaces. Not surprisingly, age of the home at the time of sale (AgeofHome) and the age of the home squared (AgeatHome_Sqrd)

[128] Put differently, the weight is the contribution of that home's inverse distance to the total sum of the five nearest neighbors' inverse distances.

[129] Condition requires rounding to the nearest integer and then creating a dummy from the 1-5 integers.

exhibited some multicollinearity (VIF equaled 11.8 and 10.6, respectively). Additionally, the home condition shows a fairly high Condition Index with square feet, indicating collinearity. More importantly, though, are the collinearity statistics for the variables of interest. The VIF for the VIEW variables range from 1.17 to 1.18 and for the DISTANCE variables they range from 1.2 to 3.6, indicating little collinearity with the other variables in the model. To test for this in another way, a number of models are compared with various identified highly collinear variables removed (e.g., AgeatSale, Sqft) and found that the removal of these variables had little influence on the variables of interest. Therefore, despite the presence of multicollinearity in the model, it is not believed that the variables of interest are inappropriately influenced. Further, any corrections for these issues might cause more harm to the model's estimating efficiency than taking no further action (Gujarati, 2003); as such, no specific adjustments to address the presence of multicollinearity are pursued further.

Appendix H: Alternative Models: Full Hedonic Regression Results

Table A - 6: Full Results for the Distance Stability Model

	Coef.	SE	p Value	*n*
Intercept	7.61	0.18	0.00	
Nbr_LN_SalePrice96_hat	0.29	0.02	0.00	4,937
AgeatSale	-0.006	0.0004	0.00	4,937
AgeatSale_Sqrd	0.00002	0.000003	0.00	4,937
Sqft_1000	0.28	0.01	0.00	4,937
Acres	0.02	0.00	0.00	4,937
Baths	0.09	0.01	0.00	4,937
ExtWalls_Stone	0.21	0.02	0.00	1,486
CentralAC	0.09	0.01	0.00	2,575
Fireplace	0.11	0.01	0.00	1,834
FinBsmt	0.08	0.02	0.00	673
Cul_De_Sac	0.10	0.01	0.00	992
Water_Front	0.33	0.04	0.00	87
Cnd_Low	-0.45	0.05	0.00	69
Cnd_BAvg	-0.24	0.02	0.00	350
Cnd_Avg	Omitted	Omitted	Omitted	2,727
Cnd_AAvg	0.13	0.01	0.00	1,445
Cnd_High	0.23	0.02	0.00	337
Vista_Poor	-0.21	0.02	0.00	310
Vista_BAvg	-0.08	0.01	0.00	2,857
Vista_Avg	Omitted	Omitted	Omitted	1,247
Vista_AAvg	0.10	0.02	0.00	448
Vista_Prem	0.13	0.04	0.00	75
WAOR	Omitted	Omitted	Omitted	519
TXHC	-0.75	0.03	0.00	1,071
OKCC	-0.44	0.02	0.00	476
IABV	-0.24	0.02	0.00	605
ILLC	-0.08	0.03	0.00	213
WIKCDC	-0.14	0.02	0.00	725
PASC	-0.30	0.03	0.00	291
PAWC	-0.07	0.03	0.01	222
NYMCOC	-0.20	0.03	0.00	346
NYMC	-0.15	0.02	0.00	469
Mile_Less_0_57	-0.04	0.04	0.29	67
Mile_0_57to1	-0.06	0.05	0.27	58
Mile_1to3	-0.01	0.02	0.71	2,019
Mile_3to5	0.01	0.01	0.26	1,923
Mile_Gtr5	Omitted	Omitted	Omitted	870

"Omitted" = reference category for fixed effects variables

"n" indicates number of cases in category when category = "1"

Model Information

Model Equation Number	**2**
Model Name	**Distance Stability**
Dependent Variable	**LN_SalePrice96**
Number of Cases	**4937**
Number of Predictors (k)	**33**
F Statistic	**496.7**
Adjusted R Squared	**0.77**

Table A - 7: Full Results for the View Stability Model

	Coef.	SE	Sig	*n*
Intercept	7.64	0.18	0.00	
Nbr_LN_SalePrice96_hat	0.29	0.02	0.00	4,937
AgeatSale	-0.006	0.0004	0.00	4,937
AgeatSale_Sqrd	0.00002	0.000003	0.00	4,937
Sqft_1000	0.28	0.01	0.00	4,937
Acres	0.02	0.00	0.00	4,937
Baths	0.09	0.01	0.00	4,937
ExtWalls_Stone	0.21	0.02	0.00	1,486
CentralAC	0.09	0.01	0.00	2,575
Fireplace	0.11	0.01	0.00	1,834
FinBsmt	0.08	0.02	0.00	673
Cul_De_Sac	0.10	0.01	0.00	992
Water_Front	0.34	0.04	0.00	87
Cnd_Low	-0.45	0.05	0.00	69
Cnd_BAvg	-0.24	0.02	0.00	350
Cnd_Avg	Omitted	Omitted	Omitted	2,727
Cnd_AAvg	0.13	0.01	0.00	1,445
Cnd_High	0.23	0.02	0.00	337
Vista_Poor	-0.21	0.02	0.00	310
Vista_BAvg	-0.08	0.01	0.00	2,857
Vista_Avg	Omitted	Omitted	Omitted	1,247
Vista_AAvg	0.10	0.02	0.00	448
Vista_Prem	0.13	0.04	0.00	75
WAOR	Omitted	Omitted	Omitted	519
TXHC	-0.75	0.02	0.00	1,071
OKCC	-0.45	0.02	0.00	476
IABV	-0.25	0.02	0.00	605
ILLC	-0.09	0.03	0.00	213
WIKCDC	-0.14	0.02	0.00	725
PASC	-0.31	0.03	0.00	291
PAWC	-0.08	0.03	0.00	222
NYMCOC	-0.20	0.03	0.00	346
NYMC	-0.15	0.02	0.00	469
Post_Con_NoView	Omitted	Omitted	Omitted	4,207
View_Minor	-0.02	0.01	0.25	561
View_Mod	0.00	0.03	0.90	106
View_Sub	-0.04	0.06	0.56	35
View_Extrm	-0.03	0.06	0.61	28

"Omitted" = reference category for fixed effects variables

"n" indicates number of cases in category when category = "1"

Model Information

Model Equation Number	**3**
Model Name	**View Stability**
Dependent Variable	**LN_SalePrice96**
Number of Cases	**4937**
Number of Predictors (k)	**33**
F Statistic	**495.9**
Adjusted R Squared	**0.77**

Table A - 8: Full Results for the Continuous Distance Model

	Coef.	SE	p Value	*n*
Intercept	7.64	0.18	0.00	
Nbr_LN_SalePrice96_hat	0.29	0.02	0.00	4,937
AgeatSale	-0.006	0.0004	0.00	4,937
AgeatSale_Sqrd	0.00002	0.000003	0.00	4,937
Sqft_1000	0.28	0.01	0.00	4,937
Acres	0.02	0.00	0.00	4,937
Baths	0.09	0.01	0.00	4,937
ExtWalls_Stone	0.21	0.02	0.00	1,486
CentralAC	0.09	0.01	0.00	2,575
Fireplace	0.11	0.01	0.00	1,834
FinBsmt	0.08	0.02	0.00	673
Cul_De_Sac	0.10	0.01	0.00	992
Water_Front	0.34	0.04	0.00	87
Cnd_Low	-0.45	0.05	0.00	69
Cnd_BAvg	-0.24	0.02	0.00	350
Cnd_Avg	Omitted	Omitted	Omitted	2,727
Cnd_AAvg	0.13	0.01	0.00	1,445
Cnd_High	0.23	0.02	0.00	337
Vista_Poor	-0.21	0.02	0.00	310
Vista_BAvg	-0.08	0.01	0.00	2,857
Vista_Avg	Omitted	Omitted	Omitted	1,247
Vista_AAvg	0.10	0.02	0.00	448
Vista_Prem	0.13	0.04	0.00	75
WAOR	Omitted	Omitted	Omitted	519
TXHC	-0.75	0.02	0.00	1,071
OKCC	-0.44	0.02	0.00	476
IABV	-0.25	0.02	0.00	605
ILLC	-0.09	0.03	0.00	213
WIKCDC	-0.14	0.02	0.00	725
PASC	-0.31	0.03	0.00	291
PAWC	-0.07	0.03	0.00	222
NYMCOC	-0.20	0.03	0.00	346
NYMC	-0.15	0.02	0.00	469
No View	Omitted	Omitted	Omitted	4,207
Minor View	-0.01	0.01	0.33	561
Moderate View	0.01	0.03	0.77	106
Substantial View	-0.02	0.07	0.72	35
Extreme View	0.01	0.10	0.88	28
InvDISTANCE	-0.01	0.02	0.46	4,937

"Omitted" = reference category for fixed effects variables
"n" indicates number of cases in category when category = "1"

Model Information

Model Equation Number	**5**
Model Name	**Continuous Distance Model**
Dependent Variable	**LN_SalePrice96**
Number of Cases	**4937**
Number of Predictors (k)	**34**
F Statistic	**481.3**
Adjusted R Squared	**0.77**

Table A - 9: Full Results for the All Sales Model

	Coef.	SE	p Value	*n*
Intercept	9.08	0.14	0.00	
Nbr_LN_SP96_hat_All_OI	0.16	0.01	0.00	7,459
AgeatSale	-0.007	0.0003	0.00	7,459
AgeatSale_Sqrd	0.00003	0.000002	0.00	7,459
Sqft_1000	0.28	0.01	0.00	7,459
Acres	0.02	0.00	0.00	7,459
Baths	0.08	0.01	0.00	7,459
ExtWalls_Stone	0.21	0.01	0.00	2,287
CentralAC	0.12	0.01	0.00	3,785
Fireplace	0.11	0.01	0.00	2,708
FinBsmt	0.09	0.01	0.00	990
Cul_De_Sac	0.09	0.01	0.00	1,472
Water_Front	0.35	0.03	0.00	107
Cnd_Low	-0.43	0.04	0.00	101
Cnd_BAvg	-0.21	0.02	0.00	519
Cnd_Avg	Omitted	Omitted	Omitted	4,357
Cnd_AAvg	0.13	0.01	0.00	2,042
Cnd_High	0.22	0.02	0.00	440
Vista_Poor	-0.25	0.02	0.00	470
Vista_BAvg	-0.09	0.01	0.00	4,301
Vista_Avg	Omitted	Omitted	Omitted	1,912
Vista_AAvg	0.10	0.01	0.00	659
Vista_Prem	0.09	0.03	0.00	117
WAOR	Omitted	Omitted	Omitted	790
TXHC	-0.82	0.02	0.00	1,311
OKCC	-0.53	0.02	0.00	1,113
IABV	-0.31	0.02	0.00	822
ILLC	-0.05	0.02	0.02	412
WIKCDC	-0.17	0.01	0.00	810
PASC	-0.37	0.03	0.00	494
PAWC	-0.15	0.02	0.00	551
NYMCOC	-0.25	0.02	0.00	463
NYMC	-0.15	0.02	0.00	693
Pre-Construction Sales	Omitted	Omitted	Omitted	2,522
No View	0.02	0.01	0.06	4,207
Minor View	0.00	0.02	0.76	561
Moderate View	0.03	0.03	0.38	106
Substantial View	0.03	0.07	0.63	35
Extreme View	0.06	0.08	0.43	28
Inside 3000 Feet	-0.06	0.05	0.23	80
Between 3000 Feet and 1 Mile	-0.08	0.05	0.08	65
Between 1 and 3 Miles	0.00	0.01	0.79	2,359
Between 3 and 5 Miles	0.01	0.01	0.58	2,200
Outside 5 Miles	0.00	0.02	0.76	1,000
Pre-Announcement Sales	Omitted	Omitted	Omitted	1,755

"Omitted" = reference category for fixed effects variables
"n" indicates number of cases in category when category = "1"

Model Information

Model Equation Number	**6**
Model Name	**All Sales Model**
Dependent Variable	**LN_SalePrice96**
Number of Cases	**7459**
Number of Predictors (k)	**39**
F Statistic	**579.9**
Adjusted R Squared	**0.75**

Table A - 10: Full Results for the Temporal Aspects Model

	Coef.	SE	p Value	*n*
Intercept	9.11	0.14	0.00	
Nbr_LN_SP96_hat_All_OI	0.16	0.01	0.00	7,459
AgeatSale	-0.007	0.0003	0.00	7,459
AgeatSale_Sqrd	0.00003	0.000002	0.00	7,459
Sqft_1000	0.28	0.01	0.00	7,459
Acres	0.02	0.00	0.00	7,459
Baths	0.08	0.01	0.00	7,459
ExtWalls_Stone	0.21	0.01	0.00	2,287
CentralAC	0.12	0.01	0.00	3,785
Fireplace	0.12	0.01	0.00	2,708
FinBsmt	0.09	0.01	0.00	990
Cul_De_Sac	0.09	0.01	0.00	1,472
Water_Front	0.35	0.03	0.00	107
Cnd_Low	-0.43	0.04	0.00	101
Cnd_BAvg	-0.21	0.02	0.00	519
Cnd_Avg	Omitted	Omitted	Omitted	4,357
Cnd_AAvg	0.13	0.01	0.00	2,042
Cnd_High	0.22	0.02	0.00	440
Vista_Poor	-0.25	0.02	0.00	470
Vista_BAvg	-0.09	0.01	0.00	4,301
Vista_Avg	Omitted	Omitted	Omitted	1,912
Vista_AAvg	0.10	0.01	0.00	659
Vista_Prem	0.09	0.03	0.00	117
WAOR	Omitted	Omitted	Omitted	790
TXHC	-0.82	0.02	0.00	1,311
OKCC	-0.52	0.02	0.00	1,113
IABV	-0.30	0.02	0.00	822
ILLC	-0.04	0.02	0.05	412
WIKCDC	-0.17	0.02	0.00	810
PASC	-0.37	0.03	0.00	494
PAWC	-0.14	0.02	0.00	551
NYMCOC	-0.25	0.02	0.00	463
NYMC	-0.15	0.02	0.00	693

"Omitted" = reference category for fixed effects variables
"n" indicates number of cases in category when category = "1"

Note: Results for variables of interest shown on following page

	Coef.	SE	p Value	*n*
No View	Omitted	Omitted	Omitted	6,729
Minor View	-0.02	0.01	0.20	561
Moderate View	0.00	0.03	0.97	106
Substantial View	0.01	0.07	0.87	35
Extreme View	0.04	0.07	0.59	28
Pre_Anc_Gtr2Yr_Lt1Mile	-0.13	0.06	0.02	38
Pre_Anc_2Yr_Lt1Mile	-0.10	0.05	0.06	40
Post_Anc_Pre_Con_Lt1Mile	-0.14	0.06	0.02	21
Post_Con_2Yr_Lt1Mile	-0.09	0.07	0.15	39
Post_Con_2_4Yr_Lt1Mile	-0.01	0.06	0.86	44
Post_Con_Gtr5Yr_Lt1Mile	-0.07	0.08	0.37	42
Pre_Anc_Gtr2Yr_1_3Mile	-0.04	0.03	0.19	283
Pre_Anc_2Yr_1_3Mile	0.00	0.03	0.91	592
Post_Anc_Pre_Con_1_3Mile	-0.02	0.03	0.53	342
Post_Con_2Yr_1_3Mile	0.00	0.03	0.90	807
Post_Con_2_4Yr_1_3Mile	0.01	0.03	0.78	503
Post_Con_Gtr5Yr_1_3Mile	0.00	0.03	0.93	710
Pre_Anc_Gtr2Yr_3_5Mile	0.00	0.04	0.93	157
Pre_Anc_2Yr_3_5Mile	0.00	0.03	0.98	380
Post_Anc_Pre_Con_3_5Mile	0.00	0.03	0.93	299
Post_Con_2Yr_3_5Mile	0.02	0.03	0.56	574
Post_Con_2_4Yr_3_5Mile	0.01	0.03	0.66	594
Post_Con_Gtr5Yr_3_5Mile	0.01	0.03	0.68	758
Pre_Anc_Gtr2Yr_Gtr5Mile	Omitted	Omitted	Omitted	132
Pre_Anc_2Yr_Gtr5Mile	-0.03	0.04	0.39	133
Post_Anc_Pre_Con_Gtr5Mile	-0.03	0.03	0.36	105
Post_Con_2Yr_Gtr5Mile	-0.03	0.03	0.44	215
Post_Con_2_4Yr_Gtr5Mile	0.03	0.03	0.42	227
Post_Con_Gtr5Yr_Gtr5Mile	0.01	0.03	0.72	424

"Omitted" = reference category for fixed effects variables
"n" indicates number of cases in category when category = "1"

Model Information

Model Equation Number	**7**
Model Name	**Temporal Aspects Model**
Dependent Variable	**LN_SalePrice96**
Number of Cases	**7459**
Number of Predictors (k)	**56**
F Statistic	**404.5**
Adjusted R2	**0.75**

Table A - 11: Full Results for the Orientation Model

	Coef.	SE	p Value	*n*
Intercept	7.62	0.18	0.00	
Nbr_LN_SalePrice96_hat	0.29	0.02	0.00	4,937
AgeatSale	-0.006	0.0004	0.00	4,937
AgeatSale_Sqrd	0.00002	0.000003	0.00	4,937
Sqft_1000	0.28	0.01	0.00	4,937
Acres	0.02	0.00	0.00	4,937
Baths	0.09	0.01	0.00	4,937
ExtWalls_Stone	0.21	0.02	0.00	1,486
CentralAC	0.09	0.01	0.00	2,575
Fireplace	0.11	0.01	0.00	1,834
FinBsmt	0.08	0.02	0.00	673
Cul_De_Sac	0.10	0.01	0.00	992
Water_Front	0.33	0.04	0.00	87
Cnd_Low	-0.44	0.05	0.00	69
Cnd_BAvg	-0.24	0.02	0.00	350
Cnd_Avg	Omitted	Omitted	Omitted	2,727
Cnd_AAvg	0.13	0.01	0.00	1,445
Cnd_High	0.24	0.02	0.00	337
Vista_Poor	-0.21	0.02	0.00	310
Vista_BAvg	-0.08	0.01	0.00	2,857
Vista_Avg	Omitted	Omitted	Omitted	1,247
Vista_AAvg	0.10	0.02	0.00	448
Vista_Prem	0.13	0.04	0.00	75
WAOR	Omitted	Omitted	Omitted	519
TXHC	-0.75	0.03	0.00	1,071
OKCC	-0.44	0.02	0.00	476
IABV	-0.24	0.02	0.00	605
ILLC	-0.08	0.03	0.00	213
WIKCDC	-0.14	0.02	0.00	725
PASC	-0.31	0.03	0.00	291
PAWC	-0.07	0.03	0.01	222
NYMCOC	-0.20	0.03	0.00	346
NYMC	-0.15	0.02	0.00	469
No View	Omitted	Omitted	Omitted	4,207
Minor View	-0.01	0.06	0.92	561
Moderate View	0.00	0.06	0.97	106
Substantial View	-0.01	0.09	0.87	35
Extreme View	0.02	0.17	0.89	28
Inside 3000 Feet	-0.04	0.07	0.55	67
Between 3000 Feet and 1 Mile	-0.05	0.05	0.37	58
Between 1 and 3 Miles	0.00	0.02	0.83	2,019
Between 3 and 5 Miles	0.02	0.01	0.22	1,923
Outside 5 Miles	Omitted	Omitted	Omitted	870
Front Orientation	-0.01	0.06	0.82	294
Back Orientation	0.03	0.06	0.55	280
Side Orientation	-0.03	0.06	0.55	253

"Omitted" = reference category for fixed effects variables

"n" indicates number of cases in category when category = "1"

Model Information

Model Equation Number	**8**
Model Name	**Orientation Model**
Dependent Variable	**LN_SalePrice96**
Number of Cases	**4937**
Number of Predictors (k)	**40**
F Statistic	**410.0**
Adjusted R Squared	**0.77**

Table A - 12: Full Results for the Overlap Model

	Coef.	SE	p Value	*n*
Intercept	7.61	0.18	0.00	
Nbr_LN_SalePrice96_hat	0.29	0.02	0.00	4,937
AgeatSale	-0.006	0.0004	0.00	4,937
AgeatSale_Sqrd	0.00002	0.000003	0.00	4,937
Sqft_1000	0.28	0.01	0.00	4,937
Acres	0.02	0.00	0.00	4,937
Baths	0.09	0.01	0.00	4,937
ExtWalls_Stone	0.21	0.02	0.00	1,486
CentralAC	0.09	0.01	0.00	2,575
Fireplace	0.11	0.01	0.00	1,834
FinBsmt	0.08	0.02	0.00	673
Cul_De_Sac	0.10	0.01	0.00	992
Water_Front	0.34	0.04	0.00	87
Cnd_Low	-0.45	0.05	0.00	69
Cnd_BAvg	-0.24	0.02	0.00	350
Cnd_Avg	Omitted	Omitted	Omitted	2,727
Cnd_AAvg	0.13	0.01	0.00	1,445
Cnd_High	0.24	0.02	0.00	337
Vista_Poor	-0.21	0.02	0.00	310
Vista_BAvg	-0.08	0.01	0.00	2,857
Vista_Avg	Omitted	Omitted	Omitted	1,247
Vista_AAvg	0.10	0.02	0.00	448
Vista_Prem	0.13	0.04	0.00	75
WAOR	Omitted	Omitted	Omitted	519
TXHC	-0.75	0.03	0.00	1,071
OKCC	-0.44	0.02	0.00	476
IABV	-0.24	0.02	0.00	605
ILLC	-0.09	0.03	0.00	213
WIKCDC	-0.14	0.02	0.00	725
PASC	-0.31	0.03	0.00	291
PAWC	-0.07	0.03	0.00	222
NYMCOC	-0.20	0.03	0.00	346
NYMC	-0.15	0.02	0.00	469
No View	Omitted	Omitted	Omitted	4,207
Minor View	-0.03	0.02	0.10	561
Moderate View	-0.02	0.04	0.67	106
Substantial View	-0.05	0.09	0.57	35
Extreme View	-0.03	0.10	0.77	28
Inside 3000 Feet	-0.05	0.06	0.41	67
Between 3000 Feet and 1 Mile	-0.05	0.05	0.38	58
Between 1 and 3 Miles	0.00	0.02	0.82	2,019
Between 3 and 5 Miles	0.02	0.01	0.22	1,923
Outside 5 Miles	Omitted	Omitted	Omitted	870
View Does Not Overlap Vista	Omitted	Omitted	Omitted	320
View Barely Overlaps Vista	0.05	0.03	0.09	150
View Somewhat Overlaps Vista	0.01	0.03	0.67	132
View Strongly Overlaps Vista	0.05	0.05	0.31	128

"Omitted" = reference category for fixed effects variables
"n" indicates number of cases in category when category = "1"

Model Information

Model Equation Number	**9**
Model Name	**Overlap Model**
Dependent Variable	**LN_SalePrice96**
Number of Cases	**4937**
Number of Predictors (k)	**40**
F Statistic	**409.7**
Adjusted R Squared	**0.77**

WIND FARM PROXIMITY AND PROPERTY VALUES: A POOLED HEDONIC REGRESSION ANALYSIS OF PROPERTY VALUES IN CENTRAL ILLINOIS

Jennifer L. Hinman

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In partial fulfillment of the requirements for the degree of

Master of Science in Applied Economics

Electricity, Natural Gas, and Telecommunications Economics Regulatory Sequence

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Abstract
The objectives of this study are to examine whether proximity to the 240-turbine, Twin Groves wind farm (Phases I and II) in eastern McLean County, Illinois, has impacted nearby residential property values and whether any impact on nearby property values remains constant over different stages of wind farm development with the different stages corresponding to different levels of risk as perceived by nearby property owners. This study uses 3,851 residential property transactions from January 1, 2001 through December 1, 2009 from McLean and Ford Counties, Illinois. This is the first wind farm proximity and property value study to adopt pooled hedonic regression analysis with difference-in-differences estimators. This methodology significantly improves upon many of the methodologies found in the wind farm proximity and property value literature. This study finds some evidence that supports wind farm anticipation stigma theory and the results strongly reject the existence of wind farm area stigma theory.

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[1] Available online <http://www.irps.ilstu.edu/research/documents/LoadForecastingHinman-HickeyFall2009.pdf>

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Executive Summary

The objectives of this study are to examine whether proximity to the 240-turbine, Twin Groves wind farm (Phases I and II) in eastern McLean County, Illinois, has impacted nearby residential property values and whether any impact on nearby property values changes over the different stages of wind farm development. This study uses 3,851 residential property transactions from January 1, 2001 through December 1, 2009 from McLean and Ford Counties, Illinois. This is the first wind farm proximity and property value study to adopt pooled hedonic regression analysis with difference-in-differences estimators. This methodology significantly improves upon many of the previous methodologies found in the wind farm proximity and property value literature.

The estimation results provide evidence that a "location effect" exists such that before the wind farm was even approved, properties located near the eventual wind farm area were devalued in comparison to other areas. Additionally, the results show that property value impacts vary based on the different stages of wind farm development. These stages of wind farm development roughly correspond to the different levels of risk as perceived by local residents and potential homebuyers. Some of the estimation results support the existence of "wind farm anticipation stigma theory," meaning that property values may have diminished in "anticipation" of the wind farm after the wind farm project was approved by the McLean County Board. Wind farm anticipation stigma is likely due to the impact associated with a fear of the unknown, a general uncertainty surrounding a proposed wind farm project regarding the aesthetic impacts on the landscape, the actual noise impacts from the wind turbines, and just how disruptive the wind farm will be. However, during the operational stage of the wind farm project, as surrounding property owners living close to the wind turbines acquired additional information on the aesthetic impacts on the landscape and actual noise impacts of the wind turbines to see if any of their concerns materialized, property values rebounded and soared higher in real terms than they were prior to wind farm approval. Thus, this study presents evidence that demonstrates close proximity to an operating wind farm does not necessarily negatively influence property values or property value appreciation rates. The estimation results strongly reject the existence of "wind farm area stigma theory" for the area surrounding Twin Groves I and II.

I. INTRODUCTION

A home is generally the largest investment that a family will make in their lifetime. Thus, factors that impact the value of one's home are of prime importance to homeowners. Over the past few years, all across the United States, wind farms have been sprouting up. Many homeowners have expressed concern at public zoning hearings for proposed wind farms that their homes may be devalued because of the close proximity to a proposed wind turbine. Although over 35 studies have examined this issue of whether a negative relationship exists between property values and those homes in close proximity to wind turbines, there does not exist a general consensus in the literature. This lack of a consensus may be likely due to various degrees of rigor that the studies have demonstrated along with the various methodologies adopted. Many of the studies have been funded by wind energy companies as well as wind farm opponents. Thus, an unbiased analysis of this very important issue is difficult to come by. Hence, this study proposes an improved methodology to examine these issues going forward.

Is there a stigma associated with properties located in close proximity to a proposed or operating wind farm? Does a negative relationship exist between property values and homes closer to wind turbines? Does the impact of a wind farm on nearby property values change over different stages of development[2]? This study uses pooled hedonic regression analysis to examine whether Twin Groves wind farm (Twin Groves Phase I and Phase II[3]) located in eastern McLean County, Illinois, has had an impact on local property values. The hedonic pricing model is based on the microeconomic theoretical framework developed by Lancaster (1966) and Rosen (1974) that decomposes the price of a good into its component attributes.

Residential property sales were obtained from the Supervisors of Assessments Offices in McLean and Ford Counties for the 2001 through 2009 study period. It is important to obtain data both before and after construction of the wind facility and not just for the target and control areas, because there likely exists a *location effect*, which when properly controlled for takes into account any housing price differential between properties near the wind farm and far from the wind farm before wind farm operations. Thus, any devaluation found using only data from after construction may not be telling the whole story.

A difference-in-differences estimator[4] is utilized to examine whether a *wind farm anticipation stigma*[5] developed after the approval of the wind farm and during the construction stage of the wind farm development. In addition, a difference-in-differences estimator is utilized to examine whether a *wind farm area stigma* developed due to the presence of the wind farm. This study examines the appreciation in real property values near the wind farm site in relation to surrounding areas over the different stages of wind farm development, which are thought to roughly correspond to the different levels of risk as perceived by local residents and homebuyers.

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[2] The different stages of the adjustment process correspond to different levels of risk as perceived by local residents and prospective homebuyers surrounding a wind farm project proposal, and these stages of the adjustment process are thought to correspond to the stages of wind farm development.

[3] Twin Groves I and II will be denoted as "TG I and II" or "wind farm(s)" throughout this article.

[4] Difference-in-differences estimators are popular estimation techniques utilized in the policy evaluation literature.

[5] *Wind farm anticipation stigma theory* is a concern surrounding a proposed or approved wind farm project that is primarily due to factors stemming from a fear of the unknown: a general uncertainty surrounding a wind farm project regarding the aesthetic impacts on the landscape, the actual noise impacts from the wind turbines, and just how disruptive the wind farm will actually be.

In addition, real property value levels in percentage terms are examined over the different stages of wind farm development. A few local real estate experts were interviewed and a local wind farm zoning hearing was attended, such that the author gained a better understanding of the local housing market and the attitudes of residents of the community.

The estimation results provide evidence that a *location effect* exists such that before the wind farm was even approved, properties located near the eventual wind farm area were devalued in comparison to other areas. Additionally, the results show that property value impacts vary based on the different stages of wind farm development. Some of the estimation results support the existence of *wind farm anticipation stigma theory*, meaning that property values may have diminished in *anticipation* of the wind farm, possibly because of the impact associated with a *fear of the unknown*: a general uncertainty surrounding a wind farm project regarding the aesthetic impacts on the landscape, the actual noise impacts from the wind turbines, and just how disruptive the wind farm will be. However, during the operational stage of the wind farm project, as surrounding property owners living close to the wind turbines acquired additional information on the aesthetic impacts on the landscape and actual noise impacts of the wind turbines to see if any of their concerns materialized, property values rebounded and soared higher in real terms than they were prior to wind farm approval. The author does not believe that property values near the wind farm rose strictly because of the wind farm locating there. However, it does seem to imply that property values in this particular area of McLean County do not necessarily decline because of a wind farm locating in the area near the properties, which is a common assumption and is often voiced during the wind farm permitting process. Thus, this study presents evidence that demonstrates close proximity to an operating wind farm does not necessarily negatively influence property values or property value appreciation rates and these results strongly reject the existence of *wind farm area stigma theory* for the area surrounding Twin Groves I and II. The results are consistent with views of some local real estate experts.

The rest of the paper is organized as follows. Section II contains a review of the wind farm proximity and property value literature. Section III provides the theoretical basis for the model. Section IV provides an overview of the methodology. Section V contains an overview of the project location and data. Section VI presents the estimation results. Section VII provides recommendations for further research and some general conclusions. Appendix A describes community attitudes and survey results. Appendix B provides a detailed description of the data and estimation assumptions. Appendix C provides descriptive statistics including summary statistics of the variables by stage of the wind farm project. Appendix D provides a review of the difference-in-differences estimator as well as several simple estimations and explanations of the proper interpretation of the estimated coefficients. Appendix E provides the full estimation results.

II. LITERATURE REVIEW

This section provides a brief overview of the wind farm proximity and property value literature. For those readers interested in reviewing literature relevant to the wind farm proximity and property value topic, a comprehensive list of the studies reviewed (author, publication date, and type of study are listed) as part of this project appears in Table 1. Sample size, study type, property value impact, and location of the wind farms for the regional and national studies

involving actual wind farms are presented in Table 2. The localized analyses are presented in Table 3[6] along with detailed statistics regarding the wind farm size, study dates, number of observations, study area location, and property value impact. This section proceeds as follows: a comparison of the national and regional property value studies is undertaken followed by a discussion of how this study contributes to and compares with the existing wind farm proximity and property value literature involving hedonic regression analysis.

Table 2 contains a summary of the regional and national property value studies that involved actual wind farms (as opposed to studies based on proposed wind farms[7]). Two studies conclude that properties are stigmatized surrounding wind farms: one based on an expert survey of realtors in Scotland, Wales, and England (Khatri, 2004), and the other study was based on a statistical model based on survey responses from homeowners in Denmark (Jordal-Jørgensen et al., 1996). The estimation results from the Denmark study could not be obtained, thus the statistical significance and details regarding the data utilized were not able to be scrutinized.

There have been a couple studies involving wind farms across the United States and they all found no impact on property values as a result of the wind farms. Hoen et al. (2009) completed the most comprehensive and rigorous study by far that involved examining residential home sales surrounding 24 wind farms across the United States[8]. Hoen et al. (2009) utilized ten different estimation models, including a repeat sales model and a sales volume model, to determine whether an area stigma, a scenic vista stigma, or a nuisance stigma existed in relation to properties located near wind farms. Hoen et al. (2009) found that none of the models uncovered any conclusive evidence of the presence of any of the property value stigmas surrounding the wind farms.

Table 3 contains a summary of the literature regarding localized property value impact studies involving actual wind farms (as opposed to proposed wind farms). All of the multiple linear regression analyses have been completed within the past four years, and so far there have not been any that specifically address the impact on property values for a wind farm located in the Midwest. In general, there have been quite a few studies addressing the impact of wind farms on property values in the Midwest; however, none of them involved rigorous statistical analysis[9]. The studies using the hedonic housing price model that focused on the impact of one particular wind farm on property values involve wind farms with less than 21 turbines. Therefore, this analysis involving 240 wind turbines is important because of the recent expansion of large wind projects.

As indicated by the asterisks in Table 3, only two studies have actually been published in academic, peer-reviewed journals. Both published studies utilized multiple regression analysis which provides support of that method in the present study. The two published studies analyzed

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[6] The only strong correlations associated with the results across studies have to do with who funds the study, i.e., those funded by wind farm developers or wind energy proponents generally do not find a negative impact, while those studies funded by wind farm opponents generally find a negative impact on property values. Also, some correlation exists between the timing of the study and the results. For example, many of the studies conducted in areas where a wind farm is proposed involve surveys posed to local real estate experts. These studies find that there is an expectation that property values will decline if the wind farm is permitted and becomes operational. Thus, this gives rise to what this author terms, wind farm anticipation stigma theory.

[7] Several studies involved interviewing local residents and real estate experts regarding their opinion of the impact that a proposed wind farm would have on local property values if the wind farm was built. The results of these studies are consistent with wind farm anticipation stigma theory.

[8] The residential homes sales were collected from nine different states (ten different study areas).

property values in the United Kingdom and the data available[10] were "limited to house type and selling price, and therefore not sufficiently detailed to highlight any small changes in value" (Sims and Dent, 2007, 626). All previous multiple regression analyses, except one, use the log-linear functional form. Sims and Dent (2007) use the linear form and include yearly dummy variables to capture inflation. Both of the published studies use property transactions that occurred after the wind farms were constructed. After Sims and Dent (2007) found a negative relationship between distance to the wind farm and property values, they spoke with local realtors and found out that before the wind farm was constructed, properties close to the eventual wind farm site were valued less than properties farther away. Thus, the present study contributes to the existing literature by taking into consideration the time period prior to wind farm operations explicitly in the model and controlling for an extensive list of housing characteristics.

[9] Rigorous statistical analysis is an important factor because the results of a study are essentially meaningless without this factor.

[10] The explanatory variables included in their models were limited to dummy variables. Though Malpezzi et al. (1980) point out that using mostly dummy variables allows maximum flexibility in estimation.

Table 1. Wind Farm Proximity and Property Value Studies.

Author (Year) – Study Type
**Canning and Simmons (2010) – Hedonic Regression Analysis and Statistics[†]
Nillen (2010) – Expert Opinion
**Hoen et al. (2009) – Hedonic Regression Analysis and Statistics
Kielisch (2009) – Simplified Regression Analysis and Expert Survey
Gardner (2009) – Statistics
Poletti (2009a) – Statistics and Expert Opinion
Poletti (2009b) – Statistics and Expert Opinion
*Firestone et al. (2009) – Homeowner Survey and Statistics
*Firestone et al. (2008) – Homeowner Survey and Statistics
Crosson (2008) – Expert Opinion
*Sims et al. (2008) – Hedonic Regression Analysis
Luxemburger (2008) – Statistics
McCann (2008) – Expert Opinion
*Bond (2008) – Homeowner Survey
*Sims and Dent (2007) – Hedonic Regression Analysis
Poletti (2007) – Statistics
*Firestone et al. (2007) – Homeowner Survey and Statistics
*Edinburgh Solicitors' Property Centre (2007) – Statistics
Lloyd, Jr. (2007) – Statistics
Lloyd, Jr. (2006) – Statistics
*Hoen (2006) – Hedonic Regression Analysis
**Goldman and Goldman (2006) – Homeowner and Expert Survey
*Bobechko and Bourne (2006) – Statistics
DeLacy (2006) – Statistics
DeLacy (2005) – Statistics
Poletti (2005) – Statistics
Beck (2004) – Statistics
**Khatri (2004) – Expert Survey
*Haughton et al. (2004) – Homeowner and Expert Survey
Sterzinger et al. (2003) – Simplified Regression Analysis
*Braunholtz and McWhannell (2003) – Homeowner Survey
*Grover (2002, 2006) – Expert Survey
Jerabek (2002) – Statistics
Jerabek (2001) – Statistics
Robertson Bell Associates (1998) – Homeowner Survey
Robertson Bell Associates (1997) – Homeowner Survey
Jordal-Jørgensen et al. (1996) – Homeowner Survey and Statistics
BWEA (1996) – Homeowner Survey

*indicates studies that the author recommends reviewing for those interested in reviewing the literature.
[†]The study type "statistics" includes a wide variety of techniques: grouped paired sales analysis, paired sales analysis using repeat sales, direct comparison paired sales analysis, difference in means calculations between a control and target group using averages of similar property types, and sales volume analysis.

Table 2. Literature: Wind Farms and Property Values: Regional and National Analyses.

Author	Type	*n*	Before or After Construction	Property Value Impact*	Location of the Wind Farms
Hoen, Wiser, Cappers, Thayer, and Sethi (2009)	Hedonic Regression Analysis	4,937	After	None	USA
Hoen, Wiser, Cappers, Thayer, and Sethi (2009)	Hedonic Regression Analysis	7,459	Before and After	None	USA
Khatri (2004)	Expert Survey (Residential Properties)	81	After	Negative†	Scotland, Wales, and England
Khatri (2004)	Expert Survey (Agricultural Land)	81	After	None	Scotland, Wales, and England
Braunholtz and McWhannell (2003)	Homeowner Survey	1,547	After	None	Scotland
Grover (2002)	Expert Survey (Residential Properties)	13	After	None	USA
Jordal-Jørgensen, Munksgaard, Pedersen, and Larsen (1996)	Homeowner Survey and Statistics	?	After	Negative	Denmark

*Property Value Impact: "None" = There was no evidence of wind farms impacting property values.
"Positive" = Property values rose in areas surrounding a wind farm, though this *does not necessarily* imply that property values rose because of the wind farm. i.e., property values could have risen for other reasons.
"Negative" = Property values declined in areas surrounding a wind farm, though this *does not necessarily* imply that property values declined because of the wind farm. i.e., property values could have declined for other reasons.
†Slightly Negative, 40% of Chartered Surveyors found there was no impact on property values, while 60% found there was a negative impact on property values.
n=number of observations.

Table 3. Literature: Wind Farms and Property Values: Localized Analyses.

Author(s) (Year)	Type	*n*	Before or After Construction	Property Value Impact†	Study Area	# Turbines	Total MW	Hub Height (meters)	Study Dates
Canning and Simmons (2010)	Hedonic Regression Analysis	40	During and After	None	Municipality of Chatham-Kent, Ontario	64	96	80	2007-2009
Canning and Simmons (2010)	Hedonic Regression Analysis	20	During and After	None	Municipality of Chatham-Kent, Ontario	64	96	80	2007-2009
Canning and Simmons (2010)	Hedonic Regression Analysis	83	During and After	Negative	Municipality of Chatham-Kent, Ontario	64	96	80	2007-2009
Canning and Simmons (2010)	Property Resale Analysis	14	Before and After	None	Municipality of Chatham-Kent, Ontario	64	96	80	2003-2009
Theron (2010)	Homeowner Survey	75	After	None	McLean County, IL	240	396	80	2009
Gardner (2009)	Property Sales - Statistics (Rural Land)	7	After	Negative	Taylor County, TX	?	?	?	?
Kielisch (2009)	Property Sales - Statistics (Vacant Residential Land Sales)	68	Before and After	Negative	Fond du Lac County, WI	88	145	80	2006-2009
Kielisch (2009)	Property Sales - Statistics (Vacant Residential Land Sales)	34	Before and After	Negative	Fond du Lac and Dodge Counties, WI	86	129	65	2005-2009
Poletti (2009)	Property Sales - Statistics (All Residential Classed Sales)	195	After	None	McLean County, IL	240	396	80	2006-2009
Poletti (2009)	Property Sales - Statistics (Residential Sales Excluding Vacant Lots, Duplex, Condos, Modular, Bi-Levels, Greater Than 5 Acres, Sales With Price Per Sqft Less Than $40)	98	After	None	McLean County, IL	240	396	80	2006-2009
Poletti (2009)	Property Sales - Statistics (Selective Residential Sales $/Sqft)	26	After	None	Lee County, IL	63	50.4	65	2003-2005
Poletti (2009)	Property Sales - Statistics (Single Family Residential Sales All, $/Sqft)	46	After	Negative	Lee County, IL	63	50.4	65	2003-2005
Poletti (2009)	Property Sales - Statistics (Agricultural Tracts, 20+Acres, $/Acre)	50	After	None	Lee County, IL	63	50.4	65	2005-2009
Poletti (2009)	Property Sales - Statistics (Small Residential Tract Sales, $/Acre)	30	After	None	Lee County, IL	63	50.4	65	2005-2009
Poletti (2009)	Property Sales - Statistics (Residential Sales, $/Sqft, Post 1955)	61	After	None	Lee County, IL	63	50.4	65	2005-2009
Poletti (2009)	Property Sales - Statistics (Residential Sales, $/Sqft)	148	After	None	Lee County, IL	63	50.4	65	2005-2009
Poletti (2009)	Property Sales - Statistics (Residential Sales, $/Sqft, Matched Paired Sales Analysis)	6	After	None	Lee County, IL	63	50.4	65	2003-2006
Bond (2008)	Homeowner Survey	304	After	None	Albany, Southwest Australia	12	21.6	65	2008
Luxemburger (2008)	Property Sales - Statistics	600	After	Negative	Canada	?	?	?	?
McCann (2008)	Expert Opinion	1	After	Negative	Lee County, IL	63	50.4	65	2008
*Sims, Dent, and Oskrochi (2008)	Hedonic Regression Analysis	199	After	None	St Eval, Cornwall, UK	16	9.6	35	2000-2007
Edinburgh Solicitors' Property Centre (2007)	Property Sales - Statistics	?	Before and After	Positive	Scottish Borders, Dunbar	20	49		2000-2006
Lloyd, Jr. (2007)	Property Sales - Statistics	88	Before and After	None	Madison County, NY	7	11.55	67	1995-2006
Lloyd, Jr. (2007)	Property Sales - Statistics	35	Before and After	None	Wyoming County, NY	10	6.6	65	1995-2006

Author(s) (Year)	Type	*n*	Before or After Construction	Property Value Impact†	Study Area	# Turbines	Total MW	Hub Height (meters)	Study Dates
Lloyd, Jr. (2007)	Property Sales - Statistics	157	Before and After	None	Madison County, NY	20	30	65	1995-2006
Lloyd, Jr. (2007)	Property Sales - Statistics, Paired Sales Analysis (Repeat Sales)	46	Before and After	None	Madison County, NY	7	11.55	67	1995-2006
Lloyd, Jr. (2007)	Property Sales - Statistics, Paired Sales Analysis (Repeat Sales)	16	Before and After	None	Wyoming County, NY	10	6.6	65	1995-2006
Lloyd, Jr. (2007)	Property Sales - Statistics, Paired Sales Analysis (Repeat Sales)	36	Before and After	None	Madison County, NY	20	30	65	1995-2006
Poletti (2007)	Property Sales - Statistics (Small Residential Tract Sales, $/Sqft)	21	After	None	Kewaunee County, WI	31	20.46	65	1998-2004
Poletti (2007)	Property Sales - Statistics (Large Tract Sales, $/Acre)	48	After	None	Kewaunee County, WI	31	20.46	65	1998-2004
Poletti (2007)	Property Sales - Statistics (Single-Family Residential Values, $/Sqft)	65	After	None	Kewaunee County, WI	31	20.46	65	1998-2004
Poletti (2007)	Property Sales - Statistics (Sales Of Residences Constructed After 1960)	19	After	None	Kewaunee County, WI	31	20.46	65	1998-2004
Poletti (2007)	Property Sales - Statistics (Agricultural Tracts, 20+Acres, $/Acre)	26	After	None	Lee County, IL	63	50.4	65	2003-2005
Poletti (2007)	Property Sales - Statistics (Small Residential Tract Sales, 5 Acres Or Less, $/Acre)	30	After	None	Lee County, IL	63	50.4	65	2003-2005
Poletti (2007)	Property Sales - Statistics (Selective Residential Sales $/Sqft)	29	After	None	Lee County, IL	63	50.4	65	2003-2005
Poletti (2007)	Property Sales - Statistics (Single Family Residential Sales All, $/Sqft)	53	After	Negative	Lee County, IL	63	50.4	65	2003-2005
Poletti (2007)	Property Sales - Statistics (Agricultural Tracts, 20+Acres, $/Acre)	20	After	None	Lee County, IL	63	50.4	65	2005-2006
Poletti (2007)	Property Sales - Statistics (Small Residential Tract Sales, $/Acre)	14	After	None	Lee County, IL	63	50.4	65	2005-2006
Poletti (2007)	Property Sales - Statistics (Residential Sales, $/Sqft)	35	After	None	Lee County, IL	63	50.4	65	2005-2006
*Sims and Dent (2007)	Hedonic Regression Analysis	919	After	Negative	St Breock Downs, Wadebridge; St Eval, Cornwall, UK	27	14.55	35	2000-2005
Bobechko and Bourne (2006)	Property Sales - Statistics, Sales Analysis, Combined Acreage	173	Before and After	Positive	Township of Melancthon, Ontario, Canada	45	67.5	80	2002, 2006
Bobechko and Bourne (2006)	Property Sales - Statistics, Sales Analysis, 1-10Acres	72	Before and After	Positive	Township of Melancthon, Ontario, Canada	45	67.5	80	2002, 2006
Bobechko and Bourne (2006)	Property Sales - Statistics, Sales Analysis, 10 Acres Plus	56	Before and After	None	Township of Melancthon, Ontario, Canada	45	67.5	80	2002, 2006
Bobechko and Bourne (2006)	Property Sales - Statistics, Sales Analysis, 50 Acres Plus	45	Before and After	None	Township of Melancthon, Ontario, Canada	45	67.5	80	2002, 2006
Bobechko and Bourne (2006)	Property Sales - Statistics, Resale Analysis	10	Before and After	Positive	Township of Melancthon, Ontario, Canada	45	67.5	80	2002, 2003, 2006
Bobechko and Bourne (2006)	Property Sales - Statistics, MLS Statistical Analysis, Detached Property And Then 1-50 Plus Acres	583	Before and After	None	Dufferin County, Melancthon, Ontario, Canada	45	67.5	80	2002, 2006
Goldman and Goldman (2006)	Expert Survey - Appraisers, Realtors, Assessors	17	After	None	Tucker County, WV, Backbone Mountain	44	66	68	2006

Author(s) (Year)	Type	*n*	Before or After Construction	Property Value Impact†	Study Area	# Turbines	Total MW	Hub Height (meters)	Study Dates
Goldman and Goldman (2006)	Homeowner Survey - Property Value, Noise, And View Questions	21	After	None	Tucker County, WV, Backbone Mountain	44	66	68	2006
Hoen (2006)	Hedonic Regression Analysis	280	Before and After	None	Madison County, NY	20	30	66	1996-2005
Lloyd, Jr. (2006)	Property Sales - Statistics	84	Before and After	None	Madison County, NY	7	11.55	67	1995-2006
Lloyd, Jr. (2006)	Property Sales - Statistics	33	Before and After	None	Wyoming County, NY	10	6.6	65	1995-2006
Lloyd, Jr. (2006)	Property Sales - Statistics	148	Before and After	None	Madison County, NY	20	30	80	1995-2006
Lloyd, Jr. (2006)	Property Sales - Statistics, Paired Sales Analysis (Repeat Sales)	46	Before and After	None	Madison County, NY	7	11.55	67	1995-2006
Lloyd, Jr. (2006)	Property Sales - Statistics, Paired Sales Analysis (Repeat Sales)	16	Before and After	None	Wyoming County, NY	10	6.6	65	1995-2006
Lloyd, Jr. (2006)	Property Sales - Statistics, Paired Sales Analysis (Repeat Sales)	36	Before and After	None	Madison County, NY	20	30	65	1995-2006
Poletti (2005)	Property Sales - Statistics (Small Residential Tract Sales, $/Sqft)	21	After	None	Kewaunee County, WI	31	20.46	65	1998-2004
Poletti (2005)	Property Sales - Statistics (Residential Tract Sales, $/Sqft)*New	14	After	None	Kewaunee County, WI	31	20.46	65	1998-2004
Poletti (2005)	Property Sales - Statistics (Large Tract Sales, $/Acre)	48	After	None	Kewaunee County, WI	31	20.46	65	1998-2004
Poletti (2005)	Property Sales - Statistics (Single-Family Residential Values, $/Sqft)	65	After	None	Kewaunee County, WI	31	20.46	65	1998-2004
Poletti (2005)	Property Sales - Statistics (Sales Of Residences Constructed After 1960)	19	After	None	Kewaunee County, WI	31	20.46	65	1998-2004
Poletti (2005)	Property Sales - Statistics (Agricultural Tracts, 20+Acres, $/Acre)	26	After	None	Lee County, IL	63	50.4	65	2003-2005
Poletti (2005)	Property Sales - Statistics (Small Residential Tract Sales, 5 Acres Or Less, $/Acre)	30	After	None	Lee County, IL	63	50.4	65	2003-2005
Poletti (2005)	Property Sales - Statistics (Selective Residential Sales $/Sqft)	29	After	None	Lee County, IL	63	50.4	65	2003-2005
Beck (2004)	Property Sales - Statistics	2	After	None	Hull, MA	1	0.66	50	2002-2004
Sterzinger, Beck, and Kostiuk (2003)	Simplistic Regression Analysis - View Shed And Comparable	9,105	Before and After	Positive	Riverside County, CA	3,067	485.6	40-63	1996-2002
Sterzinger, Beck, and Kostiuk (2003)	Simplistic Regression Analysis - View Shed And Comparable	810	Before and After	Positive	Madison County, NY	7	11.6	67	1997-2003
Sterzinger, Beck, and Kostiuk (2003)	Simplistic Regression Analysis - View Shed And Comparable	1,044	Before and After	Positive	Madison County, NY	20	30	66	1997-2003
Sterzinger, Beck, and Kostiuk (2003)	Simplistic Regression Analysis - View Shed And Comparable	624	Before and After	Positive	Kewaunee County, WI	31	20.46	65	1996-2002
Sterzinger, Beck, and Kostiuk (2003)	Simplistic Regression Analysis - View Shed And Comparable	3,340	Before and After	Positive	Bennington and Windham Counties, VT	11	6	40	1994-2002
Sterzinger, Beck, and Kostiuk (2003)	Simplistic Regression Analysis - View Shed And Comparable	1,384	Before and After	Positive	Somerset County, PA	14	19.4	60-64	1997-2002
Sterzinger, Beck, and Kostiuk (2003)	Simplistic Regression Analysis - View Shed And Comparable	3,213	Before and After	Positive	Buena Vista County, IA	364	192.7	63	1996-2002

Author(s) (Year)	Type	*n*	Before or After Construction	Property Value Impact†	Study Area	# Turbines	Total MW	Hub Height (meters)	Study Dates
Sterzinger, Beck, and Kostiuk (2003)	Simplistic Regression Analysis - View Shed And Comparable	2,867	Before and After	None	Kern County, CA	3,569	600.7	55	1996-2002
Sterzinger, Beck, and Kostiuk (2003)	Simplistic Regression Analysis - View Shed And Comparable	269	Before and After	Positive	Carson County, TX	80	80	70	1998-2002
Sterzinger, Beck, and Kostiuk (2003)	Simplistic Regression Analysis - View Shed And Comparable	89	Before and After	None	Fayette County, PA	10	15	70	1997-2002
Sterzinger, Beck, and Kostiuk (2003)	Simplistic Regression Analysis - Viewshed Before And After	5,513	Before and After	Positive	Riverside County, CA	3,067	485.6	40-63	1996-2002
Sterzinger, Beck, and Kostiuk (2003)	Simplistic Regression Analysis - Viewshed Before And After	219	Before and After	None	Madison County, NY	7	11.6	67	1997-2003
Sterzinger, Beck, and Kostiuk (2003)	Simplistic Regression Analysis - Viewshed Before And After	453	Before and After	Negative	Madison County, NY	20	30	66	1997-2003
Sterzinger, Beck, and Kostiuk (2003)	Simplistic Regression Analysis - Viewshed Before And After	329	Before and After	Positive	Kewaunee County, WI	31	20.46	65	1996-2002
Sterzinger, Beck, and Kostiuk (2003)	Simplistic Regression Analysis - Viewshed Before And After	2,788	Before and After	Positive	Bennington and Windham Counties, VT	11	6	40	1994-2002
Sterzinger, Beck, and Kostiuk (2003)	Simplistic Regression Analysis - Viewshed Before And After	962	Before and After	Positive	Somerset County, PA	14	19.4	60-64	1997-2002
Sterzinger, Beck, and Kostiuk (2003)	Simplistic Regression Analysis - Viewshed Before And After	1,557	Before and After	Positive	Buena Vista County, IA	364	192.7	63	1996-2002
Sterzinger, Beck, and Kostiuk (2003)	Simplistic Regression Analysis - Viewshed Before And After	745	Before and After	Positive	Kern County, CA	3,569	600.7	55	1996-2002
Sterzinger, Beck, and Kostiuk (2003)	Simplistic Regression Analysis - Viewshed Before And After	45	Before and After	Positive	Carson County, TX	80	80	70	1998-2002
Sterzinger, Beck, and Kostiuk (2003)	Simplistic Regression Analysis - Viewshed Before And After	39	Before and After	Positive	Fayette County, PA	10	15	70	1997-2002
Sterzinger, Beck, and Kostiuk (2003)	Simplistic Regression Analysis - Viewshed And Comparable	?	After	Positive	Riverside County, CA	3,067	485.6	40-63	1999-2002
Sterzinger, Beck, and Kostiuk (2003)	Simplistic Regression Analysis - Viewshed And Comparable	?	After	None	Madison County, NY	7	11.6	67	2000-2003
Sterzinger, Beck, and Kostiuk (2003)	Simplistic Regression Analysis - Viewshed And Comparable	?	After	None	Madison County, NY	20	30	66	2001-2003
Sterzinger, Beck, and Kostiuk (2003)	Simplistic Regression Analysis - Viewshed And Comparable	?	After	Positive	Kewaunee County, WI	31	20.46	65	1999-2002
Sterzinger, Beck, and Kostiuk (2003)	Simplistic Regression Analysis - Viewshed And Comparable	?	After	Positive	Bennington and Windham Counties, VT	11	6	40	1997-2002
Sterzinger, Beck, and Kostiuk (2003)	Simplistic Regression Analysis - Viewshed And Comparable	?	After	Positive	Somerset County, PA	14	19.4	60-64	2000-2002
Sterzinger, Beck, and Kostiuk (2003)	Simplistic Regression Analysis - Viewshed And Comparable	?	After	Positive	Buena Vista County, IA	364	192.7	63	1999-2002
Sterzinger, Beck, and Kostiuk (2003)	Simplistic Regression Analysis - Viewshed And Comparable	?	After	None	Kern County, CA	3,569	600.7	55	1999-2002
Sterzinger, Beck, and Kostiuk (2003)	Simplistic Regression Analysis - Viewshed And Comparable	?	After	Positive	Carson County, TX	80	80	70	2001-2002
Sterzinger, Beck, and Kostiuk (2003)	Simplistic Regression Analysis - Viewshed And Comparable	?	After	Positive	Fayette County, PA	10	15	70	2001-2002
Jerabek (2002)	Property Sales - Statistics	25	Before and After	None	Kewaunee County, WI	14	9.2	65	1998-2001

Author(s) (Year)	Type	*n*	Before or After Construction	Property Value Impact†	Study Area	# Turbines	Total MW	Hub Height (meters)	Study Dates
Jerabek (2001)	Property Sales - Statistics	7	After	None	Kewaunee County, WI	14	9.2	65	1999-2001
Robertson Bell Associates (1998)	Homeowner Survey	203	After	None	Alness, Scotland	34	17	35	1998
Robertson Bell Associates (1997)	Homeowner Survey	336	After	None	Wales	20	9	35	1997

†Property Value Impact: "None" = There was no evidence of wind farms impacting property values. *n* = number of observations

"Positive" = Property values rose in areas surrounding a wind farm, though this *does not necessarily* imply that property values rose because of the wind farm. i.e., property values could have risen for other reasons.

"Negative" = Property values declined in areas surrounding a wind farm, though this *does not necessarily* imply that property values declined because of the wind farm. i.e., property values could have declined for other reasons.

*indicates the study has been published in an academic peer-reviewed journal.

Notes: All numbers are approximations and accuracy cannot be guaranteed. Please note that although this table acknowledges the results of other studies, it does not in any way support the methods used to reach the conclusions. There are quite a few studies that reach conclusions that this author does not support, either due to a lack of statistical rigor or incorrect analyses of results.

III. THEORETICAL ANALYSIS

This study uses a hedonic pricing model to estimate the marginal willingness to pay for specific house structural characteristics and neighborhood characteristics including location (proximity to amenities or disamenities)[11]. The hedonic pricing model is based on the microeconomic theoretical framework developed in the landmark papers by Lancaster (1966) and Rosen (1974). Lancaster (1966) focused on the demand side of the market, he "developed a sophisticated branch of microeconomic theory in which utility is generated, not by goods *per se*, but by *characteristics* of the goods" (Malpezzi, 2002, 10). Rosen (1974) focused on "how suppliers and consumers interact within a framework of bids and offers for characteristics" (Malpezzi, 2002, 11). Hedonic pricing models have not only been applied to housing studies but to many other sectors as well (e.g., automobiles). Literally hundreds of academic, peer-reviewed journal articles have been published over the years utilizing hedonic regression analysis with a focus specifically on housing. This well-accepted use of hedonic pricing models in relation to housing provides a basis for the use of this framework for the current analysis.

Follain and Jimenez (1985) point out that Rosen's theory leads to a two-step approach to estimating the compensated demand curve; however, they do note the possible simultaneity issues that may arise in this type of estimation. Malpezzi (2002) notes that "the identification problems, imperfect specifications, and the general non-robustness of coefficient estimates—suggest that reliable two-stage structural estimation of the demand for characteristics will be difficult" (15). Thus, a simple hedonic approach utilizing one equation is taken in this analysis, and appears to be well accepted in the prevailing literature on this topic[12].

A simple hedonic pricing model for housing relates the price at which the house sold to the individual characteristics of the property. The house price (value) is the selling price that two unrelated parties acting in their own interest, namely the buyer (grantee) and the seller (grantor) of the property willingly agree upon. The price of a property can be thought of as being a function of its characteristics:

$$\mathrm{P} = P(\mathrm{S}, \mathrm{N}) \tag{1}$$

Where

- *P* represents the selling prices of properties;
- *S* represents a vector of structural characteristics of the houses (properties);
- *N* represents a vector of neighborhood characteristics and location characteristics.

An individual's utility may be expressed as:

$$\mathrm{U} = U(\mathrm{X}, \mathrm{S}, \mathrm{N}) \tag{2}$$

The homebuyer's problem is to maximize their utility [*U(.)*] subject to their budget

[11] The time period in which the property sold is also appropriately controlled for.

[12] The abundance of published articles using a simple hedonic approach and the continuing publication of articles using a simple hedonic approach exemplifies its acceptance.

constraint [$I=X+P$], where I is income and X is a composite commodity with price equal to one. For a specific utility bearing attribute s, it is assumed that an individual will choose a property such that their marginal willingness to pay will equal the price of that characteristic.

$$\frac{\left(\frac{\partial U}{\partial s}\right)}{\left(\frac{\partial U}{\partial X}\right)} = \frac{\partial P}{\partial s} \tag{3}$$

Structural characteristics of the house may include items such as the living area square feet, the age of the home, the garage square feet, the number of fireplaces, and the acres of the lot, among many other things. An increase in the size of the living area, the number of square feet in a garage, and the number of fireplaces inevitably imposes material costs on the construction on the home. To the degree that these material costs are reflected in the value of a house, these increases can reasonably be expected to put upward pressure on the selling price of the house, *ceteris paribus*[13] (holding everything else relevant constant). Though the previous variables may not be linearly related to selling price by any means, the number of acres in a lot[14] and the age of a home may have a more complicated relationship than the former.

In particular, the value one places on lot size may vary by market: the market for properties less than or equal to one acre and the market for properties greater than one acre in size. For example, one may place a very high value on increasing the lot size from 0.17 acre to 0.35 acre in an area with a very limited number of available lots, if it means they are still able to be located within a particular neighborhood or school district of their preference. However, there exist homebuyers that may not be concerned with locating in a particular school district and in fact would rather not be located in a neighborhood in close proximity to other homes (e.g., they may actually prefer the view of a rural landscape rather than the view of their neighbor's home). Consequently, demand for lots less than one acre, and demand for lots greater than one acre (which are typically located in the more rural areas, not neighborhoods) may not involve a smooth demand function. To the extent that the demand for lots less than one acre exceeds the demand for lots greater than one acre, it can be expected that the lots with less than one acre will experience upward pressure on the incremental 0.1 acre value.

As a home ages, the building materials age as well, this puts downward pressure on the price of the house. However, old homes that are built really well, have been properly maintained over the years and possibly renovated, and may be desirable for their historical characteristics would tend to put upward pressure on the price of the house. Thus, there may be a quadratic relationship in that as age increases the price of the home decreases and then after a certain age the price begins to increase. In general, the living area square feet, the garage square feet, the number of fireplaces, and the acres of the lot are expected to be an increasing function of the house price, while age is expected to be a decreasing function, *ceteris paribus*.

Neighborhood characteristics may include the quality of schools, or the socioeconomic characteristics of the neighborhood. The location characteristics within the market include the township (or school district) in which the property is located and undoubtedly represent many things such as distance/access to shopping, schools, sub-centers of employment, and other

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[13] Latin, "other things being equal."
[14] It is assumed that the land is not contaminated in any way.

important amenities.

A valuable locational characteristic may include a property being located next to a lake which allows the owner to have a nice view and this tends to put upward pressure on the price of the property, *ceteris paribus*. A property located in a cul-de-sac or amidst trees would enable the owner to have more privacy and potentially experience less noise from road traffic, thus putting upward pressure on the value of the home, *ceteris paribus*. A property located close to railroad tracks would tend to experience the negative externalities resulting from trains operating. Loud noise and vibrations, negative externalities that a property near railroad tracks would be subject to, would tend to put downward pressure on the value of that property, *ceteris paribus*.

Location may also include being located in close proximity to a wind farm. In a landmark paper, Hoen et al. (2009) formalized some potential theoretical relationships between wind turbines and homebuyers (these are not mutually exclusive and thus are likely to occur in combination with each other):

> • Area Stigma: A concern that the general area surrounding a wind energy facility will appear more developed, which may adversely affect home values in the local community regardless of whether any individual home has a view of the wind turbines.
> • Scenic Vista Stigma: A concern that a home may be devalued because of the view of a wind energy facility, and the potential impact of that view on an otherwise scenic vista.
> • Nuisance Stigma: A concern that factors that may occur in close proximity to wind turbines, such as sound and shadow flicker, will have a unique adverse influence on home values. (2)

Of the stigmas that Hoen et al. (2009) addressed, primarily *wind farm area stigma* will be addressed in this analysis[15]. The author realizes these theoretical stigmas may occur together and that overlap of these stigmas is actually what is being measured in the results. For example, the vast majority of rural properties near the wind farm in this study have a view of the wind turbines. Thus, although this analysis refers to testing for wind farm area stigma, the area stigma being tested actually incorporates the view of the wind turbines (i.e., the view of the wind turbines is so highly correlated with properties in close proximity to the wind turbines that these effects cannot be separated out[16]).

There was a recent survey conducted surrounding the wind farm in which this study is focused on, Twin Groves I and II. A random sample of residents of the Ellsworth, Saybrook, and Arrowsmith communities was surveyed in 2009 (Theron, 2010). Sixty percent of respondents claimed they were either not concerned at all or not very concerned regarding wind farms negatively impacting their property values. This survey response is significant considering it was taken during the wind farm operation stage of Twin Groves I and II. Therefore, after living with the wind turbines, approximately 60% of the randomly sampled residents of the communities

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[15] Hoen et al. (2009) considered homes within a distance of one mile to be in close proximity. Nuisance Stigma was investigated in this analysis, but since only 11 properties sold within one mile of the wind farm during wind farm operations, the results of the nuisance stigma investigation should not be taken with great confidence.

[16] If two separate explanatory variables were included in the estimation to model distance and view of the wind farm separately, then this high correlation between the two variables would result in multicollinearity. Multicollinearity occurs when there is a relationship among some of the explanatory variables such that two or more explanatory variables are so highly correlated that they largely or totally nullify one another (thus, insignificance of estimated coefficients).

were not concerned about their property values declining because of the wind farm. This finding is inconsistent with wind farm area stigma theory. Thus, this study investigates wind farm area stigma theory by analyzing the actual property transactions around the wind farm rather than opinions of local property owners.

It is important to control for the time period in which the property sold in the analysis, which is an often ignored factor in the prevailing literature. The time period the price is observed may include the year in which the property sold (e.g., including dummy variables for different years in which properties sold). Yearly dummy variables are extremely important to include in the estimation if the prices are not adjusted for inflation. It is also important to include a particular time or stage dummy variable[17] and interact it with the most important property characteristics that will likely vary with time. For example, it is important to include a dummy variable if a significant change occurred during a particular time period, where the dummy variable would take a value of one for properties that sold during the time period in which the change was in effect, and it would take a zero value for properties that sold when the change was not in effect (e.g., a wind farm constructed in an area may be considered a significant change). More will be discussed on this topic in Sections IV and V. Also, the amount of time the house takes to sell, commonly referred to as "time-on-the-market"[18] can potentially impact the selling price.

Following some excellent studies completed by Kiel and McClain (1995a, 1995b)[19], the author recognizes that the effect of a wind farm on property values may not be constant over time and that important information may be lost if the stages of the adjustment process are ignored, where the stages of the adjustment process correspond to different levels of risk as perceived by local residents, homebuyers, and sellers[20]. Theoretically, there could exist a *wind farm anticipation stigma* associated with properties that sell in a location near a proposed wind farm project. *Wind farm anticipation stigma theory* is a concern surrounding a proposed or approved wind farm project that is primarily due to factors stemming from a fear of the unknown: a general uncertainty surrounding a wind farm project regarding the aesthetic impacts

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[17] A dummy variable is a binary variable taking a value of one to indicate the presence of some categorical effect that may be expected to shift the outcome and a value of zero to indicate the absence of some categorical effect.

[18] Sirmans et al. (2005) state "Typically, a seller's goal is to sell the house at the highest possible price in the shortest possible time. These two objectives are generally reconciled with the setting of the listing price. A listing price that is too high may have the effect of both lengthening the selling time and limiting the pool of potential buyers. Setting the listing price too low may minimize the selling time but may also result in a selling price lower than what otherwise could be attained" (7).

Sirmans et al. (2005) reviewed studies that have focused on the relationship between time-on-the-market and selling price. Sirmans et al. (2005) observe, "when time-on-the-market is included and statistically significant in the selling price equation, it is generally negative. This indicates that a longer selling time results in a lower selling price. When selling price is included in a time-on-the-market estimation, the results are much less clear. In some cases, a higher selling price leads to a longer selling time whereas in others, a higher selling price results in a shorter selling time" (7). Of the 18 time-on-the-market studies Sirmans et al. (2005) examine, 50% of the time, time-on-the-market is not statistically significant, 44.4% of the time, time-on-the-market is negative and statistically significant, and 5.6% of the time, time-on-the-market is positive and significant.

The author would have loved to be able to include time-on-the-market in the estimation. Unfortunately, time-on-the-market data are not freely available for all of the property sales included in this analysis. In general, there may be inherent measurement errors in time-on-the-market data due to property owners relisting their properties.

[19] Kiel and McClain (1995a, 1995b) examine the impact of an incinerator on housing values in North Andover, Massachusetts.

[20] These stages of the adjustment process are thought to roughly correspond to the stages of wind farm development.

on the landscape, the actual noise impacts from the wind turbines, and just how disruptive the wind farm will actually be. "The uncertainty surrounding the project—whether and where the facility is located and how undesirable the facility might be—will change through time and should be reflected in the prices of houses" (Kiel and McClain, 1995a, 242). Kiel and McClain (1995a) state that the "effect of a facility on house values may change over time as neighbors acquire more information, good or bad, on the aesthetic and health consequences of the facility" (242). This statement may give light to the fact that most surveys done in areas surrounding a "proposed" wind farm find that there is an expectation that property values will diminish, yet a large number of the studies completed in areas surrounding "actual" wind farms find that property values do not diminish.

As surrounding property owners acquire additional information on the aesthetic impacts on the landscape and actual noise impacts of the wind turbines after the wind farm becomes operational, residents of the local area may get used to them (e.g., the turbines become part of the landscape such as telephone poles[21] have outside of homes) and they may not take the turbines into account when moving to another house in the local area.

Interestingly, even if evidence reveals that the wind farm has no impact, research has revealed that initial risk perceptions may persist because of the way new information is interpreted. New information which is consistent with an individual's existing beliefs is accepted as reliable and accurate, while conflicting information is labeled erroneous, unrepresentative, or propaganda (Kiel and McClain, 1995a; Slovic, 1987). Thus, any downward pressure on prices, if any, could be quite prolonged, especially if the majority of local residents are opposed to the wind farm prior to wind farm approval.

Accordingly, this study incorporates these important theoretical considerations into the econometric model (most importantly, wind farm anticipation stigma theory and wind farm area stigma theory). Utilizing the econometric method described in the next section, this study will test whether these theories hold for the specific housing market under study.

IV. EMPIRICAL METHOD

This study uses a data structure known as pooled cross sections over time and an estimation technique known as Ordinary Least Squares (OLS) multiple regression analysis. Every method used for pure cross section analysis can be applied to pooled cross sections, such as corrections for heteroskedasticity. Important "control" variables will be included in the multiple regression analysis to explain housing prices and these will help alleviate any self-selection problem[22]. In using pooled cross sections, time period dummies are usually included in the model to account for aggregate changes over time (Wooldridge, 2002). A difference-in-differences estimation approach is adopted to explicitly analyze the relationship between property price and wind farm proximity over the different stages of development. It is assumed that the relationship between the dependent variable *ln(Real Property Price)* and most of the

[21] However, telephone poles do not have moving parts and they are much smaller than industrial size wind turbines.
[22] A self selection problem occurs when a dummy variable indicator is systematically related to unobserved factors resulting in biased estimators.

independent variables remains constant over time[23]. Using this assumption, pooling is helpful because it can allow for more precise estimators. More estimation assumptions are included in Appendix B.

Spatial dependence or spatial autocorrelation exists when there is a lack of independence among cross-sectional units' relative space or location (multi-directional); i.e., the existence of a functional relationship between what happens at one point in space and what happens elsewhere (Anselin, 1988). Although prices from adjacent units are likely to be correlated (neighborhood effects), if the correlation arises mainly through the explanatory variables (as opposed to unobservables), then nothing needs to be done on a practical level (Wooldridge, 2002). When the unobservables are correlated across nearby geographical units, OLS can still have desirable properties—often unbiasedness, consistency, and asymptotic normality can be established (Wooldridge, 2002). Thus, this analysis assumes that any correlation arises mainly through the explanatory variables rather than unobservables and a spatial weights matrix is not adopted.

If it is believed that several housing submarkets[24] exist within a sample, there are two ways of dealing with them in the estimation of hedonic equations. Malpezzi et al. (1980) state "separate regressions could be estimated for each submarket. This implies rather extreme separation because it assumes all the hedonic prices are different in each submarket. The second alternative is to introduce dummy (or indicator) variables for each submarket. This is more restrictive than the first alternative in the sense that it forces the coefficients to be equal in each submarket. Only the constant term, or the base price is allowed to differ across submarket" (21-22). The latter approach is adopted and the estimated coefficients of the location dummy variables represent the base price differential between the submarkets.

Spatial heterogeneity[25] exists when there is a lack of stability over space of the relationships; i.e., functional forms and parameters vary with location and are not homogenous throughout the dataset (Anselin, 1988). Several conditions would lead to this: a byproduct of measurement errors for observations in contiguous spatial units and the existence of a variety of spatial interaction phenomena (Anselin, 1988). The former is likely to occur when data is collected only at an aggregate level, thus there may be little correspondence between the spatial scope for the phenomenon under study and the delineation of the spatial units of observation, and as a result measurement errors are likely. Spatial spillover in measurement errors is one cause for the presence of spatial dependence, which can lead to non-spherical disturbance terms and errors in variables problems (Anselin, 1988). "Each housing market produces a set of hedonic prices. This means that each set of hedonic prices… estimate[d] must be derived from a set of observations from the same housing market. To use too broad a geographical definition of a housing market would produce biased estimates from an improperly aggregated sample. To use too narrow a definition would produce inefficient estimates because the estimates would not be based on all available information" (Malpezzi et al., 1980, 21). Thus, a balance must be determined[26].

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[23] For the relationships that may not remain constant over time, time period interaction terms with the specific variables are included (e.g., properties close to wind turbines interacted with time period).

[24] Fletcher et al. (2000) provide a great overview of modeling housing submarkets.

[25] Distinguishing between spatial dependence (autocorrelation) and spatial heterogeneity can be a highly complex problem.

[26] Too broad a geographical definition of a housing market in the study sample would be *county level*. Too narrow a geographical definition of a housing market in the study sample would be *neighborhood/subdivision*. Thus, *school districts* and *townships* are included where *townships* are a narrower geographical definition of a housing market in

Several measures that address these spatial aspects are utilized in this analysis. Each of the base equations was estimated three times, each time using one of the three measures adopted to control for spatial heterogeneity, spatial trends, and/or spatial submarkets (neighborhood effects). First, the {X, Y}-coordinates[27] of the property locations were included in some of the models to address the impact that absolute location has on property values and to model any spatial trends. Second, school district dummy variables were utilized as proxies for the housing submarkets. Third, township dummy variables were used as proxies for the housing submarkets. These three specifications were utilized to demonstrate the results are robust to either specification and to allow for a more detailed comparison of property values near the wind farm to property values in each of the other housing submarkets over time.

A. DIFFERENCE-IN-DIFFERENCES ESTIMATOR

In order to analyze the relationship between the price of a property and its proximity to a wind farm over the different stages of wind farm development (stages of the adjustment process), a difference-in-differences estimator is adopted. Consider the following equation:

$$\text{RealPrice} = \beta_0 + \delta_0 \text{wfoperation} + \gamma_0 \text{nearwf} + \delta_1 \text{wfoperation} * \text{nearwf} + \varepsilon \quad (4)$$

Where

- *RealPrice* represents the selling prices of houses adjusted for inflation;
- *wfoperation* is a dummy variable equal to 1 for properties that sold during the time period in which the wind farm was operational (and 0 otherwise);
- *nearwf* is a dummy variable equal to 1 for properties that sold near the wind farm area (and 0 otherwise);
- *wfoperation*nearwf* is a dummy variable equal to 1 for properties that sold that are located near the wind farm area during the time period in which the wind farm was operational (and 0 otherwise);
- ε is an error term[28];
- $\beta_0, \delta_0, \gamma_0, \delta_1$ represent parameters[29] to be estimated.

The estimated[30] coefficients of Eq. (4) can literally be calculated using simple averages[31].

$$\hat{\beta}_0 = \overline{\text{RealPrice}}_{\text{farwf,B4Operation}} \quad (5)$$

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the sample than *school districts*, but not nearly as narrow as *towns* or *subdivisions*.

[27] More details regarding the {X,Y}-coordinates can be found in Appendix B.

[28] An error term contains unobserved factors that affect the dependent variable. It may also include measurement errors in the observed dependent or independent variables (Wooldridge, 2009).

[29] A parameter is an unknown value that describes a population relationship (Wooldridge, 2009).

[30] The equation is estimated using Ordinary Least Squares (OLS) multiple regression analysis. OLS is a method for estimating the parameters of a multiple linear regression model. The ordinary least squares estimates are obtained by minimizing the sum of squared residuals (Wooldridge, 2009). There is a residual for each observation in the sample used to obtain an OLS regression line, where a residual is calculated as the difference between the actual value and the fitted (or predicted) value (Wooldridge, 2009).

[31] The "mean" or "average" is defined as the sum of *n* numbers divided by *n*.

$$\hat{\delta}_0 = \left(\overline{\text{RealPrice}}_{\text{farwf,wfOperation}} - \overline{\text{RealPrice}}_{\text{farwf,B4Operation}}\right) \quad (6)$$

$$\hat{\gamma}_0 = \left(\overline{\text{RealPrice}}_{\text{nearwf,B4Operation}} - \overline{\text{RealPrice}}_{\text{farwf,B4Operation}}\right) \quad (7)$$

$$\hat{\delta}_1 = \left(\overline{\text{RealPrice}}_{\text{nearwf,wfOperation}} - \overline{\text{RealPrice}}_{\text{nearwf,B4Operation}}\right) - \left(\overline{\text{RealPrice}}_{\text{farwf,wfOperation}} - \overline{\text{RealPrice}}_{\text{farwf,B4Operation}}\right) \quad (8)$$

Where[32]

- $\overline{RealPrice}_{farwf,B4Operation}$ is the real average price of properties that sold *far* from the wind farm *before* the time period when the wind farm was operational.
- $\overline{RealPrice}_{farwf,wfOperation}$ is the real average price of properties that sold *far* from the wind farm during the time period when the wind farm was *operating*.
- $\overline{RealPrice}_{nearwf,B4Operation}$ is the real average price of properties that sold *near* the wind farm area *before* the time period when the wind farm was operational.
- $\overline{RealPrice}_{nearwf,wfOperation}$ is the real average price of properties that sold *near* the wind farm during the time period when the wind farm was *operating*.

The bar over *RealPrice* denotes the average and the subscript *B4Operation* denotes the time period prior to wind farm operation and the subscript *wfOperation* denotes the time period in which the wind farm was operational. The subscript *farwf* denotes properties that sold far away from the wind farm and the subscript *nearwf* denotes properties that sold near the wind farm. Thus, the estimated coefficients have the following interpretations:

- $\hat{\beta}_0$ the intercept or constant term represents the real average price of a home far from the wind farm prior to operation of the wind farm. See Eq. (5).
- $\hat{\delta}_0$ captures aggregate factors that affect real property price over time; it captures changes in housing values of properties far from the wind farm from the time period before wind farm operations to the time period when the wind farm was operational. See Eq. (6).
- $\hat{\gamma}_0$ measures the *location effect* that is *not* due to the presence of the wind farm. This takes into account any housing price differential between properties near the wind farm and far from the wind farm prior to wind farm operations. See Eq. (7).
- $\hat{\delta}_1$ the coefficient on the interaction term *wfoperation*nearwf* is the estimated parameter of interest: it measures the change in housing values due to the new wind farm, provided that houses both near and far from the site did not appreciate at different rates for other reasons. Wind farm area stigma would occur if $\hat{\delta}_1$ is negative and statistically significant. See Eq. (8).

The difference-in-differences estimator $(\hat{\delta}_1)$ applied to the present study estimates the

[32] Column (1) of Table D.1 of Appendix D contains the results of estimating Eq. (4). The real average prices of properties that sold can be found in Table C.1 of Appendix C.

difference over time in the average difference of real housing prices near the wind farm (*nearwf*) and farther away from the wind farm (*farwf*). $\hat{\delta}_1$ has also been called the average treatment effect because it measures the effect of the "treatment" or policy on the average outcome of the dependent variable (Wooldridge, 2009). $\hat{\delta}_1$ tests whether a wind farm area stigma exists, where a negative and statistically significant $\hat{\delta}_1$ would provide support for the existence of an area stigma. Please see Appendix D for more complex examples and explanations of how to interpret each of the estimated coefficients.

To see how effective the difference-in-differences estimator is for estimating housing price impacts from a wind farm, it can be compared with some alternative estimators. For example, properties farther away from the wind farm[33] could be ignored and instead the change in the real average property price over time for properties near the wind farm[34] could be used to measure the impact of the wind farm on property values near the wind farm:

$$\left(\overline{\mathrm{RealPrice}}_{\mathrm{nearwf,wfOperation}} - \overline{\mathrm{RealPrice}}_{\mathrm{nearwf,B4Operation}}\right) \tag{9}$$

The problem with this estimator in Eq. (9) is that the average response can change over time for reasons unrelated to the wind farm (e.g., housing crisis and economic recession). Thus, it is important to be able to compare the property value changes over time for the area near the wind farm to the property value changes over time for an area far from the wind farm.

Another possibility is to use the approach that most authors have used in analyzing the impact of wind farms on property values, that is to use a pure cross-section approach and ignore the time period before the wind farm achieved commercial operations and compute the difference in averages of real property prices for properties near the wind farm and properties farther away from the wind farm for the time period in which the wind farm was operational:

$$\left(\overline{\mathrm{RealPrice}}_{\mathrm{nearwf,wfOperation}} - \overline{\mathrm{RealPrice}}_{\mathrm{farwf,wfOperation}}\right) \tag{10}$$

The problem with Eq. (10) is that there might be systematic, unmeasured differences in properties near the wind farm and properties farther away from the wind farm that have nothing to do with the wind farm (e.g., distance to sub-centers of employment, grocery stores, and shopping). Thus, attributing the difference in averages of the housing prices to the wind farm would be misleading[35] (Wooldridge, 2002).

By comparing the time changes in real average property prices for the properties near the wind farm and farther away from the wind farm, both group-specific[36] and time-specific effects are allowed for[37] (Wooldridge, 2002). Please see Appendix D for more examples and explanations.

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[33] Properties farther away from the wind farm are the control group. A control group in a program evaluation is the group that does not participate in the program.

[34] Properties near the wind farm are the treatment or target group. A treatment or target group in a program evaluation is the group that participates in the program.

[35] This approach that is often misleading is demonstrated in Section VI by estimation of each stage of the wind farm separately.

[36] e.g., neighborhood effects.

[37] Nevertheless, unbiasedness of the difference-in-differences estimator still requires that the change (operation of a wind farm) not be systematically related to other factors that affect housing values (and are hidden in the error term).

V. PROJECT LOCATION AND DATA

This section begins with an explanation as to why Twin Groves I and II were chosen for this analysis. Next, maps of the study areas are presented along with area descriptions. Finally, this section concludes with a description of the data collected including summary statistics of the variables included in this study.

A. WHY TWIN GROVES WIND FARM?

The largest wind farm east of the Mississippi River, Twin Groves I and II (TG I and II) in McLean County, Illinois, was chosen for this analysis because Illinois State University, the university the author was attending while completing this study, is also located in McLean County. Thus, the site was chosen for its convenience[38]. Also, at the time of the decision, there had not been any hedonic regression studies that had examined properties that sold around a wind farm of this magnitude, 240 turbines, 1.65 megawatts (MW) per turbine, 22,000 acres, with a hub height of 262.5 feet (~80 meters) or 398 feet (~121 meters) from the base of the tower to the top of the blade.

B. STUDY AREA

The study area for this analysis consists of 21 townships in eastern McLean County, Illinois and four townships in western Ford County, Illinois. Table 4 contains a list of the townships included in the study as well as the size of the township, in terms of land area. The total study area consists of 1,023 square miles (654,239 acres). The wind farm area consists of 22,000 acres. Fig. 1 contains a map of the study area along with identifiers for the wind turbines from Twin Groves I and II. Several wind farms that have been approved by the McLean County Board but have not yet been built are pictured in Fig. 1, namely White Oak wind farm and Twin Groves IV and V[39]. It was decided to extend the study area beyond the townships immediately surrounding Twin Groves I and II because of the McLean County Board approval of Twin Groves IV and V (TG IV and V will reside in several of those townships that border TG I and II). Consequently, 1,023 square miles are included in the study area to ensure there are appropriate control areas (i.e., areas not affected by a wind farm) in the analysis.

TWIN GROVES
WIND FARM®

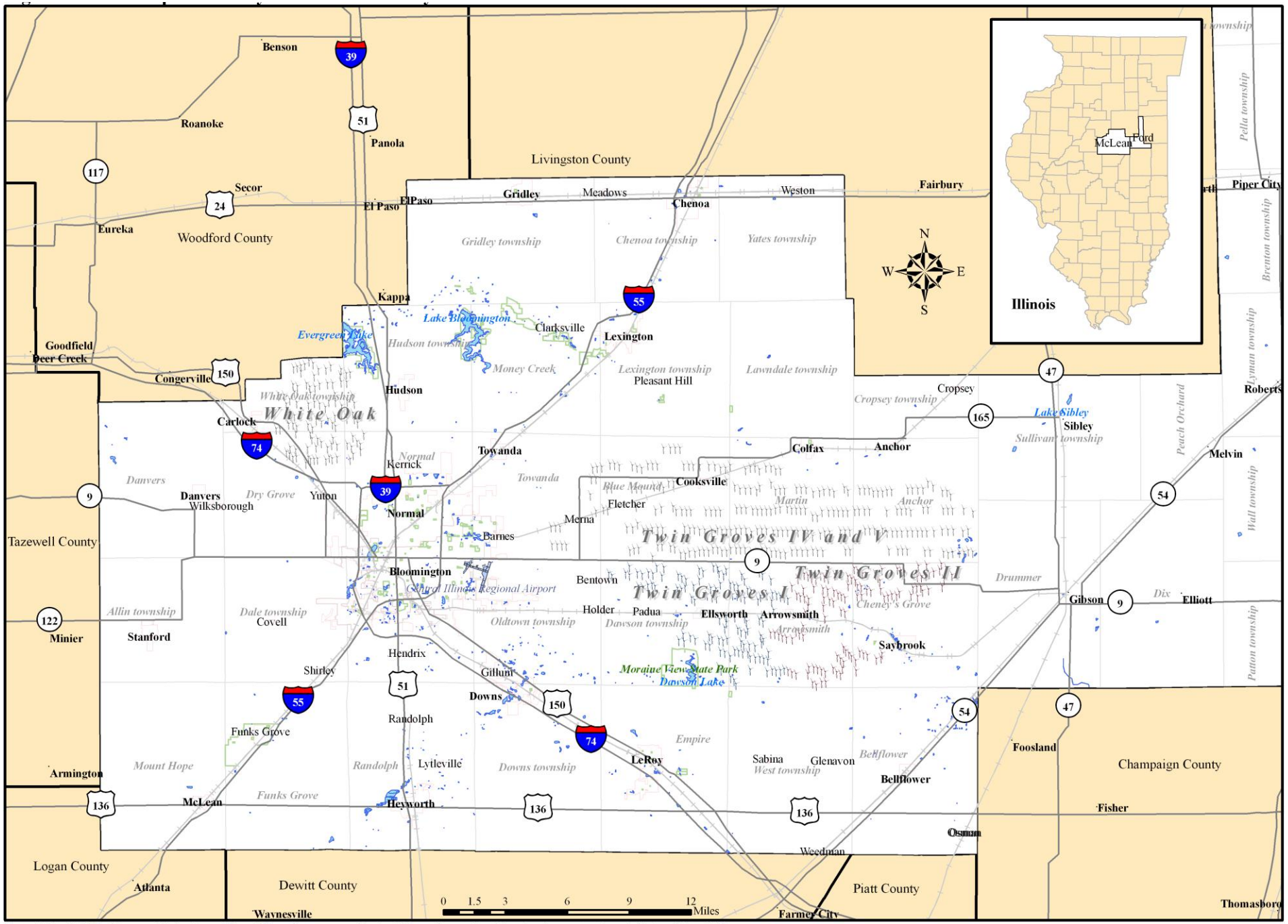
[38] Since the author had a $0 budget, it was important to have access to McLean County GIS data for the purpose of calculating distances from properties to the wind farm. Luckily, Mr. Phil Dick, Director of McLean County Building and Zoning, agreed to support the project which gave the author access to McLean County GIS data (McGIS, 2010).
[39] The planned turbine locations are identified on the map for White Oak wind farm and Twin Groves IV and V, but the actual turbine locations may differ.

Table 4. Study Area Township Size

Township	Acres	SqMiles
Gridley township	34,879	54
Dix township	34,552	54
Drummer township	34,339	54
Randolph township	31,755	50
Downs township	31,666	49
Empire township	31,619	49
Bellflower township	31,169	49
West township	31,104	49
Sullivant township	30,329	47
Lexington township	26,213	41
Lawndale township	25,439	40
Money Creek township	25,148	39
Hudson township	24,193	38
Blue Mound township	24,161	38
Dawson township	24,013	38
Oldtown township	23,677	37
Yates township	23,389	37
Anchor township	23,377	37
Cheney's Grove township	23,364	37
Chenoa township	23,334	36
Martin township	23,192	36
Arrowsmith township	23,112	36
Towanda township	23,021	36
Peach Orchard township	15,483	24
Cropsey township	11,710	18
Total Study Area	**654,239**	**1,023**

Source: U.S. Census Bureau

Notes: SqMiles=Square Miles



Notes: White Oak Wind Farm and Twin Groves IV and V have been approved by the McLean County Board, but they have not yet been built (as of May, 2010). Thus, the planned turbine locations are identified on the map, but the actual turbine locations may differ.
Data Sources: McLean County Regional GIS Consortium (McGIS), U.S. Census Bureau, Horizon Wind Energy, Invenergy

Map Designed by Jennifer L. Hinman

Fig. 1. Study Area: McLean and Ford Counties, Illinois: Wind Farms Approved as of May, 2010

According to a local realtor the top three townships that are considered prime home location spots are *Oldtown*, *Downs*, and *Hudson*. The top three villages that are considered prime home location spots are Downs, Hudson, and Heyworth. The top school districts within the study area include *Normal Community Unit School District (CUSD) 5*, *Trivalley CUSD 3*, and *Heyworth CUSD 4.*

Table 5 contains township population over the past 110 years. The percent changes in population from 1900 to 2000 for the top home location spots are -19% *Downs*, 82% *Hudson*, 178% *Oldtown*, and 104% *Randolph*[40]. The percent changes in population from 1900 to 2000 for the townships in which Twin Groves I and II are located are -47% Arrowsmith, -38% Cheney's Grove, and -48% Dawson. Thus, it appears that the wind farm was sited in areas that had a declining population over the past century.

Table 6 contains the number of housing units by township from 1970 through 2000. The percent changes in the number of housing units from 1970 to 2000 for the top home location spots are 10% *Downs*, 53% *Hudson*, 199% *Oldtown*, and 61% *Randolph.* The percent changes in the number of housing units from 1970 to 2000 for the townships in which TG I and II are primarily located are -9% Arrowsmith, 8% Cheney's Grove, and -9% Dawson. Although the number of housing units in Cheney's Grove township has increased by 8% from 1970 to 2000, the number of housing units has declined by 8.75% from 1980 to 2000. Before TG I and II were proposed, there apparently had not been any significant growth in population nor in the number of housing units within the townships where TG I and II eventually located. This fact could have contributed to the relative lack of opposition to the wind farm during the approval process[41]

[40] The village of Heyworth is in *Randolph* township.

[41] The audio recordings from the McLean County Zoning Board of Appeals hearings for the TG I and II special-use permits were obtained and listened to by the author.

Table 5. Census Population: 1890-2000 Townships

	1890	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000	1900-2000
Illinois	3.8M	4.8M	5.6M	6.485M	7.6M	7.9M	8.7M	10M	11M	11.4M	11.4M	12.4M	158%
Ford County, Illinois	17,035	18,359	17,096	16,466	15,489	15,007	15,901	16,606	16,382	15,265	14,275	14,241	-22%
McLean County, Illinois	63,036	67,843	68,008	70,107	73,117	73,930	76,577	83,877	104,389	119,149	129,180	150,433	122%
Allin township, McLean	1,209	1,302	1,197	1,115	1,006	1,037	967	938	1,053	1,057	996	1,047	-20%
Anchor township, McLean	903	957	932	825	763	666	643	644	528	441	393	376	-61%
Arrowsmith township, McLean	1,090	1,081	1,013	946	907	783	798	782	646	566	549	569	-47%
Bellflower township, McLean	1,294	1,241	1,167	1,183	1,220	1,070	964	927	952	794	702	682	-45%
Bloomington City township	20,484	23,286	25,768	28,725	30,930	32,868	34,163	36,271	39,992	44,189	51,972	64,808	178%
Bloomington township, McLean		2,250	2,025	2,034	2,211	2,239	2,582	3,514	4,896	4,939	3,835	3,176	41%
Blue Mound township, McLean	1,057	1,158	1,176	1,053	1,025	919	782	693	685	616	478	473	-59%
Brenton township, Ford	1,315	1,377	1,355	1,299	1,262	1,147	1,176	1,283	1,124	1,073	994	929	-33%
Button township, Ford	862	876	766	729	614	560	470	426	385	335	299	290	-67%
Cheney's Grove township	1,849	1,723	1,557	1,479	1,379	1,455	1,314	1,310	1,192	1,223	1,051	1,069	-38%
Chenoa township, McLean	2,004	2,219	2,117	2,002	2,002	2,021	2,032	2,053	2,440	2,368	2,228	2,305	4%
Cropsey township, McLean	543	544	531	514	500	454	424	387	341	288	240	256	-53%
Dale township, McLean	1,010	1,063	1,022	866	906	802	778	838	953	1,018	1,192	1,276	20%
Danvers township, McLean	1,665	1,760	1,543	1,497	1,412	1,496	1,468	1,461	1,486	1,595	1,692	1,953	11%
Dawson township, McLean	1,264	1,275	1,235	1,109	1,041	1,039	870	766	756	688	649	668	-48%
Dix township, Ford	1,450	1,436	1,366	1,343	1,133	1,071	1,066	957	898	792	711	686	-52%
Downs township, McLean	1,330	1,330	1,278	1,137	1,128	1,038	998	1,133	1,170	1,014	992	1,079	-19%
Drummer township, Ford	2,997	3,304	3,165	3,178	3,043	3,225	3,745	4,243	4,580	4,071	3,897	3,898	18%
Dry Grove township, McLean	1,092	1,218	903	848	812	716	756	750	993	1,501	1,494	1,649	35%
Empire township, McLean	2,325	2,639	2,635	2,523	2,391	2,517	2,437	2,694	2,957	3,473	3,379	3,845	46%
Funks Grove township, McLean	777	916	791	624	796	677	588	574	425	358	302	293	-68%
Gridley township, McLean	1,699	1,836	1,833	1,753	1,653	1,579	1,561	1,568	1,628	1,805	1,813	1,914	4%
Hudson township, McLean	1,269	1,277	1,095	1,062	1,017	956	910	1,144	1,619	1,766	1,853	2,318	82%
Lawndale township, McLean	945	840	755	685	637	554	457	447	357	273	237	227	-73%
Lexington township, McLean	2,174	2,498	2,211	2,123	2,050	2,036	1,789	1,887	2,206	2,441	2,271	2,331	-7%
Lyman township, Ford	1,298	1,413	1,248	1,212	1,052	936	924	920	838	688	617	578	-59%
Martin township, McLean	1,428	1,911	1,601	1,624	1,429	1,387	1,345	1,339	1,287	1,180	1,154	1,229	-36%
Mona township, Ford	756	853	850	801	818	721	656	533	510	479	383	387	-55%
Money Creek township, McLean	882	843	753	716	676	631	590	597	780	780	824	1,084	29%
Mount Hope township, McLean	1,432	1,361	1,486	1,497	1,520	1,367	1,313	1,329	1,276	1,170	1,130	1,172	-14%
Normal township, McLean		4,651	4,844	5,959	7,519	7,713	10,444	14,122	27,532	36,163	40,449	45,637	881%
Oldtown township, McLean	906	970	946	774	820	763	730	778	960	1,570	1,738	2,692	178%
Patton township, Ford	3,559	4,425	4,160	4,040	3,928	4,005	4,694	5,247	5,410	5,327	5,226	5,413	22%
Peach Orchard township, Ford	1,008	1,017	953	959	838	830	838	810	720	700	654	614	-40%

Pella township, Ford	800	734	624	517	558	503	495	369	341	285	206	220	-70%
Randolph township, McLean	1,833	1,891	1,829	1,978	1,983	1,970	2,022	2,181	2,700	3,010	2,934	3,856	104%
Rogers township, Ford	851	809	695	643	610	557	515	516	457	569	460	414	-49%
Sullivant township, Ford	1,322	1,397	1,185	1,123	1,065	963	893	954	827	692	608	594	-57%
Towanda township, McLean	1,255	1,242	1,210	1,123	1,134	1,094	959	1,059	1,031	1,375	1,191	1,024	-18%
Wall township, Ford	757	718	729	622	568	489	429	348	292	254	220	218	-70%
West township, McLean	1,135	1,035	999	871	896	798	677	551	424	318	264	278	-73%
White Oak township, McLean	594	607	692	655	636	627	598	541	647	761	803	807	33%
Yates township, McLean	1,017	919	864	807	718	658	618	599	477	409	375	340	-63%

Source: U.S. Census Bureau

Table 6. Housing Units: Townships

	1970	1980	1990	2000	1970-2000
Anchor township, McLean County	181	170	146	125	-31%
Arrowsmith township, McLean County	215	226	203	196	-9%
Bellflower township, McLean County	323	307	282	258	-20%
Bloomington City township, McLean County	14,459	20,050	22,640	26,642	84%
Bloomington township, McLean County	1,642	1,925	1,546	1,231	-25%
Blue Mound township, McLean County	232	249	204	194	-16%
Cheney's Grove township, McLean County	404	480	439	438	8%
Chenoa township, McLean County	788	886	870	867	10%
Cropsey township, McLean County	115	112	100	86	-25%
Dawson township, McLean County	264	289	232	240	-9%
Dix township, Ford County	290	321	281	261	-10%
Downs township, McLean County	357	356	363	393	10%
Drummer township, Ford County	1,679	1,776	1,728	1,668	-1%
Empire township, McLean County	1,030	1,346	1,338	1,489	45%
Funks Grove township, McLean County	132	137	120	109	-17%
Gridley township, McLean County	550	680	670	721	31%
Hudson township, McLean County	549	657	692	842	53%
Lawndale township, McLean County	113	99	90	75	-34%
Lexington township, McLean County	730	950	884	913	25%
Martin township, McLean County	488	524	493	486	0%
Money Creek township, McLean County	307	379	389	411	34%
Normal township, McLean County	6,586	10,548	12,454	15,257	132%
Oldtown township, McLean County	294	566	588	880	199%
Peach Orchard township, Ford County	292	307	288	245	-16%
Randolph township, McLean County	879	1,138	1,123	1,417	61%
Sullivant township, Ford County	289	293	256	221	-24%
Towanda township, McLean County	327	470	435	410	25%
West township, McLean County	136	123	99	88	-35%
Yates township, McLean County	159	149	135	125	-21%

Source: U.S. Census Bureau

Two villages are completely surrounded by the TG I and II wind turbines. Aerial photos of the village of Ellsworth and the village of Arrowsmith are pictured in Fig. 2 and Fig. 3, respectively. Ellsworth is located within the *Trivalley School District 3* and had a population of 271 in 2000 (U.S. Census Bureau, 2000). Arrowsmith is located within the *Ridgeview School District 19* and had a population of 298 in 2000 (U.S. Census Bureau, 2000). The village of Saybrook is located within the Cheney's Grove township and the *Ridgeview School District 19.* Wind turbines are located to the north and west of Saybrook. Saybrook had a population of 764 in 2000, which is a population decline of 13% from 1900 to 2000[42] (U.S. Census Bureau). None of the three villages contain a grocery store, though Saybrook does have a gas station.

[42] Saybrook had a population of 879 in 1900 (U.S. Census Bureau).

The land in the wind farm area is primarily farmland used to grow corn and soybeans. McLean County is the largest land area county in Illinois and is one of the most productive agricultural areas in the United States; fortunately, the wind turbines took only a small percentage of farm acreage out of production[43]. The wind turbines are located across moraines that formed during the Wisconsin Glacial Episode. The land area surrounding the wind farm is slightly rolling with very limited relief (i.e., generally relatively flat and is sloping in some areas). The land to the south of the wind farm gradually declines in elevation. TG I and II are primarily surrounded by land in the A-Agriculture District, though some turbines are adjacent to land in the R-1 Single Family Residence District. Although the minimum distance needed to maintain compliance with the State of Illinois Noise Regulations is 655 feet from the turbine to the nearest residence, the developer proposed and implemented a minimum 1,500 foot setback from a wind turbine to the nearest residence.

Fig. 2. Ellsworth Village

[43] Each turbine takes anywhere from one to two acres depending on how long the access road is (E-mail from Marie Streenz, Horizon Wind Energy, May 5, 2010).

Fig. 3. Arrowsmith Village

C. DATA

The property sales and a portion of the property characteristic data[44] used in this analysis were obtained from the Supervisors of Assessments Offices in McLean and Ford Counties (2010). A list of the main variables used in this analysis is presented in Table 7. These variables will be described in the subsections that follow and more details regarding the construction of some of the variables can be found in Appendix B. The final dataset contains 3,851 property transactions from 01/01/2001 through 12/01/2009[45] and the properties that sold are identified on

[44] This information is publically available.

[45] The original McLean County dataset consisted of 4,088 property transactions. The following types of transactions were not considered to be "arm's length" in nature and were accordingly removed: vacant lots, multi-parcel transactions, duplexes, triplexes, quadplexes, judicial, family, mobile homes, contract, compulsory, auctions, DHUD (Department of Housing and Urban Development), veteran's deed, foreclosures, properties that sold for less than $25,000 and above $400,000, and those that had incomplete data regarding the characteristics of the properties (e.g., missing year built, missing square feet). Market value (and a transaction considered to be "arm's length") is the highest price in terms of money, that the property will bring to a willing seller if exposed for sale on the open market; allowing a reasonable time to find a willing buyer, buying with the knowledge of all the uses to which it is adapted and for which it can be legally used, and with neither buyer nor seller acting under necessity, compulsion, nor peculiar and special circumstances. To further verify there were only "arm's length" transactions included, the

the map in Fig. 4. The time period and explanatory variables chosen were based on the available electronic data[46].

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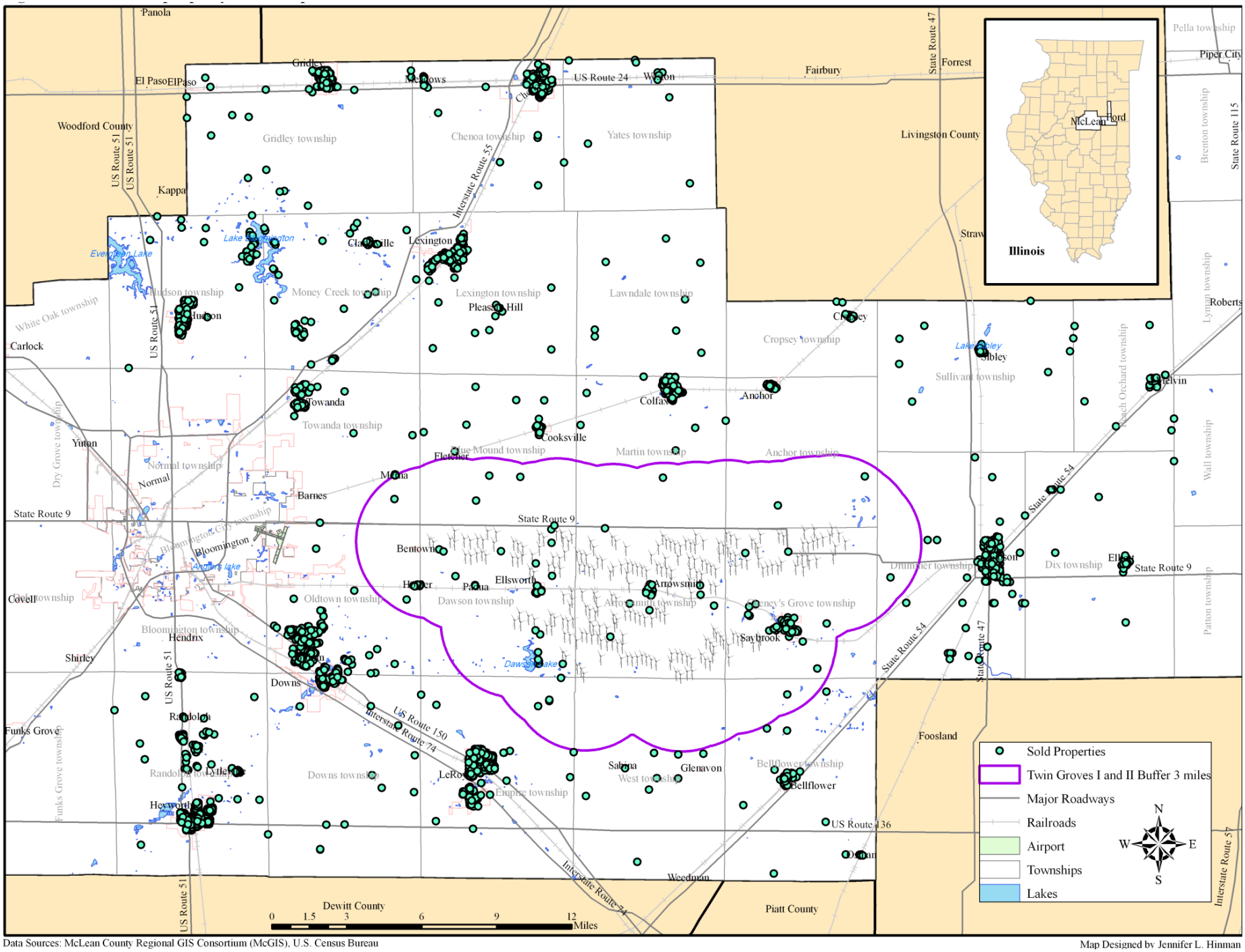
author took a rather time-consuming approach and verified the records of every single transaction near the wind farm via the following website <http://www.mcleancountyil.gov/resolution/>.
Regarding the removal of properties that sold below $25,000, this price was chosen because a local appraiser suggested that homes that sell for less than $25,000 are not likely to be in livable condition; and this analysis is concerned with the potential impact that close proximity to an operating wind farm may have on the value of properties that are indeed in livable condition. Properties that sold above $400,000 were removed because these outliers were considered to be "influential" observations which would adversely impact the parameter estimation; i.e., "OLS is susceptible to outlying observations because it minimizes the sum of squared residuals: large residuals (positive or negative) receive a lot of weight in the least squares minimization problem. If the estimates change by a practically large amount when we slightly modify our sample, we should be concerned" (Wooldridge, 2009, 325). A regression was estimated excluding the variables of interest, and the standardized residuals were obtained. The observations with high standardized residuals (greater than three) were removed (none were within a three mile distance of the wind farm).

[46] The variables included in the analysis were based on the available data. Property sales from Champaign County could not be obtained, but the author does not believe this to have any impact on the analysis because of the very small population (and likely few property sales that occurred) located in the northwest corner of Champaign County (which is the area in the Champaign County closest to TG I and II).

Table 7. Variable Definitions

***Variables* (Definitions)**
ln(Real Property Price) or *ln(Real Price)* (Natural Logarithm of Real Price of Property in 2009 Q2 $)
Real Property Price or *Real Price* (Real Price of Property in 2009 Q2 $)
Square Feet (above grade living area of the dwelling in 1000s of square feet)
Garage (area of the garage in 180s of square feet; number of cars that can fit in garage)
Acre (tenths of acres of the property, when total acreage is 1 acre or less, 0 otherwise)
Acres (number of acres of the property, when total acreage is greater than 1 acre, 0 otherwise)
Age (decades) (deed year minus year built)
Age^2 (the square of the age of the home in decades)
Fireplaces (number of fireplaces)
Railroad Tracks (1 if within 180 meters of railroad tracks, 0 otherwise)
Lakefront (1 if within 70 meters of a lake, 0 otherwise)
Cul-de-sac (1 if property located near a cul-de-sac, 0 otherwise)
Trees (1 if within 180 meters of Deciduous or Evergreen forests, 0 otherwise)
Near Wind Farm or *nearwf* (1 if property located within three mile buffer of wind farm, 0 otherwise)
Before Wind Farm Approval or *Before WF Approval* (1 if property sold 01/01/2001-09/20/2005, 0 otherwise)
Post WF Approval and Construction or *Post WF Approval/Construction* (1 if property sold 09/21/2005-02/02/2008, 0 otherwise)
Before WF Operation or *B4Operation* (1 if property sold 01/01/2001-02/02/2008, 0 otherwise)
Wind Farm Operation or *wfoperation* or *WF Operation* (1 if property sold 02/02/2008-12/01/2009, 0 otherwise)
Near Wind Farm, Post WF Approval/Construction (1 if property located within three mile buffer of wind farm and sold 09/21/2005-02/02/2008, 0 otherwise)
Near Wind Farm, WF Operation (1 if property located within three mile buffer of wind farm and sold 02/02/2008-12/01/2009, 0 otherwise)
{X,Y}-coordinates (mapping coordinates in meters of the location of the property)
C (Intercept or constant term)
Community Unit School District *(CUSD)* $\in$ *Blue Ridge CUSD 18, El Paso-Gridley CUSD 11, Gibson City-Sibley-Melvin CUSD 5, Heyworth CUSD 4, LeRoy CUSD 2, Lexington CUSD 7, Normal CUSD 5, Prairie Central CUSD 8, Ridgeview CUSD 19,* and *Trivalley CUSD 3* (1 if property located far from the wind farm within specific school district (CUSD), 0 otherwise)
CUSD, Post WF Approval and Construction (1 if property located far from the wind farm within specific school district and sold 09/21/2005-02/02/2008, 0 otherwise)
CUSD, Wind Farm Operation or *CUSD, WF Operation* (1 if property located far from the wind farm within specific school district and sold 02/02/2008-12/01/2009, 0 otherwise)
Township $\in$ *Anchor, Bellflower, Blue Mound, Chenoa, Cropsey, Dix, Downs, Drummer, Empire, Gridley, Hudson, Lawndale, Lexington, Martin, Money Creek, Oldtown, Peach Orchard, Randolph, Sullivant, Towanda, West,* and *Yates* (1 if property located far from the wind farm within specific township, 0 otherwise)
Township, Post WF Approval and Construction (1 if property located far from the wind farm within specific township and sold 09/21/2005-02/02/2008, 0 otherwise)
Township, Wind Farm Operation (1 if property located far from the wind farm within specific township and sold 02/02/2008-12/01/2009, 0 otherwise)



Data Sources: McLean County Regional GIS Consortium (McGIS), U.S. Census Bureau

Map Designed by Jennifer L. Hinman

Fig. 4. Study Area Residential Property Sales: 2001-2009

1. DEPENDENT VARIABLE

The dependent[47] variable is the natural logarithm of the real property transaction price in 2009Q2 U.S. dollars[48] (*ln(Real Price)* or *ln(Real Property Price)*). The actual (nominal) property transaction prices for properties that sold in the study area are available to the public and they were obtained from the Supervisors of Assessments offices in McLean and Ford Counties (2010). This nominal transaction price was converted to real dollars in order to allow meaning in comparisons over the time period. Sirmans et al. (2005) claim that generally the observed recent selling price is used as a proxy for the value of a house, because it is thought to be the least biased proxy (e.g., a home owner's self-assessment is thought to be biased).

Freddie Mac's Conventional Mortgage Home Price Index[49] (CMHPI) for the Bloomington-Normal, IL[50] Metropolitan Statistical Area (B-N MSA) that provides a measure of typical price inflation for houses was used to adjust for inflation (Freddie Mac©, 2010). As can be seen in Eq. (11) below, this involved multiplying the nominal property transaction price *($NominalPrice_t$)* of a property that sold in year and quarter *(t)* by the ratio of the 2009Q2 B-N CMHPI to the B-N CMHPI that corresponds to the year and quarter (*t*) in which the property transaction occurred[51].

$$\text{RealPrice}_t = \text{NominalPrice}_t * \frac{\text{B-N CMHPI}_{2009Q2}}{\text{B-N CMHPI}_t} \tag{11}$$

The natural logarithm of real property price *ln(RealPrice)* was ultimately chosen as the dependent variable. The natural log transformed the data to a closer to normal distribution than the level form. Sirmans et al. (2005) assert that the empirical specification generally used for hedonic pricing studies has been linear or semi-logarithmic functional forms, but that the most used is the semi-log form. The semi-log specification has several benefits: (1) it helps to minimize the heteroskedasticity problem; (2) the dollar value of each characteristic is allowed to vary; and (3) the estimated coefficients (*coeff*) have convenient interpretations: $(e^{coeff}-1)*100$ is the percentage change in the transaction price given a one-unit change in the characteristic (Bond and Wang, 2005; Halvorsen and Palmquist, 1980; Halvorsen and Pollakowski, 1981; Kiel and McClain, 1995b; Sirmans et al., 2005). Accordingly, the semi-log specification was adopted.

2. TIMELINE

In order to take into account the different stages of the adjustment process that correspond to different levels of risk as perceived by local residents surrounding a wind farm project proposal, a timeline for the wind farm project had to be determined[52]. Many articles

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[47] A dependent variable is the variable to be explained in a multiple regression model.
[48] Quarter two of 2009 dollars.
[49] This index has been utilized in other housing studies to adjust for inflation, including Hoen et al. (2009).
[50] Although properties that sold in the cities of Bloomington and Normal were not included in the analysis, the Bloomington-Normal, IL MSA was chosen because it was the closest MSA to the project area.
[51] The base year, 2009, was chosen because it was thought that people could relate more with relatively current prices of homes when analyzing the descriptive statistics.
[52] A significant amount of time was spent investigating the proper dates for the break points in the stages of

published in *The Pantagraph*, a local newspaper, were reviewed as well as the developer's website in determining this timeline. The dates were then verified by the Midwest Director of Development for Horizon Wind Energy (2009). The various stages are listed in Table 8.

This study analyzes two different specifications for the various stages of the wind farm development. The first is a naïve specification that ultimately involves separating the wind farm development process into two stages: (A) the time period before TG I and II became fully operational *(Before Wind Farm Operation)*; and (B) the time period that both TG I and II had achieved commercial operations *(Wind Farm Operation)*. The second specification allows for a more dynamic approach to the housing value adjustment process. In this arguably more appropriate approach, the wind farm development process is divided into three stages: (1) the time period before TG I and II were approved by the McLean County Board *(Before Wind Farm Approval)*; (2) the time period after TG I and II were approved by the McLean County Board and during construction of TG I and II *(Post WF Approval/Construction)*; and (3) the time period that both TG I and II had achieved commercial operations *(Wind Farm Operation)*.

Table 8. Twin Groves I and II Timeline: Stages of Wind Farm Development

	2 Stage Approach	**Time Period**
Stage A	Before TG I and II are Fully Operational; Before WF Operation	01/01/2001 – 02/01/2008
Stage B	Twin Groves I and II Online; Wind Farm Operation	02/02/2008 – 12/01/2009
	3 Stage Approach	**Time Period**
Stage 1	Before TG I and II Approval; Before WF Approval	01/01/2001 – 09/20/2005
Stage 2	Post WF Approval and during Construction	09/21/2005 – 02/01/2008
Stage 3	Twin Groves I and II Online; Wind Farm Operation	02/02/2008 – 12/01/2009

Sources: The Pantagraph (2001 – 2009), Horizon Wind Energy (2009)
Notes: WF=Wind Farm=TG I and II=Twin Groves I and II

The stages of the adjustment process (corresponding to perceived risk by local residents and prospective homebuyers) are thought to roughly correspond to the stages of wind farm development. Property values before the wind farm was approved (*Before Wind Farm Approval*; Stage 1) should reflect the normal supply of and demand for housing and the various structural, neighborhood, and locational characteristics of the properties.

In McLean County, Illinois, a wind farm is designated as a Major Utility and a wind farm developer must apply for a special-use[53] permit[54] as part of the development process. The

development in the wind farm timeline. All wind farm related articles appearing in the local newspaper, *The Pantagraph*, were reviewed with a focus on the content and date of the articles. The stages of the adjustment process (corresponding to perceived risk by local residents and prospective homebuyers) are thought to roughly correspond to the stages of wind farm development.

[53] Because of their unique characteristics, the uses set forth in Article 8 – Special Use Permits, shall be located in a district or districts only upon consideration in each case of the impact of such use upon neighboring land and of the

McLean County Board is authorized to decide whether special-use permits shall be granted subject to the general and specific standards contained in the McLean County, Illinois Zoning Ordinance (more specifically, Section 803 of Article 8 and Section 2 of Article 6). A public hearing must be held by the McLean County Zoning Board of Appeals (ZBA) prior to the granting of any special-use permit. The ZBA shall submit a written report that contains findings certifying that adequate provision has been made for complying with the standards for issuance of special-use permits (Chapter 40 – McLean County, Illinois Zoning Ordinance, Article 8, Section 803; Article 6, Section 2). The ZBA shall submit the written report and recommendation to the McLean County Board within 30 days after the close of the public hearing. The concurring vote of at least four members of the ZBA is necessary in order to recommend approval to the County Board of a special-use permit application[55]. If a special use is approved by the McLean County Board, then the wind farm developer is allowed to apply for building permits for each of the wind turbines (before sunset of the special-use permit). During the wind farm permitting process, the main hurdle the wind farm developer has to surmount is to provide sufficient evidence to convince the ZBA that the standards set forth in Section 803 of Article 8 are satisfied such that the ZBA will recommend approval of the special-use permit to the County Board. Meeting specific conditions that the ZBA may stipulate in its recommendation to the County Board would also be advised[56].

For this analysis, Stage 2 *(Post WF Approval/Construction)* began the day after the McLean County Board officially approved the special-use permit, and therefore construction of the wind farm was almost inevitable, September 21, 2005[57]. Construction literally began June 29, 2006, and the first towers were erected around September 28, 2006 (The Pantagraph, 2006).

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public need for such a use at the particular location.

[54] Material in this paragraph is adapted from Article 8 – Special Use Permits in Chapter 40 – McLean County, Illinois Zoning Ordinance which may be downloaded from the McLean County website. Available at <http://www.mcleancountyil.gov/build/pdf/Zoning_ordinance.pdf>.

[55] The Zoning Board of Appeals may recommend and the County Board may stipulate such conditions and restrictions upon the establishment, location, construction, maintenance and operation of the special use permit as is deemed necessary for the protection of the public interest and to secure compliance with the standards and conditions contained within Chapter 40 – McLean County, Illinois Zoning Ordinance, Article 8.

[56] For example, the ZBA found that the special-use application in case SU-05-09 (for TG I and II) met all the standards found in the McLean County Zoning Ordinance provided the following conditions were met: "1) a mitigation agreement is made between the applicant and Craig and Rose Grant to provide a planting screen between two proposed wind turbines in Section 36 in Dawson Township and the Grant property; 2) no wind turbine tower is located closer than 600 feet to the nearest R-1 Single Family Residence District boundary as measured from the tip of the turbine blade; 3) a written road agreement is approved by the County Board and Dawson, Arrowsmith, and Cheney's Grove Townships as a condition of this approval; and 4) the following has occurred after completion of Phase I and before beginning Phase II: 1) the applicant has requested a meeting with the Director of Building and Zoning; 2) a meeting takes place with the applicant and staff of the McLean County Department of Building and Zoning where the applicant will adequately address problems or concerns that are identified through Phase I by the Director of Building and Zoning; and 3) any items brought up at this meeting that cannot be adequately addressed according to the Director of Building and Zoning will need to be appealed to the Zoning Board of Appeals for resolution at their next available meeting; and the applicant will provide engineering plans certified by a registered engineer that each tower and wind turbine is designed and built according to appropriate national standards." Available at <http://www.mcleancountyil.gov/boardnotes/pdf/September2005/pro.pdf>.

[57] The McLean County Board approved the special-use permit September 20, 2005 with a waiver to allow up to 16 wind towers to be as close as 600 feet to an R-1 Single Family Residence District rather than 2,000 feet as required and to be allowed to apply for Building Permits for TG I up to three years after County Board approval and for TG II up to five years after the beginning of construction of TG I, rather than one year as allowed.

During Stage 2 *(Post WF Approval/Construction)*, the probability that the wind turbines are to be constructed and go online is assumed to be one, "so a mobility decision will be based on expected damages relative to expected moving costs and future property losses" (Kiel and McClain, 1995a, 244). Uncertainty arises regarding how disruptive the wind farm will actually be; and as a result this uncertainty may be reflected in the form of lower property prices (wind farm anticipation stigma theory) or longer days-on-the-market. Consequently, from a theoretical standpoint, it is plausible that during Stage 2 *(Post WF Approval/Construction)*, a property owner, who is fearful of living near wind turbines or one who just does not want to live near wind turbines, may try to sell their property before the wind farm becomes operational (wind farm anticipation stigma theory). A property owner may fear that their property will not be able to sell once the wind farm project is fully operational; and as a consequence, the owner may end up selling their property for much less than it is actually worth[58]. The author denotes this property value impact from this uncertainty as *wind farm anticipation stigma theory*.

The *Wind Farm Operation* stage, Stage 3, begins when all of the wind turbines of TG I and II are generating electricity[59]. Knowledge of any "facility effects" (e.g., noise, visual) will accumulate over this period until no more uncertainty about the effects exist. Thus, damage should be measurable as an actual figure rather than an expected value. As this knowledge moves through the market, prices should make their final adjustment (Kiel and McClain, 1995a). Finally, if after adjustment is complete the facility is regarded as harmless, prices will rebound and the total change in social welfare will be zero (Kiel and McClain, 1995a). Interestingly, even if evidence reveals that the wind farm has no impact, research has revealed that initial risk perceptions may persist because of the way new information is interpreted. New information which is consistent with an individual's existing beliefs is accepted as reliable and accurate, while conflicting information is labeled erroneous, unrepresentative, or propaganda[60] (Kiel and McClain, 1995a; Slovic, 1987). Thus, any downward pressure on prices, if any, could be quite prolonged, especially if the majority of local residents are opposed to the wind farm prior to wind farm approval.

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[58] Some people have stated that property values might initially diminish when a project that they would prefer not to live next to (e.g., nuclear facility, incinerator) is proposed (a so-called "rumor" stage) because they think the likelihood of it becoming a reality is high so they immediately try to sell their home to get out of the area (which could lower the price the seller is willing to accept because of the "urgency" of getting out of the area) . Kiel and McClain state that "Households which assign a high probability to a facility going on-line and/or which expect to suffer a great deal from the arrival of the facility are likely to try to move out, even if they 'take a loss' on their unit" (1995a, 244). At the time the Twin Groves wind farm was originally proposed (late November of 2001 was the earliest landowner contact that the author is aware of), there existed zero wind farm projects in Illinois, thus the likelihood that property values would be impacted during a so-called "rumor" phase is slim because the expectation that the wind farm would actually be built was likely low because there were not any wind farms in the state of Illinois. Accordingly, this study seeks to identify whether there has been any impact on property values after the wind farm project was approved and during construction, as well as during the operational phase of the wind farm project when property owners living close to the wind turbines will actually have had a chance to see if any of their concerns materialize.

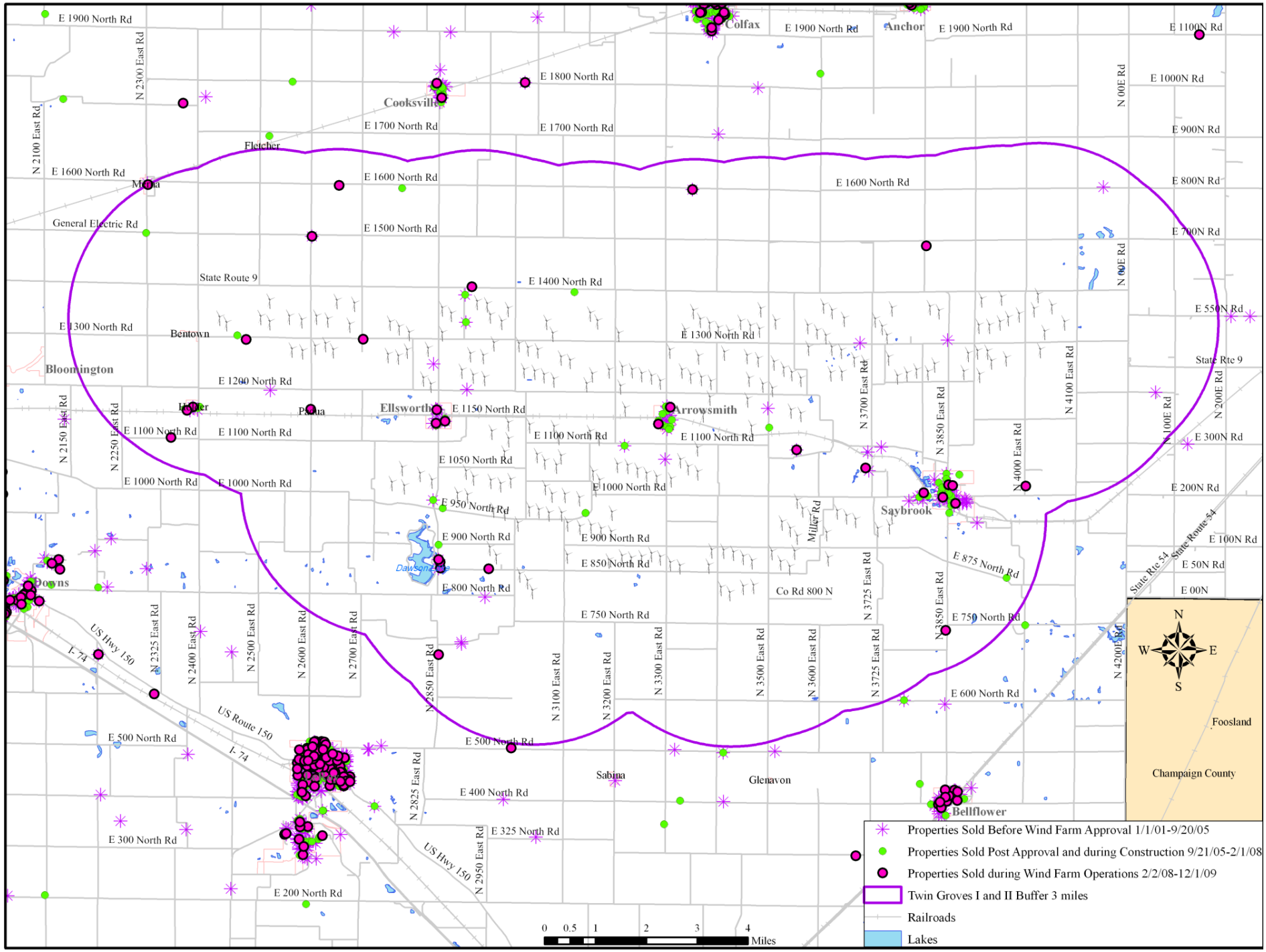
[59] Stage (3) starts when TG II achieved commercial operations.

[60] For example, the author received a letter in the mail about wind farms and it contained testimony from a local resident regarding impacts on an autistic child. The author later found out that the testimony was written by the same person who filed a lawsuit against the wind farm developer before the wind farm was even constructed (see the reference to the article in *The Pantagraph*). Thus, it appears that the initial perceptions of wind farm impacts have lasted through the operational stage for certain residents.
Source: Miller, S., 2006. Lawyer: Wind farm presents hazards. *The Pantagraph.* Money Section: C1. May 23, 2006.

3. DISTANCE – NEAR TWIN GROVES I AND II

Distance from the home to the nearest turbine was determined by spatially joining the wind turbines to the properties that sold using Geographic Information Systems (GIS) software[61]. Thus, each property received the distance measured from the nearest turbine to the property. The wind turbine locations were obtained from McGIS (2010) and Horizon Wind Energy (2010). A local real estate agent with over 23 years of experience was consulted regarding the local real estate market. The realtor was completely confident that there had been zero impact from the wind farm on housing values at a distance greater than three miles[62]. The author also visited all of the areas within three miles of the wind farm. Almost all of those homes that were not located within a small town had a crystal clear view of the wind farm towers. In the author's opinion, the wind farm towers still appear "large" at a three-mile distance[63]. A map of the area near TG I and II can be found in Fig. 5. Each residential property included in the dataset is identified by the wind farm stage in which the transaction occurred.

[61] ESRI® ArcMap™ 9.3 (2010) was the GIS software utilized in this study.
[62] A map of the study area with various distance buffers surrounding the wind farm was given to the realtor to examine. The realtor had been involved in only a couple transactions within three miles of the wind turbines. While the realtor had not noticed a negative impact on the property values of those transactions and had not heard of any negative impact in the area, the author has more confidence in the opinion that there has definitely not been an impact outside of three miles because of the realtor's experience with many transactions in that area.
[63] Only one property from the dataset sold at a distance between 2.5 and 3 miles of a wind turbine.



Data Sources: McLean County Regional GIS Consortium (McGIS), U.S. Census Bureau

Map Designed by Jennifer L. Hinman

Fig. 5. Residential Property Sales Near Twin Groves I and II: 2001-2009

Table 9 provides descriptive statistics for *Real Property Price* for properties within three miles of the wind farm categorized by wind farm stage (using the two stage approach: before and after the wind farm became operational) and distance from the wind farm in miles. By comparing the means (or medians) of properties that sold before and after wind farm operation at the various distance ranges within three miles, it is clear that there is no *linear* relationship whatsoever between distance from a wind turbine and *Real Property Price*. During *the Wind Farm Operation* stage, the average *Real Property Price* is $138,806 (within 0.5 mile), $89,356 (0.5-1 mile), and then $100,158 (1-1.5 miles), which is clearly not a linear relationship between *Real Property Price* and distance from a wind turbine. As a result, a linear distance variable was not included in any of the models, and this provides support for the use of an indicator (dummy) variable for properties within three miles of the wind farm (as opposed to using a linear, quadratic, or inverse distance variable to model wind farm proximity stigma).

Table 9. Descriptive Statistics for Real Property Price for Properties Near TG I and II

Categorized by Wind Farm Stage (2 Stage Approach) and Distance from the Wind Farm in Miles								
Distance‡	**Wind Farm Stages†**	**Mean$**	**Median$**	**Max$**	**Min.$**	**Quant.*$**	**StDev$**	***n***
[0, 0.5)	Before Wind Farm Operation	154,509	151,970	344,704	43,690	187,870	61,647	26
[0, 0.5)	Wind Farm Operation	138,806	164,650	174,529	82,541	167,394	41,200	5
[0, 0.5)	All Stages	151,976	154,978	344,704	43,690	176,554	58,547	31
[0.5, 1)	Before Wind Farm Operation	97,305	93,789	199,480	33,445	120,904	35,647	45
[0.5, 1)	Wind Farm Operation	89,356	96,910	144,197	30,000	125,000	47,161	6
[0.5, 1)	All Stages	96,370	93,789	199,480	30,000	121,022	36,706	51
[1, 1.5)	Before Wind Farm Operation	88,496	83,758	186,045	30,146	115,217	37,873	58
[1, 1.5)	Wind Farm Operation	100,158	83,544	154,915	52,645	134,002	36,734	11
[1, 1.5)	All Stages	90,355	83,612	186,045	30,146	119,989	37,673	69
[1.5, 2)	Before Wind Farm Operation	116,743	100,849	218,312	52,440	155,548	51,553	11
[1.5, 2)	Wind Farm Operation	136,626	136,626	144,899	128,354	144,899	11,699	2
[1.5, 2)	All Stages	119,802	117,774	218,312	52,440	154,014	47,770	13
[2, 2.5)	Before Wind Farm Operation	105,113	100,898	148,765	55,854	132,249	32,741	6
[2, 2.5)	Wind Farm Operation	148,638	148,194	211,550	103,729	154,425	36,166	6
[2, 2.5)	All Stages	126,875	128,991	211,550	55,854	149,383	39,981	12
[2.5, 3)	Wind Farm Operation	124,236	124,236	124,236	124,236			1
[2.5, 3)	All Stages	124,236	124,236	124,236	124,236			1
0-3 mi	Before Wind Farm Operation	105,778	95,385	344,704	30,146	130,051	49,006	146
0-3 mi	Wind Farm Operation	116,814	124,342	211,550	30,000	146,142	42,814	31
0-3 mi	All Stages	107,711	98,576	344,704	30,000	133,492	48,050	177

Notes: Area: Properties that sold within three miles of the wind farm. *n*=177=# of observations; Max=Maximum; Min.=Minimum; StDev=Standard Deviation; 0-3 mi=All properties that sold within three miles of Twin Groves I and II;
Statistics reported for Real Property Price are 2009Q2 dollars ($).
‡Distance from the property to the nearest wind turbine in miles.
Please see Appendix B for a detailed account of property identification and distance calculations.
†Before Wind Farm Operation (01/01/2001 - 02/01/2008): Stage A;
Wind Farm Operation (02/02/2008 - 12/01/2009): Stage B;
All Stages (01/01/2001 - 12/01/2009).
*Quant.=Quantiles computed for p=0.75, using the Rankit (Cleveland) definition.

Table 10 provides descriptive statistics for *Real Property Price* for properties within three miles of the wind farm categorized by wind farm stage (using the three stage approach) and distance from the wind farm in miles. By comparing the means (or medians) of the real property prices during each of the three stages (*Before Wind Farm Approval, Post WF Approval/Construction, Wind Farm Operation*) at the various distance ranges within three miles, it is clear that there is no *linear* relationship whatsoever between distance from a wind turbine and *Real Property Price*. Accordingly, a linear distance variable was not included in any of the models, and this provides support for the use of an indicator variable for properties within three miles of the wind farm.

A proxy for property transactions that occurred near TG I and II was formed, *Near Wind Farm*. A dummy variable was created such that homes located within a three mile buffer of the wind farm receive a value of one, and zero otherwise. Thus, properties that are far from TG I and II (greater than three miles away) receive a value of zero.

Table 10. Descriptive Statistics for Real Property Price for Properties Near TG I and II

Categorized by Wind Farm Stage (3 Stage Approach) and Distance from the Wind Farm in Miles								
Distance (miles)	**Wind Farm Stages‡**	**Mean$**	**Median$**	**Max$**	**Min.$**	**Quant.*$**	**Std. Dev.$**	***n***
[0, 0.5)	Stage 1	157,558	163,508	344,704	43,690	195,867	72,047	16
[0, 0.5)	Stage 2	149,631	148,176	223,645	97,236	165,849	43,152	10
[0, 0.5)	Stage 3	138,806	164,650	174,529	82,541	167,394	41,200	5
[0, 0.5)	All Stages	151,976	154,978	344,704	43,690	176,554	58,547	31
[0.5, 1)	Stage 1	98,794	93,559	187,862	38,942	120,845	33,049	30
[0.5, 1)	Stage 2	94,326	94,356	199,480	33,445	119,990	41,435	15
[0.5, 1)	Stage 3	89,356	96,910	144,197	30,000	125,000	47,161	6
[0.5, 1)	All Stages	96,370	93,789	199,480	30,000	121,022	36,706	51
[1, 1.5)	Stage 1	88,570	85,414	186,045	31,318	113,086	38,833	35
[1, 1.5)	Stage 2	88,383	83,612	162,476	30,146	118,670	37,226	23
[1, 1.5)	Stage 3	100,158	83,544	154,915	52,645	134,002	36,734	11
[1, 1.5)	All Stages	90,355	83,612	186,045	30,146	119,989	37,673	69
[1.5, 2)	Stage 1	135,875	135,511	218,312	76,534	156,314	51,375	6
[1.5, 2)	Stage 2	93,785	83,249	169,458	52,440	118,001	46,230	5
[1.5, 2)	Stage 3	136,626	136,626	144,899	128,354	144,899	11,699	2
[1.5, 2)	All Stages	119,802	117,774	218,312	52,440	154,014	47,770	13
[2, 2.5)	Stage 1	111,725	94,396	148,765	92,014	135,173	32,100	3
[2, 2.5)	Stage 2	98,501	107,401	132,249	55,854	126,037	38,967	3
[2, 2.5)	Stage 3	148,638	148,194	211,550	103,729	154,425	36,166	6
[2, 2.5)	All Stages	126,875	128,991	211,550	55,854	149,383	39,981	12
[2.5, 3)	Stage 3	124,236	124,236	124,236	124,236			1
[2.5, 3)	All Stages	124,236	124,236	124,236	124,236			1
0-3 mi	Stage 1	108,168	94,112	344,704	31,318	130,396	51,475	90
0-3 mi	Stage 2	101,937	97,545	223,645	30,146	129,858	44,940	56
0-3 mi	Stage 3	116,814	124,342	211,550	30,000	146,142	42,814	31
0-3 mi	All Stages	107,711	98,576	344,704	30,000	133,492	48,050	177

Notes: Area: Properties that sold within three miles of the wind farm. *n*=177=# of observations; Max=Maximum; Min.=Minimum;
Std. Dev.=Standard Deviation; 0-3 mi=All properties that sold within three miles of Twin Groves I and II;
Statistics reported for Real Property Price are 2009Q2 dollars ($).
‡Stage 1: Before Wind Farm Approval (01/01/2001 - 09/20/2005);
Stage 2: Post Wind Farm Approval and during Construction (09/21/2005 - 02/01/2008);
Stage 3: Wind Farm Operation (02/02/2008 - 12/01/2009);
All Stages (01/01/2001 - 12/01/2009).
*Quant.=Quantiles computed for p=0.75, using the Rankit (Cleveland) definition.

4. EXPLANATORY VARIABLES

The explanatory variables (e.g., house structural and neighborhood characteristics) included in the model were primarily limited to those available from the McLean County Supervisor of Assessments Office. Table 11 contains descriptive statistics of all of the variables.

Table 11. Descriptive Statistics

Variable	Mean	Median	Max.	Min.	Std. Dev.	Sum
Real Property Price	126,347	115,390	399,314	25,047	63,435	
ln(Real Property Price)	11.62	11.66	12.90	10.13	0.51	
Square Feet *(1000s)*	1.51	1.40	4.05	0.43	0.54	
Garage	2.46	2.67	16.67	0.00	1.71	
Acre *(tenths)*	2.98	2.70	10.00	0.00	1.96	
Acres	0.30	0.00	13.64	0.00	1.12	
Age *(decades)*	5.44	4.30	18.00	0.00	4.06	
Age^2	46.07	18.49	324.00	0.00	54.05	
Fireplaces	0.29	0.00	3.00	0.00	0.47	1,102
Railroad Tracks	0.19	0.00	1.00	0.00	0.39	731
Lakefront	0.02	0.00	1.00	0.00	0.14	76
Cul-de-sac	0.08	0.00	1.00	0.00	0.27	314
Trees	0.11	0.00	1.00	0.00	0.31	429
Year Built	1951	1962	2008	1824	40.50	
Acreage	0.60	0.30	13.64	0.04	1.06	2,296
Before WF Approval: 01/01/2001 - 09/20/2005	0.53	1.00	1.00	0.00	0.50	2,036
Post WF Approval/Construction: 9/21/05 - 2/1/08	0.29	0.00	1.00	0.00	0.45	1,121
Wind Farm Operation: 02/02/2008 - 12/01/2009	0.18	0.00	1.00	0.00	0.38	694
X	263,956	262,421	308,440	240,199	17,164	
Y	425,601	421,667	454,066	401,697	16,120	
XY	1.12E+11	1.10E+11	1.34E+11	9.76E+10	8.55E+09	
X^2	7.00E+10	6.89E+10	9.51E+10	5.77E+10	9.32E+09	
Y^2	1.81E+11	1.78E+11	2.06E+11	1.61E+11	1.38E+10	
X^2Y^2	1.27E+22	1.22E+22	1.80E+22	9.53E+21	1.94E+21	
Blue Ridge CUSD 18	0.02	0.00	1.00	0.00	0.13	71
El Paso-Gridley CUSD 11	0.06	0.00	1.00	0.00	0.24	229
Gibson City-Melvin-Sibley CUSD 5	0.14	0.00	1.00	0.00	0.34	530
Heyworth CUSD 4	0.15	0.00	1.00	0.00	0.35	559
LeRoy CUSD 2	0.13	0.00	1.00	0.00	0.34	519
Lexington CUSD 7 - Reference	0.09	0.00	1.00	0.00	0.29	352
Normal CUSD 5	0.12	0.00	1.00	0.00	0.33	475
Prairie Central CUSD 8	0.08	0.00	1.00	0.00	0.27	314
Ridgeview CUSD 19	0.06	0.00	1.00	0.00	0.24	245
Trivalley CUSD 3	0.10	0.00	1.00	0.00	0.30	380
Near Wind Farm	0.05	0.00	1.00	0.00	0.21	177
Anchor Township	0.01	0.00	1.00	0.00	0.08	24
Bellflower Township	0.02	0.00	1.00	0.00	0.13	68
Blue Mound Township	0.01	0.00	1.00	0.00	0.11	43
Chenoa Township	0.07	0.00	1.00	0.00	0.26	282
Cropsey Township	0.00	0.00	1.00	0.00	0.06	15
Dix Township	0.01	0.00	1.00	0.00	0.09	35
Downs Township	0.04	0.00	1.00	0.00	0.19	138
Drummer Township	0.11	0.00	1.00	0.00	0.31	419
Empire Township	0.13	0.00	1.00	0.00	0.34	503
Gridley Township	0.06	0.00	1.00	0.00	0.24	228
Hudson Township	0.09	0.00	1.00	0.00	0.28	336
Lawndale Township	0.00	0.00	1.00	0.00	0.05	11
Lexington Township - Reference	0.08	0.00	1.00	0.00	0.28	325
Martin Township	0.04	0.00	1.00	0.00	0.20	169
Money Creek Township	0.02	0.00	1.00	0.00	0.13	64
Oldtown Township	0.07	0.00	1.00	0.00	0.25	254
Peach Orchard Township	0.01	0.00	1.00	0.00	0.10	42

Randolph Township	0.14	0.00	1.00	0.00	0.35	558
Sullivant Township	0.01	0.00	1.00	0.00	0.09	34
Towanda Township	0.03	0.00	1.00	0.00	0.16	99
West Township	0.00	0.00	1.00	0.00	0.05	10
Yates Township	0.00	0.00	1.00	0.00	0.07	17

Notes: The school district and township dummy variables exclude properties near TG I and II (*Near Wind Farm*) (within three miles). Time period: 01/01/2001 - 12/01/2009. *n*=3,851.

CUSD=Community Unit School District

The data regarding the number of square feet of the house and garage were provided with the original dataset from the counties. The variable, *Square Feet*, is the above grade living area of the dwelling. These variables were transformed to allow for more convenient interpretations. Living area square feet has been divided by 1,000 such that a one unit increase in *Square Feet* corresponds to a 1,000 square feet increase. Garage square feet has been divided by 180 such that a one unit increase in *Garage* corresponds to an increase in garage size by one car.

Lot size was provided with the original dataset from the counties. Properties in Ford County that had an irregular lot size were excluded from the analysis because there was no way to quantify the lot size. Properties in McLean County that did not contain the lot size in the original dataset received the parcel area in acres that was calculated using ESRI® ArcMap™ 9.3 (2010). Lot size was divided into two variables, lot size of one acre or less (*Acre*[64]) and lot size greater than one acre (*Acres*[65]). Including two separate variables for lot size allowed for a more precise estimation of the parameter on lot size. However, the results are robust to the inclusion of either measure (using two variables for lot size or just using one variable). By using two variables instead of one, the magnitude of the estimated coefficient on *Acres* decreases and on *Acre* increases (using the same units), which may indicate that there is a stronger demand for lots less than one acre, which would put upward pressure on the tenth of an acre price for these lots. Lot size of one acre or less was multiplied by ten such that a one unit increase in *Acre* corresponds to a tenth of an acre increase in lot size. A one unit increase in *Acres* corresponds to a one acre increase in lot size.

Age of the home was determined by subtracting the year built from the deed year. Actual age (deed year – year built) was the only proxy available for effective age[66]. It is expected that housing price will decrease with age up to a certain point because of physical depreciation. Very old houses that are "historical" in nature may sell for a premium because of their uniqueness and a proven ability to survive that may be linked to quality. In order to model the nonlinear nature of these effects, variables for both age and age-squared (age^2) are included in the model. Age of the home has been divided by ten such that a one unit increase in *Age* corresponds to an increase in *Age* by one decade. The results are robust to exclusion of age-squared (Age^2); however, the Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC) both preferred the

[64] *Acre*: All properties greater than one acre receive a zero, while properties less than or equal to one acre receive the acreage of the lot size (in tenths of acres).

[65] *Acres:* All properties less than or equal to one acre receive a zero, while properties greater than one acre receive the acreage of the lot size.

[66] "Effective age is an appraiser's estimate of the physical condition of a building. The actual age of a building may be shorter or longer than its effective age." Available at <http://homesbykathybrown.com/FrameSet.aspx?RedirectTo=http://www.realestateabc.com/glossary/index.htm>.

model with age-squared (*Age*^{2}) included.

Fireplaces is a count variable that indicates the number of fireplaces within the home and was provided with the original dataset from the counties.

Railroad Tracks is a dummy variable that takes on a value of one if the home is located within 180 meters (590.55 feet) of railroad tracks, and zero otherwise. A distance of 180 meters was chosen by viewing a map of the houses located near railroad tracks and determining the distance in which adjacent homes are typically positioned from the railroad tracks.

Lakefront is a dummy variable that takes on a value of one for properties that sold that were less than 70 meters (229.66 feet) from a lake, and a zero value otherwise. A distance of 70 meters was chosen as a proxy for lake view because time would not permit individually viewing each property close to a lake or pond. Thus, a distance of 70 meters was chosen by viewing a map of the houses located next to lakes and determining the distance that adjacent homes are typically positioned from the lake.

Cul-de-sac is a dummy variable such that a value of one indicates properties that sold that were located close to a cul-de-sac. *Cul-de-sac* is a proxy for reduced road traffic, because homes located in a cul-de-sac typically do not experience "through" traffic. The benefits of reduced road traffic include safer environments for kids and less noise from vehicles, among other things.

An attempt was made to code specific properties as wooded lots, as both an appraiser and a real estate agent from the local area indicated having a wooded lot is an amenity that is highly valued in the area. A dummy variable named *Trees* was created such that homes located within a distance of 180 meters (590.55 feet) from a Deciduous[67] Forest or an Evergreen[68] Forest point (created using GIS software) receive a value of one, and zero otherwise. Please note that this variable does not capture all properties with trees[69]. A distance of 180 meters was chosen by viewing a map of the houses located close to trees and determining the distance in which the homes are typically positioned from the trees. Please see Appendix B for details regarding this variable's construction.

Several measures that address spatial heterogeneity were utilized in this analysis. Following Dubin (1992), Pace and Gilley (1997, 1998), Pavlov (2000), Fik et al. (2003), and Beron et al. (2004), the {X, Y}-coordinates[70] were included in some of the models to address the impact that absolute location has on property values, to model any spatial trends, and in an attempt to avoid some of the errors that occur by choosing neighborhood boundaries. Often times in practice these chosen boundaries tend to be the same as those used by the data collector, such as census tract boundaries (Dubin, 1992)[71].

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[67] Deciduous Forest - Areas dominated by trees generally greater than five meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to seasonal change (U.S. Geological Survey, 2001).

[68] Evergreen Forest - Areas dominated by trees generally greater than five meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species maintain their leaves all year. Canopy is never without green foliage (U.S. Geological Survey, 2001).

[69] Please note that not every home that has a tree on their property is reflected in this variable.

[70] {X,Y}-coordinates are the mapping coordinates of the locations of each of the properties as determined by the GIS software (ESRI® ArcMap™ 9.3, 2010). The {X,Y}-coordinates are measured in meters. Please see Appendix B for details regarding how these coordinates were determined.

[71] Due to the fact that there exist locational attributes that might not be picked up by the {X,Y}-coordinates (this may result if there are only a few houses which are impacted by these attributes directly and only one impacted home in the area actually sold during the entire study period), the influences of lakes, trees, cul-de-sacs, and railroad tracks on property values were addressed through the inclusion of dummy variables representing the presence of

School district dummy variables are utilized in some of the models as proxies for housing submarkets. Township dummy variables are utilized in some of the models as proxies for housing submarkets. These three specifications (XY[72], SD[73], TWP[74]) were utilized to demonstrate the results are robust to the various specifications and to allow for a more detailed analysis of the housing submarkets over the different stages of wind farm development.

VI. EMPIRICAL RESULTS

This section will proceed as follows: first, the results are presented from estimating the model[75] involving the two stages. The estimation regarding the two stages tests whether properties near the wind farm have appreciated[76] at a different rate on average than properties farther from the wind farm from the time period before wind farm operation (Stage A) to the time period after the wind farm became operational (Stage B). Three separate regression models are estimated to test this hypothesis: the first involves the spatial expansion of the {X,Y}-coordinates, the second involves school district dummy variable interactions by stage, and the third involves township dummy variable interactions by stage, and these results are presented in Table 12, Columns (1), (2), and (3), respectively (Table E.1 of Appendix E contains the full set of estimated coefficients including the spatial variables).

Next, the results are presented in Table 13 from estimating the model involving three stages of wind farm development. The model involving three stages essentially tests whether the rates of appreciation in property values near the wind farm and far from the wind farm are significantly different on average over the different stages of wind farm development, which are thought to roughly correspond to different levels of risk as perceived by homebuyers. In particular, to test for wind farm anticipation stigma, the appreciation in property values is measured from the time period before the wind farm was approved (Stage 1) to the time period post wind farm approval and during construction (Stage 2). To test for wind farm area stigma, the appreciation in property values is measured from the time period before the wind farm was approved (Stage 1) to the time period when the wind farm was fully operational (Stage 3).

Next, each stage of the wind farm development process is estimated separately (Tables 14-16). These estimations allow for comparisons in real property value levels (rather than the appreciation in real property values) near to and far from the wind farm site for each stage of wind farm development. Column (3) of Tables 14-16 demonstrates the inherent problems with

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each of these attributes directly.

[72] XY={X,Y}-Coordinates

[73] SD=School Districts

[74] TWP=Townships

[75] Each estimated coefficient is the semi-elasticity of *Real Property Price* with respect to the independent variable. The estimated coefficients and standard errors presented in this section are for the standard explanatory variables (control variables, e.g., property characteristics) as well as the variables of interest (e.g., *Near Wind Farm*, and *Near Wind Farm, WF Operation*), and the full estimation results including the estimated coefficients for the spatial variables (i.e., {X,Y}-coordinates (XY), school districts (SD), and townships (TWP)) are presented in Appendix E. The percentage listed in front of the estimated coefficient is the actual interpretation of the coefficient, calculated as $[e^{coeff}-1]*100$.

[76] Appreciation is calculated using *Real Property Price*s (i.e., adjusted for inflation).

trying to estimate the effect from a wind farm without appropriately controlling for property values in the area before the wind farm located there.

Next, the results from an investigation of wind farm nuisance stigma for properties within one mile of a wind turbine are presented (Table 17). The number of properties actually located within one mile of a wind turbine is small[77] and this limits the number of properties available for sale in the housing market. A limited number of potential properties available for sale results in a very limited number of properties sold within one mile of a wind turbine. Thus, the results from the nuisance stigma estimations are not very compelling, and they should not be construed as the main results of this study.

Finally, Section VI concludes with an analysis of the estimation results. Potential reasons for these findings are also presented.

For those unfamiliar with difference-in-differences estimators, it is *strongly* recommended to thoroughly review Appendix D in order to avoid misrepresenting the results presented in this section and Appendix E.

A. TWO WIND FARM DEVELOPMENT STAGES ESTIMATIONS

The results from estimating the pooled hedonic house price model involving two stages are presented in Table 12 (Table E.1 of Appendix E contains the full set of estimated coefficients including the spatial variables). Taking into account two different time periods explicitly in the model tests whether properties near the wind farm have appreciated at a different rate on average than properties farther from the wind farm from the time period before wind farm operation (Stage A) to the time period after the wind farm became fully operational (Stage B). Three separate regression models are estimated to test this hypothesis: the first involves the spatial expansion of the {X,Y}-coordinates, the second involves school district dummy variable interactions by stage (i.e., by time period), and the third involves township dummy variable interactions by stage (i.e., by time period), and these results are presented in Table 12, Columns (1), (2), and (3), respectively.

1. RESULTS: TWO WIND FARM STAGES, {X,Y}-COORDINATES

In Column (1) of Table 12, all estimated coefficients (with the exception of *Wind Farm Operation*) are statistically significant beyond the 5% level, and most at the 1% level[78]. The *F*-

[77] Homes located in rural areas typically have larger lot sizes, thus the likelihood of many houses close together within one mile of a wind turbine is quite slim.

[78] Statistically significant at the 10% level means that, over many trials, one expects to *reject* the null hypothesis that the coefficient is zero, when it is in fact zero, one time out of ten (Malpezzi et al., 1980). Statistically significant at the 5% level means that, over many trials, one expects to *reject* the null hypothesis that the coefficient is zero, when it is in fact zero, one time out of twenty. Statistically significant at the 1% level means that, over many trials, one expects to *reject* the null hypothesis that the coefficient is zero, when it is in fact zero, one time out of one hundred. Thus, statistically significant at the 1% level is a more powerful result than statistically significant at the 10% level. Small levels of statistical significance are evidence against the null hypothesis. The null hypothesis is that there is no significant relationship between the dependent variable and the independent variable; i.e., the coefficient is zero. Thus small levels of statistical significance are evidence against the null hypothesis, since they indicate that the outcome of the data occurs with small probability if the null hypothesis is true. An estimated coefficient that is statistically significant at the 1% level implies that it is statistically significant at the 5% and 10% level. However, the opposite is not necessarily true. The strongest level of statistical significance is reported throughout this report;

statistic is relatively large at 380 and is statistically significant at the 1% level. The coefficient of determination indicates that approximately 66% of the variation in *ln(Real Property Price)* can be explained by all of the independent variables taken together. Spatial expansion[79] of the {X,Y}-coordinates of the sold properties are included such that spatial heterogeneity is incorporated into the model, (X, Y, XY, X^2, Y^2, and X^2Y^2). Please see Appendix B for more details.

A one unit (1,000 square feet) increase in the living area of a dwelling (*Square Feet*) is expected to increase price by 40.4%, *ceteris paribus (holding constant all other explanatory variables included in the model).* A one unit (180 square feet) increase in *Garage* (one car increase in garage space) is expected to increase price by 2.7%, *ceteris paribus.* A one unit increase in *Acre* (a tenth of an acre increase in lot size for lots one acre or less) is expected to increase price by 2.1%, *ceteris paribus.* A one unit increase in *Acres* (an acre increase in lot size for lots greater than one acre) is expected to increase price by 7.6%, *ceteris paribus.* The slope of the relationship between *Age* and *ln(Real Property Price)* depends on the *Age* of the property. A U-shape arises and this captures an increasing effect of *Age* on *ln(Real Property Price)* that occurs after a certain *Age* (after a turning point). The turning point or minimum of the function is when the age of a house is 149 years (when *Age*=14.9). A one unit increase in the number of fireplaces (*Fireplaces*) is expected to increase price by 8.7%, *ceteris paribus*. This estimate is consistent with previous empirical findings[80]. *Railroad Tracks* are expected to depress the value of nearby properties by 9.5%, *ceteris paribus.* A property located next to a lake (*Lakefront*) is expected to increase the property's price by 29.8%, *ceteris paribus.* A property located near a *Cul-de-sac* (amenities of less road traffic and increased privacy) is expected to increase the property's price by 3.2%, *ceteris paribus.* A property located in close proximity to wooded areas (*Trees*) is expected to increase the property's price by 3.5%, *ceteris paribus.* The signs of the estimated coefficients mentioned in this paragraph are all consistent with theory as presented in Section III.

Before wind farm operation, properties near the eventual wind farm site (*Near Wind Farm*) were valued 11.8% less on average than properties farther away from the eventual wind farm site, *ceteris paribus*; and this estimated coefficient on *Near Wind Farm* is statistically significant at the 1% level. This measures the *location effect* that is *not* due to the presence of the wind farm. Thus, even before the wind farm was operational, homes near the wind farm site sold for less than homes farther away from the site. This *location effect* is a factor that is often ignored in the literature and is one that the author feels is essential to almost any property value impact evaluation.

The estimated coefficient on *Wind Farm Operation* captures changes in housing values for houses far from the wind farm from the time period prior to wind farm operation to the period when the wind farm was operational. The estimated coefficient on *Wind Farm Operation* indicates that housing values farther from the wind farm, after the wind farm began operating, are not statistically different on average from values before the wind farm became operational.

The estimated coefficient of interest is on the interaction term, *Near Wind Farm, WF Operation*. The estimated coefficient measures the change in housing values due to the new wind

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e.g., 1% would be reported instead of reporting 1%, 5%, and 10%.

[79] Trend surface polynomials in terms of coordinates of the locations of the observations (properties).

[80] Sirmans et al. (2005) report the estimated coefficients from hedonic pricing models for fireplaces by geographic area. The fireplace coefficient estimates for the Midwest range from 0.045 to 0.110, and the current estimate of 0.083 lies within this range.

farm, provided that houses both near and far from the wind farm site did not appreciate at different rates for other reasons. From the time period before the wind farm was operational to the time period after TG I and II achieved commercial operations (during *Wind Farm Operation)*, the appreciation in the value of properties located near the wind farm site (*Near Wind Farm)* was 17.2% greater[81] on average than the appreciation in the value of properties located farther from the wind farm site, *ceteris paribus*. This estimate is statistically significant at the 1% level. This estimate is opposite in sign than wind farm area stigma theory suggests. Thus, the results presented in Column (1) of Table 12 reject the existence of a wind farm area stigma[82] for the area under study. The 95% confidence interval[83] for the coefficient of the variable of interest is (0.0292, 0.2877) or (2.96%, 33.34%). If random samples were obtained over and over again, with lower and upper bounds of the confidence intervals computed each time, then the ("unknown" or "true") population value would lie in this confidence interval, (2.96%, 33.34%), for 95% of the samples. Since the confidence interval contains only positive values, wind farm area stigma theory is strongly rejected for the local area.

2. TWO WIND FARM STAGES, SCHOOL DISTRICTS AND TOWNSHIPS

Table 12 displays the estimation results for regressions using school districts as the spatial controls in Column (2), and townships as the spatial controls in Column (3) (instead of the spatial expansion of the {X,Y}-coordinates as was used in Column (1) of Table 12). School districts and townships are proxies for various housing submarkets in the area. Dummy variables for properties that sold in *Lexington Community Unit School District (CUSD) 7* and *Lexington* township were excluded from each of the regressions and they are considered the base groups or benchmark groups, the groups against which comparisons are made. These areas were chosen as the base groups for a number of reasons. The average and median *Real Property Price*s for properties located within *Lexington CUSD 7* and *Lexington* township were closest to the average and median *Real Property Price*s for properties located throughout the entire study area (see Appendix C, Tables C.7 and C.10). Accordingly, it was thought that using *Lexington CUSD 7* and *Lexington* township as benchmark groups would allow for easier to understand estimated

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[81] The appreciation in property values for each area is calculated from the time period before the wind farm achieved commercial operations to the time period in which the wind farm was fully operational. 17.2% is roughly the difference between the appreciation for the area near the wind farm and the appreciation for the area farther from the wind farm.

[82] Please note that even though property values near the wind farm rose during wind farm operations, the author does not believe that the property values rose strictly because of the wind farm locating there; however, it does seem to imply that property values do not necessarily decline because of a wind farm locating in the area near the properties.

[83] A confidence interval is a rule used to construct a random interval so that a certain percentage of all datasets, determined by the confidence level, yields an interval that contains the population value. Confidence level is the percentage of samples in which we want our confidence interval to contain the population value; 95% is the most common confidence level, but 90% and 99% are also used. If random samples were obtained over and over again, with lower and upper bounds of the confidence intervals computed each time, then the ("unknown" or "true") population value would lie in the confidence interval for 95% of the samples. Unfortunately, for the single sample that is used to construct the confidence interval, it is not possible to know if the ("unknown" or "true") population value is contained in the interval. It is hoped that the sample would be one of the 95% of all samples where the interval estimate contains the "true" population parameter, but there is no guarantee (Wooldridge, 2009).

coefficients[84]. It was also thought that the base groups should not be located near any approved wind farms (e.g., Twin Groves IV and V) because of the complications that may arise; e.g., because of the complicated nature of property values in those areas due to the approval of wind farms (see Fig. 1).

Results for the variables of interest and main explanatory variables are presented in Columns (2) and (3) of Table 12 for the estimations including wind farm operation dummy variable interactions between each of the school district dummy variables and each of the township dummy variables[85]. The full sets of results are presented in Columns (12.2) and (12.3) of Table E.1 in Appendix E. The estimated coefficients do not change in any meaningful way as compared to the results from the regression involving the {X,Y}-coordinates presented in Column (1) of Table 12. However, the main impact is a loss of degrees of freedom as is evident by the decline in the *F-statistic* from 380 in Column (1) to 240 in Column (2) and 148 in Column (3) of Table 12.

a. RESULTS: TWO WIND FARM STAGES, SCHOOL DISTRICTS

Lexington Community Unit School District 7 is excluded from the regression in Column (2) of Table 12 and is considered to be the base or benchmark group, the group against which comparisons are made. *C*, the intercept or constant term of the regression model, is the intercept for *Lexington CUSD 7*. The intercept for each school district (or *Near Wind Farm*) is the constant term *C* plus the estimated coefficient of the school district under consideration. The estimated coefficient of each school district represents the difference in intercepts between the school district under consideration and *Lexington CUSD 7*. Please see Appendix D for examples and proper interpretations of the estimated coefficients.

The coefficient of determination indicates that approximately 66.5% of the variation in *ln(Real Property Price)* can be explained by all of the independent variables taken together. Before wind farm operation, properties located near the eventual wind farm site (*Near Wind Farm)* were worth 18.4% less on average than properties located within *Lexington Community Unit School District*[86] *7*, *ceteris paribus*; and this estimated coefficient on *Near Wind Farm* is statistically significant at the 1% level. This measures the *location effect* that is *not* due to the presence of the wind farm. Thus, even before the wind farm was in operation, homes near the wind farm site sold for less than homes in *Lexington CUSD 7*. Before Twin Groves I and II achieved commercial operations, properties located near the eventual wind farm site were devalued in comparison to properties located in the following school districts: *El Paso-Gridley CUSD 11, Heyworth CUSD 4, LeRoy CUSD 2, Lexington CUSD 7, Normal CUSD 5,* and *Trivalley CUSD 3*. See Column (12.2) of Table E.1 in Appendix E.

The estimated coefficient of interest is on the interaction term, *Near Wind Farm, WF Operation*. From the time period before the wind farm was operational to the time period after

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[84] Since *Lexington CUSD 7* and *Lexington* township are the base groups or benchmark groups, the groups against which comparisons of the estimated coefficients are made, and since they have average and median *Real Property Price*s that are closest to the overall average and median *Real Property Price*s for the entire study area, one could roughly interpret the coefficients as compared to the entire study area rather than focusing solely on *Lexington* being the base group (if this helps with understanding better—though not technically accurate).

[85] A time period interaction with West township is not included because there were no properties that sold during the wind farm operations stage in this township.

[86] Community Unit School District (CUSD)

TG I and II achieved commercial operations (during *Wind Farm Operation)*, property values near the wind farm site (*Near Wind Farm)* appreciated[87] 22.4% more[88] on average than property values in *Lexington CUSD 7, ceteris paribus;* and this estimated coefficient on *Near Wind Farm, WF Operation* is statistically significant at the 1% level. The 95% confidence interval for the coefficient of the variable of interest is (0.0433, 0.3611) or (4.42%, 43.49%). Since the confidence interval contains only positive numbers, there is a strong rejection of wind farm area stigma theory. In addition, from the time period before the wind farm was operational to the time period after TG I and II achieved commercial operations (during *Wind Farm Operation)*, the value of properties located near the wind farm site (*Near Wind Farm)* appreciated more on average than the value of properties located in the following school districts: *Blue Ridge CUSD 18, El Paso-Gridley CUSD 11, Gibson City-Melvin-Sibley CUSD 5, Heyworth CUSD 4, LeRoy CUSD 2, Lexington CUSD 7, Normal CUSD 5, Prairie Central CUSD 8, Ridgeview CUSD 19,* and *Trivalley CUSD 3.* Please see Column (12.2) of Table E.1 in Appendix E. Thus, surprisingly there does not appear to be a stigma associated with locating near the wind farm, given that since Twin Groves I and II achieved commercial operations, houses near the wind farm have appreciated at a faster rate on average than houses in all of the school districts which are located farther from the wind farm.

b. RESULTS: TWO WIND FARM STAGES, TOWNSHIPS

Lexington township is excluded from the regression in Column (3) of Table 12 and is considered to be the base or benchmark group, the group against which comparisons are made. The constant term *C*, the intercept of the regression model, is the intercept for *Lexington* township. Therefore, the intercept for each township (or *Near Wind Farm*) is the constant term *C* plus the estimated coefficient of the township under consideration. The estimated coefficient of each township represents the difference in intercepts between the township under consideration and *Lexington* township. The results from the estimation that allows for all of the township intercepts to vary by wind farm development stage are presented in Column (3) of Table 12 and Column (12.3) of Table E.1 found in Appendix E.

The coefficient of determination indicates that approximately 68% of the variation in *ln(Real Property Price)* can be explained by all of the explanatory variables taken together. The housing submarkets are most narrowly defined using the townships as the spatial controls, as is evidenced by the relatively high coefficient of determination. Though due to the large number of townships, this resulted in a loss in the degrees of freedom as is evidenced by the decline in the *F-statistic* (though still statistically significant at the 1% level). The *Durbin-Watson statistic* is

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[87] The coefficient on *Near Wind Farm, WF Operation* can be interpreted as roughly equaling $\left(\overline{\ln(\text{RealPrice})}_{\text{nearwf,wfOperation}} - \overline{\ln(\text{RealPrice})}_{\text{nearwf,B4Operation}}\right) - \left(\overline{\ln(\text{RealPrice})}_{\text{Lex,wfOperation}} - \overline{\ln(\text{RealPrice})}_{\text{Lex,B4Operation}}\right)$ after partialling out (controlling for the housing characteristics which are important in determining the price of a home) the housing characteristics included in the estimation. The bar over *ln(RealPrice)* indicates the average value. Taking the difference of the natural logarithm of a variable can be interpreted as the growth of the variable. Please review Appendix D for more information.

[88] Property value appreciation for each area is calculated from the time period before the wind farm achieved commercial operations to the time period in which the wind farm was fully operational. 22.4% is roughly the difference between property value appreciation for the area near the wind farm and property value appreciation for the area in *Lexington CUSD 7*. Thus, the appreciation in the value of properties near the wind farm was 22.4% more on average than the appreciation in the value of properties in *Lexington CUSD 7, ceteris paribus.*

very close to a value of two indicating that serial correlation is not a serious issue in the regression. The estimated coefficient of the *Trees* variable is not statistically significant indicating the possibility of multicollinearity[89] among *Trees* and the townships.

Roughly speaking, before Twin Groves I and II achieved commercial operations, properties located near the eventual wind farm site (*Near Wind Farm)* were valued 20% less on average than properties located in *Lexington* township, *ceteris paribus;* and this estimated coefficient on *Near Wind Farm* is statistically significant at the 1% level. This measures the *location effect* that is *not* due to the presence of the wind farm. Thus, even before the wind farm was in operation, homes near the eventual wind farm site sold for less than homes in *Lexington* township. Before Twin Groves I and II achieved commercial operations, properties located near the eventual wind farm site *(Near Wind Farm)* were devalued in comparison to properties in the following townships: *Blue Mound, Downs, Drummer, Empire, Gridley, Hudson, Lawndale, Lexington, Money Creek, Oldtown, Randolph,* and *Towanda.* See Column (12.3) of Table E.1 in Appendix E.

The estimated coefficient of interest is on the interaction term, *Near Wind Farm, WF Operation*. From the time period before the wind farm was operational to the time period after TG I and II achieved commercial operations (during *Wind Farm Operation),* the appreciation in the value of properties located near the wind farm site (*Near Wind Farm)* was 26% greater[90] on average than the appreciation in the value of properties located in *Lexington* township, *ceteris paribus;* and this estimated coefficient on *Near Wind Farm, WF Operation* is statistically significant at the 1% level. The 95% confidence interval for the coefficient of the variable of interest is (0.0704, 0.3916) or (7.30%, 47.94%). Since the confidence interval contains only positive numbers, there is a strong rejection of wind farm area stigma theory. In addition, the value of properties located near the wind farm site (*Near Wind Farm)* appreciated[91] more on average than the value of properties located in the following townships: *Anchor, Bellflower, Blue Mound, Chenoa, Dix, Downs, Drummer, Empire, Gridley, Hudson, Lawndale, Lexington, Martin, Money Creek, Oldtown, Peach Orchard, Randolph, Sullivant, Towanda,* and *Yates*[92]. *Cropsey* is the only township in which property values appreciated more on average than property values near the wind farm *(Near Wind Farm).* Thus, there does not appear to be a wind farm area stigma associated with locating near Twin Groves I and II, given that houses near the wind farm have appreciated at a faster rate on average in real terms after Twin Groves I and II achieved commercial operations than most houses in the townships in the surrounding area.

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[89] Multicollinearity is a condition that exists when two or more explanatory variables are so highly correlated that they largely or totally nullify one another. Thus, *Trees* may be insignificant in the township regression because the township submarkets (represented by the township dummy variables) may be capturing this effect already.

[90] Property value appreciation for each area is calculated from the time period before the wind farm achieved commercial operations to the time period in which the wind farm was fully operational. 26% is roughly the difference between the property value appreciation for the area near the wind farm (*Near Wind Farm*) and the property value appreciation for the *Lexington* township area.

[91] Property value appreciation for each area is calculated from the time period before Twin Groves I and II achieved commercial operations to the time period in which the wind farm was fully operational.

[92] See Column (12.3) of Table E.1 in Appendix E. A local realtor stated that home values in the higher-end market have taken the hardest hit during the recession (housing market crisis). This factor could potentially explain why homes near the wind farm appreciated at a faster rate than homes within the *Downs* and *Empire* townships, which consist of many high-end properties; however, it does not explain why homes near the wind farm appreciated at a faster rate than comparable homes in many of the other townships.

3. SUMMARY OF RESULTS INVOLVING TWO WIND FARM DEVELOPMENT STAGES

The two stages of wind farm development estimations involved estimating three equations[93] using three different controls for neighborhood effects, namely: the trend surface polynomials in terms of the {X,Y}-coordinates of the property locations, which controls for the effect of a property's individual location on property price and models any spatial trends; school district dummy variable interactions with the stages of the wind farm development, which allows for different intercepts and wind farm impacts across the different housing submarkets for each stage of the wind farm development process; and township dummy variable interactions with the stages of the wind farm development, which allows for different intercepts and wind farm impacts across the different housing submarkets for each stage of the wind farm development process.

The results of all three estimations demonstrate that before Twin Groves I and II were fully operational, properties near the eventual wind farm site were devalued in comparison to properties farther away from the eventual wind farm site, and these results are statistically significant at the 1% level across all three estimations. This demonstrates the *location effect* that is *not* due to the presence of the wind farm. This result is further supported by the evidence of a declining population and a declining number of housing units that the areas near the wind farm have been experiencing for a number of years (e.g., see Tables 5 and 6 from Section V).

The results of all three estimations demonstrate that from the time period before Twin Groves I and II were fully operational to the time period after TG I and II achieved commercial operations (during *Wind Farm Operation)*, the value of properties located near the wind farm site (*Near Wind Farm)* had a higher appreciation rate on average in real terms than the value of properties located farther from the wind farm site, and this estimate is statistically significant at the 1% level for all three estimations. Using various spatial controls, a *wind farm area stigma* associated with properties near the wind farm that sold after Twin Groves I and II both achieved commercial operation is strongly rejected.

[93] Essentially the same equation three times with the only difference being the spatial controls included in the model.

Table 12. Results: Two Wind Farm Development Stages

Dependent Variable: ln(Real Property Price)									
Explanatory Variable		XY			SD			TWP	
(Description/units)		**(1)**			**(2)**			**(3)**	
Square Feet *(1000s)*	40.4%	0.339	***	40.6%	0.341	***	40.2%	0.338	***
		(0.011)			(0.011)			(0.011)	
Garage	2.7%	0.026	***	2.6%	0.026	***	2.5%	0.025	***
		(0.003)			(0.004)			(0.003)	
Acre *(tenths)*	2.1%	0.021	***	2.2%	0.022	***	2.5%	0.024	***
		(0.003)			(0.003)			(0.003)	
Acres	7.6%	0.073	***	7.7%	0.074	***	8.0%	0.077	***
		(0.007)			(0.007)			(0.008)	
Age *(decades)*	-6.9%	-0.072	***	-6.9%	-0.072	***	-6.8%	-0.070	***
		(0.005)			(0.005)			(0.005)	
Age^2	0.2%	0.002	***	0.2%	0.002	***	0.2%	0.002	***
		(0.000)			(0.000)			(0.000)	
Fireplaces *(number)*	8.7%	0.083	***	8.9%	0.085	***	8.4%	0.081	***
		(0.012)			(0.012)			(0.011)	
Railroad Tracks	-9.5%	-0.100	***	-8.2%	-0.086	***	-7.4%	-0.077	***
		(0.014)			(0.015)			(0.014)	
Lakefront	29.8%	0.261	***	26.5%	0.235	***	25.6%	0.228	***
		(0.053)			(0.052)			(0.053)	
Cul-de-sac	3.2%	0.031	**	3.9%	0.039	***	4.0%	0.040	***
		(0.014)			(0.014)			(0.014)	
Trees	3.5%	0.035	**	2.6%	0.026	*	2.3%	0.023	
		(0.015)			(0.015)			(0.015)	
C *(Intercept)*		262.841	***		11.310	***		11.317	***
		(63.436)			(0.031)			(0.032)	
Wind Farm Operation	-1.4%	-0.014		-3.4%	-0.034		-6.2%	-0.064	
(02/02/2008 - 12/01/2009)		(0.014)			(0.042)			(0.043)	
Near Wind Farm	-12%	-0.126	***	-18%	-0.204	***	-20%	-0.221	***
		(0.031)			(0.035)			(0.035)	
Near Wind Farm, WF Operation	17.2%	0.158	***	22.4%	0.202	***	26.0%	0.231	***
		(0.065)			(0.079)			(0.080)	
Adjusted R-squared		0.6634			0.6648			0.6777	
Standard Error of Regression		0.2981			0.2975			0.2917	
Sum Squared Residuals		340.36			337.93			322.92	
Log Likelihood		-792.9			-779.1			-691.6	
F-statistic		380.40	***		239.57	***		148.20	***
Mean ln(Real Property Price)		11.62			11.62			11.62	
Standard Deviation ln(Real Property Price)		0.51			0.51			0.51	
Akaike Information Criterion (AIC)		0.42			0.42			0.39	
Schwarz Criterion (SIC)		0.46			0.48			0.48	
Durbin-Watson Statistic		1.90			1.95			1.97	

***denotes significance at 1% level **denotes significance at 5% level *denotes significance at 10% level

Notes: White Heteroskedasticity-Consistent Standard Errors & Covariance are in parentheses (White, 1980).
Estimation sample includes the period 01/01/2001 - 12/01/2009. *n*=3,851. %=[e^{coeff}-1]*100

Base Groups: (1) Before Wind Farm Operation (01/01/2001 - 02/01/2008); Far from the wind farm;
(2) Before Wind Farm Operation (01/01/2001 - 02/01/2008); Lexington CUSD 7;
(3) Before Wind Farm Operation (01/01/2001 - 02/01/2008); Lexington Township.

B. THREE WIND FARM DEVELOPMENT STAGES ESTIMATIONS

Considering the sign on the estimated coefficient of the variable of interest (*Near Wind Farm, WF Operation*) was not as expected[94], a more detailed analysis of the wind farm development stages[95] is necessary. In particular, the time period post wind farm approval and during construction is analyzed. The results are presented in Table 13 and the full set of results can be found in Columns (13.1), (13.2), and (13.3) of Table E.1 in Appendix E.

1. RESULTS: THREE WIND FARM STAGES, {X,Y}-COORDINATES

Results are presented in Column (1) of Table 13 using the spatial expansion of the {X,Y}-coordinates to control for spatial effects. The coefficient of determination indicates that roughly 66% of the variation in *ln(Real Property Price)* can be explained by all of the explanatory variables taken together. The *F-statistic* is relatively large at 346 and is statistically significant at the 1% level.

Most of the estimated coefficients are statistically significant at the conventional levels of statistical significance except two: *Post WF Approval/Construction* and *Wind Farm Operation*. The estimated coefficient on *Post WF Approval/Construction* captures changes in housing values for houses far from the wind farm from the time period before the wind farm was approved to the time period after the wind farm was approved and was under construction. The estimated coefficient on *Post WF Approval/Construction* is not statistically significant at conventional levels indicating that housing values far from the wind farm during the post wind farm approval and construction period *(Post WF Approval/Construction)* are not statistically different on average from housing values before wind farm approval. The estimated coefficient on *Wind Farm Operation* captures changes in housing values for houses far from the wind farm from the time period prior to wind farm approval to the period when the wind farm was operational. The estimated coefficient on *Wind Farm Operation* is not statistically significant at conventional levels indicating that housing values far from the wind farm during wind farm operations are not statistically different on average from housing values before approval of the wind farm.

The results presented in Column (1) of Table 13 and in Column (13.1) of Table E.1 of Appendix E indicate that a 1,000 square feet increase in the living area of a dwelling (*Square Feet*) is expected to increase price by 40.4%, *ceteris paribus.* A 180 square feet increase in the area of a *Garage* (one car increase in garage space) is expected to increase price by 2.7%, *ceteris paribus.* A tenth of an acre increase in lot size for lots one acre or less (*Acre*) is expected to increase price by 2.2%, *ceteris paribus.* An acre increase in lot size for lots greater than one acre (*Acres*) is expected to increase price by 7.6%, *ceteris paribus.* The slope of the relationship between *Age* and *ln(Real Property Price)* depends on the *Age* of the property. A U-shape arises and this captures an increasing effect of *Age* on *ln(Real Property Price)* that occurs after a certain *Age*. The turning point or minimum of the function is when the age of a house is 149 years (when *Age*=14.9). A one unit increase in the number of fireplaces (*Fireplaces*) is expected to increase price by 8.6%, *ceteris paribus*. This estimate is consistent with previous empirical

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[94] The sign of the estimated coefficient of *Near Wind Farm, WF Operation* was not consistent with wind farm area stigma theory.

[95] The stages of the adjustment process (corresponding to perceived risk by local residents and prospective homebuyers) are thought to roughly correspond to the stages of wind farm development.

findings[96]. A property located in close proximity to railroad tracks (*Railroad Tracks*) is expected to depress the property's price by 9.5%, *ceteris paribus.* A property located next to a lake (*Lakefront*) is expected to increase the property's price by 29.6%, *ceteris paribus.* A property located near a *Cul-de-sac* (amenities of less road traffic, less noise, and increased privacy) is expected to increase the property's price by 3.1%, *ceteris paribus.* A property located in close proximity to wooded areas (*Trees*) is expected to increase the property's price by 3.4%, *ceteris paribus.* The signs of the estimated coefficients mentioned in this paragraph are all consistent with theory.

Before wind farm approval, properties near the eventual wind farm site (*Near Wind Farm)* were valued 7.6% less on average than properties farther away from the eventual wind farm site, *ceteris paribus*; and this estimated coefficient on *Near Wind Farm* is statistically significant beyond the 5% level. This measures the *location effect* that is *neither* due to the approval *nor* the presence of the wind farm. Thus, before the wind farm was even approved, properties in the eventual wind farm area exhibited lower property values than properties in areas farther away. This finding is significant to point out because the time periods prior to wind farm approval and prior to wind farm operations are often ignored in the wind farm and property value literature[97].

One of the estimated coefficients of interest is on the interaction term *Near Wind Farm, Post WF Approval/Construction*. The estimated coefficient measures the change in housing values due to the approval of the wind farm, provided that houses both near and far from the site did not appreciate at different rates for other reasons. From the time period before the McLean County Board approved Twin Groves I and II, to the time period after McLean County Board approval of the wind farm and during construction of Twin Groves I and II (*Post WF Approval/Construction*), the appreciation in the value of properties located near the wind farm site was 11.7% lower on average than the appreciation in the value of properties located in areas farther from the wind farm site, *ceteris paribus;* and this estimated coefficient on *Near Wind Farm, Post WF Approval/Construction* is statistically significant at the 5% level. The 95% confidence interval for the estimated coefficient of *Near Wind Farm, Post WF Approval/Construction* is (-0.2458, -0.0019) or (-21.80%, -0.19%). The confidence interval containing only negative values provides strong support for wind farm anticipation stigma theory. Thus, there does appear to be some depression in the appreciation of property values near TG I and II after the wind farm was approved and during the construction stage of the wind farm development process, presumably because some of the residents located near the eventual wind farm location did not want to live near the wind farm, so they may have sold their houses and were willing to accept a lower value because they assumed the property was going to be devalued even more after the wind farm achieved commercial operations. Thus, the results are consistent with wind farm anticipation stigma theory, meaning that property values may have diminished in anticipation of the wind farm, possibly due to the general uncertainty surrounding a wind farm project regarding the aesthetic impacts on the landscape, the actual noise impacts

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[96] Sirmans et al. (2005) report the estimated coefficients from hedonic pricing models for fireplaces by geographic area. The fireplace coefficient estimates for the Midwest range from 0.045 to 0.110, and the current estimate of 0.083 lies within this range.

[97] *Location effect* is rarely taken into consideration and almost never directly controlled for in the model in the wind farm and property value literature. The author believes this to be a serious flaw of previous wind farm proximity and property value impact studies.

from the wind turbines, and just how disruptive the wind farm will be.

The second estimated coefficient of interest is on the interaction term *Near Wind Farm, WF Operation.* From the time period prior to wind farm approval[98] to the time period that Twin Groves I and II were fully operational, the appreciation in the value of properties located near the wind farm site was 11.7% greater[99] on average than the appreciation in the value of properties located farther from the wind farm site, *ceteris paribus*; and this estimated coefficient on *Near Wind Farm, WF Operation* is statistically significant at the 10% level. The 95% confidence interval for the coefficient of *Near Wind Farm, WF Operation* is (-0.0235, 0.2457) or (-2.33%, 27.85%). If random samples were obtained over and over again, with lower and upper bounds of the confidence intervals computed each time, then the ("unknown" or "true") population value would lie in the confidence interval for 95% of the samples. The confidence interval contains very small negative values and practically large positive values. Consequently, wind farm area stigma theory is not as overwhelmingly rejected as in the estimations involving the two stages of wind farm development presented in Table 12 (though the 90% confidence interval contains only positive values).

This estimation provides evidence that the impacts of a wind farm on surrounding property values are not constant across the wind farm development process, as the depression in property value appreciation rates for the time period after the wind farm was approved and during construction clearly demonstrates. During the operational stage of the wind farm project, when property owners living close to the wind turbines actually had a chance to see if any of their concerns materialized, property values rebounded. These results provide evidence that support wind farm anticipation stigma theory and reject wind farm area stigma theory.

2. RESULTS: THREE WIND FARM STAGES, SCHOOL DISTRICTS

Column (2) of Table 13 and Column (13.2) of Table E.1 of Appendix E contain the estimation results using school districts as proxies for the spatial housing submarkets and the estimated coefficients are presented in comparison to *Lexington* School District *(Lexington CUSD 7*, the base or benchmark group). The coefficient of determination indicates that over 66% of the variation in *ln(Real Property Price)* can be explained by all of the explanatory variables taken together. The *F-statistic* is relatively large at 179 and is statistically significant at the 1% level.

Before TG I and II were approved by the McLean County Board, properties located near the eventual wind farm site (*Near Wind Farm*) were valued 17.4% less on average than properties located within *Lexington CUSD 7*, *ceteris paribus*; and this estimated coefficient on *Near Wind Farm* is statistically significant at the 1% level. This measures the *location effect* that is *neither* due to the approval of the wind farm *nor* the presence of the wind farm. Thus, before Twin Groves I and II were fully operational and even before TG I and II were approved by the McLean County Board, properties located near the eventual wind farm site (*Near Wind Farm*)

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[98] The time period prior to wind farm approval, houses near the eventual wind farm location were valued 7.6% less on average than houses in the surrounding areas.

[99] The appreciation in property values for each area is calculated from the time period before wind farm approval to the time period during wind farm operations. 11.7% is roughly the difference between the property value appreciation for the area near the wind farm and the property value appreciation for the area farther from the wind farm.

were devalued in comparison to properties located farther away from the site, including properties within the following school districts: *El Paso-Gridley CUSD 11, Heyworth CUSD 4, LeRoy CUSD 2, Lexington CUSD 7, Normal CUSD 5,* and *Trivalley CUSD 3*[100].

One of the estimated coefficients of interest is on the interaction term *Near Wind Farm, Post WF Approval/Construction*. From the time period before Twin Groves I and II were approved by the McLean County Board to the time period after McLean County Board approval of the wind farm and during construction of Twin Groves I and II (*Post WF Approval/Construction*), the appreciation in the value of properties located near the wind farm site (*Near Wind Farm*) was *not* statistically different on average from the appreciation in the value of properties in *Lexington CUSD 7, ceteris paribus*; this coefficient (-0.0295 or -2.9%) on *Near Wind Farm, Post WF Approval/Construction* is *not* statistically significant at the conventional levels of significance, at least 10%. The 95% confidence interval for the coefficient of *Near Wind Farm, Post WF Approval/Construction* is (-0.1752, 0.1163) or (-16.07%, 12.33%)[101]. However, from the time period before wind farm approval to the time period after the wind farm was approved and during construction of Twin Groves I and II, the value of properties located near the eventual wind farm site (*Near Wind Farm*) appreciated less on average than the value of properties located in the following school districts: *Gibson City-Sibley-Melvin CUSD 5, Heyworth CUSD 4, LeRoy CUSD 2,* and *Trivalley CUSD 3.*The confidence interval contains a wide range of negative and positive values. Thus, a wind farm anticipation stigma is not overwhelmingly apparent in this specific estimation using school districts as spatial controls for the various housing submarkets.

The second estimated coefficient of interest is on the interaction term *Near Wind Farm, WF Operation.* From the time period before wind farm approval[102] to the time period that Twin Groves I and II were fully operational (*Wind Farm Operation*), housing values near the wind farm site appreciated 20.8% more[103] on average than housing values in *Lexington CUSD 7, ceteris paribus*; and this estimated coefficient on *Near Wind Farm, WF Operation* is statistically significant at the 5% level. The 95% confidence interval for the coefficient of *Near Wind Farm, WF Operation* is (0.0238, 0.3543) or (2.41%, 42.51%). If random samples were obtained over and over again, with lower and upper bounds of the confidence intervals computed each time, then the ("unknown" or "true") population value would lie in the confidence interval, (2.41%, 42.51%), for 95% of the samples. Since the confidence interval contains only positive values, wind farm area stigma theory is strongly rejected for the local area. In addition, from the time period before wind farm approval to the time period when the wind farm was operational, the value of properties located near the wind farm (*Near Wind Farm*) appreciated more on average than the value of properties located in the following school districts[104]: *Blue Ridge CUSD 18, El*

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[100] See Column (13.2) of Table E.1 in Appendix E.

[101] If random samples were obtained over and over again, with lower and upper bounds of the confidence intervals computed each time, then the ("unknown" or "true") population value would lie in the confidence interval for 95% of the samples.

[102] The time period before wind farm approval was when houses near the eventual wind farm location were valued 17.4% less on average than those in *Lexington CUSD 7*.

[103] The appreciation in property values for each area is calculated from the time period before wind farm approval to the time period after Twin Groves I and II achieved commercial operations. 20.8% is roughly the difference between housing value appreciation for the area near the wind farm and housing value appreciation for the *Lexington CUSD 7* area.

[104] Although not all of the estimated coefficients of the *School District, Wind Farm Operation* interaction terms are

Paso-Gridley CUSD 11, Gibson City-Melvin-Sibley CUSD 5, Heyworth CUSD 4, LeRoy CUSD 2, Lexington CUSD 7, Normal CUSD 5, Prairie Central CUSD 8, Ridgeview CUSD 19, and *Trivalley CUSD 3*. Given this appreciation in housing values in areas near an operating wind farm, the results reject the existence of wind farm area stigma theory associated with locating near Twin Groves I and II.

3. RESULTS: THREE WIND FARM STAGES, TOWNSHIPS

Column (3) of Table 13 and Column (13.3) of Table E.1 of Appendix E contain the estimation results using townships as proxies for the spatial housing submarkets and the estimated coefficients are presented in comparison to *Lexington* township (the base or benchmark group). The coefficient of determination (*adjusted R-squared*) indicates that roughly 67.8% of the variation in *ln(Real Property Price)* can be explained by all of the explanatory variables taken together. The *F-statistic* is large at 106 and is statistically significant at the 1% level.

Before Twin Groves I and II were approved by the McLean County Board, properties located near the eventual wind farm site (*Near Wind Farm*) were valued 18% less on average than properties within *Lexington* township, *ceteris paribus*; and this estimated coefficient on *Near Wind Farm* is statistically significant at the 1% level. This measures the *location effect* that is *neither* due to the approval of the wind farm *nor* the presence of the wind farm. Thus, even before Twin Groves I and II were approved by the McLean County Board, properties located near the eventual wind farm site (*Near Wind Farm*) were devalued in comparison to properties located farther away from the site, including properties located within the following townships: *Blue Mound, Downs, Empire, Gridley, Hudson, Lawndale, Lexington, Money Creek, Oldtown, Randolph,* and *Towanda.*[105]. Before Twin Groves I and II were approved by the McLean County Board, properties located near the eventual wind farm site (*Near Wind Farm*) were valued more on average than properties located in the following townships: *Anchor, Bellflower, Chenoa, Cropsey, Dix, Drummer, Martin, Peach Orchard, Sullivant,* and *Yates.*

From the time period before Twin Groves I and II were approved by the McLean County Board to the time period after McLean County Board approval of the wind farm and during construction of Twin Groves I and II (*Post WF Approval/Construction*), the appreciation in the value of properties located near the wind farm site (*Near Wind Farm*) was *not* statistically different on average from the appreciation in the value of properties located in *Lexington* township, *ceteris paribus*; this estimated coefficient (-0.0553 or -5.4%) on *Near Wind Farm, Post WF Approval/Construction* is *not* statistically significant at the conventional levels of significance. The 95% confidence interval for the coefficient of *Near Wind Farm, Post WF Approval/Construction* is (-0.1994, 0.0888) or (-18.08%, 9.28%). If random samples were obtained over and over again, with lower and upper bounds of the confidence intervals computed each time, then the ("unknown" or "true") population value would lie in the confidence interval, (-18.08%, 9.28%), for 95% of the samples. The confidence interval contains a wide range of

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statistically significant, this lack of statistical significance means that the estimated coefficients are not statistically different from that of *Lexington CUSD 7*. Thus, it is okay to compare the statistically significant appreciation of property values near the wind farm *(Near Wind Farm)* to those that are not statistically different from *Lexington CUSD 7*.

[105] See Column (13.3) of Table E.1 in Appendix E.

negative and positive values (though admittedly a larger number of negative values than positive). From the time period before wind farm approval to the time period after the wind farm was approved and during construction, the value of properties located near the eventual wind farm site (*Near Wind Farm*) appreciated less on average than the value of properties located in the following townships: *Downs, Drummer, Empire, Oldtown,* and *Towanda*. From the time period before wind farm approval to the time period after the wind farm was approved and during construction of Twin Groves I and II, the value of properties located near the eventual wind farm site (*Near Wind Farm*) appreciated more on average than the value of properties located in *Cropsey* township. Wind farm anticipation stigma is not strongly apparent in this specific estimation using townships as spatial controls for the various housing submarkets.

From the time period before wind farm approval[106] to the time period that Twin Groves I and II were fully operational (*Wind Farm Operation*), property values near the wind farm site appreciated 23.2% more[107] on average than property values in *Lexington* township, *ceteris paribus*; and this estimated coefficient on *Near Wind Farm, WF Operation* is statistically significant at the 1% level. The 95% confidence interval for the coefficient of *Near Wind Farm, WF Operation* is (0.0410, 0.3758) or (4.18%, 45.61%). If random samples were obtained over and over again, with lower and upper bounds of the confidence intervals computed each time, then the ("unknown" or "true") population value would lie in the confidence interval, (4.18%, 45.61%), for 95% of the samples. Since the confidence interval contains only positive values, wind farm area stigma theory is strongly rejected for the local area. From the time period before wind farm approval to the time period that Twin Groves I and II were fully operational (*Wind Farm Operation*), the value of properties located near the eventual wind farm site (*Near Wind Farm*) appreciated more on average than the value of properties located in the following townships[108]: *Anchor, Bellflower, Blue Mound, Chenoa, Cropsey, Drummer, Empire, Gridley, Hudson, Lawndale, Lexington, Martin, Money Creek, Oldtown, Peach Orchard, Randolph, Towanda,* and *Yates.* From the time period before wind farm approval to the time period that Twin Groves I and II were fully operational (*Wind Farm Operation*), the value of properties located near the eventual wind farm site (*Near Wind Farm*) appreciated less on average than the value of properties located in the following townships: *Dix, Downs,* and *Sullivant*. Considering the fact that housing values near the wind farm have appreciated more[109] on average than housing values in most of the other townships, wind farm area stigma theory is strongly rejected for the area near Twin Groves I and II[110].

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[106] The time period before wind farm approval was when houses near the eventual wind farm location were valued 18% less on average than those in *Lexington t*ownship.

[107] Property value appreciation for each area is calculated from the time period before wind farm approval to the time period during wind farm operations. 23.2% is roughly the difference between housing value appreciation for the area near the wind farm and housing value appreciation for the *Lexington* township area.

[108] Although not all of the estimated coefficients of the *Township, Wind Farm Operation* interaction terms are statistically significant, this lack of statistical significance means that the estimated coefficients are not statistically different from that of *Lexington* township. Thus, it is okay to compare the statistically significant rate of appreciation of the properties near the wind farm to those that are not statistically different from *Lexington* township.

[109] The appreciation in property values for each area is calculated from the time period before wind farm approval to the time period after Twin Groves I and II achieved commercial operations.

[110] The author is *not* claiming that wind farm area stigma theory can be rejected for any other wind farm area.

4. SUMMARY OF RESULTS INVOLVING THREE WIND FARM DEVELOPMENT STAGES

The stages of the adjustment process (corresponding to perceived risk by local residents and prospective homebuyers) are thought to roughly correspond to the stages of wind farm development. The three wind farm development stage estimations involved estimating three equations (essentially the same equation three times with the only difference being the spatial controls included in the model) using three different controls for neighborhood effects, namely: the trend surface polynomials in terms of the {X,Y}-coordinates of the property locations, which controls for the effect of a property's individual location on property price and models any spatial trends; school district dummy variable interactions with the stages of the wind farm development, which allows for different intercepts and wind farm impacts across the different housing submarkets for each stage of the wind farm development process; and township dummy variable interactions with the stages of the wind farm development, which allows for different intercepts and wind farm impacts across the different housing submarkets for each stage of the wind farm development process.

The results of all three estimations demonstrate that before Twin Groves I and II were even approved by the McLean County Board, properties near the eventual wind farm site were valued less on average than properties located farther away from the eventual wind farm site, and these results are statistically significant across all three estimations. Thus, a *location effect* exists such that the wind farm happened to locate in an area that already exhibited depressed property values in comparison to other areas within parts of McLean and Ford Counties. This result is further supported by the evidence of a declining population and a declining number of housing units that the areas near the wind farm have been experiencing for a number of years (e.g., see Tables 5 and 6 from Section V).

The results indicate that from the time period before Twin Groves I and II were approved by the McLean County Board to the time period after McLean County Board approval of the wind farm and during construction of Twin Groves I and II, the appreciation rate of property values near the eventual wind farm site may have been diminished in comparison to other surrounding areas because of the uncertainty as to how disruptive the wind farm would actually be. Thus, there is some evidence that supports *wind farm anticipation stigma theory*.

The results of all three estimations demonstrate that from the time period before the wind farm was approved to the time period in which the wind farm achieved commercial operations, the value of properties located near the wind farm site appreciated[111] at a greater rate on average than the value of properties located farther from the wind farm site, and this estimate is statistically significant across all three estimations. Using various spatial controls, *wind farm area stigma theory* is strongly rejected. Thus, during the operational stage of the wind farm project, when property owners living close to the wind turbines actually had a chance to see if any of their concerns materialized, property values rebounded[112].

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[111] The appreciation rate for each area is calculated from the time period before the wind farm was approved by the McLean County Board to the time period in which the wind farm was fully operational.
[112] Property values rebounded above their levels before approval of the wind farm.

Table 13. Results: Three Wind Farm Development Stages

Dependent Variable: ln(Real Property Price)									
	XY			SD			TWP		
		(1)			**(2)**			**(3)**	
Square Feet *(1000s)*	40.4%	0.3393	***	40.6%	0.3404	***	40.3%	0.3384	***
		(0.011)			(0.011)			(0.011)	
Garage	2.7%	0.0264	***	2.6%	0.0255	***	2.5%	0.0251	***
		(0.003)			(0.004)			(0.004)	
Acre *(tenths)*	2.2%	0.0214	***	2.2%	0.0221	***	2.5%	0.0247	***
		(0.003)			(0.003)			(0.003)	
Acres	7.6%	0.0732	***	7.7%	0.0743	***	8.0%	0.0770	***
		(0.007)			(0.007)			(0.008)	
Age *(decades)*	-7.0%	-0.0721	***	-7.0%	-0.0727	***	-6.8%	-0.0706	***
		(0.005)			(0.005)			(0.005)	
Age^2	0.2%	0.0024	***	0.3%	0.0025	***	0.2%	0.0024	***
		(0.000)			(0.000)			(0.000)	
Fireplaces *(number)*	8.6%	0.0830	***	8.8%	0.0845	***	8.3%	0.0801	***
		(0.012)			(0.012)			(0.011)	
Railroad Tracks	-9.5%	-0.1002	***	-8.4%	-0.0879	***	-7.5%	-0.0781	***
		(0.014)			(0.015)			(0.014)	
Lakefront	29.6%	0.2596	***	26.4%	0.2339	***	25.5%	0.2272	***
		(0.053)			(0.052)			(0.053)	
Cul-de-sac	3.1%	0.0305	**	3.7%	0.0363	***	3.9%	0.0382	***
		(0.014)			(0.014)			(0.014)	
Trees	3.4%	0.0339	**	2.6%	0.0253	*	2.2%	0.0221	
		(0.015)			(0.015)			(0.016)	
C *(Intercept)*		261.7872	***		11.3386	***		11.3340	***
		(63.437)			(0.032)			(0.033)	
Post WF Approval/Construction	1.1%	0.0107		-7.2%	-0.0747	**	-4.8%	-0.0495	
		(0.011)			(0.039)			(0.037)	
Wind Farm Operation	-1.0%	-0.0102		-5.9%	-0.0613		-7.8%	-0.0810	*
		(0.014)			(0.043)			(0.044)	
Near Wind Farm	-7.6%	-0.0790	**	-17.4%	-0.1909	***	-18.0%	-0.1988	***
		(0.036)			(0.041)			(0.042)	
Near Wind Farm, Post WF Approval/Construction	-11.7%	-0.1239	**	-2.9%	-0.0295		-5.4%	-0.0553	
		(0.061)			(0.073)			(0.072)	
Near Wind Farm, WF Operation	11.7%	0.1111	*	20.8%	0.1890	**	23.2%	0.2084	***
		(0.067)			(0.083)			(0.084)	
Adjusted R-squared		0.6637			0.6655			0.6780	
Standard Error of Regression		0.2980			0.2972			0.2916	
Sum Squared Residuals		339.84			336.23			320.74	
Log Likelihood		-789.99			-769.37			-678.59	
F-statistic		346.43	***		179.12	***		106.29	***
Mean ln(Real Property Price)		11.62			11.62			11.62	
Standard Deviation ln(Real Price)		0.514			0.514			0.514	
Akaike Information Criterion		0.422			0.422			0.393	
Schwarz Criterion		0.460			0.494			0.520	
Durbin-Watson Statistic		1.91			1.95			1.97	

***denotes significance at 1% level **denotes significance at 5% level *denotes significance at 10% level
Notes: White Heteroskedasticity-Consistent Standard Errors & Covariance are in parentheses (White, 1980).
Estimation sample includes the period 01/01/2001 - 12/01/2009. *n*=3,851. %=[e^{coeff}-1]*100.
Base Groups: (1) Before Wind Farm Approval (01/01/2001 - 09/20/2005); Far from the wind farm;
(2) Before Wind Farm Approval (01/01/2001 - 09/20/2005); Lexington CUSD 7;
(3) Before Wind Farm Approval (01/01/2001 - 09/20/2005); Lexington Township.

C. SEPARATE WIND FARM DEVELOPMENT STAGES ESTIMATIONS

This section provides separate estimations for each stage of the wind farm development process. These estimations allow for comparisons in real property value levels in percentage terms, rather than comparisons in appreciation rates of properties, near to and far from the wind farm across the different stages of wind farm development. These estimations also highlight the inherent problems with excluding property sales that occur during the time period before wind farm operations in an analysis of wind farm area stigma. The results reveal that a lot of information is lost by using only property sales occurring after wind farm operations and this illustrates that inappropriate conclusions may be drawn by exclusion of property sales prior to wind farm operations in an analysis.

1. RESULTS: SEPARATE WIND FARM STAGES, {X,Y}-COORDINATES

Table 14 contains estimation results by each stage of the development process using the {X,Y}-coordinates to model any spatial trend. The full set of results may be found in Table E.2 of Appendix E.

Column (1) of Table 14 uses data from property transactions that occurred before wind farm approval, 01/01/2001 – 09/20/2005. The coefficient of determination *(adjusted R-squared)* indicates that roughly 68.5% of the variation in *ln(Real Property Price)* can be explained by all of the explanatory variables taken together. The *F-statistic* is relatively large at 246 and is statistically significant at the 1% level. Before wind farm approval, properties located near the eventual wind farm site *(Near Wind Farm)* were valued 5.82% less on average than properties farther from the eventual wind farm site, *ceteris paribus*; and this result is statistically significant at the 10% level. This result demonstrates the *location effect* that is *neither* due to the approval *nor* the presence of the wind farm. Thus, before the wind farm was even approved, home values near the eventual wind farm area exhibited lower property values than homes in areas farther away.

Column (2) of Table 14 uses data from property transactions that occurred after the wind farm was approved by the McLean County Board and during the construction stage of the wind farm project (09/21/2005 – 02/01/2008). The coefficient of determination *(adjusted R-squared)* indicates that roughly 66.8% of the variation in *ln(Real Property Price)* can be explained by all of the explanatory variables taken together. The *F-statistic* is relatively large at 126 and is statistically significant at the 1% level. After the wind farm was approved by the McLean County Board and during the construction stage of the wind farm project, properties near the eventual wind farm site *(Near Wind Farm)* were valued 16.2% less on average than properties farther from the eventual wind farm site, and this result is statistically significant at the 1% level. This result[113] provides evidence to support wind farm anticipation stigma theory.

Column (3) of Table 14 uses data from property sales that occurred after Twin Groves I and II achieved commercial operations (02/02/2008 – 12/01/2009). The coefficient of determination *(adjusted R-squared)* indicates that roughly 61.8% of the variation in *ln(Real*

[113] The result being that properties near the wind farm *(Near Wind Farm)* sold at a much lower level in percentage terms than properties farther from the wind farm during the time period after the wind farm was approved and during construction (-16.2%), as compared with the time period before wind farm approval (-5.82%).

Property Price) can be explained by all of the explanatory variables taken together. The *F-statistic* is large at 63 and is statistically significant at the 1% level. Using only property transactions from the wind farm operational period, the value of properties located near the wind farm site *(Near Wind Farm)* were *not* statistically different on average from the value of properties located farther from the wind farm site, *ceteris paribus*. This does not provide any evidence to support or reject wind farm area stigma theory. Thus, if one used only property transactions occurring after the wind farm began operating, a great deal of information is lost (e.g., the fact that values were depressed in the area near the eventual wind farm site to begin with). The insignificance of the estimated coefficient of the property value impact variable when using only data from after the wind farm is in operation is a typical finding in the wind farm and property value impact literature. This loss of valuable information by using only data from wind farm operations clearly demonstrates the importance of taking into consideration the *location effect*, the relationship between property values near to and far from the eventual wind farm site before wind farm approval.

Table 14. Results: Separate Wind Farm Development Stages, {X,Y}-Coordinates

Dependent Variable: ln(Real Property Price)									
		Stage 1			Stage 2			Stage 3	
		(1)			**(2)**			**(3)**	
Square Feet *(1000s)*	40.49%	0.340	***	43.88%	0.364	***	33.41%	0.288	***
		(0.015)			(0.020)			(0.031)	
Garage	2.78%	0.027	***	2.79%	0.028	***	2.22%	0.022	***
		(0.005)			(0.007)			(0.008)	
Acre *(tenths)*	2.48%	0.025	***	1.80%	0.018	***	1.62%	0.016	**
		(0.004)			(0.006)			(0.008)	
Acres	7.16%	0.069	***	7.14%	0.069	***	9.75%	0.093	***
		(0.010)			(0.013)			(0.015)	
Age *(decades)*	-6.56%	-0.068	***	-7.25%	-0.075	***	-9.66%	-0.102	***
		(0.007)			(0.010)			(0.015)	
Age^2	0.24%	0.002	***	0.23%	0.002	***	0.43%	0.004	***
		(0.000)			(0.001)			(0.001)	
Fireplaces *(number)*	6.90%	0.067	***	5.94%	0.058	***	17.29%	0.159	***
		(0.016)			(0.023)			(0.025)	
Railroad Tracks	-11.15%	-0.118	***	-6.83%	-0.071	***	-9.87%	-0.104	***
		(0.020)			(0.026)			(0.037)	
Lakefront	42.08%	0.351	***	29.33%	0.257	***	4.65%	0.045	
		(0.074)			(0.100)			(0.088)	
Cul-de-sac	2.34%	0.023		6.14%	0.060	**	1.47%	0.015	
		(0.019)			(0.027)			(0.035)	
Trees	4.15%	0.041	**	3.16%	0.031		1.38%	0.014	
		(0.019)			(0.030)			(0.033)	
C *(Intercept)*		250.698	***		281.035	**		326.052	*
		(81.204)			(121.094)			(171.067)	
Near Wind Farm	-5.82%	-0.060	*	-16.2%	-0.177	***	-7.71%	-0.080	
		(0.037)			(0.052)			(0.072)	
n		2,036			1,121			694	
Time Period		1/1/01 - 9/20/05			9/21/05 - 2/1/08			2/2/08 - 12/1/09	
Adjusted R-squared		0.6846			0.6684			0.6183	
Std Error of Regression		0.2856			0.2970			0.3248	
Sum Squared Residuals		164.51			97.23			71.19	
Log Likelihood		-327.92			-220.24			-194.60	
F-statistic		246.42	***		126.43	***		63.36	***
Mean ln(RealPrice)		11.63			11.61			11.60	
Std Deviation ln(RealPrice)		0.51			0.52			0.53	
AIC		0.34			0.43			0.62	
Schwarz Criterion		0.39			0.51			0.74	
Durbin-Watson Statistic		1.93			1.97			1.83	

***denotes significance at 1% level **denotes significance at 5% level *denotes significance at 10% level

Notes: White Heteroskedasticity-Consistent Standard Errors & Covariance are in parentheses (White, 1980).
Base Group: Far from the wind farm.

2. RESULTS: SEPARATE WIND FARM STAGES, SCHOOL DISTRICTS

Table 15 contains estimation results by each stage of the wind farm development process using school district dummy variables as spatial controls for the housing submarkets. The full set of results may be found in Table E.3 of Appendix E.

Column (1) of Table 15 uses data from property transactions that occurred before wind farm approval, 01/01/2001 – 09/20/2005. The coefficient of determination *(adjusted R-squared)* indicates that roughly 68.2% of the variation in *ln(Real Property Price)* can be explained by all of the explanatory variables taken together. The *F-statistic* is relatively large at 208.9 and is statistically significant at the 1% level. Before the wind farm was approved, properties located near the eventual wind farm site *(Near Wind Farm)* were valued 17.7% less on average than properties located in *Lexington CUSD 7*, *ceteris paribus*; and this result is statistically significant at the 1% level. This result demonstrates the *location effect* that is *neither* due to the approval *nor* the presence of the wind farm. Thus, before the wind farm was even approved, properties located in the eventual wind farm area exhibited lower property values than properties in areas within *Lexington CUSD 7*. Before the wind farm was approved, properties located near the eventual wind farm site *(Near Wind Farm)* were valued less on average in percentage terms than properties located in the following school districts: *El Paso-Gridley CUSD 11, Heyworth CUSD 4, LeRoy CUSD 2, Lexington CUSD 7, Normal CUSD 5,* and *Trivalley CUSD 3* (see Column (15.1) of Table E.3 of Appendix E). Before the wind farm was approved, properties located near the eventual wind farm site *(Near Wind Farm)* were valued higher on average in percentage terms than properties located in the following school districts: *Blue Ridge CUSD 18, Gibson City-Melvin-Sibley CUSD 5, Prairie Central CUSD 8,* and *Ridgeview CUSD 19.*

Column (2) of Table 15 uses data from property transactions that occurred after the wind farm was approved by the McLean County Board and during the construction stage of the wind farm project (09/21/2005 – 02/01/2008). The coefficient of determination *(adjusted R-squared)* indicates that roughly 67% of the variation in *ln(Real Property Price)* can be explained by all of the explanatory variables taken together. The *F-statistic* is relatively large at 109 and is statistically significant at the 1% level. After the wind farm was approved and during the construction stage of the wind farm project, properties located near the eventual wind farm site *(Near Wind Farm)* were valued 19.1% less on average than properties located in *Lexington CUSD 7, ceteris paribus*; and this result is statistically significant at the 1% level. This result[114] supports wind farm anticipation stigma theory. After the wind farm was approved and during the construction stage of the wind farm project, properties located near the eventual wind farm site *(Near Wind Farm)* were valued less on average in percentage terms than properties located in the following school districts: *El Paso-Gridley CUSD 11, Gibson City-Sibley-Melvin CUSD 5, Heyworth CUSD 4, LeRoy CUSD 2, Lexington CUSD 7, Normal CUSD 5, Ridgeview CUSD 19,* and *Trivalley CUSD 3* (see Column (15.2) of Table E.3 of Appendix E). After the wind farm was approved and during the construction stage of the wind farm project, properties located near the eventual wind farm site *(Near Wind Farm)* were valued higher on average in percentage terms than properties located in the following school districts: *Blue Ridge CUSD 18* and *Prairie*

[114] The result being that properties near the wind farm *(Near Wind Farm)* sold at a lower level in percentage terms on average than properties that sold in *Lexington CUSD 7* during the post wind farm approval and construction stage (-19.1%) as compared to the before wind farm approval stage (-17.7%).

Central CUSD 8. Thus, wind farm anticipation stigma theory is strongly supported considering property value levels in percentage terms for the area near the eventual wind farm site were lower on average than those in a large number of school districts after the wind farm was approved and during the construction stage.

Column (3) of Table 15 uses data from property transactions that occurred after Twin Groves I and II achieved commercial operations (02/02/2008 – 12/1/2009). The coefficient of determination *(adjusted R-squared)* indicates that roughly 62% of the variation in *ln(Real Property Price)* can be explained by all of the explanatory variables taken together. The *F-statistic* is large at 54.72 and is statistically significant at the 1% level. The value of properties located near the wind farm *(Near Wind Farm)* during the operational stage of the wind farm project were not statistically different on average from the value of properties located in *Lexington CUSD 7*. Properties located near the wind farm *(Near Wind Farm)* during the operational stage of the wind farm project were valued higher on average in percentage terms than properties located in the following school districts: *Blue Ridge CUSD 18, El Paso-Gridley CUSD 11, Gibson City-Melvin-Sibley CUSD 5, Prairie Central CUSD 8,* and *Ridgeview CUSD 19* (see Column (15.3) of Table E.3 of Appendix E). Properties located near the wind farm *(Near Wind Farm)* that sold during the wind farm operational stage were valued less on average in percentage terms than properties located in *Trivalley CUSD 3*. These results provide sufficient evidence to reject the existence of wind farm area stigma theory.

Table 15. Results: Separate Wind Farm Development Stages, School Districts

Dependent Variable: ln(Real Property Price)									
		Stage 1			Stage 2			Stage 3	
		(1)			**(2)**			**(3)**	
Square Feet *(1000s)*	41.32%	0.346	***	42.88%	0.357	***	33.65%	0.290	***
		(0.015)			(0.020)			(0.031)	
Garage	2.72%	0.027	***	2.61%	0.026	***	2.18%	0.022	***
		(0.005)			(0.007)			(0.008)	
Acre *(tenths)*	2.63%	0.026	***	1.86%	0.018	***	1.41%	0.014	*
		(0.004)			(0.006)			(0.008)	
Acres	7.48%	0.072	***	7.19%	0.069	***	9.24%	0.088	***
		(0.010)			(0.013)			(0.015)	
Age *(decades)*	-6.44%	-0.067	***	-7.28%	-0.076	***	-9.90%	-0.104	***
		(0.007)			(0.010)			(0.015)	
Age^2	0.24%	0.002	***	0.25%	0.002	***	0.45%	0.004	***
		(0.000)			(0.001)			(0.001)	
Fireplaces *(number)*	7.21%	0.070	***	6.38%	0.062	***	16.86%	0.156	***
		(0.016)			(0.023)			(0.025)	
Railroad Tracks	-10.3%	-0.109	***	-5.39%	-0.055	**	-7.93%	-0.083	**
		(0.020)			(0.025)			(0.037)	
Lakefront	39.33%	0.332	***	26.04%	0.231	**	1.69%	0.017	
		(0.074)			(0.097)			(0.085)	
Cul-de-sac	3.01%	0.030		6.23%	0.060	**	3.13%	0.031	
		(0.019)			(0.027)			(0.032)	
Trees	3.30%	0.032	*	3.33%	0.033		-0.78%	-0.008	
		(0.020)			(0.030)			(0.034)	
C *(Intercept)*		11.299	***		11.274	***		11.453	***
		(0.037)			(0.057)			(0.085)	
Near Wind Farm	-17.7%	-0.195	***	-19.1%	-0.212	***	-1.3%	-0.013	
		(0.042)			(0.060)			(0.080)	
n		2,036			1,121			694	
Time Period		1/1/01 - 9/20/05			9/21/05 - 2/1/08			2/2/08 - 12/1/09	
Adjusted R-squared		0.6821			0.6702			0.6195	
Std Error of Regression		0.2867			0.2962			0.3243	
Sum Squared Residuals		165.59			96.42			70.66	
Log Likelihood		-334.58			-215.60			-191.97	
F-statistic		208.90	***		109.40	***		54.72	***
Mean ln(RealPrice)		11.63			11.61			11.60	
Std Deviation ln(RealPrice)		0.51			0.52			0.53	
AIC		0.35			0.42			0.62	
Schwarz Criterion		0.41			0.52			0.76	
Durbin-Watson Statistic		1.96			2.01			1.90	

***denotes significance at 1% level **denotes significance at 5% level *denotes significance at 10% level
Notes: White Heteroskedasticity-Consistent Standard Errors & Covariance are in parentheses (White, 1980).
Base Group: Lexington CUSD 7.

3. RESULTS: SEPARATE WIND FARM STAGES, TOWNSHIPS

Table 16 contains estimation results by each stage of the wind farm development process using the township dummy variables as the spatial controls for the housing submarkets. The full set of results may be found in Table E.4 of Appendix E.

Column (1) of Table 16 uses data from property sales that occurred prior to wind farm approval, 01/01/2001 – 09/20/2005. Before the wind farm was approved, properties located near the eventual wind farm location *(Near Wind Farm)* were valued 18.24% less on average than properties located in *Lexington* township, *ceteris paribus*; and this result is statistically significant at the 1% level. This result demonstrates the *location effect* that is *neither* due to the approval *nor* the presence of the wind farm. Thus, before the wind farm was even approved, homes in the eventual wind farm area exhibited lower property values than homes in areas within *Lexington* township. Before the wind farm was approved, properties located near the eventual wind farm location *(Near Wind Farm)* were valued less on average in percentage terms than properties located in the following townships: *Blue Mound, Downs, Empire, Gridley, Hudson, Lawndale, Lexington, Money Creek, Oldtown, Randolph, Towanda,* and *West* (see Column (16.1) of Table E.4 of Appendix E). Before the wind farm was approved, properties located near the eventual wind farm location *(Near Wind Farm)* were valued higher on average in percentage terms than properties located in the following townships: *Anchor, Bellflower, Chenoa, Cropsey, Dix, Drummer, Martin, Peach Orchard, Sullivant,* and *Yates.*

Column (2) of Table 16 uses data from property sales that occurred after the wind farm was approved by the McLean County Board and during the construction stage of the wind farm project (09/21/2005 – 02/01/2008). After the wind farm was approved and during the construction stage of the wind farm project, properties located near the eventual wind farm site *(Near Wind Farm)* were valued 21.63% less on average than properties located in *Lexington* township, *ceteris paribus*; and this result is statistically significant at the 1% level. This result[115] supports wind farm anticipation stigma theory. After the wind farm was approved and during the construction stage of the wind farm project, properties located near the eventual wind farm site *(Near Wind Farm)* were valued less on average in percentage terms than properties located in the following townships: *Blue Mound, Downs, Drummer, Empire, Gridley, Hudson, Lawndale, Lexington, Martin, Money Creek, Oldtown, Randolph, Towanda,* and *West* (see Column (16.2) of Table E.4 of Appendix E). After the wind farm was approved and during the construction stage of the wind farm project, properties located near the eventual wind farm site *(Near Wind Farm)* were valued higher on average in percentage terms than properties located in the following townships: *Anchor, Bellflower, Chenoa, Cropsey, Dix, Peach Orchard, Sullivant,* and *Yates.*

Column (3) of Table 16 uses data from property transactions that occurred after Twin Groves I and II achieved commercial operations (02/02/2008 – 12/1/2009). During wind farm operations, the value of properties located near the wind farm *(Near Wind Farm)* were not statistically different on average from the value of properties located in *Lexington* township. Properties located near the wind farm *(Near Wind Farm)* during the operational stage of the wind farm project were valued higher on average in percentage terms than properties located in the

[115] The result being that properties near the wind farm *(Near Wind Farm)* were more depressed in value in than properties that sold in *Lexington* township during the post approval and construction stage (-21.63%) as compared to the before wind farm approval stage (-18.24%).

following townships: *Anchor, Bellflower, Blue Mound, Chenoa, Cropsey, Gridley, Martin, Peach Orchard, Sullivant,* and *Yates* (see Column (16.3) of Table E.4 of Appendix E). Properties located near the wind farm *(Near Wind Farm)* during the operational stage of the wind farm project were valued less on average in percentage terms than properties located in the following townships: *Downs* and *Oldtown.* These results provide sufficient evidence to reject the existence of wind farm area stigma theory.

Table 16. Results: Separate Wind Farm Development Stages, Townships

Dependent Variable: ln(Real Property Price)									
		Stage 1			Stage 2			Stage 3	
		(1)			**(2)**			**(3)**	
Square Feet *(1000s)*	40.80%	0.342	***	42.77%	0.356	***	33.99%	0.293	***
		(0.015)			(0.020)			(0.030)	
Garage	2.77%	0.027	***	2.44%	0.024	***	2.12%	0.021	***
		(0.005)			(0.007)			(0.008)	
Acre *(tenths)*	2.80%	0.028	***	2.10%	0.021	***	2.06%	0.020	***
		(0.004)			(0.006)			(0.008)	
Acres	7.73%	0.074	***	7.30%	0.070	***	9.82%	0.094	***
		(0.011)			(0.014)			(0.015)	
Age *(decades)*	-6.27%	-0.065	***	-7.23%	-0.075	***	-9.29%	-0.097	***
		(0.007)			(0.010)			(0.015)	
Age^2	0.22%	0.002	***	0.24%	0.002	***	0.41%	0.004	***
		(0.001)			(0.001)			(0.001)	
Fireplaces *(number)*	7.04%	0.068	***	6.07%	0.059	***	15.00%	0.140	***
		(0.015)			(0.023)			(0.025)	
Railroad Tracks	-8.94%	-0.094	***	-4.60%	-0.047	*	-8.38%	-0.088	**
		(0.020)			(0.025)			(0.037)	
Lakefront	38.03%	0.322	***	26.81%	0.238	**	-0.63%	-0.006	
		(0.074)			(0.100)			(0.083)	
Cul-de-sac	3.87%	0.038	*	5.63%	0.055	**	2.14%	0.021	
		(0.020)			(0.027)			(0.032)	
Trees	2.75%	0.027		3.44%	0.034		-0.51%	-0.005	
		(0.021)			(0.031)			(0.034)	
C *(Intercept)*		11.296	***		11.301	***		11.404	***
		(0.039)			(0.059)			(0.086)	
Near Wind Farm	-18.24%	-0.201	***	-21.63%	-0.244	***	-0.79%	-0.008	
		(0.042)			(0.059)			(0.081)	
n		2,036			1,121			694	
Time Period		1/1/01 - 9/20/05			9/21/05 - 2/1/08			2/2/08 - 12/1/09	
Adjusted R-squared		0.6923			0.6786			0.6418	
Standard Error of Regression		0.2821			0.2924			0.3146	
Sum Squared Residuals		159.29			92.96			65.42	
Log Likelihood		-295.10			-195.08			-165.26	
F-statistic		139.77	***		72.66	***		39.80	***
Mean ln(Real Property Price)		11.63			11.61			11.60	
Std Dev ln(RealPrice)		0.51			0.52			0.53	
AIC		0.32			0.41			0.57	
SIC		0.42			0.56			0.79	
Durbin-Watson Statistic		1.98			2.02			1.93	

***denotes significance at 1% level **denotes significance at 5% level *denotes significance at 10% level
Notes: White Heteroskedasticity-Consistent Standard Errors & Covariance are in parentheses (White, 1980).
Base Group: Lexington Township.

4. SUMMARY OF SEPARATE WIND FARM STAGE ESTIMATIONS

The results of the individual wind farm development stage estimations using the various spatial controls have some commonalities. The estimations using only data from before wind farm approval (Column (1) of Tables 14-16) show that properties located near the eventual wind farm area exhibited lower property values on average than those of some of the other areas within McLean and Ford Counties; this demonstrates the *location effect* that is *neither* due to the approval *nor* presence of the wind farm. The results strongly support *wind farm anticipation stigma theory*. The results provide some evidence to reject the existence of *wind farm area stigma theory*.

D. SUMMARY OF TWO, THREE, AND SEPARATE WIND FARM STAGES ESTIMATIONS

Across all stages of wind farm development, property values near Twin Groves I and II *(Near Wind Farm)* were significantly higher on average than property values in *Blue Ridge CUSD 18* and *Prairie Central CUSD 8*. Across all stages of wind farm development, property values near the wind farm *(Near Wind Farm)* were significantly lower on average than property values in *Trivalley CUSD 3*. Although the rate of appreciation[116] for properties near the wind farm *(Near Wind Farm)* was significantly higher on average than the rate of appreciation for properties in *Trivalley CUSD 3*, property value levels near the wind farm *(Near Wind Farm)* were significantly lower on average than property value levels in *Trivalley CUSD 3*, across all stages of wind farm development. This suggests that it may be a good idea to look at the impact of a wind farm on a local housing market in terms of the appreciation rates of properties in addition to property value levels, both in comparison to other areas.

The rate of appreciation of property values near the wind farm *(Near Wind Farm)* was significantly lower on average than the rate of appreciation of property values in *Downs* township across all stages of wind farm development. In addition, across all stages of wind farm development, property value levels near the wind farm *(Near Wind Farm)* were significantly lower on average than property value levels in *Downs* and *Oldtown* townships.

The rate of appreciation of property values near the wind farm *(Near Wind Farm)* was significantly higher on average than the rate of appreciation of property values in *Cropsey* township across all stages of wind farm development. In addition, across all stages of wind farm development, property value levels near the wind farm *(Near Wind Farm)* were significantly higher on average than the property value levels in the following townships: *Anchor, Bellflower, Chenoa, Cropsey, Peach Orchard, Sullivant,* and *Yates.*

The results demonstrate that before Twin Groves I and II were even approved by the McLean County Board, properties near the eventual wind farm site *(Near Wind Farm)* were valued less on average than properties located farther away from the eventual wind farm site, and these results are statistically significant across all estimations. Thus, a *location effect* exists such that the wind farm happened to locate in an area that already exhibited depressed property values

[116] The appreciation rate for each area is calculated from the time period before the wind farm was approved by the McLean County Board to the time period in which the wind farm was fully operational.

in comparison to other areas within parts of McLean and Ford Counties. This result is further supported by the evidence of a declining population and a declining number of housing units that the areas near the wind farm have been experiencing for a number of years (e.g., see Tables 5 and 6 from Section V).

The results indicate that from the time period before Twin Groves I and II were approved by the McLean County Board to the time period after McLean County Board approval of the wind farm and during construction of Twin Groves I and II, the appreciation rate of property values near the eventual wind farm site *(Near Wind Farm)* may have been diminished in comparison to other surrounding areas because of the uncertainty as to how disruptive the wind farm facility would actually be[117]. In addition, after the wind farm was approved and during construction, properties located near the eventual wind farm site *(Near Wind Farm)* were valued less on average in percentage terms than properties located in many of the school districts and townships in the surrounding area. Thus, there is some evidence that supports *wind farm anticipation stigma theory*.

The results demonstrate that from the time period before the wind farm was approved to the time period in which the wind farm achieved commercial operations, the value of properties located near the wind farm site *(Near Wind Farm)* appreciated[118] at a greater rate on average than the value of properties located farther from the wind farm site, and this estimate is statistically significant across all estimations. Using various spatial controls, *wind farm area stigma theory* is strongly rejected. Thus, during the operational stage of the wind farm project, when property owners living close to the wind turbines actually had a chance to see if any of their concerns materialized, property values rebounded[119].

E. NUISANCE STIGMA ESTIMATION

Table 17 contains the estimation results investigating wind farm nuisance stigma (properties within one mile of a wind turbine) using the {X,Y}-coordinates for the spatial controls[120].

Column (1) of Table 17 contains the estimation results examining the time periods before wind farm operations and after the wind farm began operating. The estimated coefficient of interest in on the interaction term *1 mile, Wind Farm Operation* located in Column (1) of Table 17. From the time period before the wind farm was operational to the time period after the wind farm achieved commercial operations (*Wind Farm Operation*), the appreciation in the value of properties within one mile of the wind farm (*1 mile)* was *not* statistically different on average

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[117] Meaning property values may have diminished due to a fear of the unknown: a general uncertainty surrounding a wind farm project regarding the aesthetic impacts on the landscape, the actual noise impacts from the wind turbines, and just how disruptive the wind farm will actually be.

[118] The appreciation rate for each area is calculated from the time period before the wind farm was approved by the McLean County Board to the time period in which the wind farm was fully operational.

[119] Property values rebounded above their levels before approval of the wind farm.

[120] Only {X,Y}-coordinates are used for the spatial controls in the investigation of nuisance stigma rather than including the results for the school districts and townships for the sake of brevity (i.e., this report is already long enough as it is). If anyone is sincerely interested in the results from the test of nuisance stigma using the school districts and townships as spatial controls for the housing submarkets, please e-mail the author (HinmanJenL@gmail.com) and author will estimate the models and e-mail back the results. The results are not expected to be any different from those presented here.

than the appreciation in the value of properties in areas outside of one mile from the wind farm. Thus, the results presented in Column (1) of Table 17 neither support nor reject the existence of a wind farm nuisance stigma after the wind farm achieved commercial operations.

Column (2) of Table 17 contains the estimation results examining property value impacts for the time periods before wind farm approval, post wind farm approval and during wind farm construction, and after the wind farm achieved commercial operations. The first estimated coefficient of interest is on the interaction term *1 mile, Post WF Approval and Construction* located in Column (2) of Table 17. From the time period before the wind farm was approved to the time period after the wind farm was approved and during construction (*Post WF Approval and Construction*), the value of properties located within one mile of the wind farm (*1 mile)* appreciated 15.3% less on average than the value of properties located in areas outside of one mile of the wind farm, *ceteris paribus*; and this estimated coefficient is statistically significant at the 10% level. This result is consistent with wind farm anticipation stigma theory. Thus, there does appear to be some depression in the appreciation of property values within one mile of the wind farm (*1 mile)* after the wind farm was approved and during the construction stage of the wind farm development process (*Post WF Approval and Construction*), presumably because there was an increase in the level of risk as perceived by homebuyers. In addition, some of those residents located within one mile of the wind farm (*1 mile)* that did not want to live so close to the wind farm sold their houses and were willing to accept a lower value because they assumed the property was going to be devalued even more after the wind farm achieved commercial operations. Thus, the results support the existence of *wind farm anticipation stigma theory*, meaning that property values may have diminished due to the uncertainty surrounding a wind farm project regarding the aesthetic impacts on the landscape, the actual noise impacts from the wind turbines, and just how disruptive the wind farm will actually be.

The second estimated coefficient of interest is on the interaction term *1 mile, Wind Farm Operation* located in Column (2) of Table 17. From the time period before the wind farm was approved to the time period that the wind farm was fully operational *(Wind Farm Operation)*, the appreciation in the value of properties within one mile of the wind farm (*1 mile)* was *not* statistically different on average than the appreciation in the value of properties in areas outside of one mile from the wind farm. Thus, the results neither support nor reject the existence of a *wind farm nuisance stigma* after the wind farm achieved commercial operations. The author believes this to likely be due to only 11 properties selling during wind farm operations within one mile of the wind farm.

Table 17. Nuisance Stigma Test

Dependent Variable: ln(Real Property Price)				
	2 Stage **(1)**		3 Stage **(2)**	
Square Feet *(1000s)*	0.339	***	0.339	***
Garage	0.027	***	0.027	***
Acre *(tenths)*	0.020	***	0.021	***
Acres	0.070	***	0.070	***
Age *(decades)*	-0.072	***	-0.072	***
Age^2	0.002	***	0.002	***
Fireplaces *(number)*	0.084	***	0.084	***
Railroad Tracks	-0.099	***	-0.100	***
Lakefront	0.262	***	0.263	***
Cul-de-sac	0.034	**	0.034	**
Trees	0.034	**	0.033	**
C *(Intercept)*	245.407	***	244.617	***
1 mile (properties sold located within 1 mile buffer of wind farm)	-0.049		0.010	
Post Wind Farm Approval and Construction (09/21/2005 - 02/01/2008)			0.008	
1 mile, Post WF Approval and Construction			-0.166	*
Wind Farm Operation (02/02/2008 - 12/01/2009)	-0.008		-0.005	
1 mile, Wind Farm Operation	0.030		-0.029	
X	-0.001	***	-0.001	***
Y	-0.001	***	-0.001	***
XY	0.000	***	0.000	***
X^2	0.000	***	0.000	***
Y^2	0.000	**	0.000	**
X^2Y^2	0.000	***	0.000	***
Adjusted R-squared	0.6616		0.6619	
Standard Error of Regression	0.2989		0.2988	
Sum Squared Residuals	342.16		341.72	
Log Likelihood	-803.09		-800.56	
F-statistic	377.39	***	343.58	***
Mean ln(Real Property Price)	11.62		11.62	
Standard Deviation ln(Real Property Price)	0.5138		0.5138	
Akaike Information Criterion	0.4280		0.4277	
Schwarz Criterion	0.4621		0.4651	
Durbin-Watson Statistic	1.90		1.90	

***denotes significance at 1% level **denotes significance at 5% level *denotes significance at 10% level

Notes: White Heteroskedasticity-Consistent Standard Errors & Covariance are in parentheses (White, 1980).

Base Group: Outside of 1 mile of TG I and II.

F. ANALYSIS OF RESULTS

The results demonstrate that before Twin Groves I and II were even approved by the McLean County Board, properties near the eventual wind farm site were valued less on average than properties located farther away from the eventual wind farm site, and these results are statistically significant across all estimations. Thus, a *location effect* exists such that the wind farm happened to locate in an area that already exhibited depressed property values in comparison to other areas within parts of McLean and Ford Counties. This result is further supported by the evidence of a declining population and a declining number of housing units that the areas near the wind farm have been experiencing for a number of years (e.g., see Tables 5 and 6 from Section V).

The results of this study provide some evidence that a transfer of welfare between buyers and sellers may have occurred[121]. As Kiel and McClain state "if a house was sold during a phase when fears of the facility depressed prices, the seller would suffer a capital loss. If those fears are later unrealized and prices rebound, that loss becomes the buyer's gain" (1995a, 242). The net effect on social welfare could potentially be zero as a result of this welfare transfer.

Some of the estimation results support the existence of *wind farm anticipation stigma theory*, meaning that property values may have diminished due to the uncertainty surrounding a wind farm project regarding the aesthetic impacts on the landscape, the actual noise impacts from the wind turbines, and just how disruptive the wind farm will actually be.

However, the results demonstrate that in comparison to properties in many of the surrounding areas in McLean and Ford Counties, properties in close proximity to Twin Groves I and II *(Near Wind Farm)* experienced higher appreciation rates[122], in addition to, higher property value levels (in percentage terms) after the wind farm achieved commercial operations *(Wind Farm Operation).* Thus, during the operational stage of the wind farm project, as surrounding property owners living close to the wind turbines acquired additional information on the aesthetic impacts on the landscape and actual noise impacts of the wind turbines to see if any of their concerns materialized, property values rebounded and soared higher in real terms than they were prior to wind farm approval. This may be due to the fact that residents of the local area became accustomed to them (e.g., the turbines became part of the landscape such as telephone poles do outside of homes) such that they do not even consider the wind turbines when moving to another house in the local area. In addition, environmentally conscious homebuyers may be

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[121] The results from the regression that includes the {X,Y}-coordinates and the three stages (Column (13.1) of Table E.1 in Appendix E) show that before TG I and II were approved by the McLean County Board, properties near the eventual wind farm site were valued less on average than properties farther away from the eventual wind farm site, *ceteris paribus*. From the time period before the wind farm was approved to the time period in which the TG I and II were approved by the McLean County Board and during construction of TG I and II, the value of properties located near the wind farm site experienced a lower appreciation rate on average than the value of properties located farther from the wind farm site, *ceteris paribus*. From the time period before the wind farm was approved to the time period in which the TG I and II achieved commercial operations, the value of properties located near the wind farm site appreciated at a greater rate on average than the value of properties located farther from the wind farm site, *ceteris paribus.* Thus, after TG I and II achieved full commercial operations, property values had rebounded and soared higher in real terms than even before wind farm approval.

[122] The appreciation in property values for each area is calculated from the time period before wind farm approval to the time period during wind farm operations.

attracted to the area because of the wind farm. Thus, *wind farm area stigma theory* is strongly rejected for the area surrounding Twin Groves I and II.

The author believes that to some extent the particular circumstances in which Twin Groves I and II developed contributed to the final results of this study (i.e., property values near TG I and II did not decline during wind farm operations). These particular circumstances include the following[123]:

- There was not much vocal opposition during the McLean County Zoning Board of Appeals public hearing.
- Property tax rates declined in the wind farm townships because of the huge new revenue stream that the wind farm generated in local property taxes.
- School districts received and still receive substantial property tax revenues from the wind farm and this may increase the attractiveness of the area for families.
- The wind farm developer was very upfront with area residents and explained the wind farm was going to have a *significant impact* on the area.
- Residents in the local area were very aware of the wind farm project before the ZBA hearing (i.e., the developer did not try to keep it a secret and the developer made an effort to inform area residents early on in the development process such that they were able to be included in the process and any concerns could be addressed).
- Nonparticipating landowners (no turbine on their property) in close proximity to a wind turbine have the option to sign a contract to receive "Good Neighbor Payments" over the life of the wind farm project.
- The wind farm developer's regional office (headquarters) is located in the local area. Thus, the wind farm supports the members of the community who work at the regional headquarters in addition to the local wind farm operation and maintenance jobs.
- Many local construction jobs were created during the construction period.
- Some of the construction materials were obtained from local companies which supports the local economy.
- There had not been much population growth in the immediate area surrounding the wind farm over the past century.
- There were not too many "pocket farms"[124] located in the immediate area surrounding the wind farm.
- Residents seemed interested in keeping the area farmland, rather than have a nearby city[125] expand over the territory.
- Residents seemed supportive of clean alternative energy, and appeared to prefer a wind farm move to the area over a coal or nuclear plant.
- There appeared to be a great deal of community outreach. The developer even made a donation to the Arrowsmith Fire Department to be used toward the purchase of an ambulance.
- Instead of building a new facility for the operation and maintenance center, the

[123] Some of these are based on the McLean County Zoning Board of Appeals hearing that the author listened to.
[124] Residential lots consisting of less than five acres.
[125] Bloomington-Normal

> developer decided to convert an existing home in the community into their operation and maintenance facility, which allowed the facility to blend in nicely with the surrounding area.

Slovic states that "Research further indicates that disagreements about risk should not be expected to evaporate in the presence of evidence. Strong initial views are resistant to change because they influence the way that subsequent information is interpreted. New evidence appears reliable and informative if it is consistent with one's initial beliefs; contrary evidence tends to be dismissed as unreliable, erroneous, or unrepresentative" (1987, 281). Consequently, in areas where a large percentage of local residents strongly oppose the development of a wind farm; there is no reason to think that their opposition will end after the wind farm achieves commercial operation. Thus, the results from this study should *not* be extended to other areas[126] near proposed or operating wind farm projects[127].

VII. CONCLUSION

The estimation results provide evidence that a *location effect* exists such that before the wind farm was even approved, properties located near the eventual wind farm area were devalued in comparison to other areas. Additionally, the results show that property value impacts vary based on the different stages of wind farm development. These stages of wind farm development roughly correspond to the different levels of risk as perceived by local residents and potential homebuyers. Some of the estimation results support the existence of *wind farm anticipation stigma theory*, meaning that property values may have diminished due to a *fear of the unknown*: a general uncertainty surrounding a wind farm project regarding the aesthetic impacts on the landscape, the actual noise impacts from the wind turbines, and just how disruptive the wind farm will actually be.

However, during the operational stage of the wind farm project, as property owners, living in close proximity to Twin Groves I and II wind turbines, acquired additional information on the aesthetic impacts on the landscape and actual noise impacts of the wind turbines to see if any of their concerns materialized, property values rebounded and soared higher in real terms than they were even before wind farm approval. Thus, this study presents evidence that demonstrates close proximity to an operating wind farm does not necessarily negatively influence property value appreciation rates or property value levels (in percentage terms). The estimation results strongly reject the existence of *wind farm area stigma theory* for the area surrounding Twin Groves I and II. The results from this study are consistent with the results from a recent survey conducted surrounding Twin Groves I and II. A random sample of residents of the Ellsworth, Saybrook, and Arrowsmith communities were surveyed in 2009, during the time period that Twin Groves I and II were operational; and approximately sixty percent of respondents claimed they were not concerned about their property values declining because of the wind farm (Theron, 2010).

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[126] Property values may not rise in other areas immediately surrounding a wind farm.
[127] The results of this study should not even be extended to other areas within the same county.

It is recommended that authors of future studies take different stages[128] of wind farm development into consideration in their analyses to allow for more precise estimations of the property value impacts from a wind farm development. Furthermore, when examining the impact of a wind farm on surrounding properties, it is recommended to compare properties near the wind farm and farther away from the wind farm, in terms of both property value levels and the appreciation rates of property values. Many more studies of properties surrounding individual wind farms around the country are recommended using the methodology adopted in this study (i.e., pooled hedonic regression analysis with difference-in-differences estimators) such that general conclusions can start to form regarding this subject. Currently, the severe lack of statistical rigor, unbiasedness, and reliable methodologies across the wind farm proximity and property value studies cannot allow *any* general conclusions to be made—only site-specific findings.

[128] The different stages of wind farm development should model the changes in risk as perceived by local homebuyers. Depending on the number of operating wind farms in the state at the time of the wind farm proposal, it may be important to take into consideration a "rumor" stage in the analysis (i.e., to allow the property value impacts to vary by a rumor stage in addition to a post wind farm approval and construction stage).

APPENDIX A: COMMUNITY VIEWS AND SURVEYS

A. ILLINOIS STATEWIDE SURVEY

Theron and Winter[129] (2010) sent out surveys to several communities around the state of Illinois in an attempt to quantify the level of support and opposition to wind farms in central Illinois and to evaluate the impact of the proximity of a wind farm on opinions and attitudes. They found that proximity to wind energy projects does not influence the respondents' opinions. The majority of the respondents in central Illinois support wind energy and its development in their community, state, or country. They also support policies and mandates to help achieve this development. However, wind energy must be cost competitive with other energy resources to be widely acceptable to Illinois consumers (Theron and Winter, 2010).

Respondents stated that they were very concerned about the following characteristics of wind energy:

- "Interferes with telecommunications (Radio/TV/Internet service/Cell phone)" at 20.7%
- "Cost of power generated is expensive" at 19.3%
- "Takes farmland out of production" at 18.1%

82% agrees or strongly agrees with the following statement:
"I support the development of a wind farm in my community."

Respondents agree or strongly agree with the statements:
- "Wind farms are good for the environment" at 78%
- "Wind farms are good for job creation" at 72%
- "Wind farms are good for rural economic development" at 70%

67.5% agrees or strongly agrees that "Human activity has a major impact on global warming."
55% believe that the Federal government should have a mandate for renewable energy.

Thus, the level of support for wind energy in Illinois appears to be relatively high (Theron and Winter, 2010).

B. TWIN GROVES I AND II ZONING BOARD OF APPEALS HEARING

Although the author was not present during the Twin Groves I and II Zoning Board of Appeals Hearing, July 5 and 6, 2005, the author obtained a copy of the audio from those hearings in order to analyze the attitudes of members of the community during the wind farm approval

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[129] Theron, S., Winter, R., 2010. Public Beliefs and Attitudes Concerning Wind Farms in Central Illinois. Presentation at Peoria Civic Center - Peoria, IL. Illinois Wind Working Group – Siting, Zoning, and Taxing Conference. February 24, 2010.
The full report by Theron et al. (2010) is available at <http://renewableenergy.illinoisstate.edu/wind/publications/2010%20Public%20Attitudes%20Report%20FINAL.pdf>.

process. The Mendota Hills Wind Farm (63 turbines less than 1 MW each) in Lee County was the only wind farm operating in Illinois at the time of this hearing. A wind farm being located in the eastern part of McLean County was first mentioned in the local newspaper, *The Pantagraph*, in February of 2002.

The attorney for the wind farm developer started out the hearing by saying that the company does not want to hide anything from anybody and that this wind farm proposal is a significant project and it *will* have a significant impact on the area in which it is located. There also appeared to be a great deal of community outreach by the developer. The developer even made a donation to the Arrowsmith Fire Department toward the purchase of an ambulance.

There were about eight people during the first half of the first hearing that had general questions for the developer regarding a variety of issues, including the following: environmental benefits of wind energy, power purchasers, vibrations, TV interference, sounds, blade throws during fierce tornados, transferability of lease agreements, reasons for height limitations surrounding population centers with greater than 20,000 people, impact on community-based wind projects, concerns regarding request to allow turbines to be 400 feet from an R1-zoned district, road agreements, property tax assessment, decommissioning, and property value guarantee. Other issues raised during the testimony portion of the ZBA hearing include aerial spraying, ice throws, drainage, careful placement of towers, application should be posted on a website[130], visual impact, shadow flicker, and school district benefits. Though the list of concerns may seem rather large, these are fairly typical questions, especially in a state that had only one wind farm operating at that time. There were not many objectors who actually spoke out against the wind farm and said that it should not be approved.

One resident of a local village asked what the towers are going to do to the property values in Ellsworth with the towers sitting so close to the town. The resident noted that there are some people now that do not want to live in Ellsworth, which is out of town, and that is normal. There are a lot of people who want to live in the city limits and do not want to live 12 miles out of town. The resident asked the developer if they were going to guarantee that their properties are going to be valued the same after the towers are put up. The developer's attorney stated that of course not, there cannot be a property value guarantee because there may be a lot of reasons that people may not want to live out of town in Ellsworth, as the resident had previously noted. The attorney claimed that it would be virtually impossible to separate out property value impacts due to the wind farm and those resulting from Ellsworth's out-of-town location.

Based on comments from the hearing, it seemed as if most residents had been made aware of the proposed wind farm early in the process. However, there was one person who gave testimony on behalf of a property owner that stated they were unaware of any plans for the wind farm until June 13, 2005. The property owner resides out of state and does not follow the local media.

There appeared 16 articles in *The Pantagraph*, a local newspaper, mentioning the potential for a wind farm in eastern McLean County before the Public Hearing article on June 21, 2005. The Public Hearing took place on July 5, 2005 and July 6, 2005. On July 6, 2005, the McLean County Zoning Board of Appeals voted to recommend the approval of the special-use permit in case SU-05-09 because it met all the standards found in the McLean County Zoning Ordinance provided the following conditions were met[131]: "1) a mitigation agreement is made

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[130] The author strongly agrees with this issue of having the application posted on a website.
[131] Available at <http://www.mcleancountyil.gov/boardnotes/pdf/September2005/pro.pdf>.

between the applicant and Craig and Rose Grant to provide a planting screen between two proposed wind turbines in Section 36 in Dawson Township and the Grant property; 2) no wind turbine tower is located closer than 600 feet to the nearest R-1 Single Family Residence District boundary as measured from the tip of the turbine blade; 3) a written road agreement is approved by the County Board and Dawson, Arrowsmith, and Cheney's Grove Townships as a condition of this approval; and 4) the following has occurred after completion of Phase I and before beginning Phase II: 1) the applicant has requested a meeting with the Director of Building and Zoning; 2) a meeting takes place with the applicant and staff of the McLean County Department of Building and Zoning where the applicant will adequately address problems or concerns that are identified through Phase I by the Director of Building and Zoning; and 3) any items brought up at this meeting that cannot be adequately addressed according to the Director of Building and Zoning will need to be appealed to the Zoning Board of Appeals for resolution at their next available meeting; and the applicant will provide engineering plans certified by a registered engineer that each tower and wind turbine is designed and built according to appropriate national standards." The McLean County Board approved the special-use permit September 20, 2005. As part of the permit, the developer received permission to go beyond the one-year construction deadline for each phase of the project. The permit gave the developer three years to build the first phase and five years for the second phase.

C. TWIN GROVES IV AND V ZONING BOARD OF APPEALS HEARING

In preparation for this project and in order to see first-hand the attitudes and general sentiment of the community, the author attended the first three Twin Groves IV and V Zoning Board of Appeals Hearings in late October of 2009. The author obtained a copy of the audio to listen to the last hearing which the author was not able to attend. Consideration of a third phase of the wind farm was first mentioned in the local newspaper, *The Pantagraph*, in September of 2006, though no locations were given. In May of 2007, *The Pantagraph* newspaper mentioned that the developer may proceed with an expansion of about 48 towers near Colfax and Anchor townships, conditional on the test towers reporting favorable wind conditions over the next one to three years. There were over 1,000 MW of wind energy in Illinois at the time of these hearings, as compared with less than 60 MW just four years before.

There were approximately six landowner dinners from March of 2008 through June of 2009 and there were four open houses. Even though there were a number of dinners and informational meetings, many of the residents that testified during the hearing seemed to have been left in the dark regarding the projected locations of the wind turbines.

These hearings were completely different from the ones that occurred just four years earlier. There were a large number of supporters at the meetings and many that spoke out; however, there were also quite a few local residents that were opposed to the wind farm development. One supporter that the author spoke with stated he was able to pay off his house after working during the construction phases of Twin Groves I and II. Some benefits that supporters mentioned include: tax rate lowered in Cheney's Grove, Arrowsmith, and Dawson townships, significant revenue streams for the school districts, and around 45 permanent employees running the operations and maintenance center.

The reasons for the opposition include the following: aerial applicator concerns; low frequency noise vibrations; health concerns; economic development; noise; road agreements and

repairs; setbacks from a turbine to the nearest residence; amount of energy actually produced; the electricity grid not being "smart" enough to efficiently utilize the intermittent renewable energy (e.g., there still has to be nuclear or coal power to back up the renewable energy when the wind doesn't blow); residents did not want to look at the turbines next to their homes; and lack finalized turbine choice and placement plans. Many of the residents have lived their entire lives in McLean County and enjoy living out in the country without towers "obstructing" their view. Interestingly, even though Twin Groves IV and V would be adjacent to Twin Groves I and II, those opposed to Twin Groves IV and V did not appear bothered at all by the already constructed Twin Groves I and II.

D. REALTOR SURVEY

A local real estate agent with 23 years of experience was consulted regarding the local real estate market. A questionnaire was completed and a discussion followed. This section will not go through every single question from the survey, but will provide some of the more interesting and useful responses that can help with understanding the estimation results better. In general, the realtor has not noticed any impact on home values due to the wind farm. Based on experience, the realtor was completely confident that there has been zero impact from the wind farm on housing values at a distance greater than three miles[132].

The realtor's responses tend to support the findings from the estimations and provide some background knowledge that helps explain some of the signs on the school district and township estimated coefficients. The top three townships considered to be prime home location spots: (1) *Oldtown*, desirable lots with trees and great schools; (2) *Downs*, desirable lots with trees and great schools; (3) *Hudson*, proximity to Bloomington/Normal and great schools. The top three villages considered to be prime home location spots: (1) Downs, rolling landscape and trees and great schools (*Trivalley CUSD 3*); (2) Hudson, proximity to Bloomington/Normal and great schools (*Normal CUSD 5*); and (3) Heyworth, larger lots with trees and good schools *(Heyworth CUSD 4).* Thus, the top school districts within the study area include *Normal CUSD 5*, *Trivalley CUSD 3*, and *Heyworth CUSD 4*.

The top three characteristics of a home in the local area that have a positive impact on its value: (1) lot characteristics, private yard, non-busy street; (2) school district; and (3) effective age, age of roof, furnace, AC, electrical, and plumbing. The top three characteristics of a home in the local area that have a negative impact on its value: (1) located near a busy street, railroad, airport, etcetera; (2) zoning issues other than residential low density; and (3) undesirable school district. The realtor believed there were definitely going to be wind farms in the eastern part of McLean County in 2005. The realtor stated that a few clients have mentioned wind farms, but mainly as a "point of interest" regarding area current events and the comments were more positive to indifferent. The realtor is not aware of any change in time-on-the-market for homes located within the wind farm townships as compared with other comparable townships. However, the realtor noted that since the recession (housing market crisis), time-on-the-market has increased in pretty much all areas.

When asked about areas in Dawson township, and near Dawson Lake, the realtor stated that there is a big variance in the type of houses constructed (square feet, quality, etcetera). A

[132] A map of the study area with various distance buffers surrounding the wind farm was given to the realtor to examine.

person may move to areas near Dawson Lake if they want privacy, but in general, it is a little far for work. The author concluded that when comparing the *Downs* and *Oldtown* area to the west of the wind farm, with the Dawson area *(Near Wind Farm)*, both of which are primarily in *Trivalley CUSD 3*, there are significant differences in the way homebuyers value the two areas.

The realtor stated that, if anything, the wind farm has likely helped the local communities in which it resides because of the vast amount of property tax revenues it provides to the local school districts.

E. APPRAISER SURVEY

A local McLean County appraiser with 17 years of experience was consulted regarding the local real estate market. The appraiser stated that there has been no evidence of a negative impact on property values from the wind farm. In addition, an appraiser located in the Gibson City area of Ford County has not seen any negative impact on property values from the wind farm.

A local landowner whose property has three wind turbines on it was looking to purchase some additional farmland and found out from an appraiser that farmland with wind turbines is selling for a premium in the local area. This is likely due to the guaranteed income stream the wind turbines provide over the 30-year life of the turbines.

APPENDIX B: DATA DESCRIPTION AND MODELING ASSUMPTIONS

A. DATA ACQUISITION AND VALIDITY

Data quality is the most important aspect of any statistical analysis. Quantity of data is also important; however, quantity of data is useless without quality. Thus this study tried to ensure the highest quality of data. The first data collection approach for this study involved obtaining an electronic copy of the sales from the Supervisor of Assessments and manually inputting characteristics using Multiple Listing Service information (thank you Su Hu). It turned out that not all sales were included in MLS so a trip to the Supervisor of Assessments office became inevitable. The manual pulling of property record cards revealed significant differences between the MLS square footage and the official square footage reported on the property record cards. This result was unacceptable and accordingly MLS property characteristic data were not used in this analysis.

The property sales and a portion of the property characteristic data used in this analysis were obtained from the McLean County Supervisor of Assessments and the Ford County Supervisor of Assessments Offices (2010).

All geographic analyses (e.g., distance calculations) were performed using the NAD_1983_StatePlane_Illinois_East_FIPS_1201 Projected Coordinate System.

NAD_1983_StatePlane_Illinois_East_FIPS_1201 Projected Coordinate System
Transverse Mercator Projection
Linear Unit: Meter
Projection: Transverse Mercator

False Easting: 300000.00
False Northing: 0.00
Central Meridian: -88.33
Scale Factor: 0.99997500
Latitude Of Origin: 36.667
Linear Unit: Meter
GCS_North_American_1983 Geographic Coordinate System
D_North_American_1983 Datum
Prime Meridian: Greenwich
Angular Unit: Degree

All maps included in this report as well as distance calculations were produced using ESRI® ArcMap™ 9.3 (2010). Ford County townships, roads, and hydrology shapefiles were obtained from the U.S. Census TIGER (2000) Topologically Integrated Geographic Encoding and Referencing system (http://www.census.gov/geo/www/tiger/). Illinois cities, major roads, and railroad shapefiles were obtained from the Illinois Natural Resources Geospatial Data Clearinghouse (2010) website (http://www.isgs.uiuc.edu/nsdihome/).

McLean County Geographic Information Systems (GIS) data were obtained from the McLean County Regional GIS Consortium (McGIS, 2010) (http://www.mcgis.org/). Parcel Identification Numbers (PIN) of the properties that sold, based on the data from the Assessor's office, were joined with the PIN shapefile to enable to the geographic location of the properties. A point shapefile was created to more precisely identify home locations within the parcels (this allows for greater accuracy in distance calculations, which is especially important for homes located in very close proximity to wind turbines). The {X,Y}-coordinates of the home locations from the point shapefile are included in the regression model to control for spatial trends. The following steps were taken to create a point shapefile for the homes that sold in McLean County: A parcel centroid (i.e., center point of a polygon) was calculated for each parcel. A building shapefile was obtained from McGIS and a building centroid was calculated for each building. Parcels that sold that contained one building received the building centroid {X,Y}-coordinates (~1300). Many parcels contained more than one building and several approaches were applied for those cases. If the parcel contained a building that was coded with an address, then the addressed building centroid {X,Y}-coordinates were chosen as the home location (~1219). In general, parcels that sold that did not have buildings coded or had more than one building (without addresses), were given the parcel centroid {X,Y}-coordinates. Oddly, there were about 11 parcels that contained multiple buildings with multiple addresses within each parcel; most of these were given the parcel centroid {X,Y}-coordinates. Properties that sold within five miles of the wind farm that had more than one building within the parcel were analyzed visually and given the appropriate building centroid {X,Y}-coordinates (~4). Overall, the building centroid assignments tremendously improved distance from the home accuracy over the typical parcel centroid (as was apparent by comparison of the distance calculations and visually inspecting the county orthophoto files).

Unfortunately, neither parcel nor building GIS data were available for the property transactions that occurred in Ford County. Geocoding of addresses to Latitude/Longitude was completed through the fantastic Stephen P. Morse website (2006) (https://stevemorse.org/jcal/latlonbatch.html?direction=forward) using the data provided by Google Maps (2010). The data was first transformed from WGS_1984 to

GCS_North_American_1983 using the NAD_1983_To_WGS_1984_5 transformation for the Continental U.S., and then projected to NAD_1983_StatePlane_Illinois_East_FIPS_1201. Several points did have to be manually moved to their correct location, but this was likely due to address recognition issues or formatting. It is recognized that the Ford County property locations are much less precise than those of the McLean County properties. The author thinks this does not have any impact on the estimation results since the Ford properties are located farther away from the turbines (and are thus classified as such in the estimations).

A viewshed calculation that takes into account surface elevation and turbine height was performed. It suffered from severe inaccuracies, and thus was not ultimately included in the model (e.g., land 35 miles away was considered to be in the viewshed of the turbines). Unfortunately, LIDAR data was not available for the rural areas of the county. LIDAR data takes into consideration trees, houses, and heights of other objects which may obstruct the view one has of the wind turbines.

B. VARIABLE CONSTRUCTION

The dummy variables for *Railroad Tracks* and *Lakefront* were created by first spatially joining railroad tracks (lines) and lakes (polygons) to the properties that sold (points) which created a distance field to the nearest line (railroad) and polygon (lake). Then dummy variables were created based on this distance field. *Railroad Tracks* is a dummy variable in which a value of 1 indicates the home is located within 180 meters (590.55 feet) of railroad tracks. A distance of 180 meters was chosen by viewing a map of the houses located near railroad tracks and determining the distance in which adjacent homes are positioned from the railroad tracks. *Lakefront* is a dummy variable (binary) such that a value of 1 indicates properties that sold that were less than 70 meters (229.66 feet) from a lake, and a 0 value otherwise. A distance of 70 meters was chosen as a proxy for lakefront because time would not permit individually viewing and visiting each property close to a lake or pond. Thus, a distance of 70 meters was chosen by viewing a map of the houses located next to lakes and determining the distance that adjacent homes are typically positioned from the lake.

Cul-de-sac is a dummy variable such that a value of 1 indicates properties that sold that were located close to a cul-de-sac. This variable was created by first coding all properties that were located in a court. Then visual inspection of the road layout via GIS software allowed for manual coding of the properties.

A land cover raster for the study area was downloaded from the National Land Cover Database 2001 (U.S. Geological Survey, 2001). The raster was converted to a point shapefile, consisting of 8,636,334 points (the polygon shapefile had 95,168 objects). Points coded as Deciduous Forest or Evergreen Forest were exported to a new shapefile and a spatial join was performed from the properties that sold to the points. A distance field to the near forest point resulted. A dummy variable named *Trees* was created such that homes located within a distance of 180 meters (590.55 feet) from a forest point receive a value of 1, and 0 otherwise. Please note that not every home that has a tree on their property is reflected in this variable. A distance of 180 meters was chosen by viewing a map of the houses located close to trees and determining the distance in which the homes are positioned from the trees.

Distance from the home to the nearest turbine was determined by spatially joining the

wind turbines to the properties that sold. Thus, each property received the distance measured from the nearest turbine to the property[133]. The wind turbine locations were obtained from the county (McGIS, 2010) and the developer (Horizon Wind Energy, 2010). A dummy variable named *Near Wind Farm* was created such that homes located within a three mile buffer of the wind farm receive a value of 1, and 0 otherwise. A local real estate agent with over 23 years of experience was consulted regarding the local real estate market. In general, the realtor had not noticed any impact on home values due to the wind farm. The realtor felt confident that there had been zero impact from the wind farm on housing values at a distance greater than three miles[134].

The author visited all of the areas within three miles of the wind farm. It turned out that nearly all properties that sold within three miles of the wind farm that were not located within a village had a clear view of the wind farm towers. A view of the wind turbines was possible from a large portion of homes within the villages of Ellsworth and Arrowsmith. One of the closest located homes in Ellsworth to a wind turbine actually sold for a higher price (and multiple times over the study period) than all of the other homes within the village. This fact gives some indication that a direct view of the wind turbines may not be of much concern compared with the actual characteristics of the property.

In Saybrook village, a view of the wind turbines was not possible from many homes; e.g., if one were to look up inside the village, one probably could not see any wind turbines. Saybrook is the largest of the three villages near the wind farm and it even has a gas station. The trees within and around the village, as well as the closeness of houses, effectively block out the view of the turbines from a large portion of the houses.

The variety of houses on any given street was quite interesting; e.g., a newly constructed home, nice paint job, great lawn can be located right next to a 100 year old home with horrible landscaping that looks like it is falling apart. The diversity within the houses on any particular street in the villages further confirmed the recommendation by the appraiser of excluding the property sales below $25,000.

While visiting the areas near the wind farm, t he author listened to get an idea of the noise level from the wind turbines. The road noise in particular as well as the sound the wind makes in general majorly overpowered any sound from the turbines. The author did note some houses from which the author could hear a light whooshing sound and the distance from the house to the turbines. However, on days that are more windy, the sound would likely travel farther, thus the author does not think trying to incorporate sound into the model is a viable option at this time.

C. SPATIAL EFFECTS

Spatial dependence or spatial autocorrelation exists when there is a lack of independence among cross-sectional units' relative space or location (multi-directional); i.e., the existence of a functional relationship between what happens at one point in space and what happens elsewhere (Anselin, 1988). The standard rule of thumb is that autocorrelation is a problem in time series data, temporal autocorrelation. However, there are many instances in which an entity's location

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[133] The point shapefile that was created for the home locations was used to increase the accuracy of the distance calculations.

[134] A map of the study area with various distance buffers surrounding the wind farm was given to the realtor to examine. The realtor sold many properties at a distance just outside of three miles from the wind farm, which explains the level of confidence.

affects its behavior. Housing prices are a prime example: clearly the location of the house will have an effect on its selling price. In the case of housing prices, the location factors are called neighborhood effects (Dubin, 1998). If the location of the house influences its price, then the possibility arises that nearby houses will be affected by the same location factors. Any error in measuring these factors will cause their error terms to be correlated.

The consequences of spatial autocorrelation are the same as those of time series autocorrelation: the OLS estimators are unbiased but inefficient, and the estimates of the variance of the estimators are biased. Thus the precision of the estimates as well as the reliability of hypotheses testing can be improved by making a correction for autocorrelation (Dubin, 1998). Once the structure of the autocorrelation has been estimated, this information can be incorporated into any predictions, thereby improving their accuracy. Just as with time series autocorrelation, maximum likelihood (ML) techniques are commonly used to estimate the autocorrelation parameters and the regression coefficients. Despite the similarities, spatial autocorrelation is conceptually more difficult to model than time series autocorrelation, because of the ordering issue. In a time series context, the researcher typically assumes that earlier observations can influence later ones, but not the reverse. In the spatial context, an ordering assumption such as this is not possible: if A affects B, it is likely that the reverse is also true. Also, the direction of influence is not limited to one dimension as in time series, but can occur in any direction (Dubin, 1998). There are two commonly used methods of modeling the autocorrelation structure. The first is to model the process itself. This approach is based on the work of geographers (Cliff and Ord, 1981) and requires the use of a weight matrix (Dubin, 1998). This approach is probably the more common of the two in the real estate literature. The second approach is to model the covariance matrix of the error terms directly. This approach is based on the work of geologists (Matheron, 1963) and has also been used in the real estate literature. There are many complicated techniques to take care of this issue (Dubin, 1998). However, these complicated techniques introduce some major assumptions, such as an identification of the structure of the autocorrelation itself, of which may be virtually impossible to really know. So it is very important to note that although outcomes from adjacent units are likely to be correlated, if the correlation arises mainly through the explanatory variables (as opposed to unobservables), then nothing needs to be done on a practical level (Wooldridge, 2002). When the unobservables are correlated across nearby geographical units, OLS can still have desirable properties—often unbiasedness, consistency, and asymptotic normality can be established (Wooldridge, 2002). Thus, this analysis assumes that any correlation arises mainly through the explanatory variables rather than unobservables and a spatial weights matrix is not adopted.

Spatial heterogeneity[135] exists when there is a lack of stability over space of the relationships, i.e., functional forms and parameters vary with location and are not homogenous throughout the dataset (Anselin, 1988). Several conditions would lead to this: a byproduct of measurement errors for observations in contiguous spatial units and the existence of a variety of spatial interaction phenomena (Anselin, 1988). Please see Section IV for more details regarding spatial heterogeneity.

Several measures that address the spatial aspects were utilized in this analysis. The {X, Y}-coordinates were included in some of the models to address the impact that absolute location

[135] Distinguishing between spatial dependence (autocorrelation) and spatial heterogeneity can be a highly complex problem.

has on property values and to model any spatial trends. Township dummy variables were utilized in some of the models as proxies for the housing submarkets. School district dummy variables were utilized in some of the models as proxies for the housing submarkets. These three specifications were utilized to demonstrate the results were robust to either specification.

D. ASSUMPTIONS

The least controversial assumption is that a house is a bundle of size, quality, and locational characteristics (Malpezzi et al., 1980). The value of a property "stems from the quantity and type of characteristics it contains, and that the 'prices' of the characteristics can be estimated from the… values of many units via multivariate regression analysis" (Malpezzi et al., 1980, 11). It is assumed that the data were obtained as a random sample. Homoskedasticity assumption states that the variance of the unobservable error conditional on the explanatory variables is constant. Homoskedasticity fails whenever the variance of the unobservables changes across different segments of the population, where the segments are determined by the different values of the explanatory variables (Wooldridge, 2009). If the homoskedasticity assumption fails, and heteroskedasticity is present, then the estimators of the variances are biased[136], and consequently the OLS standard errors based directly on those variances are no longer valid for constructing confidence intervals and *t-statistics.* OLS *t-statistics* no longer have *t*-distributions and *F-statistics* are no longer *F*-distributed. Fortunately, heteroskedasticity-robust procedures have been developed that adjust standard errors and the corresponding test statistics that rely on the standard errors such that that they are valid in large samples regardless of the kind of heteroskedasticity present in the population (Wooldridge, 2009). Accordingly, White heteroskedasticity-robust standard errors are reported and utilized in determining the statistical significance of the estimated coefficients (White, 1980). It is assumed that each explanatory variable changes over time and no perfect linear relationships exist among the explanatory variables. It is assumed that the explanatory variables are strictly exogenous, conditioned on the unobserved effect. For each time period, the expected value of the idiosyncratic error given the explanatory variables in all time periods and the unobserved effect is zero.

[136] When an estimator is unbiased, one expects to estimate the "true" value of the parameter on average. In other words, if random samples are drawn from the population over and over, and an estimate is computed each time, and then an average of these estimates is taken over all random samples, then this average would equal the "true" parameter (Wooldridge, 2009). When an estimator is consistent, adding more observations gives more precise estimators. Thus, a sufficiently large sample is important such that the estimated coefficients are arbitrarily close to the "true" parameters. If a regressor (explanatory variable) is correlated with the error term, the estimator no longer has these desirable properties.

APPENDIX C. DESCRIPTIVE STATISTICS: CROSS TABULATIONS

Table C. 1. Near and Far from TG I and II and 2-Stage Wind Farm Development Cross Tabulations

Wind Farm Stages		*n*	RealPrice Mean	RealPrice Median	RealPrice Max	RealPrice Min.	RealPrice Std. Dev.	ln(RealPrice) Mean	ln(RealPrice) Median	ln(RealPrice) Max	ln(RealPrice) Min.	ln(RealPrice) Std. Dev.
Before WF Operations	Far WF	3,011	127,694	117,199	399,314	25,047	63,867	11.63	11.67	12.90	10.13	0.51
Before WF Operations	Near WF	146	105,778	95,385	344,704	30,146	49,006	11.46	11.47	12.75	10.31	0.47
Before WF Operations	All	3,157	126,680	115,797	399,314	25,047	63,418	11.63	11.66	12.90	10.13	0.51
WF Operation	Far WF	663	125,206	114,756	398,154	25,932	64,340	11.61	11.65	12.90	10.16	0.53
WF Operation	Near WF	31	116,814	124,342	211,550	30,000	42,814	11.59	11.73	12.26	10.31	0.45
WF Operation	All	694	124,831	114,834	398,154	25,932	63,536	11.60	11.65	12.90	10.16	0.53
All	Far WF	3,674	127,245	116,530	399,314	25,047	63,951	11.63	11.67	12.90	10.13	0.52
All	Near WF	177	107,711	98,576	344,704	30,000	48,050	11.49	11.50	12.75	10.31	0.46
All	All	3,851	126,347	115,390	399,314	25,047	63,435	11.62	11.66	12.90	10.13	0.51

Notes: n=# of observations; Std. Dev.=Standard Deviation; Max=Maximum; Min.=Minimum; ln=natural logarithm;

RealPrice=Real Price of Property in 2009 Q2 $; ln(RealPrice)=Natural Logarithm of the Real Price of Property in 2009 Q2 $, dependent variable;

Near WF=Near Twin Groves I & II=Near Wind Farm=1 if property located near the wind farm, 0 otherwise;

Far WF=Far Twin Groves I & II=1 if property located near the wind farm, 0 otherwise;

Before WF Operations=Before both Twin Groves I and II achieved commercial operation=01/01/2001 – 02/01/2008;

WF Operation=Wind Farm Operation=Both Twin Groves I and II achieved commercial operation=02/02/2008 – 12/01/2009.

Table C. 2. Near and Far from TG I and II and 2-Stage Wind Farm Development Cross Tabulations

Wind Farm Stages		*n*	SQFT Mean	SQFT Median	SQFT Max	SQFT Min.	SQFT St. Dev.	Garage Mean	Garage Median	Garage Max	Garage St. Dev.	Acreage Mean	Acreage Median	Acreage Max	Acreage Min.	Acreage Sum.	Acreage St. Dev.
Before WF Operations	Far WF	3,011	1.51	1.40	4.05	0.43	0.54	2.47	2.67	11.20	1.68	0.54	0.29	13.64	0.04	1616.26	0.93
Before WF Operations	Near WF	146	1.55	1.44	3.90	0.58	0.63	1.46	0.00	9.50	1.85	1.62	0.55	12.73	0.11	237.23	2.33
Before WF Operations	All	3,157	1.51	1.40	4.05	0.43	0.55	2.43	2.67	11.20	1.70	0.59	0.30	13.64	0.04	1853.49	1.06
WF Operation	Far WF	663	1.51	1.39	3.71	0.56	0.51	2.63	2.80	16.67	1.75	0.57	0.30	10.00	0.08	378.18	0.91
WF Operation	Near WF	31	1.38	1.32	2.14	0.62	0.40	1.65	1.71	6.00	1.66	2.09	1.10	6.84	0.13	64.69	2.14
WF Operation	All	694	1.51	1.39	3.71	0.56	0.51	2.59	2.69	16.67	1.75	0.64	0.32	10.00	0.08	442.87	1.04
All	Far WF	3,674	1.51	1.40	4.05	0.43	0.54	2.50	2.68	16.67	1.70	0.54	0.30	13.64	0.04	1994.44	0.93
All	Near WF	177	1.52	1.40	3.90	0.58	0.60	1.49	0.00	9.50	1.81	1.71	0.61	12.73	0.11	301.92	2.30
All	All	3,851	1.51	1.40	4.05	0.43	0.54	2.46	2.67	16.67	1.71	0.60	0.30	13.64	0.04	2296.36	1.06

Notes: n=# of observations; St. Dev.=Standard Deviation; Max=Maximum; Min.=Minimum; SQFT=Square Feet=above grade living area of the dwelling in 1000s of square feet;

Garage=area of the garage in 180s of square feet, approximately the number of standard cars that can fit in the garage; Acreage=total number of acres of the property; Sum.=Summation or Total;

Near WF=Near Twin Groves I & II=Near Wind Farm=1 if property located within 3 mile buffer of wind farm, 0 otherwise;

Far WF=Far Twin Groves I & II=1 if property located outside of 3 mile buffer of wind farm, 0 otherwise;

Before WF Operations=Before both Twin Groves I and II achieved commercial operation=01/01/2001 – 02/01/2008;

WF Operation=Wind Farm Operation=Both Twin Groves I and II achieved commercial operation=02/02/2008 – 12/01/2009.

Table C. 3. Near and Far from TG I and II and 2-Stage Wind Farm Development Cross Tabulations

Wind Farm Stages		*n*	Year Built Mean	Year Built Median	Year Built Max	Year Built Min.	Year Built Std. Dev.	Fireplaces Sum.	RR Tracks Sum.	Lakefront Sum.	Cul-de-sac Sum.	Trees Sum.
Before WF Operations	Far WF	3,011	1952	1963	2008	1824	40	886	561	57	254	326
Before WF Operations	Near WF	146	1927	1919	2006	1849	38	28	34	4	3	18
Before WF Operations	All	3,157	1951	1962	2008	1824	41	914	595	61	257	344
WF Operation	Far WF	663	1951	1962	2008	1867	40	184	129	15	56	77
WF Operation	Near WF	31	1927	1920	2004	1859	39	4	7	0	1	8
WF Operation	All	694	1950	1961	2008	1859	40	188	136	15	57	85
All	Far WF	3,674	1952	1963	2008	1824	40	1070	690	72	310	403
All	Near WF	177	1927	1919	2006	1849	39	32	41	4	4	26
All	All	3,851	1951	1962	2008	1824	41	1102	731	76	314	429

Notes: n=# of observations; Std. Dev.=Standard Deviation; Max=Maximum; Min.=Minimum; Sum.=Summation or Total; Year Built=the year the property was originally built; Fireplaces=# of fireplaces;
RR Tracks=Railroad Tracks=1 if within 180 meters of railroad tracks, 0 otherwise; Lakefront=1 if within 70 meters of a lake, 0 otherwise; Cul-de-sac=1 if property located near a cul-de-sac, 0 otherwise;
Near WF=Near Twin Groves I & II=Near Wind Farm=1 if property located within 3 mile buffer of wind farm, 0 otherwise; Trees=1 if within 180 meters of trees, 0 otherwise;
Far WF=Far Twin Groves I & II=1 if property located outside of 3 mile buffer of wind farm, 0 otherwise;
Before WF Operations=Before both Twin Groves I and II achieved commercial operation=01/01/2001 – 02/01/2008;
WF Operation=Wind Farm Operation=Both Twin Groves I and II achieved commercial operation=02/02/2008 – 12/01/2009.

Table C. 4. Near and Far from TG I and II and 3-Stage Wind Farm Development Cross Tabulations

Wind Farm Stages		*n*	RealPrice Mean	RealPrice Median	RealPrice Max	RealPrice Min.	RealPrice Std. Dev.	ln(RealPrice) Mean	ln(RealPrice) Median	ln(RealPrice) Max	ln(RealPrice) Min.	ln(RealPrice) Std. Dev.
Stage 1	Far WF	1,946	128,491	117,894	399,314	26,837	63,551	11.64	11.68	12.90	10.20	0.51
Stage 1	Near WF	90	108,168	94,112	344,704	31,318	51,475	11.49	11.45	12.75	10.35	0.47
Stage 1	All	2,036	127,593	116,665	399,314	26,837	63,194	11.63	11.67	12.90	10.20	0.51
Stage 2	Far WF	1,065	126,237	115,109	395,688	25,047	64,445	11.62	11.65	12.89	10.13	0.52
Stage 2	Near WF	56	101,937	97,545	223,645	30,146	44,940	11.43	11.49	12.32	10.31	0.47
Stage 2	All	1,121	125,023	114,587	395,688	25,047	63,818	11.61	11.65	12.89	10.13	0.52
Stage 3	Far WF	663	125,206	114,756	398,154	25,932	64,340	11.61	11.65	12.90	10.16	0.53
Stage 3	Near WF	31	116,814	124,342	211,550	30,000	42,814	11.59	11.73	12.26	10.31	0.45
Stage 3	All	694	124,831	114,834	398,154	25,932	63,536	11.60	11.65	12.90	10.16	0.53
All	Far WF	3,674	127,245	116,530	399,314	25,047	63,951	11.63	11.67	12.90	10.13	0.52
All	Near WF	177	107,711	98,576	344,704	30,000	48,050	11.49	11.50	12.75	10.31	0.46
All	All	3,851	126,347	115,390	399,314	25,047	63,435	11.62	11.66	12.90	10.13	0.51

Notes: n=# of observations; Std. Dev.=Standard Deviation; Max=Maximum; Min.=Minimum; ln=natural logarithm;
RealPrice=Real Price of Property in 2009 Q2 $; ln(RealPrice)=Natural Logarithm of the Real Price of Property in 2009 Q2 $, dependent variable;
Near WF=Near Twin Groves I & II=Near Wind Farm=1 if property located within 3 mile buffer of wind farm, 0 otherwise;
Far WF=Far Twin Groves I & II=1 if property located outside of 3 mile buffer of wind farm, 0 otherwise;
Stage 1=Before TG I and II Approval=Before Wind Farm Approval=01/01/2001 – 09/20/2005;
Stage 2=Post TG I and II (WF) Approval and during Construction=09/21/2005 – 02/01/2008;
Stage 3=Twin Groves I and II Online, WF Operation=Wind Farm Operation=02/02/2008 – 12/01/2009.

Table C. 5. Near and Far from TG I and II and 3-Stage Wind Farm Development Cross Tabulations

Wind Farm Stages		*n*	SQFT Mean	SQFT Median	SQFT Max	SQFT Min.	SQFT St.Dev.	Garage Mean	Garage Median	Garage Max	Garage St.Dev.	Acreage Mean	Acreage Median	Acreage Max	Acreage Min.	Acreage Sum.	Acreage St.Dev.
Stage 1	Far WF	1,946	1.51	1.41	4.05	0.43	0.54	2.44	2.67	10.27	1.71	0.54	0.30	13.64	0.04	1052.36	0.94
Stage 1	Near WF	90	1.50	1.36	3.90	0.58	0.62	1.29	0.00	8.00	1.79	1.51	0.56	9.70	0.11	135.97	2.16
Stage 1	All	2,036	1.51	1.41	4.05	0.43	0.54	2.39	2.67	10.27	1.73	0.58	0.30	13.64	0.04	1188.33	1.04
Stage 2	Far WF	1,065	1.51	1.39	3.78	0.57	0.55	2.54	2.69	11.20	1.63	0.53	0.29	10.00	0.06	563.90	0.92
Stage 2	Near WF	56	1.62	1.58	3.90	0.72	0.64	1.74	1.66	9.50	1.93	1.81	0.55	12.73	0.11	101.26	2.60
Stage 2	All	1,121	1.51	1.40	3.90	0.57	0.56	2.50	2.68	11.20	1.65	0.59	0.30	12.73	0.06	665.16	1.10
Stage 3	Far WF	663	1.51	1.39	3.71	0.56	0.51	2.63	2.80	16.67	1.75	0.57	0.30	10.00	0.08	378.18	0.91
Stage 3	Near WF	31	1.38	1.32	2.14	0.62	0.40	1.65	1.71	6.00	1.66	2.09	1.10	6.84	0.13	64.69	2.14
Stage 3	All	694	1.51	1.39	3.71	0.56	0.51	2.59	2.69	16.67	1.75	0.64	0.32	10.00	0.08	442.87	1.04
All	Far WF	3,674	1.51	1.40	4.05	0.43	0.54	2.50	2.68	16.67	1.70	0.54	0.30	13.64	0.04	1994.44	0.93
All	Near WF	177	1.52	1.40	3.90	0.58	0.60	1.49	0.00	9.50	1.81	1.71	0.61	12.73	0.11	301.92	2.30
All	All	3,851	1.51	1.40	4.05	0.43	0.54	2.46	2.67	16.67	1.71	0.60	0.30	13.64	0.04	2296.36	1.06

Notes: n=# of observations; St.Dev.=Standard Deviation; Max=Maximum; Min.=Minimum; SQFT=Square Feet=above grade living area of the dwelling in 1000s of square feet;
Garage=area of the garage in 180s of square feet, approximately the number of standard cars that can fit in the garage; Acreage=total number of acres of the property; Sum.=Summation or Total;
Near WF=Near Twin Groves I & II=Near Wind Farm=1 if property located within 3 mile buffer of wind farm, 0 otherwise;
Far WF=Far Twin Groves I & II=1 if property located outside of 3 mile buffer of wind farm, 0 otherwise;
Stage 1=Before TG I and II Approval=Before Wind Farm Approval=01/01/2001 – 09/20/2005;
Stage 2=Post TG I and II (WF) Approval and during Construction=09/21/2005 – 02/01/2008;
Stage 3=Twin Groves I and II Online, WF Operation=Wind Farm Operation=02/02/2008 – 12/01/2009.

Table C. 6. Near and Far from TG I and II and 3-Stage Wind Farm Development Cross Tabulations

Wind Farm Stages		*n*	Year Built Mean	Year Built Median	Year Built Max	Year Built Min.	Year Built Std. Dev.	Fireplaces Sum.	RR Tracks Sum.	Lakefront Sum.	Cul-de-sac Sum.	Trees Sum.
Stage 1	Far WF	1,946	1953	1964	2005	1824	40	596	355	34	165	224
Stage 1	Near WF	90	1929	1919	2001	1849	38	19	23	3	3	13
Stage 1	All	2,036	1952	1963	2005	1824	40	615	378	37	168	237
Stage 2	Far WF	1,065	1950	1961	2008	1849	41	290	206	23	89	102
Stage 2	Near WF	56	1924	1916	2006	1859	39	9	11	1	0	5
Stage 2	All	1,121	1949	1960	2008	1849	41	299	217	24	89	107
Stage 3	Far WF	663	1951	1962	2008	1867	40	184	129	15	56	77
Stage 3	Near WF	31	1927	1920	2004	1859	39	4	7	0	1	8
Stage 3	All	694	1950	1961	2008	1859	40	188	136	15	57	85
All	Far WF	3,674	1952	1963	2008	1824	40	1070	690	72	310	403
All	Near WF	177	1927	1919	2006	1849	39	32	41	4	4	26
All	All	3,851	1951	1962	2008	1824	41	1102	731	76	314	429

Notes: n=# of observations; Std. Dev.=Standard Deviation; Max=Maximum; Min.=Minimum; Sum.=Summation or Total; Year Built=the year the property was originally built; Fireplaces=# of fireplaces; RR Tracks=Railroad Tracks=1 if within 180 meters of railroad tracks, 0 otherwise; Lakefront=1 if within 70 meters of a lake, 0 otherwise; Cul-de-sac=1 if property located near a cul-de-sac, 0 otherwise; Near WF=Near Twin Groves I & II=Near Wind Farm=1 if property located within 3 mile buffer of wind farm, 0 otherwise; Trees=1 if within 180 meters of trees, 0 otherwise;
Far WF=Far Twin Groves I & II=1 if property located outside of 3 mile buffer of wind farm, 0 otherwise;
Stage 1=Before TG I and II Approval=Before Wind Farm Approval=01/01/2001 – 09/20/2005;
Stage 2=Post TG I and II (WF) Approval and during Construction=09/21/2005 – 02/01/2008;
Stage 3=Twin Groves I and II Online, WF Operation=Wind Farm Operation=02/02/2008 – 12/01/2009.

Table C. 7. School District and Wind Farm 3-Stage Cross Tabulations

Wind Farm Stages		*n*	RealPrice Mean	RealPrice Median	RealPrice Max	RealPrice Min.	RealPrice Std. Dev.	ln(RealPrice) Mean	ln(RealPrice) Median	ln(RealPrice) Max	ln(RealPrice) Min.	ln(RealPrice) Std. Dev.
Stage 1	Near WF	90	108,168	94,112	344,704	31,318	51,475	11.49	11.45	12.75	10.35	0.47
Stage 1	Trivalley	209	191,018	177,138	396,875	29,769	78,974	12.06	12.09	12.89	10.30	0.47
Stage 1	Lexington	173	129,761	116,642	388,113	36,881	53,664	11.70	11.67	12.87	10.52	0.39
Stage 1	LeRoy	281	123,468	123,290	314,025	26,872	47,632	11.64	11.72	12.66	10.20	0.41
Stage 1	El P-Gridley	111	106,534	95,985	270,973	26,837	46,917	11.48	11.47	12.51	10.20	0.45
Stage 1	Heyworth	302	144,341	138,935	341,951	27,990	54,004	11.80	11.84	12.74	10.24	0.41
Stage 1	Gibson City	305	89,218	79,246	298,402	28,259	43,531	11.29	11.28	12.61	10.25	0.47
Stage 1	NormalUnit 5	244	165,774	159,786	399,314	34,162	64,364	11.94	11.98	12.90	10.44	0.40
Stage 1	Ridgeview	134	96,721	91,015	230,266	26,837	42,182	11.38	11.42	12.35	10.20	0.47
Stage 1	Blue Ridge	38	87,143	79,896	182,732	28,699	39,949	11.27	11.29	12.12	10.27	0.47
Stage 1	Prair Central	149	91,472	83,115	251,792	29,149	42,023	11.32	11.33	12.44	10.28	0.46
Stage 1	All	2,036	127,593	116,665	399,314	26,837	63,194	11.63	11.67	12.90	10.20	0.51
Stage 2	Near WF	56	101,937	97,545	223,645	30,146	44,940	11.43	11.49	12.32	10.31	0.47
Stage 2	Trivalley	108	185,353	180,424	394,831	40,206	72,328	12.05	12.10	12.89	10.60	0.43
Stage 2	Lexington	98	124,620	122,454	280,959	25,694	55,186	11.62	11.72	12.55	10.15	0.50
Stage 2	LeRoy	142	124,715	120,430	395,688	36,580	53,624	11.65	11.70	12.89	10.51	0.40
Stage 2	El P-Gridley	70	105,150	95,482	311,454	29,996	44,494	11.48	11.47	12.65	10.31	0.43
Stage 2	Heyworth	145	140,011	132,581	333,001	39,940	57,011	11.77	11.80	12.72	10.60	0.41
Stage 2	Gibson City	158	101,996	92,891	261,152	27,496	50,578	11.41	11.44	12.47	10.22	0.52
Stage 2	NormalUnit 5	143	165,097	149,437	391,432	31,354	74,325	11.92	11.92	12.88	10.35	0.43
Stage 2	Ridgeview	78	89,111	79,605	211,020	25,047	40,860	11.29	11.29	12.26	10.13	0.47
Stage 2	Blue Ridge	22	77,578	72,347	174,445	30,154	39,093	11.14	11.19	12.07	10.31	0.50
Stage 2	Prair Central	101	83,744	80,051	195,368	25,129	34,576	11.25	11.29	12.18	10.13	0.43
Stage 2	All	1,121	125,023	114,587	395,688	25,047	63,818	11.61	11.65	12.89	10.13	0.52
Stage 3	Near WF	31	116,814	124,342	211,550	30,000	42,814	11.59	11.73	12.26	10.31	0.45
Stage 3	Trivalley	63	202,645	184,608	398,154	55,000	83,645	12.13	12.13	12.90	10.92	0.44
Stage 3	Lexington	81	117,826	117,750	272,500	30,016	47,451	11.58	11.68	12.52	10.31	0.46
Stage 3	LeRoy	96	122,972	110,482	287,793	35,669	50,236	11.64	11.61	12.57	10.48	0.41
Stage 3	El P-Gridley	48	94,045	88,504	174,093	30,003	39,219	11.35	11.39	12.07	10.31	0.48
Stage 3	Heyworth	112	137,532	125,407	319,321	28,579	57,555	11.74	11.74	12.67	10.26	0.46
Stage 3	Gibson City	67	107,523	83,044	283,900	34,003	60,005	11.45	11.33	12.56	10.43	0.53
Stage 3	NormalUnit 5	88	150,159	141,855	308,349	38,784	59,974	11.83	11.86	12.64	10.57	0.43
Stage 3	Ridgeview	33	80,827	70,193	183,018	29,834	37,859	11.20	11.16	12.12	10.30	0.45
Stage 3	Blue Ridge	11	78,900	69,359	175,483	30,016	40,547	11.17	11.15	12.08	10.31	0.48
Stage 3	Prair Central	64	78,508	69,222	180,000	25,932	36,450	11.17	11.15	12.10	10.16	0.47
Stage 3	All	694	124,831	114,834	398,154	25,932	63,536	11.60	11.65	12.90	10.16	0.53

All	Near WF	177	107,711	98,576	344,704	30,000	48,050	11.49	11.50	12.75	10.31	0.46
All	Trivalley	380	191,335	180,159	398,154	29,769	77,948	12.07	12.10	12.90	10.30	0.45
All	Lexington	352	125,583	118,148	388,113	25,694	52,809	11.65	11.68	12.87	10.15	0.44
All	LeRoy	519	123,718	120,331	395,688	26,872	49,723	11.65	11.70	12.89	10.20	0.41
All	El P-Gridley	229	103,493	95,474	311,454	26,837	44,747	11.45	11.47	12.65	10.20	0.45
All	Heyworth	559	141,854	133,981	341,951	27,990	55,488	11.78	11.81	12.74	10.24	0.42
All	Gibson City	530	95,341	82,567	298,402	27,496	48,487	11.34	11.32	12.61	10.22	0.49
All	NormalUnit 5	475	162,677	154,017	399,314	31,354	66,893	11.92	11.95	12.90	10.35	0.42
All	Ridgeview	245	92,158	84,988	230,266	25,047	41,430	11.33	11.35	12.35	10.13	0.47
All	Blue Ridge	71	82,902	75,148	182,732	28,699	39,473	11.22	11.23	12.12	10.27	0.48
All	Prair Central	314	86,344	81,167	251,792	25,129	38,880	11.27	11.30	12.44	10.13	0.46
All	All	3,851	126,347	115,390	399,314	25,047	63,435	11.62	11.66	12.90	10.13	0.51

Notes: n=# of observations; Std. Dev.=Standard Deviation; Max=Maximum; Min.=Minimum; ln=natural logarithm;
RealPrice=Real Price of Property in 2009 Q2 $; ln(RealPrice)=Natural Logarithm of the Real Price of Property in 2009 Q2 $, dependent variable;
Near WF=Near Twin Groves I & II=Near Wind Farm=1 if property located within 3 mile buffer of wind farm, 0 otherwise;
Blue Ridge CUSD 18; El Paso-Gridley CUSD 11; Gibson City-Melvin-Sibley CUSD 5; Heyworth CUSD 4; LeRoy CUSD 2; Lexington CUSD 7 (Reference Group); Normal CUSD 5; Prairie Central CUSD 8; Ridgeview CUSD 19; Trivalley CUSD 3; School district dummy variables exclude properties near TG I and II; Stage 1=Before TG I and II (WF) Approval=01/01/2001 – 09/20/2005; Stage 2=Post TG I and II (WF) Approval and during Construction=09/21/2005 – 02/01/2008; Stage 3=Twin Groves I and II Online, Wind Farm Operation=02/02/2008 – 12/01/2009.

Table C. 8. School District and Wind Farm 3-Stage Cross Tabulations

Wind Farm Stages		*n*	SQFT Mean	SQFT Median	SQFT Max	SQFT Min.	SQFT St. Dev.	Garage Mean	Garage Median	Garage Max	Garage St. Dev.	Acreage Mean	Acreage Median	Acreage Max	Acreage Min.	Acreage Sum.	Acreage St. Dev.
Stage 1	NearWF	90	1.50	1.36	3.90	0.58	0.62	1.29	0.00	8.00	1.79	1.51	0.56	9.70	0.11	135.97	2.16
Stage 1	Trivalley	209	1.79	1.60	4.05	0.67	0.68	2.88	3.07	8.60	1.68	0.75	0.54	5.23	0.10	156.97	0.79
Stage 1	Lexington	173	1.46	1.29	3.87	0.60	0.56	2.32	2.53	6.84	1.69	0.60	0.30	13.64	0.09	104.06	1.44
Stage 1	LeRoy	281	1.51	1.42	3.83	0.62	0.53	2.50	2.67	6.67	1.50	0.46	0.27	10.41	0.04	128.23	0.75
Stage 1	EP-Gridley	111	1.52	1.39	3.23	0.76	0.53	1.99	1.96	6.73	1.36	0.60	0.28	6.18	0.10	66.64	1.07
Stage 1	Heyworth	302	1.51	1.43	3.39	0.43	0.51	2.66	2.86	9.07	1.47	0.47	0.25	7.13	0.06	141.66	0.81
Stage 1	Gibson City	305	1.31	1.20	3.33	0.48	0.46	2.03	2.00	9.33	1.92	0.53	0.25	11.00	0.09	161.44	1.10
Stage 1	NormUnit 5	244	1.60	1.57	3.52	0.57	0.51	3.02	3.02	8.53	1.55	0.43	0.31	2.41	0.14	105.02	0.36
Stage 1	Ridgeview	134	1.43	1.40	2.70	0.76	0.42	2.46	2.67	10.27	2.02	0.61	0.32	9.49	0.08	81.96	1.08
Stage 1	Blue Ridge	38	1.70	1.56	3.04	0.90	0.53	0.77	0.00	5.00	1.50	0.92	0.33	5.97	0.12	35.05	1.41
Stage 1	PrairCentral	149	1.50	1.41	3.54	0.72	0.48	2.01	2.13	10.00	1.75	0.48	0.29	5.79	0.10	71.33	0.79
Stage 1	All	2,036	1.51	1.41	4.05	0.43	0.54	2.39	2.67	10.27	1.73	0.58	0.30	13.64	0.04	1188.33	1.04
Stage 2	NearWF	56	1.62	1.58	3.90	0.72	0.64	1.74	1.66	9.50	1.93	1.81	0.55	12.73	0.11	101.26	2.60
Stage 2	Trivalley	108	1.73	1.64	3.31	0.64	0.63	2.73	2.78	8.86	1.50	0.72	0.52	5.01	0.15	78.24	0.82
Stage 2	Lexington	98	1.52	1.39	3.19	0.72	0.57	2.79	3.14	11.20	1.82	0.50	0.29	5.02	0.09	48.81	0.67
Stage 2	LeRoy	142	1.51	1.39	3.78	0.72	0.62	2.38	2.47	7.50	1.49	0.45	0.26	7.71	0.09	63.78	0.88
Stage 2	EP-Gridley	70	1.47	1.37	3.63	0.76	0.55	2.17	2.39	6.67	1.59	0.48	0.28	4.57	0.10	33.80	0.74
Stage 2	Heyworth	145	1.47	1.38	3.10	0.66	0.48	2.67	2.81	9.17	1.49	0.41	0.26	5.60	0.06	59.21	0.66
Stage 2	Gibson City	158	1.42	1.33	3.49	0.57	0.49	2.78	2.69	8.53	1.48	0.60	0.28	10.00	0.09	95.12	1.27
Stage 2	NormUnit 5	143	1.58	1.46	3.45	0.67	0.57	2.96	3.07	6.67	1.48	0.65	0.34	10.00	0.13	93.40	1.32
Stage 2	Ridgeview	78	1.43	1.44	2.52	0.58	0.43	2.40	2.67	9.77	1.99	0.46	0.30	4.08	0.11	36.01	0.59
Stage 2	Blue Ridge	22	1.39	1.21	2.50	0.58	0.58	0.46	0.00	5.38	1.30	0.69	0.33	2.86	0.15	15.20	0.82
Stage 2	PrairCentral	101	1.43	1.27	3.60	0.69	0.55	2.00	2.02	6.24	1.64	0.40	0.29	3.49	0.14	40.33	0.46
Stage 2	All	1,121	1.51	1.40	3.90	0.57	0.56	2.50	2.68	11.20	1.65	0.59	0.30	12.73	0.06	665.16	1.10
Stage 3	NearWF	31	1.38	1.32	2.14	0.62	0.40	1.65	1.71	6.00	1.66	2.09	1.10	6.84	0.13	64.69	2.14
Stage 3	Trivalley	63	1.70	1.56	3.01	0.73	0.53	2.79	2.93	6.27	1.64	0.96	0.63	5.27	0.17	60.61	1.11
Stage 3	Lexington	81	1.47	1.35	2.41	0.56	0.45	2.28	2.60	10.00	1.71	0.49	0.30	3.35	0.08	39.97	0.59
Stage 3	LeRoy	96	1.46	1.29	3.71	0.61	0.56	2.60	2.72	7.29	1.55	0.44	0.29	5.08	0.13	42.15	0.63
Stage 3	EP-Gridley	48	1.47	1.40	2.54	0.78	0.41	2.54	2.67	6.67	1.43	0.36	0.29	1.82	0.10	17.19	0.28
Stage 3	Heyworth	112	1.57	1.41	2.98	0.65	0.57	2.92	2.97	16.67	1.92	0.65	0.25	10.00	0.09	72.69	1.34
Stage 3	Gibson City	67	1.46	1.32	2.76	0.68	0.43	2.92	2.80	9.11	1.98	0.65	0.25	5.00	0.12	43.67	1.14
Stage 3	NormUnit 5	88	1.57	1.42	3.00	0.57	0.57	2.91	2.94	7.79	1.63	0.66	0.35	5.10	0.15	57.73	0.89
Stage 3	Ridgeview	33	1.44	1.35	2.77	0.93	0.43	2.30	2.67	4.36	1.43	0.55	0.33	5.40	0.14	18.30	0.95
Stage 3	Blue Ridge	11	1.44	1.39	2.45	0.93	0.40	0.85	0.00	4.36	1.39	0.42	0.33	1.36	0.16	4.63	0.35
Stage 3	PrairCentral	64	1.41	1.29	2.95	0.79	0.45	2.30	2.40	8.27	1.92	0.33	0.29	1.00	0.14	21.24	0.14
Stage 3	All	694	1.51	1.39	3.71	0.56	0.51	2.59	2.69	16.67	1.75	0.64	0.32	10.00	0.08	442.87	1.04

All	NearWF	177	1.52	1.40	3.90	0.58	0.60	1.49	0.00	9.50	1.81	1.71	0.61	12.73	0.11	301.92	2.30
All	Trivalley	380	1.76	1.60	4.05	0.64	0.64	2.82	2.93	8.86	1.62	0.78	0.55	5.27	0.10	295.82	0.86
All	Lexington	352	1.48	1.34	3.87	0.56	0.54	2.44	2.68	11.20	1.74	0.55	0.30	13.64	0.08	192.84	1.11
All	LeRoy	519	1.50	1.40	3.83	0.61	0.56	2.49	2.67	7.50	1.51	0.45	0.27	10.41	0.04	234.16	0.76
All	EP-Gridley	229	1.50	1.38	3.63	0.76	0.51	2.16	2.13	6.73	1.46	0.51	0.28	6.18	0.10	117.63	0.86
All	Heyworth	559	1.51	1.40	3.39	0.43	0.51	2.71	2.89	16.67	1.57	0.49	0.25	10.00	0.06	273.56	0.91
All	Gibson City	530	1.36	1.25	3.49	0.48	0.47	2.37	2.40	9.33	1.85	0.57	0.26	11.00	0.09	300.23	1.15
All	NormUnit 5	475	1.59	1.50	3.52	0.57	0.54	2.98	3.01	8.53	1.54	0.54	0.32	10.00	0.13	256.15	0.86
All	Ridgeview	245	1.43	1.40	2.77	0.58	0.42	2.42	2.67	10.27	1.93	0.56	0.32	9.49	0.08	136.27	0.93
All	Blue Ridge	71	1.56	1.43	3.04	0.58	0.54	0.69	0.00	5.38	1.42	0.77	0.33	5.97	0.12	54.88	1.14
All	PrairCentral	314	1.46	1.38	3.60	0.69	0.50	2.07	2.12	10.00	1.75	0.42	0.29	5.79	0.10	132.90	0.61
All	All	3,851	1.51	1.40	4.05	0.43	0.54	2.46	2.67	16.67	1.71	0.60	0.30	13.64	0.04	2296.36	1.06

Notes: n=# of observations; St. Dev.=Standard Deviation; Max=Maximum; Min.=Minimum; SQFT=Square Feet=above grade living area of the dwelling in 1000s of square feet;
Garage=area of the garage in 180s of square feet, approximately the number of standard cars that can fit in the garage; Acreage=total number of acres of the property; Sum.=Summation or Total;
NearWF=Near Twin Groves I & II=Near Wind Farm=1 if property located within 3 mile buffer of wind farm, 0 otherwise;
Blue Ridge CUSD 18; El Paso-Gridley CUSD 11; Gibson City-Melvin-Sibley CUSD 5; Heyworth CUSD 4; LeRoy CUSD 2; Lexington CUSD 7 (Reference Group); Normal CUSD 5; Prairie Central CUSD 8;
Ridgeview CUSD 19; Trivalley CUSD 3; School district dummy variables exclude properties near TG I and II; Stage 1=Before TG I and II (WF) Approval=01/01/2001 – 09/20/2005;
Stage 2=Post TG I and II (WF) Approval and during Construction=09/21/2005 – 02/01/2008; Stage 3=Twin Groves I and II Online, WF Operation=02/02/2008 – 12/01/2009.

Table C. 9. School District and Wind Farm 3-Stage Cross Tabulations

Wind Farm Stages		*n*	Year Built Mean	Year Built Median	Year Built Max	Year Built Min.	Year Built Std. Dev.	Fireplaces Sum.	RR Tracks Sum.	Lakefront Sum.	Cul-de-sac Sum.	Trees Sum.
Stage 1	Near WF	90	1929	1919	2001	1849	38	19	23	3	3	13
Stage 1	Trivalley	209	1979	1986	2004	1889	24	125	35	14	41	73
Stage 1	Lexington	173	1942	1961	2004	1824	45	54	36	2	17	21
Stage 1	LeRoy	281	1953	1969	2005	1849	44	77	18	0	35	6
Stage 1	El P-Gridley	111	1934	1940	2003	1869	38	23	22	0	0	2
Stage 1	Heyworth	302	1971	1982	2005	1869	33	119	52	1	26	71
Stage 1	Gibson City	305	1942	1950	2004	1883	31	34	60	0	4	2
Stage 1	NormalUnit 5	244	1969	1974	2003	1836	33	105	21	17	19	42
Stage 1	Ridgeview	134	1930	1913	2004	1858	42	31	46	0	23	6
Stage 1	Blue Ridge	38	1937	1925	1998	1889	36	5	19	0	0	0
Stage 1	PrairieCentral	149	1932	1935	2003	1859	42	23	46	0	0	1
Stage 1	All	2,036	1952	1963	2005	1824	40	615	378	37	168	237
Stage 2	Near WF	56	1924	1916	2006	1859	39	9	11	1	0	5
Stage 2	Trivalley	108	1977	1980	2005	1880	25	68	17	7	27	28
Stage 2	Lexington	98	1938	1958	2008	1859	46	21	12	0	8	7
Stage 2	LeRoy	142	1951	1963	2005	1849	43	33	17	0	13	2
Stage 2	El P-Gridley	70	1941	1952	2002	1859	39	11	14	0	0	2
Stage 2	Heyworth	145	1967	1978	2004	1859	35	46	24	3	14	33
Stage 2	Gibson City	158	1942	1950	2005	1860	32	15	41	0	4	1
Stage 2	NormalUnit 5	143	1966	1972	2003	1880	32	61	11	13	15	26
Stage 2	Ridgeview	78	1926	1907	2005	1869	43	17	31	0	8	3
Stage 2	Blue Ridge	22	1927	1910	1999	1884	35	2	9	0	0	0
Stage 2	PrairieCentral	101	1928	1916	2003	1859	41	16	30	0	0	0
Stage 2	All	1,121	1949	1960	2008	1849	41	299	217	24	89	107
Stage 3	Near WF	31	1927	1920	2004	1859	39	4	7	0	1	8
Stage 3	Trivalley	63	1980	1986	2004	1899	25	35	9	8	14	24
Stage 3	Lexington	81	1934	1940	2005	1869	45	25	18	0	10	9
Stage 3	LeRoy	96	1945	1960	2003	1867	40	23	12	0	11	1
Stage 3	El P-Gridley	48	1943	1953	2002	1869	42	10	11	0	0	0
Stage 3	Heyworth	112	1965	1978	2004	1879	35	36	20	1	4	26
Stage 3	Gibson City	67	1944	1953	2008	1890	32	10	15	0	1	1
Stage 3	NormalUnit 5	88	1967	1972	2003	1890	29	36	9	6	10	16
Stage 3	Ridgeview	33	1931	1910	2005	1869	41	3	9	0	6	0
Stage 3	Blue Ridge	11	1935	1919	1997	1879	41	0	6	0	0	0
Stage 3	PrairieCentral	64	1929	1929	2003	1869	40	6	20	0	0	0
Stage 3	All	694	1950	1961	2008	1859	40	188	136	15	57	85

All Stages	Near WF	177	1927	1919	2006	1849	39	32	41	4	4	26
All Stages	Trivalley	380	1979	1984	2005	1880	25	228	61	29	82	125
All Stages	Lexington	352	1939	1958	2008	1824	45	100	66	2	35	37
All Stages	LeRoy	519	1951	1964	2005	1849	43	133	47	0	59	9
All Stages	El P-Gridley	229	1938	1947	2003	1859	39	44	47	0	0	4
All Stages	Heyworth	559	1969	1979	2005	1859	34	201	96	5	44	130
All Stages	Gibson City	530	1942	1950	2008	1860	31	59	116	0	9	4
All Stages	NormalUnit 5	475	1968	1973	2003	1836	32	202	41	36	44	84
All Stages	Ridgeview	245	1929	1909	2005	1858	42	51	86	0	37	9
All Stages	Blue Ridge	71	1934	1919	1999	1879	36	7	34	0	0	0
All Stages	PrairieCentral	314	1930	1921	2003	1859	41	45	96	0	0	1
All Stages	All	3,851	1951	1962	2008	1824	41	1102	731	76	314	429

Notes: n=# of observations; Std. Dev.=Standard Deviation; Max=Maximum; Min.=Minimum; Sum.=Summation or Total; Year Built=the year the property was originally built; Fireplaces=# of fireplaces; RR Tracks=Railroad Tracks=1 if within 180 meters of railroad tracks, 0 otherwise; Lakefront=1 if within 70 meters of a lake, 0 otherwise; Cul-de-sac=1 if property located near a cul-de-sac, 0 otherwise; Near WF=Near Twin Groves I & II=Near Wind Farm=1 if property located within 3 mile buffer of wind farm, 0 otherwise; Trees=1 if within 180 meters of trees, 0 otherwise; Blue Ridge CUSD 18; El Paso-Gridley CUSD 11; Gibson City-Melvin-Sibley CUSD 5; Heyworth CUSD 4; LeRoy CUSD 2; Lexington CUSD 7 (Reference Group); Normal CUSD 5; Prairie Central CUSD 8; Ridgeview CUSD 19; Trivalley CUSD 3; School district dummy variables exclude properties near TG I and II; Stage 1=Before TG I and II (WF) Approval=01/01/2001 – 09/20/2005; Stage 2=Post TG I and II (WF) Approval and during Construction=09/21/2005 – 02/01/2008; Stage 3=Twin Groves I and II Online, WF Operation=02/02/2008 – 12/01/2009; All Stages=01/01/2001 – 12/01/2009.

Table C. 10. Township and Wind Farm 3-Stage Cross Tabulations

Wind Farm Stages		*n*	RealPrice Mean	RealPrice Median	RealPrice Max	RealPrice Min.	RealPrice Std. Dev.	ln(RealPrice) Mean	ln(RealPrice) Median	ln(RealPrice) Max	ln(RealPrice) Min.	ln(RealPrice) Std. Dev.
Stage 1	Near WF	90	108,168	94,112	344,704	31,318	51,475	11.49	11.45	12.75	10.35	0.47
Stage 1	Anchor	13	70,694	78,861	94,800	32,627	19,978	11.12	11.28	11.46	10.39	0.34
Stage 1	Bellflower	36	83,238	77,657	182,732	28,699	37,260	11.23	11.26	12.12	10.27	0.45
Stage 1	Blue Mound	26	92,375	79,696	158,492	29,135	38,564	11.34	11.29	11.97	10.28	0.44
Stage 1	Chenoa	133	91,211	83,878	251,792	29,149	40,691	11.32	11.34	12.44	10.28	0.46
Stage 1	Cropsey	9	89,420	63,684	203,965	44,079	56,202	11.26	11.06	12.23	10.69	0.54
Stage 1	Dix	20	70,648	69,893	119,886	35,263	20,264	11.13	11.16	11.69	10.47	0.29
Stage 1	Downs	72	140,607	160,813	230,802	37,572	46,515	11.78	11.99	12.35	10.53	0.41
Stage 1	Drummer	236	95,324	84,407	298,402	29,228	45,463	11.36	11.34	12.61	10.28	0.46
Stage 1	Empire	273	122,969	123,290	314,025	26,872	47,734	11.64	11.72	12.66	10.20	0.42
Stage 1	Gridley	111	106,534	95,985	270,973	26,837	46,917	11.48	11.47	12.51	10.20	0.45
Stage 1	Hudson	179	163,300	159,785	399,314	48,414	55,840	11.95	11.98	12.90	10.79	0.35
Stage 1	Lawndale	4	122,706	113,399	167,285	96,740	32,313	11.69	11.63	12.03	11.48	0.25
Stage 1	Lexington	161	126,712	116,257	360,089	36,881	49,402	11.68	11.66	12.79	10.52	0.38
Stage 1	Martin	91	100,539	98,778	230,266	26,837	44,500	11.41	11.50	12.35	10.20	0.49
Stage 1	Money Creek	32	228,021	219,968	388,113	87,404	90,458	12.25	12.30	12.87	11.38	0.43
Stage 1	Oldtown	142	214,888	199,895	396,875	29,769	80,024	12.20	12.21	12.89	10.30	0.43
Stage 1	Peach Orchard	29	68,570	71,100	165,865	28,259	32,360	11.03	11.17	12.02	10.25	0.46
Stage 1	Randolph	301	144,338	138,840	341,951	27,990	54,093	11.80	11.84	12.74	10.24	0.41
Stage 1	Sullivant	20	65,679	59,694	136,532	29,436	27,212	11.02	11.00	11.82	10.29	0.40
Stage 1	Towanda	45	132,656	136,051	234,312	34,162	49,333	11.71	11.82	12.36	10.44	0.44
Stage 1	West	6	144,835	150,770	164,977	120,148	19,629	11.88	11.92	12.01	11.70	0.14
Stage 1	Yates	7	99,089	91,921	189,149	48,856	53,345	11.39	11.43	12.15	10.80	0.51
Stage 1	All	2,036	127,593	116,665	399,314	26,837	63,194	11.63	11.67	12.90	10.20	0.51
Stage 2	Near WF	56	101,937	97,545	223,645	30,146	44,940	11.43	11.49	12.32	10.31	0.47
Stage 2	Anchor	7	63,622	61,666	100,486	37,180	21,902	11.01	11.03	11.52	10.52	0.35
Stage 2	Bellflower	21	73,464	71,843	174,445	30,154	34,838	11.10	11.18	12.07	10.31	0.47
Stage 2	Blue Mound	15	91,387	75,142	211,020	25,047	53,968	11.26	11.23	12.26	10.13	0.59
Stage 2	Chenoa	92	83,785	81,086	162,787	29,376	30,881	11.26	11.30	12.00	10.29	0.39
Stage 2	Cropsey	5	51,904	41,806	92,295	25,129	27,692	10.74	10.64	11.43	10.13	0.53
Stage 2	Dix	10	102,157	100,056	174,975	41,624	41,238	11.46	11.51	12.07	10.64	0.43
Stage 2	Downs	41	143,170	148,762	276,335	40,206	55,182	11.79	11.91	12.53	10.60	0.45
Stage 2	Drummer	132	105,127	99,688	261,152	27,496	51,716	11.44	11.51	12.47	10.22	0.52
Stage 2	Empire	136	122,077	117,451	395,688	36,580	51,758	11.64	11.67	12.89	10.51	0.39
Stage 2	Gridley	69	104,142	95,474	311,454	29,996	44,007	11.47	11.47	12.65	10.31	0.42
Stage 2	Hudson	98	165,741	154,766	391,432	31,354	74,378	11.93	11.95	12.88	10.35	0.43

Stage 2	Lawndale	3	125,319	133,609	150,230	92,119	29,930	11.72	11.80	11.92	11.43	0.26
Stage 2	Lexington	88	126,067	125,374	280,959	25,694	56,364	11.63	11.74	12.55	10.15	0.50
Stage 2	Martin	53	89,784	84,066	173,052	33,777	37,857	11.31	11.34	12.06	10.43	0.44
Stage 2	Money Creek	21	187,644	152,172	336,665	32,451	98,210	11.98	11.93	12.73	10.39	0.64
Stage 2	Oldtown	71	210,728	204,708	394,831	80,412	69,472	12.20	12.23	12.89	11.30	0.34
Stage 2	Peach Orchard	7	65,307	58,912	102,776	44,574	19,514	11.05	10.98	11.54	10.71	0.28
Stage 2	Randolph	145	140,011	132,581	333,001	39,940	57,011	11.77	11.80	12.72	10.60	0.41
Stage 2	Sullivant	9	84,446	80,388	168,884	33,949	50,232	11.18	11.30	12.04	10.43	0.62
Stage 2	Towanda	34	135,040	135,401	265,282	69,355	41,829	11.77	11.82	12.49	11.15	0.32
Stage 2	West	4	146,374	144,230	163,976	133,060	12,975	11.89	11.88	12.01	11.80	0.09
Stage 2	Yates	4	122,605	129,529	195,368	35,995	78,716	11.51	11.68	12.18	10.49	0.80
Stage 2	All	1,121	125,023	114,587	395,688	25,047	63,818	11.61	11.65	12.89	10.13	0.52
Stage 3	Near WF	31	116,814	124,342	211,550	30,000	42,814	11.59	11.73	12.26	10.31	0.45
Stage 3	Anchor	4	60,545	44,002	124,342	29,834	43,321	10.85	10.68	11.73	10.30	0.62
Stage 3	Bellflower	11	78,900	69,359	175,483	30,016	40,547	11.17	11.15	12.08	10.31	0.48
Stage 3	Blue Mound	2	66,387	66,387	84,045	48,729	24,972	11.07	11.07	11.34	10.79	0.39
Stage 3	Chenoa	57	82,208	75,579	180,000	29,936	36,300	11.22	11.23	12.10	10.31	0.44
Stage 3	Cropsey	1	83,508	83,508	83,508	83,508		11.33	11.33	11.33	11.33	
Stage 3	Dix	5	86,328	82,824	141,630	40,004	36,355	11.29	11.32	11.86	10.60	0.45
Stage 3	Downs	25	159,499	176,000	349,291	55,000	67,300	11.89	12.08	12.76	10.92	0.46
Stage 3	Drummer	51	118,351	102,282	283,900	35,097	62,871	11.55	11.54	12.56	10.47	0.52
Stage 3	Empire	94	120,811	110,029	287,793	35,669	48,488	11.62	11.61	12.57	10.48	0.40
Stage 3	Gridley	48	94,045	88,504	174,093	30,003	39,219	11.35	11.39	12.07	10.31	0.48
Stage 3	Hudson	59	144,695	136,000	308,349	60,006	52,381	11.82	11.82	12.64	11.00	0.37
Stage 3	Lawndale	4	122,875	127,577	155,583	80,764	37,855	11.68	11.73	11.96	11.30	0.32
Stage 3	Lexington	76	116,570	115,481	272,500	30,016	48,461	11.57	11.66	12.52	10.31	0.47
Stage 3	Martin	25	84,422	70,193	183,018	35,801	39,168	11.25	11.16	12.12	10.49	0.43
Stage 3	Money Creek	11	193,150	194,586	282,000	60,876	76,701	12.08	12.18	12.55	11.02	0.49
Stage 3	Oldtown	41	230,918	215,594	398,154	85,045	78,758	12.29	12.28	12.90	11.35	0.34
Stage 3	Peach Orchard	6	56,165	53,374	75,207	35,097	14,604	10.91	10.88	11.23	10.47	0.27
Stage 3	Randolph	112	137,532	125,407	319,321	28,579	57,555	11.74	11.74	12.67	10.26	0.46
Stage 3	Sullivant	5	79,902	65,180	120,012	34,003	38,009	11.19	11.09	11.70	10.43	0.53
Stage 3	Towanda	20	134,384	128,396	235,125	38,784	57,485	11.70	11.76	12.37	10.57	0.51
Stage 3	West	0										
Stage 3	Yates	6	42,524	39,989	66,500	25,932	16,355	10.60	10.56	11.11	10.16	0.39
Stage 3	All	694	124,831	114,834	398,154	25,932	63,536	11.60	11.65	12.90	10.16	0.53
All	Near WF	177	107,711	98,576	344,704	30,000	48,050	11.49	11.50	12.75	10.31	0.46
All	Anchor	24	66,940	67,364	124,342	29,834	24,425	11.04	11.11	11.73	10.30	0.39
All	Bellflower	68	79,518	73,940	182,732	28,699	36,768	11.18	11.21	12.12	10.27	0.46
All	Blue Mound	43	90,822	77,025	211,020	25,047	43,600	11.30	11.25	12.26	10.13	0.49
All	Chenoa	282	86,968	81,998	251,792	29,149	36,955	11.28	11.31	12.44	10.28	0.44
All	Cropsey	15	76,521	63,684	203,965	25,129	48,486	11.09	11.06	12.23	10.13	0.56
All	Dix	35	81,890	78,333	174,975	35,263	32,143	11.24	11.27	12.07	10.47	0.38

All	Downs	138	144,791	158,638	349,291	37,572	53,416	11.80	11.97	12.76	10.53	0.43
All	Drummer	419	101,215	89,915	298,402	27,496	50,332	11.41	11.41	12.61	10.22	0.49
All	Empire	503	122,325	119,983	395,688	26,872	48,901	11.64	11.70	12.89	10.20	0.41
All	Gridley	228	103,181	95,417	311,454	26,837	44,595	11.45	11.47	12.65	10.20	0.45
All	Hudson	336	160,745	153,766	399,314	31,354	61,562	11.92	11.94	12.90	10.35	0.38
All	Lawndale	11	123,480	125,599	167,285	80,764	30,392	11.70	11.74	12.03	11.30	0.25
All	Lexington	325	124,166	117,056	360,089	25,694	51,182	11.64	11.67	12.79	10.15	0.44
All	Martin	169	94,782	88,453	230,266	26,837	42,017	11.36	11.39	12.35	10.20	0.47
All	Money Creek	64	208,779	208,162	388,113	32,451	91,661	12.13	12.25	12.87	10.39	0.53
All	Old Town	254	216,313	203,908	398,154	29,769	77,003	12.21	12.23	12.90	10.30	0.39
All	Peach Orchard	42	66,254	60,556	165,865	28,259	28,561	11.02	11.01	12.02	10.25	0.41
All	Randolph	558	141,848	133,612	341,951	27,990	55,537	11.78	11.80	12.74	10.24	0.42
All	Sullivant	34	72,738	61,694	168,884	29,436	35,896	11.08	11.03	12.04	10.29	0.47
All	Towanda	99	133,824	135,107	265,282	34,162	48,205	11.73	11.81	12.49	10.44	0.41
All	West	10	145,451	147,059	164,977	120,148	16,456	11.88	11.90	12.01	11.70	0.12
All	Yates	17	84,658	60,074	195,368	25,932	58,561	11.14	11.00	12.18	10.16	0.66
All	All	3,851	126,347	115,390	399,314	25,047	63,435	11.62	11.66	12.90	10.13	0.51

Notes: n=# of observations; Std. Dev.=Standard Deviation; Max=Maximum; Min.=Minimum; ln=natural logarithm;

RealPrice=Real Price of Property in 2009 Q2 $; ln(RealPrice)=Natural Logarithm of the Real Price of Property in 2009 Q2 $, dependent variable;

Near WF=Near Twin Groves I & II=Near Wind Farm=1 if property located within 3 mile buffer of wind farm, 0 otherwise;

Township dummy variables exclude properties near TG I and II (WF); Stage 1=Before TG I and II (WF) Approval=01/01/2001 – 09/20/2005;

Stage 2=Post TG I and II (WF) Approval and during Construction=09/21/2005 – 02/01/2008; Stage 3=Twin Groves I and II Online, WF Operation=02/02/2008 – 12/01/2009.

Table C. 11. Township and Wind Farm 3-Stage Cross Tabulations

Wind Farm Stages		*n*	SQFT Mean	SQFT Median	SQFT Max	SQFT Min.	SQFT StDev.	Garage Mean	Garage Median	Garage Max	Garage StDev.	Acreage Mean	Acreage Median	Acreage Max	Acreage Min.	Acreage Sum.	Acreage StDev.
Stage 1	Near WF	90	1.50	1.36	3.90	0.58	0.62	1.29	0.00	8.00	1.79	1.51	0.56	9.70	0.11	135.97	2.16
Stage 1	Anchor	13	1.55	1.49	2.70	0.90	0.48	1.96	2.00	7.38	2.18	0.29	0.29	0.40	0.17	3.74	0.08
Stage 1	Bellflower	36	1.71	1.56	3.04	0.90	0.54	0.82	0.00	5.00	1.53	0.85	0.33	5.97	0.12	30.77	1.40
Stage 1	Blue Mound	26	1.27	1.17	1.81	0.76	0.34	3.12	2.93	10.27	2.84	0.51	0.28	2.33	0.11	13.25	0.56
Stage 1	Chenoa	133	1.49	1.42	2.89	0.79	0.45	2.08	2.26	10.00	1.75	0.39	0.29	5.79	0.10	51.36	0.61
Stage 1	Cropsey	9	1.51	1.39	2.21	0.72	0.51	0.69	0.00	2.22	1.04	1.27	0.34	5.42	0.23	11.42	1.79
Stage 1	Dix	20	1.18	1.14	1.80	0.78	0.24	1.70	1.73	5.20	1.58	0.49	0.28	2.00	0.13	9.73	0.47
Stage 1	Downs	72	1.39	1.36	2.14	0.67	0.36	2.61	2.76	6.58	1.51	0.47	0.36	2.75	0.10	33.59	0.52
Stage 1	Drummer	236	1.33	1.24	3.33	0.48	0.47	2.01	1.95	9.11	1.88	0.45	0.22	11.00	0.09	105.16	1.00
Stage 1	Empire	273	1.51	1.42	3.83	0.62	0.53	2.48	2.67	6.67	1.50	0.42	0.27	10.41	0.04	113.36	0.71
Stage 1	Gridley	111	1.52	1.39	3.23	0.76	0.53	1.99	1.96	6.73	1.36	0.60	0.28	6.18	0.10	66.64	1.07
Stage 1	Hudson	179	1.55	1.51	3.11	0.57	0.46	2.85	2.93	6.40	1.43	0.38	0.30	2.41	0.14	67.92	0.35
Stage 1	Lawndale	4	1.71	1.64	2.46	1.10	0.59	0.39	0.00	1.58	0.79	2.89	2.76	5.03	1.00	11.55	1.97
Stage 1	Lexington	161	1.46	1.29	3.87	0.60	0.57	2.27	2.43	6.76	1.66	0.49	0.28	12.92	0.09	78.67	1.06
Stage 1	Martin	91	1.45	1.40	2.61	0.77	0.42	2.43	2.78	6.36	1.66	0.59	0.33	9.49	0.08	53.42	1.12
Stage 1	Money Creek	32	1.96	1.95	3.52	0.86	0.76	3.35	3.67	6.84	1.76	1.22	0.63	13.64	0.20	39.16	2.32
Stage 1	Oldtown	142	1.98	1.96	4.05	0.88	0.71	3.04	3.20	8.60	1.73	0.94	0.67	5.23	0.17	133.98	0.89
Stage 1	Peach Orchard	29	1.30	1.17	2.59	0.72	0.49	2.38	2.44	9.33	2.34	0.81	0.34	7.02	0.17	23.59	1.53
Stage 1	Randolph	301	1.51	1.42	3.39	0.43	0.51	2.66	2.87	9.07	1.47	0.46	0.25	7.13	0.06	139.35	0.81
Stage 1	Sullivant	20	1.12	1.01	2.10	0.51	0.40	2.10	2.20	6.13	2.09	1.15	0.31	5.00	0.14	22.96	1.61
Stage 1	Towanda	45	1.54	1.59	2.19	0.72	0.39	3.46	3.20	8.53	1.85	0.52	0.47	1.60	0.15	23.33	0.34
Stage 1	West	6	1.75	1.81	2.06	1.25	0.29	1.81	1.17	4.28	2.11	1.81	1.61	3.13	1.03	10.86	0.80
Stage 1	Yates	7	1.69	1.23	3.54	1.08	0.90	2.45	2.02	5.07	2.01	1.22	1.10	3.46	0.17	8.55	1.05
Stage 1	All	2,036	1.51	1.41	4.05	0.43	0.54	2.39	2.67	10.27	1.73	0.58	0.30	13.64	0.04	1188.33	1.04
Stage 2	Near WF	56	1.62	1.58	3.90	0.72	0.64	1.74	1.66	9.50	1.93	1.81	0.55	12.73	0.11	101.26	2.60
Stage 2	Anchor	7	1.48	1.70	1.75	0.58	0.44	1.26	0.00	3.20	1.58	0.40	0.35	0.62	0.28	2.82	0.13
Stage 2	Bellflower	21	1.35	1.13	2.50	0.58	0.57	0.48	0.00	5.38	1.33	0.60	0.33	2.86	0.15	12.63	0.73
Stage 2	Blue Mound	15	1.29	1.39	2.00	0.64	0.41	3.55	3.20	9.77	2.31	0.54	0.28	2.36	0.14	8.15	0.64
Stage 2	Chenoa	92	1.40	1.25	2.95	0.69	0.50	2.06	2.04	6.24	1.63	0.34	0.28	2.41	0.14	31.04	0.29
Stage 2	Cropsey	5	1.31	1.06	2.02	0.90	0.51	1.03	0.00	2.93	1.43	0.53	0.30	1.14	0.30	2.64	0.37
Stage 2	Dix	10	1.58	1.30	3.49	0.78	0.80	3.37	3.02	6.67	1.91	0.86	0.50	3.09	0.25	8.62	0.94
Stage 2	Downs	41	1.41	1.36	3.15	0.70	0.52	2.48	2.67	8.86	1.79	0.42	0.25	2.57	0.15	17.34	0.49
Stage 2	Drummer	132	1.40	1.34	2.90	0.57	0.46	2.77	2.84	8.53	1.47	0.47	0.25	8.70	0.09	62.55	0.97
Stage 2	Empire	136	1.50	1.36	3.78	0.72	0.61	2.39	2.47	7.50	1.46	0.35	0.25	7.71	0.09	47.94	0.67
Stage 2	Gridley	69	1.47	1.36	3.63	0.76	0.55	2.20	2.44	6.67	1.58	0.42	0.28	3.07	0.10	29.23	0.55
Stage 2	Hudson	98	1.59	1.45	3.45	0.82	0.55	2.97	3.09	6.67	1.47	0.60	0.31	10.00	0.16	58.87	1.45

Stage 2	Lawndale	3	2.02	1.80	2.46	1.80	0.38	0.89	0.00	2.67	1.54	2.62	2.14	4.08	1.65	7.87	1.29
Stage 2	Lexington	88	1.54	1.43	3.19	0.72	0.58	2.79	3.17	11.20	1.84	0.41	0.27	3.30	0.09	36.09	0.48
Stage 2	Martin	53	1.43	1.41	2.52	0.69	0.42	2.32	2.57	8.00	1.84	0.32	0.26	1.20	0.11	17.17	0.21
Stage 2	Money Creek	21	1.65	1.49	3.20	0.67	0.68	2.99	3.29	6.40	1.66	1.15	0.76	5.02	0.26	24.12	1.07
Stage 2	Oldtown	71	1.94	1.94	3.31	0.64	0.61	2.83	3.06	6.11	1.36	1.00	0.68	5.01	0.19	71.02	1.04
Stage 2	Peach Orchard	7	1.57	1.27	2.42	1.17	0.56	2.76	2.67	5.33	1.78	0.33	0.33	0.52	0.26	2.33	0.09
Stage 2	Randolph	145	1.47	1.38	3.10	0.66	0.48	2.67	2.81	9.17	1.49	0.41	0.26	5.60	0.06	59.21	0.66
Stage 2	Sullivant	9	1.44	1.30	2.82	0.96	0.57	2.25	2.32	3.47	0.66	2.40	0.43	10.00	0.19	21.62	3.31
Stage 2	Towanda	34	1.42	1.37	3.20	0.71	0.53	2.84	2.89	6.67	1.49	0.67	0.43	4.86	0.13	22.78	0.99
Stage 2	West	4	1.82	1.76	2.18	1.59	0.26	1.07	0.00	4.28	2.14	3.30	3.01	6.17	1.03	13.21	2.16
Stage 2	Yates	4	2.33	2.10	3.60	1.51	1.01	1.93	1.73	4.27	2.26	1.66	1.29	3.49	0.58	6.65	1.39
Stage 2	All	1,121	1.51	1.40	3.90	0.57	0.56	2.50	2.68	11.20	1.65	0.59	0.30	12.73	0.06	665.16	1.10
Stage 3	Near WF	31	1.38	1.32	2.14	0.62	0.40	1.65	1.71	6.00	1.66	2.09	1.10	6.84	0.13	64.69	2.14
Stage 3	Anchor	4	1.29	1.30	1.58	0.97	0.25	3.09	4.00	4.36	2.08	0.34	0.36	0.37	0.26	1.34	0.05
Stage 3	Bellflower	11	1.44	1.39	2.45	0.93	0.40	0.85	0.00	4.36	1.39	0.42	0.33	1.36	0.16	4.63	0.35
Stage 3	Blue Mound	2	1.42	1.42	1.84	1.00	0.59	1.33	1.33	2.67	1.89	0.31	0.31	0.48	0.14	0.62	0.24
Stage 3	Chenoa	57	1.39	1.29	2.95	0.79	0.44	2.37	2.40	8.27	1.90	0.31	0.29	0.66	0.14	17.53	0.10
Stage 3	Cropsey	1	1.39	1.39	1.39	1.39		0.00	0.00	0.00		0.34	0.34	0.34	0.34	0.34	
Stage 3	Dix	5	1.29	1.22	1.74	0.78	0.36	2.41	2.44	4.00	1.70	1.12	0.33	4.35	0.25	5.59	1.81
Stage 3	Downs	25	1.47	1.48	2.84	0.73	0.43	2.50	2.67	4.98	1.27	0.61	0.36	2.84	0.17	15.18	0.75
Stage 3	Drummer	51	1.47	1.34	2.76	0.84	0.42	3.07	3.18	9.11	2.08	0.42	0.22	5.00	0.12	21.21	0.74
Stage 3	Empire	94	1.45	1.28	3.71	0.61	0.56	2.57	2.69	7.29	1.55	0.39	0.28	5.08	0.13	36.47	0.53
Stage 3	Gridley	48	1.47	1.40	2.54	0.78	0.41	2.54	2.67	6.67	1.43	0.36	0.29	1.82	0.10	17.19	0.28
Stage 3	Hudson	59	1.55	1.43	2.85	0.57	0.58	2.86	2.83	6.04	1.33	0.63	0.32	5.10	0.15	37.38	1.03
Stage 3	Lawndale	4	2.00	1.76	2.77	1.71	0.52	0.00	0.00	0.00	0.00	2.91	2.09	5.40	2.04	11.62	1.66
Stage 3	Lexington	76	1.48	1.37	2.41	0.56	0.46	2.26	2.61	6.00	1.45	0.41	0.29	2.81	0.08	31.37	0.44
Stage 3	Martin	25	1.40	1.35	2.36	0.93	0.37	2.44	2.93	4.00	1.18	0.35	0.32	1.33	0.16	8.80	0.23
Stage 3	Money Creek	11	1.77	1.54	2.67	1.12	0.57	3.18	3.07	10.00	2.83	0.99	0.69	3.35	0.30	10.85	0.83
Stage 3	Oldtown	41	1.88	1.73	3.01	1.15	0.55	2.96	3.18	6.27	1.84	1.28	0.76	5.27	0.20	52.60	1.25
Stage 3	Peach Orchard	6	1.60	1.53	2.37	1.10	0.50	2.75	2.52	4.98	1.24	1.55	0.41	5.00	0.24	9.29	2.00
Stage 3	Randolph	112	1.57	1.41	2.98	0.65	0.57	2.92	2.97	16.67	1.92	0.65	0.25	10.00	0.09	72.69	1.34
Stage 3	Sullivant	5	1.32	1.22	2.07	0.68	0.57	2.03	2.20	4.76	2.07	1.52	0.38	3.52	0.14	7.58	1.76
Stage 3	Towanda	20	1.40	1.31	2.24	0.72	0.41	3.30	3.31	7.79	2.23	0.63	0.40	1.86	0.19	12.53	0.55
Stage 3	West	0															
Stage 3	Yates	6	1.59	1.23	2.75	1.12	0.65	2.00	2.00	4.00	2.19	0.56	0.52	1.00	0.29	3.37	0.23
Stage 3	All	694	1.51	1.39	3.71	0.56	0.51	2.59	2.69	16.67	1.75	0.64	0.32	10.00	0.08	442.87	1.04
All	Near WF	177	1.52	1.40	3.90	0.58	0.60	1.49	0.00	9.50	1.81	1.71	0.61	12.73	0.11	301.92	2.30
All	Anchor	24	1.49	1.50	2.70	0.58	0.43	1.94	2.07	7.38	2.01	0.33	0.34	0.62	0.17	7.90	0.10
All	Bellflower	68	1.56	1.43	3.04	0.58	0.55	0.72	0.00	5.38	1.44	0.71	0.33	5.97	0.12	48.03	1.11
All	Blue Mound	43	1.28	1.17	2.00	0.64	0.37	3.18	2.93	10.27	2.62	0.51	0.28	2.36	0.11	22.02	0.57
All	Chenoa	282	1.44	1.38	2.95	0.69	0.46	2.13	2.13	10.00	1.74	0.35	0.29	5.79	0.10	99.93	0.45
All	Cropsey	15	1.43	1.39	2.21	0.72	0.48	0.76	0.00	2.93	1.13	0.96	0.34	5.42	0.23	14.40	1.42
All	Dix	35	1.31	1.20	3.49	0.78	0.50	2.28	2.13	6.67	1.80	0.68	0.30	4.35	0.13	23.94	0.90

All	Downs	138	1.41	1.39	3.15	0.67	0.42	2.55	2.69	8.86	1.55	0.48	0.36	2.84	0.10	66.11	0.56
All	Drummer	419	1.37	1.28	3.33	0.48	0.46	2.38	2.33	9.11	1.84	0.45	0.23	11.00	0.09	188.92	0.96
All	Empire	503	1.49	1.38	3.83	0.61	0.56	2.47	2.67	7.50	1.50	0.39	0.27	10.41	0.04	197.77	0.67
All	Gridley	228	1.49	1.38	3.63	0.76	0.51	2.17	2.19	6.73	1.46	0.50	0.28	6.18	0.10	113.06	0.82
All	Hudson	336	1.56	1.46	3.45	0.57	0.51	2.88	2.93	6.67	1.42	0.49	0.31	10.00	0.14	164.17	0.93
All	Lawndale	11	1.90	1.80	2.77	1.10	0.49	0.39	0.00	2.67	0.89	2.82	2.14	5.40	1.00	31.04	1.53
All	Lexington	325	1.49	1.35	3.87	0.56	0.55	2.41	2.67	11.20	1.68	0.45	0.28	12.92	0.08	146.13	0.81
All	Martin	169	1.43	1.40	2.61	0.69	0.41	2.40	2.67	8.00	1.65	0.47	0.32	9.49	0.08	79.39	0.84
All	Money Creek	64	1.83	1.74	3.52	0.67	0.71	3.20	3.36	10.00	1.92	1.16	0.68	13.64	0.20	74.13	1.77
All	Oldtown	254	1.96	1.89	4.05	0.64	0.66	2.97	3.17	8.60	1.65	1.01	0.69	5.27	0.17	257.60	1.00
All	Peach Orchard	42	1.39	1.20	2.59	0.72	0.51	2.50	2.52	9.33	2.10	0.84	0.34	7.02	0.17	35.21	1.48
All	Randolph	558	1.51	1.40	3.39	0.43	0.51	2.71	2.89	16.67	1.58	0.49	0.25	10.00	0.06	271.25	0.91
All	Sullivant	34	1.23	1.12	2.82	0.51	0.48	2.13	2.20	6.13	1.78	1.53	0.36	10.00	0.14	52.16	2.19
All	Towanda	99	1.47	1.44	3.20	0.71	0.45	3.21	3.18	8.53	1.82	0.59	0.47	4.86	0.13	58.64	0.67
All	West	10	1.78	1.81	2.18	1.25	0.26	1.52	0.00	4.28	2.04	2.41	2.03	6.17	1.03	24.07	1.58
All	Yates	17	1.80	1.36	3.60	1.08	0.85	2.17	2.02	5.07	2.01	1.09	0.58	3.49	0.17	18.57	1.00
All	All	3,851	1.51	1.40	4.05	0.43	0.54	2.46	2.67	16.67	1.71	0.60	0.30	13.64	0.04	2296.36	1.06

Notes: n=# of observations; StDev.=Standard Deviation; Max=Maximum; Min.=Minimum; SQFT=above grade living area of the dwelling in 1000s of square feet;

Garage=area of the garage in 180s of square feet, approximately the number of standard cars that can fit in the garage; Acreage=total number of acres of the property; Sum.=Summation or Total;

Near WF=Near Twin Groves I & II=Near Wind Farm=1 if property located within 3 mile buffer of wind farm, 0 otherwise;

Township dummy variables exclude properties near TG I and II; Stage 1=Before TG I and II (WF) Approval=01/01/2001 – 09/20/2005;

Stage 2=Post TG I and II (WF) Approval and during Construction=09/21/2005 – 02/01/2008; Stage 3=Twin Groves I and II Online, WF Operation=02/02/2008 – 12/01/2009.

Table C. 12. Township and Wind Farm 3-Stage Cross Tabulations

Wind Farm Stages		*n*	Year Built Mean	Year Built Median	Year Built Max	Year Built Min.	Year Built Std. Dev.	Fireplaces Sum.	RR Tracks Sum.	Lakefront Sum.	Cul-de-sac Sum.	Trees Sum.
Stage 1	Near WF	90	1929	1919	2001	1849	38	19	23	3	3	13
Stage 1	Anchor	13	1913	1894	1973	1858	37	3	8	0	0	0
Stage 1	Bellflower	36	1940	1930	1998	1889	35	5	19	0	0	0
Stage 1	Blue Mound	26	1909	1897	2003	1879	31	3	10	0	0	0
Stage 1	Chenoa	133	1932	1935	2003	1859	43	22	41	0	0	0
Stage 1	Cropsey	9	1932	1921	2000	1871	39	0	4	0	0	1
Stage 1	Dix	20	1941	1955	1986	1900	30	0	1	0	0	0
Stage 1	Downs	72	1977	1999	2003	1867	33	25	19	0	14	9
Stage 1	Drummer	236	1943	1951	2004	1883	31	29	46	0	4	0
Stage 1	Empire	273	1954	1969	2005	1849	44	76	18	0	35	5
Stage 1	Gridley	111	1934	1940	2003	1869	38	23	22	0	0	2
Stage 1	Hudson	179	1972	1978	2003	1836	31	81	0	11	6	26
Stage 1	Lawndale	4	1922	1924	1930	1909	10	1	0	0	0	0
Stage 1	Lexington	161	1939	1958	2002	1824	44	48	36	1	17	16
Stage 1	Martin	91	1938	1920	2004	1874	44	24	28	0	23	6
Stage 1	Money Creek	32	1982	1988	2004	1875	22	18	1	5	7	21
Stage 1	Oldtown	142	1979	1981	2004	1899	22	101	16	14	27	64
Stage 1	Peach Orchard	29	1935	1930	1982	1900	29	2	13	0	0	1
Stage 1	Randolph	301	1971	1982	2005	1869	33	119	52	1	26	71
Stage 1	Sullivant	20	1934	1929	1978	1900	26	3	0	0	0	1
Stage 1	Towanda	45	1949	1971	2000	1883	36	12	20	2	6	0
Stage 1	West	6	1930	1906	1999	1891	46	0	0	0	0	1
Stage 1	Yates	7	1933	1940	1965	1896	25	1	1	0	0	0
Stage 1	All	2,036	1952	1963	2005	1824	40	615	378	37	168	237
Stage 2	Near WF	56	1924	1916	2006	1859	39	9	11	1	0	5
Stage 2	Anchor	7	1928	1890	2001	1879	52	2	5	0	0	0
Stage 2	Bellflower	21	1928	1910	1999	1884	35	2	9	0	0	0
Stage 2	Blue Mound	15	1920	1899	1994	1879	41	2	7	0	0	0
Stage 2	Chenoa	92	1929	1919	2003	1859	42	14	28	0	0	0
Stage 2	Cropsey	5	1924	1904	1958	1896	32	1	2	0	0	0
Stage 2	Dix	10	1945	1959	2000	1860	51	0	2	0	0	0
Stage 2	Downs	41	1971	1976	2005	1869	37	17	12	0	5	9
Stage 2	Drummer	132	1943	1951	2005	1880	31	15	36	0	4	1
Stage 2	Empire	136	1952	1964	2005	1849	43	30	17	0	13	2
Stage 2	Gridley	69	1940	1951	2002	1859	39	11	14	0	0	1
Stage 2	Hudson	98	1968	1974	2003	1880	32	47	0	9	9	20

Stage 2	Lawndale	3	1932	1910	1976	1909	38	1	0	0	0	0
Stage 2	Lexington	88	1935	1952	2003	1859	46	18	12	0	8	5
Stage 2	Martin	53	1927	1909	2005	1869	43	12	19	0	8	3
Stage 2	Money Creek	21	1975	1980	2008	1894	26	5	2	2	1	9
Stage 2	Oldtown	71	1979	1979	2004	1888	18	55	5	7	22	19
Stage 2	Peach Orchard	7	1941	1953	1960	1900	23	0	2	0	0	0
Stage 2	Randolph	145	1967	1978	2004	1859	35	46	24	3	14	33
Stage 2	Sullivant	9	1919	1910	1955	1900	21	0	1	0	0	0
Stage 2	Towanda	34	1955	1971	2000	1886	32	11	9	2	5	0
Stage 2	West	4	1917	1917	1933	1900	14	0	0	0	0	0
Stage 2	Yates	4	1911	1915	1920	1896	11	1	0	0	0	0
Stage 2	All	1,121	1949	1960	2008	1849	41	299	217	24	89	107
Stage 3	Near WF	31	1927	1920	2004	1859	39	4	7	0	1	8
Stage 3	Anchor	4	1945	1954	1964	1909	25	0	1	0	0	0
Stage 3	Bellflower	11	1935	1919	1997	1879	41	0	6	0	0	0
Stage 3	Blue Mound	2	1884	1884	1899	1869	21	0	0	0	0	0
Stage 3	Chenoa	57	1929	1921	2003	1869	41	6	16	0	0	0
Stage 3	Cropsey	1	1960	1960	1960	1960		0	0	0	0	0
Stage 3	Dix	5	1920	1907	1956	1890	29	0	1	0	0	0
Stage 3	Downs	25	1966	1997	2004	1899	41	5	8	0	2	4
Stage 3	Drummer	51	1951	1956	2008	1892	31	10	14	0	1	0
Stage 3	Empire	94	1946	1961	2003	1867	40	23	10	0	11	1
Stage 3	Gridley	48	1943	1953	2002	1869	42	10	11	0	0	0
Stage 3	Hudson	59	1970	1974	2003	1890	29	22	0	3	6	11
Stage 3	Lawndale	4	1904	1902	1910	1900	5	0	0	0	0	0
Stage 3	Lexington	76	1935	1954	2005	1869	46	24	18	0	10	8
Stage 3	Martin	25	1934	1914	2005	1880	43	3	8	0	6	0
Stage 3	Money Creek	11	1967	1981	2002	1895	37	9	1	1	1	6
Stage 3	Oldtown	41	1984	1981	2004	1960	11	31	3	8	12	20
Stage 3	Peach Orchard	6	1925	1920	1950	1900	20	0	0	0	0	1
Stage 3	Randolph	112	1965	1978	2004	1879	35	36	20	1	4	26
Stage 3	Sullivant	5	1919	1915	1955	1900	23	0	0	0	0	0
Stage 3	Towanda	20	1954	1970	1974	1901	27	5	8	2	3	0
Stage 3	West	0										
Stage 3	Yates	6	1931	1929	1995	1886	36	0	4	0	0	0
Stage 3	All	694	1950	1961	2008	1859	40	188	136	15	57	85
All Stages	Near WF	177	1927	1919	2006	1849	39	32	41	4	4	26
All Stages	Anchor	24	1923	1917	2001	1858	40	5	14	0	0	0
All Stages	Bellflower	68	1935	1924	1999	1879	36	7	34	0	0	0
All Stages	Blue Mound	43	1912	1899	2003	1869	35	5	17	0	0	0
All Stages	Chenoa	282	1930	1921	2003	1859	42	42	85	0	0	0
All Stages	Cropsey	15	1931	1921	2000	1871	35	1	6	0	0	1
All Stages	Dix	35	1939	1955	2000	1860	37	0	4	0	0	0

All Stages	Downs	138	1973	1999	2005	1867	36	47	39	0	21	22
All Stages	Drummer	419	1944	1951	2008	1880	31	54	96	0	9	1
All Stages	Empire	503	1952	1964	2005	1849	43	129	45	0	59	8
All Stages	Gridley	228	1938	1946	2003	1859	39	44	47	0	0	3
All Stages	Hudson	336	1971	1975	2003	1836	31	150	0	23	21	57
All Stages	Lawndale	11	1918	1910	1976	1900	22	2	0	0	0	0
All Stages	Lexington	325	1937	1956	2005	1824	45	90	66	1	35	29
All Stages	Martin	169	1934	1915	2005	1869	43	39	55	0	37	9
All Stages	Money Creek	64	1977	1986	2008	1875	26	32	4	8	9	36
All Stages	Oldtown	254	1980	1981	2004	1888	19	187	24	29	61	103
All Stages	Peach Orchard	42	1935	1934	1982	1900	27	2	15	0	0	2
All Stages	Randolph	558	1969	1979	2005	1859	34	201	96	5	44	130
All Stages	Sullivant	34	1928	1923	1978	1900	25	3	1	0	0	1
All Stages	Towanda	99	1952	1971	2000	1883	33	28	37	6	14	0
All Stages	West	10	1925	1911	1999	1891	36	0	0	0	0	1
All Stages	Yates	17	1927	1929	1995	1886	27	2	5	0	0	0
All Stages	All	3,851	1951	1962	2008	1824	41	1,102	731	76	314	429

Notes: n=# of observations; Std. Dev.=Standard Deviation; Max=Maximum; Min.=Minimum; Sum.=Summation or Total; Year Built=the year the property was originally built; Fireplaces=# of fireplaces; RR Tracks=Railroad Tracks=1 if within 180 meters of railroad tracks, 0 otherwise; Lakefront=1 if within 70 meters of a lake, 0 otherwise; Cul-de-sac=1 if property located near a cul-de-sac, 0 otherwise; Near WF=Near Twin Groves I & II=Near Wind Farm=1 if property located within 3 mile buffer of wind farm, 0 otherwise; Trees=1 if within 180 meters of trees, 0 otherwise; Township dummy variables exclude properties near TG I and II; Stage 1=Before TG I and II (WF) Approval=01/01/2001 – 09/20/2005; Stage 2=Post TG I and II (WF) Approval and during Construction=09/21/2005 – 02/01/2008; Stage 3=Twin Groves I and II Online, WF Operation=02/02/2008 – 12/01/2009; All Stages=01/01/2001 – 12/01/2009.

APPENDIX D. INTRODUCTION TO DIFFERENCE-IN-DIFFERENCES ESTIMATORS

This analysis utilizes a difference-in-differences estimator. In order to get a better understanding of how to interpret the results, this section goes through simplified examples that can be extended to most of the models estimated[137]. The estimated coefficients from the real estimation results (Appendix E) cannot be calculated exactly as indicated in this section because of the addition of various housing characteristics into the model which provides appropriate controls such that the wind farm impact on property values can be estimated more precisely (however, the estimated coefficients can be interpreted roughly the same).

1. EXAMPLE: TWO WIND FARM DEVELOPMENT STAGES

Consider the following equation:

$$\text{RealPrice} = \beta_0 + \delta_0 \text{wfoperation} + \gamma_0 \text{nearwf} + \delta_1 \text{wfoperation} * \text{nearwf} + \varepsilon \qquad \text{(D1)}$$

Where

- *RealPrice* is the selling price of properties adjusted for inflation;
- *wfoperation* is a dummy variable equal to 1 for properties that sold during the time period in which the wind farm was operational (and 0 otherwise);
- *nearwf* is a dummy variable equal to 1 for properties that sold near the wind farm area (and 0 otherwise);
- *wfoperation*nearwf* is a dummy variable equal to 1 for properties that sold that are located near the wind farm area during the time period in which the wind farm was operational (and 0 otherwise);
- ε is an error term[138];
- $\beta_0, \delta_0, \gamma_0, \delta_1$ represent parameters[139] to be estimated.

Eq. (D1) contains the "true" or "unknown" population parameters, while regression analysis involves estimating these "true" or "unknown" parameters by using a sample of data from the population[140]. The estimated[141] coefficients of Eq. (D1) can literally be calculated using simple averages[142].

$$\hat{\beta}_0 = \overline{\text{RealPrice}}_{\text{farwf,B4Operation}} \qquad \text{(D2)}$$

$$\hat{\delta}_0 = \left(\overline{\text{RealPrice}}_{\text{farwf,wfOperation}} - \overline{\text{RealPrice}}_{\text{farwf,B4Operation}}\right) \qquad \text{(D3)}$$

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[137] It can be extended to the rest of the models estimated except the separate stage estimations presented in Tables 14-16 from Section VI and Table E.3 of Appendix E.
[138] An error term contains unobserved factors that affect the dependent variable. It may also include measurement errors in the observed dependent or independent variables (Wooldridge, 2009).
[139] A parameter is an unknown value that describes a population relationship (Wooldridge, 2009).
[140] Using the sample of data collected from the population on particular variables of interest, one estimates the parameters of the model by regressing the dependent variable on the explanatory variables via Ordinary Least Squares (OLS) multiple linear regression analysis.
[141] The equation is estimated using Ordinary Least Squares (OLS) multiple linear regression analysis. OLS is a method for estimating the parameters of a multiple linear regression model. The ordinary least squares estimates are obtained by minimizing the sum of squared residuals (Wooldridge, 2009).
[142] The "mean" or "average" is defined as the sum of *n* numbers divided by *n*. The bar over a variable represents the average value.

$$\hat{\gamma}_0 = \left(\overline{\text{RealPrice}}_{\text{nearwf,B4Operation}} - \overline{\text{RealPrice}}_{\text{farwf,B4Operation}}\right) \quad \text{(D4)}$$

$$\hat{\delta}_1 = \left(\overline{\text{RealPrice}}_{\text{nearwf,wfOperation}} - \overline{\text{RealPrice}}_{\text{nearwf,B4Operation}}\right) - \left(\overline{\text{RealPrice}}_{\text{farwf,wfOperation}} - \overline{\text{RealPrice}}_{\text{farwf,B4Operation}}\right) \quad \text{(D5)}$$

Where[143]

- $\overline{RealPrice}_{farwf,B4Operation}$ is the real average price of properties that sold *far* from the wind farm during the time period *before* the wind farm was *operational.*
- $\overline{RealPrice}_{farwf,wfOperation}$ is the real average price of properties that sold *far* from the wind farm during the time period when the wind farm was *operational*.
- $\overline{RealPrice}_{nearwf,B4Operation}$ is the real average price of properties that sold *near* the wind farm during the time period *before* the wind farm was *operational.*
- $\overline{RealPrice}_{nearwf,wfOperation}$ is the real average price of properties that sold *near* the wind farm during the time period when the wind farm was *operational.*

The bar over *RealPrice* denotes the average and the subscript *B4Operation* denotes the time period before wind farm operation and the subscript *wfOperation* denotes the time period in which the wind farm was fully operational. The subscript *farwf* denotes properties that sold far away from the wind farm and the subscript *nearwf* denotes properties that sold near the wind farm. Thus, the estimated coefficients have the following interpretations:

- $\hat{\beta}_0$ the intercept represents the real average price of a home far from the wind farm prior to operation of the wind farm.
- $\hat{\delta}_0$ captures aggregate factors that affect the real prices of properties over time; it captures changes in the real value of properties far from the wind farm from the period before wind farm operations to the period when the wind farm was operational.
- $\hat{\gamma}_0$ measures the *location effect* that is *not* due to the presence of the wind farm. This takes into account any housing price differential between properties near the wind farm and far from the wind farm prior to wind farm operations.
- $\hat{\delta}_1$ the coefficient on the interaction term *wfoperation*nearwf* is the estimated coefficient of interest: it measures the change in real housing values due to the new wind farm, provided we assume that houses both near and far from the wind farm site did not appreciate at different rates for other reasons. Wind farm area stigma would occur if $\hat{\delta}_1$ is negative and statistically significant at conventional levels of significance[144].

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[143] Column (1) of Table D.1 of Appendix D contains the results of estimating Eq. (D1). The real average prices of properties that sold can be found in Table C.1 of Appendix C.

[144] Statistically significant at the 10% level means that, over many trials, one expects to *reject* the null hypothesis that the coefficient is zero, when it is in fact zero, one time out of ten (Malpezzi et al., 1980). Statistically significant at the 5% level means that, over many trials, one expects to *reject* the null hypothesis that the coefficient is zero, when it is in fact zero, one time out of twenty. Statistically significant at the 1% level means that, over many trials, one expects to *reject* the null hypothesis that the coefficient is zero, when it is in fact zero, one time out of one hundred. Small levels of statistical significance are evidence against the null hypothesis. The null hypothesis is that there is no significant relationship between the dependent variable and the independent variable; i.e., the coefficient is zero. Thus small levels of statistical significance are evidence against the null hypothesis, since they indicate that the outcome of the data occurs with small probability if the null hypothesis is true. An estimated coefficient that is statistically significant at the 1% level implies that it is statistically significant at the 5% and 10% level. However, the opposite is not necessarily true. The strongest level of statistical significance is reported throughout this report;

The results from OLS estimation of Eq. (D1) are presented in Column (1) of Table D.1 and in Eq. (D6). For those unfamiliar with difference-in-differences estimators or regression analysis, it would be a good idea to prove to yourself that the estimated coefficients in Eq. (D6) can be calculated using the averages of *RealPrice* presented in Eqs. (D2-D5). Real average property prices (the averages of *RealPrice*) can be found in Table C.1 of Appendix C; however, some are provided below for convenience.

$$\widehat{\text{RealPrice}} = 127{,}694 - 2{,}488\ \text{wfoperation} - 21{,}916\ \text{nearwf} + 13{,}524\ \text{wfoperation} * \text{nearwf} \qquad \text{(D6)}$$

$$\hat{\beta}_0 = \overline{\text{RealPrice}}_{\text{farwf,B4Operation}} = \$127{,}694$$

$$\hat{\delta}_0 = \left(\overline{\text{RealPrice}}_{\text{farwf,wfOperation}} - \overline{\text{RealPrice}}_{\text{farwf,B4Operation}}\right) = -\$2{,}488$$

$$\hat{\gamma}_0 = \left(\overline{\text{RealPrice}}_{\text{nearwf,B4Operation}} - \overline{\text{RealPrice}}_{\text{farwf,B4Operation}}\right) = -\$21{,}916$$

$$\hat{\delta}_1 = \left(\overline{\text{RealPrice}}_{\text{nearwf,wfOperation}} - \overline{\text{RealPrice}}_{\text{nearwf,B4Operation}}\right) - \left(\overline{\text{RealPrice}}_{\text{farwf,wfOperation}} - \overline{\text{RealPrice}}_{\text{farwf,B4Operation}}\right)$$

$$\hat{\delta}_1 = (\$116{,}814 - \$105{,}778) - (\$125{,}206 - \$127{,}694)$$

$$\hat{\delta}_1 = \$11{,}036 - (-\$2{,}488)$$

$$\hat{\delta}_1 = \$13{,}524$$

The real average price of a home far from the eventual wind farm site prior to operation of the wind farm was $127,694. Homes located far from the wind farm site have lost on average $2,488 in value since the wind farm began operating. Homes located near the wind farm were valued on average $21,916 less than homes far from the wind farm, before the wind farm began operating. Homes located near the wind farm had their values appreciate $13,524 more on average than homes located far from the wind farm, after the wind farm began operating. Only the coefficient of the intercept, *C* ($\hat{\beta}_0$) and *nearwf* ($\hat{\gamma}_0$) are statistically significant at conventional levels.

2. EXAMPLE: THREE WIND FARM DEVELOPMENT STAGES

The difference-in-differences estimator can be extended to take into account the different stages of the wind farm development. Consider the following equation:

$$\text{RealPrice} = \alpha_0 + \varphi_1\text{wfconstr} + \varphi_2\text{wfoperation} + \gamma_0\text{nearwf} + \theta_1\text{wfconstr} * \text{nearwf} + \theta_2\text{wfoperation} * \text{nearwf} + \varepsilon \qquad \text{(D7)}$$

Where

- *RealPrice* is the selling prices of properties adjusted for inflation;
- *wfconstr* is a dummy variable equal to 1 for properties that sold during the time period after the wind farm was approved and during construction (and 0 otherwise);

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e.g., 1% would be reported instead of reporting 1%, 5%, and 10%.

- *wfoperation* is a dummy variable equal to 1 for properties that sold during the time period that the wind farm was operational (and 0 otherwise);
- *nearwf* is a dummy variable equal to 1 for properties that sold near the wind farm area (and 0 otherwise);
- *wfconstr*nearwf* is a dummy variable equal to 1 for properties that sold that are located near the wind farm area during the time period after the wind farm was approved and during construction (and 0 otherwise);
- *wfoperation*nearwf* is a dummy variable equal to 1 for properties that sold that are located near the wind farm area during the time period in which the wind farm was operational (and 0 otherwise);
- ε is an error term;
- $\alpha_0, \varphi_1, \varphi_2, \gamma_0, \theta_1, \theta_2$ represent parameters to be estimated.

Again, Eq. (D7) contains the "true" or "unknown" population parameters, while regression analysis involves estimating these unknown parameters by using a sample of data from the population. The estimated coefficients of Eq. (D7) can literally be calculated using simple averages.

$$\hat{\alpha}_0 = \overline{\text{RealPrice}}_{\text{farwf,B4approv}} \tag{D8}$$

$$\hat{\varphi}_1 = \left(\overline{\text{RealPrice}}_{\text{farwf,wfconstr}} - \overline{\text{RealPrice}}_{\text{farwf,B4approv}}\right) \tag{D9}$$

$$\hat{\varphi}_2 = \left(\overline{\text{RealPrice}}_{\text{farwf,wfOperation}} - \overline{\text{RealPrice}}_{\text{farwf,B4approv}}\right) \tag{D10}$$

$$\hat{\gamma}_0 = \left(\overline{\text{RealPrice}}_{\text{nearwf,B4approv}} - \overline{\text{RealPrice}}_{\text{farwf,B4approv}}\right) \tag{D11}$$

$$\hat{\theta}_1 = \left(\overline{\text{RealPrice}}_{\text{nearwf,wfconstr}} - \overline{\text{RealPrice}}_{\text{nearwf,B4approv}}\right) - \left(\overline{\text{RealPrice}}_{\text{farwf,wfconstr}} - \overline{\text{RealPrice}}_{\text{farwf,B4approv}}\right) \tag{D12}$$

$$\hat{\theta}_2 = \left(\overline{\text{RealPrice}}_{\text{nearwf,wfOperation}} - \overline{\text{RealPrice}}_{\text{nearwf,B4approv}}\right) - \left(\overline{\text{RealPrice}}_{\text{farwf,wfOperation}} - \overline{\text{RealPrice}}_{\text{farwf,B4approv}}\right) \tag{D13}$$

Where[145]

- $\overline{RealPrice}_{farwf,B4approv}$ is the real average price of properties that sold *far* from the wind farm during the time period *before* the wind farm was *approved*[146].
- $\overline{RealPrice}_{farwf,wfconstr}$ is the real average price of properties that sold *far* from the wind farm during the time period *after* the wind farm was *approved* and during *construction.*
- $\overline{RealPrice}_{farwf,wfOperation}$ is the real average price of properties that sold *far* from the wind farm during the time period when the wind farm was *operational*.
- $\overline{RealPrice}_{nearwf,B4approv}$ is the real average price of properties that sold *near* the eventual wind farm location during the time period *before* the wind farm was *approved*.
- $\overline{RealPrice}_{nearwf,wfconstr}$ is the real average price of properties that sold *near* the wind farm during the time period *after* the wind farm was *approved* and during *construction.*
- $\overline{RealPrice}_{nearwf,wfOperation}$ is the real average price of properties that sold *near* the wind

[145] Column (2) of Table D.1 of Appendix D contains the results of estimating Eq. (D7). The real average prices of properties that sold can be found in Table C.4 of Appendix C.
[146] Before the wind farm (TG I and II) was approved by the McLean County Board.

farm during the time period when the wind farm was *operational*.

The bar over *RealPrice* denotes the average value of the real property prices. The subscript *farwf* denotes properties that sold far from the wind farm and the subscript *nearwf* denotes properties that sold near the wind farm. The subscript *B4approv* denotes the time period before the wind farm received approval from the McLean County Board (01/01/2001 – 09/20/2005). The subscript *wfconstr* denotes the time period after the wind farm received approval from the McLean County Board and during the construction stage of the wind farm project (09/21/2005 – 02/01/2008), and the subscript *wfOperation* denotes the time period in which the wind farm was fully operational (02/02/2008 – 12/01/2009).

The difference-in-differences estimators from Eq. (D7) include $\hat{\theta}_1$ and $\hat{\theta}_2$, Eqs. (D12-D13). $\hat{\theta}_1$ is an estimate of the difference over time in the average difference of real housing prices near the wind farm (*nearwf*) and farther away from the wind farm (*farwf*), and the difference over time is in relation to before wind farm approval *(B4approv)* and post wind farm approval and during the construction stage of the wind farm *(wfconstr)*. A negative and statistically significant $\hat{\theta}_1$ would provide support for *wind farm anticipation stigma theory*. Whereas $\hat{\theta}_2$ estimates the difference over time in the average difference of housing prices near the wind farm (*nearwf*) and farther away from the wind farm (*farwf*), and the difference over time is in relation to before wind farm approval *(B4approv)* and during wind farm operations *(wfOperation)*. A negative and statistically significant $\hat{\theta}_2$would provide support for *wind farm area stigma theory*. The results from estimation of Eq. (D7) using Ordinary Least Squares are presented in Column (2) of Table D.1. For those unfamiliar with difference-in-differences estimators or regression analysis, it would be a good idea to prove to yourself that the estimated coefficients in Column (2) of Table D.1 can be calculated using the averages of *RealPrice* presented in Eqs. (D8-D13). The averages of *RealPrice* can be found in Table C.4.

$$\hat{\alpha}_0 = \overline{\text{RealPrice}}_{\text{farwf,B4approv}} = \$128{,}491$$

$$\hat{\varphi}_1 = \left(\overline{\text{RealPrice}}_{\text{farwf,wfconstr}} - \overline{\text{RealPrice}}_{\text{farwf,B4approv}}\right) = -\$2{,}254$$

$$\hat{\varphi}_2 = \left(\overline{\text{RealPrice}}_{\text{farwf,wfOperation}} - \overline{\text{RealPrice}}_{\text{farwf,B4approv}}\right) = -\$3{,}286$$

$$\hat{\gamma}_0 = \left(\overline{\text{RealPrice}}_{\text{nearwf,B4approv}} - \overline{\text{Real Price}}_{\text{farwf,B4approv}}\right) = -\$20{,}323$$

$$\hat{\theta}_1 = \left(\overline{\text{Real Price}}_{\text{nearwf,wfconstr}} - \overline{\text{Real Price}}_{\text{nearwf,B4approv}}\right) - \left(\overline{\text{Real Price}}_{\text{farwf,wfconstr}} - \overline{\text{Real Price}}_{\text{farwf,B4approv}}\right) = -\$3{,}977$$

$$\ddot{\theta}_2 = \left(\overline{\text{Real Price}}_{\text{nearwf,wfOperation}} - \overline{\text{Real Price}}_{\text{nearwf,B4approv}}\right) - \left(\overline{\text{Real Price}}_{\text{farwf,wfOperation}} - \overline{\text{Real Price}}_{\text{farwf,B4approv}}\right) = \$11{,}931$$

The real average price of a home far from the wind farm prior to McLean County Board approval of the wind farm was $128,491. Homes located far from the wind farm depreciated $2,254 on average post approval and during construction of the wind farm as compared to home values before approval of the wind farm. Homes located far from the wind farm depreciated $3,286 on average after the wind farm became operational as compared to home values before approval of the wind farm.

Before the wind farm was approved by the McLean County Board, homes located near the wind farm were valued on average $20,323 less than homes located far from the wind farm. This estimate is statistically significant at the one percent level, thus we can strongly reject the hypothesis that the real average property value for homes near and far from the wind farm were the same before wind farm approval, and this demonstrates the *location effect* that is *not* due to the presence of the wind farm.

When comparing the appreciation in property values from the time period before approval of the wind farm to the time period after the wind farm was approved and during the construction stage of the wind farm project, the appreciation in property values was $3,977 lower on average for properties near the wind

farm when compared with properties far from the wind farm, *ceteris paribus.* When comparing the appreciation in property values from the time period before approval of the wind farm to the time period during wind farm operations, the appreciation in property values was $11,931 higher on average for properties near the wind farm when compared with properties far from the wind farm, *ceteris paribus.* Only the coefficient of the intercept, *C* ($\hat{\alpha}_0$) and *nearwf* ($\hat{\gamma}_0$) are statistically significant at conventional levels.

Table D. 1. Example Results: Two and Three Wind Farm Stages

Dependent Variable: RealPrice	2 stages		3 stages	
	(1)		**(2)**	
C (intercept)	127,694	***	128,491	***
	(1,164)		(1,441)	
Post Wind Farm Approval/Construction (wfconstr)			-2,254	
			(2,445)	
Wind Farm Operation (wfoperation)	-2,488		-3,286	
	(2,756)		(2,885)	
Near Wind Farm (nearwf)	-21,916	***	-20,323	***
	(4,208)		(5,589)	
Near Wind Farm, Post WF Approval/Construction (wfconstr*nearwf)			-3,977	
			(8,403)	
Near Wind Farm, WF Operation (wfoperation*nearwf)	13,524		11,931	
	(9,013)		(9,736)	
Adjusted R-squared	0.0038		0.0036	
Standard Error of Regression	63,314		63,321	
Log Likelihood	-48,038		-48,038	
F-statistic	6	***	4	***
Mean Real Property Price	126,347		126,347	
Std Dev. Real Property Price	63,435		63,435	
Akaike Information Criterion	24.95		24.95	
Schwarz Criterion	24.96		24.96	
Durbin-Watson Statistic	1.54		1.54	

***denotes significance at 1% level **denotes significance at 5% level *denotes significance at 10% level
Notes: White Heteroskedasticity-Consistent Standard Errors & Covariance are in parentheses (White, 1980). Estimation sample includes the period 01/01/2001 - 12/01/2009. *n*=3,851. The results from this estimation are not considered the "main" results of this study. This estimation is for demonstrative purposes only.

3. EXAMPLE: THREE WIND FARM DEVELOPMENT STAGES, TOWNSHIPS

Now moving on to a more complicated example that explicitly estimates the impact of the wind farm on property values over the different stages of wind farm development, in which the different stages are thought to roughly correspond to the different levels of risk as perceived by homebuyers. The following estimations directly compare changes in property values near the wind farm with changes in property values for each of the townships farther from the wind farm over time.

Consider the following equations:

$$\ln(\text{RealPrice}) = \omega_0 + \omega_1 \text{wfconstr} + \omega_2 \text{wfoperation} + \gamma_0 \text{nearwf} + \vartheta_1 \text{wfconstr} * \text{nearwf} + \psi_2 \text{wfoperation} * \text{nearwf} + \boldsymbol{\gamma_i \text{TWP}_i} + \boldsymbol{\vartheta_i} \text{wfconstr} * \boldsymbol{\text{TWP}_i} + \boldsymbol{\psi_i} \text{wfoperation} * \boldsymbol{\text{TWP}_i} + \varepsilon \quad \text{(D14)}$$

$$\text{RealPrice} = \alpha_0 + \alpha_1 \text{wfconstr} + \alpha_2 \text{wfoperation} + \lambda_0 \text{nearwf} + \theta_1 \text{wfconstr} * \text{nearwf} + \phi_2 \text{wfoperation} * \text{nearwf} + \boldsymbol{\lambda_i \text{TWP}_i} + \boldsymbol{\theta_i} \text{wfconstr} * \boldsymbol{\text{TWP}_i} + \boldsymbol{\phi_i} \text{wfoperation} * \boldsymbol{\text{TWP}_i} + \varepsilon \quad \text{(D15)}$$

Where

- *ln(RealPrice)* represents the natural logarithm of the selling prices of houses adjusted for inflation;
- *RealPrice* represents the selling prices of houses adjusted for inflation;
- *wfconstr* is a dummy variable equal to 1 for properties that sold during the time period after the wind farm was approved and during construction (and 0 otherwise);
- *wfoperation* is a dummy variable equal to 1 for properties that sold during the time period in which the wind farm was operational (and 0 otherwise);
- *nearwf* is a dummy variable equal to 1 for properties that sold near the wind farm area (and 0 otherwise);
- *wfconstr*nearwf* is a dummy variable equal to 1 for properties that sold that are located near the wind farm area during the time period after the wind farm was approved and during the construction period (and 0 otherwise);
- *wfoperation*nearwf* is a dummy variable equal to 1 for properties that sold that are located near the wind farm area during the time period in which the wind farm was operational (and 0 otherwise);
- $\boldsymbol{\text{TWP}_i}$ represents a vector of township *(twp-i)* dummy variables and the excluded township is *Lexington* township *(Lex)*. For each *township-i (twp-i)*, the dummy variable equals 1 for properties that sold that are located in that particular township *(twp-i)* far from the wind farm (and 0 otherwise), where *i* represents each of the following townships (*TWP*): *Anchor, Bellflower, Blue Mound, Chenoa, Cropsey, Dix, Downs, Drummer, Empire, Gridley, Hudson, Lawndale, Martin, Money Creek, Oldtown, Peach Orchard, Randolph, Sullivant, Towanda, West,* and *Yates.*
- *wfconstr** $\boldsymbol{\text{TWP}_i}$ is a dummy variable equal to 1 for properties that sold during the time period after the wind farm was approved and during construction that are located in *township-i (twp-i)* (and 0 otherwise);
- *wfoperation** $\boldsymbol{\text{TWP}_i}$ is a dummy variable equal to 1 for properties that sold during the time period in which the wind farm was operational that are located in *township-i (twp-i)* (and 0 otherwise);
- ε is an error term;
- the Greek letters represent parameters to be estimated.

The results of the OLS estimation of Eqs. (D14) and (D15) are presented in Table D.2, in Columns (1) and (2), respectively. Using the formulas listed in Eqs. (D16-D33), along with averages of *ln(RealPrice)* and *RealPrice* tabulated in Table C.10, and the estimated coefficients listed in Columns (1) and (2) of Table D.2, a verification can be made to ensure that the interpretation the author has given is indeed accurate.

a. THREE WIND FARM STAGES, TOWNSHIPS, LN(REALPRICE)

$$\ln(\text{RealPrice}) = \omega_0 + \omega_1 \text{wfconstr} + \omega_2 \text{wfoperation} + \gamma_0 \text{nearwf} + \vartheta_1 \text{wfconstr} * \text{nearwf} + \psi_2 \text{wfoperation} * \text{nearwf} + \boldsymbol{\gamma_i \text{TWP}_i} + \boldsymbol{\vartheta_i} \text{wfconstr} * \boldsymbol{\text{TWP}_i} + \boldsymbol{\psi_i} \text{wfoperation} * \boldsymbol{\text{TWP}_i} + \varepsilon \quad \text{(D14)}$$

Since the dependent variable, *ln(RealPrice),* is the natural logarithm of *RealPrice*, the estimated coefficients are in percentage (%) terms rather than dollar ($) terms. Also note that differencing the natural logarithm of a variable can be interpreted as the growth rate of a variable. The estimated coefficients of Eq. (D14) can literally be calculated using the formulas presented in Eqs. (D16-D24). Table C.10 of Appendix C contains the averages of *ln(RealPrice)* that you can use to make your calculations for Eqs. (D16-D24) and Column (1) of Table D.2 presents the OLS estimates of the regression coefficients, feel free to make comparisons between the two.

$$\hat{\omega}_0 = \overline{\ln(\text{RealPrice})}_{\text{Lex,B4approv}} \quad \text{(D16)}$$

$$\hat{\omega}_1 = \left(\overline{\ln(\text{RealPrice})}_{\text{Lex,wfconstr}} - \overline{\ln(\text{RealPrice})}_{\text{Lex,B4approv}}\right) \quad \text{(D17)}$$

$\hat{\omega}_1$ measures the appreciation in percentage terms of real property values in *Lexington* township from the time period before the wind farm was approved to the time period after the wind farm was approved and during the construction stage of the wind farm project.

$$\hat{\omega}_2 = \left(\overline{\ln(\text{RealPrice})}_{\text{Lex,wfOperation}} - \overline{\ln(\text{RealPrice})}_{\text{Lex,B4approv}}\right) \quad \text{(D18)}$$

$\hat{\omega}_2$ measures the appreciation in percentage terms of real property values in *Lexington* township from the time period before the wind farm was approved to the time period during wind farm operations.

$$\hat{\gamma}_0 = \left(\overline{\ln(\text{RealPrice})}_{\text{nearwf,B4approv}} - \overline{\ln(\text{RealPrice})}_{\text{Lex,B4approv}}\right) \quad \text{(D19)}$$

$\hat{\gamma}_0$ measures the *location effect* that is *neither* due to the approval of the wind farm *nor* the presence of the wind farm. It indicates the percentage difference in real property values on average that existed before approval of the wind farm for properties near the eventual wind farm site in comparison to properties located in *Lexington* township.

$\hat{\gamma}_0$=-18% or -0.1926 and is statistically significant at the 1% level. This indicates that before the wind farm was approved, properties located near the eventual wind farm location were valued 18% less on average than properties located in *Lexington* township, *ceteris paribus*.

$$\hat{\vartheta}_1 = \left(\ln(\text{RealPrice})_{\text{nearwf,wfconstr}} - \ln(\text{RealPrice})_{\text{nearwf,B4approv}}\right) - \left(\overline{\ln(\text{RealPrice})}_{\text{Lex,wfconstr}} - \overline{\ln(\text{RealPrice})}_{\text{Lex,B4approv}}\right) \quad \text{(D20)}$$

$\hat{\vartheta}_1$ measures whether the appreciation in percentage terms of real housing values near the wind farm is different from the appreciation in percentage terms of real housing values in *Lexington* township, where housing value appreciation is calculated from the time period prior to wind farm approval to the time period after the wind farm was approved and during construction. A negative and statistically significant $\hat{\vartheta}_1$would indicate that the real value of properties near the wind farm appreciated less on average in percentage terms

than the real value of properties in *Lexington* township, from the time period prior to wind farm approval to the time period after the wind farm was approved and during construction, and this would provide support for *wind farm anticipation stigma theory*.

$\hat{\vartheta}_1$=-1% or -0.0114 and is not statistically significant.

$$\hat{\psi}_2 = \left(\ln(\text{RealPrice})_{\text{nearwf,wfOperation}} - \ln(\text{RealPrice})_{\text{nearwf,B4approv}}\right) - \left(\overline{\ln(\text{RealPrice})}_{\text{Lex,wfOperation}} - \overline{\ln(\text{RealPrice})}_{\text{Lex,B4approv}}\right) \quad \text{(D21)}$$

$\hat{\psi}_2$ measures whether the appreciation in percentage terms of real housing values near the wind farm is different from the appreciation in percentage terms of real housing values in *Lexington* township, where housing value appreciation is calculated from the time period prior to wind farm approval to the time period during wind farm operations. A negative and statistically significant $\hat{\psi}_2$ would indicate that the real value of properties near the wind farm appreciated less on average in percentage terms than the real value of properties in *Lexington* township, from the time period prior to wind farm approval to the time period during wind farm operations. A negative and statistically significant $\hat{\psi}_2$ would provide evidence supporting *wind farm area stigma theory*.

$\hat{\psi}_2$=23% or 0.2104 and is statistically significant at the 10% level. This indicates that the real value of properties near the wind farm appreciated 23% more on average than the real value of properties in *Lexington* township, from the time period prior to wind farm approval to the time period during wind farm operations, *ceteris paribus*. This result provides evidence against wind farm area stigma theory.

$$\hat{\gamma}_i = \left(\overline{\ln(\text{RealPrice})}_{\text{twp-i,B4approv}} - \overline{\ln(\text{RealPrice})}_{\text{Lex,B4approv}}\right) \quad \text{(D22)}$$

$\hat{\gamma}_i$ indicates the percentage difference in real property values on average that properties in *township-i* sold for when compared to properties that sold in *Lexington* township before approval of the wind farm.

$$\hat{\vartheta}_i = \left(\ln(\text{RealPrice})_{\text{twp-i,wfconstr}} - \ln(\text{RealPrice})_{\text{twp-i,B4approv}}\right) - \left(\overline{\ln(\text{RealPrice})}_{\text{Lex,wfconstr}} - \overline{\ln(\text{RealPrice})}_{\text{Lex,B4approv}}\right) \quad \text{(D23)}$$

$\hat{\vartheta}_i$ measures whether the appreciation in real housing values in *township-i* is different from the appreciation in real housing values in *Lexington* township, where the appreciation in real housing values is in percentage terms and is calculated from the time period prior to wind farm approval to the time period after the wind farm was approved and during construction. A positive and statistically significant $\hat{\vartheta}_i$would indicate that the real value of properties located in *township-i* appreciated more on average in percentage terms than the real value of properties in *Lexington* township, from the time period prior to wind farm approval to the time period after the wind farm was approved and during construction.

$$\hat{\psi}_i = \left(\ln(\text{RealPrice})_{\text{twp-i,wfOperation}} - \ln(\text{RealPrice})_{\text{twp-i,B4approv}}\right) - \left(\overline{\ln(\text{RealPrice})}_{\text{Lex,wfOperation}} - \overline{\ln(\text{RealPrice})}_{\text{Lex,B4approv}}\right) \quad \text{(D24)}$$

$\hat{\psi}_i$ measures whether the appreciation in real housing values in *township-i* is different from the appreciation in real housing values in *Lexington* township, where the appreciation in real housing values in percentage terms is calculated from the time period prior to wind farm approval to the time period when the wind farm was operational. A positive and statistically significant $\hat{\psi}_i$ would indicate that the real value of properties in *township-i* appreciated more on average in percentage terms than the real value of properties in *Lexington* township, from the time period prior to wind farm approval to the time period when the wind farm was

operational.

b. THREE WIND FARM STAGES, TOWNSHIPS, REALPRICE

$$\text{RealPrice} = \alpha_0 + \alpha_1 \text{wfconstr} + \alpha_2 \text{wfoperation} + \lambda_0 \text{nearwf} + \theta_1 \text{wfconstr} * \text{nearwf} + \phi_2 \text{wfoperation} * \text{nearwf} + \boldsymbol{\lambda_i} \mathbf{TWP_i} + \boldsymbol{\theta_i} \text{wfconstr} * \mathbf{TWP_i} + \boldsymbol{\phi_i} \text{wfoperation} * \mathbf{TWP_i} + \varepsilon \quad \text{(D15)}$$

The interpretation of the estimated coefficients of Eq. (D15) are analogous to those of Eq. (D14). The main difference is that the estimated coefficients are in dollar ($) terms rather than percentage (%) terms. The estimated coefficients of Eq. (D15) can literally be calculated using the formulas presented in Eqs. (D25-D33). Table C.10 of Appendix C contains the averages of *RealPrice* that you can use to make your calculations for Eqs. (D25-D33) and Column (2) of Table D.2 presents the OLS estimates of the regression coefficients, feel free to make comparisons between the two to ensure they are consistent.

$$\hat{\alpha}_0 = \overline{\text{RealPrice}}_{\text{Lex,B4approv}} \quad \text{(D25)}$$

$$\hat{\alpha}_1 = \left(\overline{\text{RealPrice}}_{\text{Lex,wfconstr}} - \overline{\text{RealPrice}}_{\text{Lex,B4approv}}\right) \quad \text{(D26)}$$

$$\hat{\alpha}_2 = \left(\overline{\text{RealPrice}}_{\text{Lex,wfOperation}} - \overline{\text{RealPrice}}_{\text{Lex,B4approv}}\right) \quad \text{(D27)}$$

$$\hat{\lambda}_0 = \left(\overline{\text{RealPrice}}_{\text{nearwf,B4approv}} - \overline{\text{RealPrice}}_{\text{Lex,B4approv}}\right) \quad \text{(D28)}$$

$$\hat{\theta}_1 = \left(\overline{\text{RealPrice}}_{\text{nearwf,wfconstr}} - \overline{\text{RealPrice}}_{\text{nearwf,B4approv}}\right) - \left(\overline{\text{RealPrice}}_{\text{Lex,wfconstr}} - \overline{\text{RealPrice}}_{\text{Lex,B4approv}}\right) \quad \text{(D29)}$$

$\hat{\theta}_1$ When comparing the appreciation in property values from the time period before approval of the wind farm to the time period after the wind farm was approved and during the construction stage of the wind farm project, the appreciation in property values was $\$\hat{\theta}_1$ different on average for properties near the wind farm when compared with properties in *Lexington* township, *ceteris paribus.*

$$\hat{\phi}_2 = \left(\overline{\text{RealPrice}}_{\text{nearwf,wfOperation}} - \overline{\text{RealPrice}}_{\text{nearwf,B4approv}}\right) - \left(\overline{\text{RealPrice}}_{\text{Lex,wfOperation}} - \overline{\text{RealPrice}}_{\text{Lex,B4approv}}\right) \quad \text{(D30)}$$

$\hat{\phi}_2$When comparing the appreciation in property values from the time period before approval of the wind farm to the time period during wind farm operations, the appreciation in property values was $\$\hat{\phi}_2$ different on average for properties near the wind farm when compared with properties in *Lexington* township, *ceteris paribus.*

$$\hat{\boldsymbol{\lambda}}_1 = \left(\overline{\text{RealPrice}}_{\text{twp-i,B4approv}} - \overline{\text{RealPrice}}_{\text{Lex,B4approv}}\right) \quad \text{(D31)}$$

$$\hat{\boldsymbol{\theta}}_1 = \left(\overline{\text{RealPrice}}_{\text{twp-i,wfconstr}} - \overline{\text{RealPrice}}_{\text{twp-i,B4approv}}\right) - \left(\overline{\text{RealPrice}}_{\text{Lex,wfconstr}} - \overline{\text{RealPrice}}_{\text{Lex,B4approv}}\right) \quad \text{(D32)}$$

$$\hat{\boldsymbol{\phi}}_1 = \left(\overline{\text{RealPrice}}_{\text{twp-i,wfOperation}} - \overline{\text{RealPrice}}_{\text{twp-i,B4approv}}\right) - \left(\overline{\text{RealPrice}}_{\text{Lex,wfOperation}} - \overline{\text{RealPrice}}_{\text{Lex,B4approv}}\right) \quad \text{(D33)}$$

Table D. 2. Example Results: Three Wind Farm Stages, Townships

Dependent Variable:		ln(RealPrice)			RealPrice		
		(1)	Std. Error†		(2)	Std. Error†	
C (Intercept)		11.6787	(0.030)	***	126,681	(3,863)	***
Post WF Approval/Construction (wfconstr)	-4%	-0.0439	(0.059)		-557	(6,907)	
Wind Farm Operation (wfoperation)	-11%	-0.1111	(0.062)	*	-10,111	(6,779)	
Near Wind Farm (nearwf)	-18%	-0.1926	(0.058)	***	-18,513	(6,675)	***
Near Wind Farm, Post WF Approval/Construction (wfconstr*nearwf)	-1%	-0.0114	(0.099)		-5,675	(10,648)	
Near Wind Farm, WF Operation (wfoperation*nearwf)	23%	0.2104	(0.112)	*	18,756	(11,568)	
Anchor Township	-43%	-0.5600	(0.097)	***	-55,987	(6,615)	***
Anchor Township, Post WF Approval/Construction (wfconstr*Anchor)	-6%	-0.0664	(0.166)		-6,516	(11,676)	
Anchor Township, Wind Farm Operation (wfoperation*Anchor)	-15%	-0.1576	(0.294)		-38	(20,807)	
Bellflower Township	-36%	-0.4459	(0.081)	***	-43,443	(7,285)	***
Bellflower Township, Post WF Approval/Construction (wfconstr*Bellflower)	-8%	-0.0879	(0.139)		-9,218	(11,911)	
Bellflower Township, Wind Farm Operation (wfoperation*Bellflower)	5%	0.0486	(0.169)		5,772	(14,913)	
Blue Mound Township	-28%	-0.3344	(0.091)	***	-34,306	(8,420)	***
Blue Mound Township, Post WF Approval/Construction (wfconstr*Blue Mound)	-4%	-0.0364	(0.181)		-431	(16,974)	
Blue Mound Township, Wind Farm Operation (wfoperation*Blue Mound)	-15%	-0.1667	(0.221)		-15,878	(16,143)	
Chenoa Township	-30%	-0.3580	(0.050)	***	-35,470	(5,244)	***
Chenoa Township, Post WF Approval/Construction (wfconstr*Chenoa)	-1%	-0.0133	(0.082)		-6,869	(8,409)	
Chenoa Township, Wind Farm Operation (wfoperation*Chenoa)	1%	0.0142	(0.094)		1,108	(9,036)	
Cropsey Township	-34%	-0.4199	(0.173)	**	-37,261	(18,232)	**
Cropsey Township, Post WF Approval/Construction (wfconstr*Cropsey)	-38%	-0.4705	(0.280)	*	-36,959	(22,137)	*
Cropsey Township, Wind Farm Operation (wfoperation*Cropsey)	20%	0.1853	(0.181)		4,199	(19,064)	
Dix Township	-42%	-0.5525	(0.070)	***	-56,033	(5,897)	***
Dix Township, Post WF Approval/Construction (wfconstr*Dix)	45%	0.3744	(0.156)	**	32,066	(14,944)	**
Dix Township, Wind Farm Operation (wfoperation*Dix)	32%	0.2741	(0.203)		25,791	(16,764)	
Downs Township	11%	0.1038	(0.057)	*	13,926	(6,714)	**
Downs Township, Post WF Approval/Construction (wfconstr*Downs)	5%	0.0475	(0.103)		3,120	(12,312)	
Downs Township, Wind Farm Operation (wfoperation*Downs)	24%	0.2144	(0.120)	*	29,003	(15,910)	
Drummer Township	-27%	-0.3198	(0.042)	***	-31,357	(4,878)	***
Drummer Township, Post WF Approval/Construction (wfconstr*Drummer)	13%	0.1222	(0.080)		10,359	(8,777)	
Drummer Township, Wind Farm Operation (wfoperation*Drummer)	35%	0.3035	(0.100)	***	33,138	(11,496)	***
Empire Township	-4%	-0.0396	(0.039)		-3,712	(4,836)	
Empire Township, Post WF Approval/Construction (wfconstr*Empire)	4%	0.0405	(0.072)		-335	(8,721)	
Empire Township, Wind Farm Operation (wfoperation*Empire)	10%	0.0965	(0.079)		7,953	(8,922)	
Gridley Township	-18%	-0.1985	(0.052)	***	-20,146	(5,909)	***
Gridley Township, Post WF Approval/Construction (wfconstr*Gridley)	3%	0.0330	(0.089)		-1,836	(9,790)	
Gridley Township, Wind Farm Operation (wfoperation*Gridley)	-2%	-0.0185	(0.102)		-2,378	(9,894)	
Hudson Township	31%	0.2666	(0.040)	***	36,619	(5,705)	***
Hudson Township, Post WF Approval/Construction (wfconstr*Hudson)	3%	0.0273	(0.078)		2,998	(11,054)	
Hudson Township, Wind Farm Operation (wfoperation*Hudson)	-2%	-0.0165	(0.082)		-8,494	(10,493)	
Lawndale Township	1%	0.0145	(0.113)		-3,975	(14,634)	
Lawndale Township, Post WF Approval/Construction (wfconstr*Lawndale)	7%	0.0687	(0.174)		3,170	(21,202)	
Lawndale Township, Wind Farm Operation (wfoperation*Lawndale)	10%	0.0986	(0.189)		10,280	(22,774)	
Martin Township	-24%	-0.2686	(0.059)	***	-26,142	(6,068)	***
Martin Township, Post WF Approval and Construction (wfconstr*Martin)	-5%	-0.0512	(0.099)		-10,198	(9,829)	
Martin Township, Wind Farm Operation (wfoperation*Martin)	-5%	-0.0479	(0.117)		-6,006	(11,305)	
Money Creek Township	77%	0.5734	(0.082)	***	101,341	(16,341)	***
Money Creek, Post WF Approval/Construction (wfconstr*Money Creek)	-21%	-0.2330	(0.168)		-39,820	(27,294)	
Money Creek Township, Wind Farm Operation (wfoperation*Money Creek)	-6%	-0.0634	(0.173)		-24,761	(28,158)	
Oldtown Township	68%	0.5189	(0.047)	***	88,207	(7,778)	***
Oldtown Township, Post WF Approval/Construction (wfconstr*Oldtown)	5%	0.0491	(0.080)		-3,603	(12,707)	
Oldtown Township, Wind Farm Operation (wfoperation*Oldtown)	23%	0.2072	(0.089)	**	26,141	(15,548)	*
Peach Orchard Township	-48%	-0.6448	(0.090)	***	-58,111	(7,100)	***
Peach Orchard, Post WF Approval/Construction (wfconstr*Peach Orchard)	6%	0.0622	(0.142)		-2,706	(11,430)	
Peach Orchard Township, Wind Farm Operation (wfoperation*Peach Orchard)	-2%	-0.0166	(0.147)		-2,294	(10,563)	
Randolph Township	13%	0.1254	(0.038)	***	17,657	(4,978)	***
Randolph Township, Post WF Approval/Construction (wfconstr*Randolph)	1%	0.0088	(0.072)		-3,770	(8,956)	
Randolph Township, Wind Farm Operation (wfoperation*Randolph)	4%	0.0428	(0.079)		3,305	(9,255)	
Sullivant Township	-48%	-0.6621	(0.092)	***	-61,002	(7,122)	***
Sullivant Township, Post WF Approval/Construction (wfconstr*Sullivant)	23%	0.2063	(0.222)		19,324	(18,361)	
Sullivant Township, Wind Farm Operation (wfoperation*Sullivant)	32%	0.2799	(0.238)		24,335	(17,804)	
Towanda Township	3%	0.0339	(0.072)		5,975	(8,291)	
Towanda Township, Post WF Approval/Construction (wfconstr*Towanda)	10%	0.0977	(0.103)		2,940	(12,343)	
Towanda Township, Wind Farm Operation (wfoperation*Towanda)	10%	0.0992	(0.144)		11,839	(16,109)	
West Township	25%	0.2206	(0.046)	***	18,992	(6,020)	***
Yates Township	-25%	-0.2917	(0.184)		-27,592	(19,224)	

Yates Township, Post WF Approval/Construction (wfconstr*Yates)	18%	0.1649	(0.399)		24,073	(39,808)	
Yates Township, Wind Farm Operation (wfoperation*Yates)	-49%	-0.6800	(0.241)	***	-46,454	(20,938)	**
Adjusted R-squared		0.2892			0.3089		
Standard Error of Regression		0.4332			52735		
Sum Squared Residuals		710.10			1.05E+13		
Log Likelihood		-2208.93			-47,303		
F-statistic		24.74	***		27.07	***	
Mean Dependent Variable		11.62			126,347		
Standard Deviation Dependent Variable		0.51			63,435		
Akaike Information Criterion		1.18			24.60		
Schwarz Criterion		1.29			24.71		
Durbin-Watson Statistic		1.99			1.98		

***denotes significance at 1% level **denotes significance at 5% level *denotes significance at 10% level

Notes: Estimation sample includes the period 01/01/2001 - 12/01/2009. *n*=3,851. %=[e^{coeff}-1]*100.

Base Groups: Before Wind Farm Approval (01/01/2001 - 09/20/2005); Lexington township.

†White Heteroskedasticity-Consistent Standard Errors & Covariance are in parentheses (White, 1980). The results from this estimation are not considered the "main" results of this study. This estimation is for demonstrative purposes only.

APPENDIX E. FULL ESTIMATION RESULTS

Table E. 1. Full Estimation Results: Two and Three Wind Farm Stages

Dependent Variable: ln(Real Property Price)												
	XY		SD		TWP		XY		SD		TWP	
	2 WF stages				*2 WF stages*		*3 WF stages*				*3 WF stages*	
	(12.1)		**(12.2)**		**(12.3)**		**(13.1)**		**(13.2)**		**(13.3)**	
Square Feet *(1000s)*	0.339	***	0.341	***	0.338	***	0.339	***	0.340	***	0.338	***
Garage	0.026	***	0.026	***	0.025	***	0.026	***	0.025	***	0.025	***
Acre *(tenths)*	0.021	***	0.022	***	0.024	***	0.021	***	0.022	***	0.025	***
Acres	0.073	***	0.074	***	0.077	***	0.073	***	0.074	***	0.077	***
Age *(decades)*	-0.072	***	-0.072	***	-0.070	***	-0.072	***	-0.073	***	-0.071	***
Age^2	0.002	***	0.002	***	0.002	***	0.002	***	0.003	***	0.002	***
Fireplaces *(number)*	0.083	***	0.085	***	0.081	***	0.083	***	0.084	***	0.080	***
Railroad Tracks	-0.100	***	-0.086	***	-0.077	***	-0.100	***	-0.088	***	-0.078	***
Lakefront	0.261	***	0.235	***	0.228	***	0.260	***	0.234	***	0.227	***
Cul-de-sac	0.031	**	0.039	***	0.040	***	0.030	**	0.036	***	0.038	***
Trees	0.035	**	0.026	*	0.023		0.034	**	0.025	*	0.022	
C *(Intercept)*	262.841	***	11.310	***	11.317	***	261.787	***	11.339	***	11.334	***
Post WF Approval and Construction							0.011		-0.075	**	-0.050	
Wind Farm Operation	-0.014		-0.034		-0.064		-0.010		-0.061		-0.081	*
X	-1.6E-3	***					-1.6E-3	***				
Y	-7.1E-4	***					-7.1E-4	***				
XY	3.8E-9	***					3.8E-09	***				
X^2	1.5E-9	***					1.53E-9	***				
Y^2	2.7E-10	**					2.7E-10	**				
X^2Y^2	-9E-21	***					-9E-21	***				
Near Wind Farm	-0.126	***	-0.204	***	-0.221	***	-0.079	**	-0.191	***	-0.199	***
Near Wind Farm, Post WF Approval/Construction							-0.124	**	-0.029		-0.055	
Near Wind Farm, WF Operation	0.158	***	0.202	***	0.231	***	0.111	*	0.189	**	0.208	***
Blue Ridge CUSD 18			-0.361	***					-0.406	***		
Blue Ridge CUSD 18, Post WF Approval and Construction									0.126			
Blue Ridge CUSD 18, Wind Farm Operation			0.076						0.122			
El Paso-Gridley CUSD 11			-0.139	***					-0.167	***		
El Paso-Gridley CUSD 11, Post WF Approval and Construction									0.078			
El Paso-Gridley CUSD 11, Wind Farm Operation			-0.096						-0.068			
Gibson City CUSD 5			-0.239	***					-0.287	***		
Gibson City CUSD 5, Post WF Approval and Construction									0.140	***		
Gibson City CUSD 5, WF Operation			0.096						0.146	**		
Heyworth CUSD 4			-0.006						-0.038			
Heyworth CUSD 4, Post WF Approval and Construction									0.089	**		
Heyworth CUSD 4, Wind Farm Operation			-0.011						0.021			
LeRoy CUSD 2			-0.077	***					-0.122	***		
LeRoy CUSD 2, Post WF Approval and Construction									0.127	***		
LeRoy CUSD 2, Wind Farm Operation			0.101	**					0.146	***		
Normal CUSD 5			0.065	***					0.038			
Normal CUSD 5, Post WF Approval and Construction									0.075			
Normal CUSD 5, Wind Farm Operation			-0.026						0.002			
Prairie Central CUSD 8			-0.280	***					-0.299	***		
Prairie Central CUSD 8, Post WF Approval and Construction									0.053			
Prairie Central CUSD 8, Wind Farm Operation			-0.048						-0.030			
Ridgeview CUSD 19			-0.232	***					-0.244	***		

Ridgeview CUSD 19, Post WF Approval and Construction					0.035			
Ridgeview CUSD 19, Wind Farm Operation	-0.096				-0.084			
Trivalley CUSD 3	0.045	*			0.004			
Trivalley CUSD 3, Post WF Approval and Construction					0.116	***		
Trivalley CUSD 3, Wind Farm Operation	0.120	**			0.161	***		
Anchor Township			-0.455	***			-0.418	***
Anchor Township, Post WF Approval and Construction							-0.105	
Anchor Township, Wind Farm Operation			-0.185				-0.222	
Bellflower Township			-0.420	***			-0.464	***
Bellflower Township, Post WF Approval and Construction							0.121	
Bellflower Township, Wind Farm Operation			0.145				0.189	
Blue Mound Township			-0.166	***			-0.138	**
Blue Mound Township, Post WF Approval and Construction							-0.074	
Blue Mound Township, Wind Farm Operation			-0.108				-0.137	
Chenoa Township			-0.283	***			-0.300	***
Chenoa Township, Post WF Approval and Construction							0.049	
Chenoa Township, Wind Farm Operation			0.032				0.049	
Cropsey Township			-0.474	***			-0.355	***
Cropsey Township, Post WF Approval and Construction							-0.331	**
Cropsey Township, Wind Farm Operation			0.283	***			0.164	*
Dix Township			-0.356	***			-0.400	***
Dix Township, Post WF Approval and Construction							0.129	
Dix Township, Wind Farm Operation			0.205				0.249	*
Downs Township			-0.012				-0.049	
Downs Township, Post WF Approval and Construction							0.106	*
Downs Township, Wind Farm Operation			0.204	***			0.241	***
Drummer Township			-0.201	***			-0.236	***
Drummer Township, Post WF Approval and Construction							0.099	*
Drummer Township, Wind Farm Operation			0.158	**			0.193	***
Empire Township			-0.095	***			-0.128	***
Empire Township, Post WF Approval and Construction							0.096	**
Empire Township, Wind Farm Operation			0.120	**			0.153	***
Gridley Township			-0.154	***			-0.173	***
Gridley Township, Post WF Approval and Construction							0.053	
Gridley Township, Wind Farm Operation			-0.066				-0.048	
Hudson Township			0.060	***			0.053	*
Hudson Township, Post WF Approval and Construction							0.019	
Hudson Township, Wind Farm Operation			-0.019				-0.012	
Lawndale Township			-0.116	***			-0.098	*
Lawndale Township, Post WF Approval and Construction							-0.034	
Lawndale Township, Wind Farm Operation			0.121				0.103	
Martin Township			-0.249	***			-0.266	***
Martin Township, Post WF Approval and Construction							0.049	
Martin Township, Wind Farm Operation			-0.008				0.010	
Money Creek Township			0.030				0.033	
Money Creek Township, Post WF Approval and Construction							-0.002	
Money Creek Township, Wind Farm Operation			0.086				0.083	
Oldtown Township			0.054	**			0.024	
Oldtown Township, Post WF Approval and Construction							0.087	*
Oldtown Township, Wind Farm Operation			0.142	***			0.172	***
Peach Orchard Township			-0.525	***			-0.529	***
Peach Orchard Township, Post WF Approval and Construction							-0.018	
Peach Orchard Township, Wind Farm Operation			-0.178				-0.175	
Randolph Township			-0.018				-0.040	
Randolph Township, Post WF Approval and Construction							0.063	
Randolph Township, Wind Farm Operation			0.018				0.040	
Sullivant Township			-0.495	***			-0.528	***

Sullivant Township, Post WF Approval and Construction												0.101	
Sullivant Township, Wind Farm Operation						0.218	*					0.252	*
Towanda Township						-0.012						-0.059	
Towanda Township, Post WF Approval and Construction												0.117	*
Towanda Township, Wind Farm Operation						0.084						0.132	
West Township						0.123						0.125	*
Yates Township						-0.335	***					-0.322	***
Yates Township, Post WF Approval and Construction												-0.035	
Yates Township, Wind Farm Operation						-0.617	***					-0.630	***
n	3,851		3,851		3,851		3,851		3,851		3,851		
Adjusted R-squared	0.6634		0.6648		0.6777		0.6637		0.6655		0.6780		
Standard Error of Regression	0.2981		0.2975		0.2917		0.2980		0.2972		0.2916		
Sum Squared Residuals	340.36		337.93		322.92		339.84		336.23		320.74		
Log Likelihood	-792.9		-779.1		-691.6		-789.99		-769.4		-678.6		
F-statistic	380.40	***	239.57	***	148.20	***	346.43	***	179.12	***	106.29	***	
Mean ln(Real Property Price)	11.62		11.62		11.62		11.62		11.62		11.62		
Std Deviation ln(RealPrice)	0.51		0.51		0.51		0.51		0.51		0.51		
Akaike Information Criterion	0.42		0.42		0.39		0.42		0.42		0.39		
Schwarz Criterion	0.46		0.48		0.48		0.46		0.49		0.52		
Durbin-Watson Statistic	1.90		1.95		1.97		1.91		1.95		1.97		

***denotes significance at 1% level **denotes significance at 5% level *denotes significance at 10% level

Notes: White Heteroskedasticity-Consistent Standard Errors & Covariance are used in determining statistical significance (White, 1980).

Base Groups: (12.1) Before Wind Farm Operation (01/01/2001 - 02/01/2008); Far from the wind farm;
(12.2) Before Wind Farm Operation (01/01/2001 - 02/01/2008); Lexington CUSD 7;
(12.3) Before Wind Farm Operation (01/01/2001 - 02/01/2008); Lexington township;
(13.1) Before Wind Farm Approval (01/01/2001 - 09/20/2005); Far from the wind farm;
(13.2) Before Wind Farm Approval (01/01/2001 - 09/20/2005); Lexington CUSD 7;
(13.3) Before Wind Farm Approval (01/01/2001 - 09/20/2005); Lexington Township.

Table E. 2. Full Estimation Results: Separate Wind Farm Stages, {X,Y}-Coordinates

Dependent Variable: ln(Real Property Price)									
	$[e^{coeff}-1]*100$	Stage 1		$[e^{coeff}-1]*100$	Stage 2		$[e^{coeff}-1]*100$	Stage 3	
		(14.1)			**(14.2)**			**(14.3)**	
Square Feet *(1000s)*	40.49%	0.340	***	43.88%	0.364	***	33.41%	0.288	***
		(0.015)			(0.020)			(0.031)	
Garage	2.78%	0.027	***	2.79%	0.028	***	2.22%	0.022	***
		(0.005)			(0.007)			(0.008)	
Acre *(tenths)*	2.48%	0.025	***	1.80%	0.018	***	1.62%	0.016	**
		(0.004)			(0.006)			(0.008)	
Acres	7.16%	0.069	***	7.14%	0.069	***	9.75%	0.093	***
		(0.010)			(0.013)			(0.015)	
Age *(decades)*	-6.56%	-0.068	***	-7.25%	-0.075	***	-9.66%	-0.102	***
		(0.007)			(0.010)			(0.015)	
Age^2	0.24%	0.002	***	0.23%	0.002	***	0.43%	0.004	***
		(0.000)			(0.001)			(0.001)	
Fireplaces *(number)*	6.90%	0.067	***	5.94%	0.058	***	17.29%	0.159	***
		(0.016)			(0.023)			(0.025)	
Railroad Tracks	-11.15%	-0.118	***	-6.83%	-0.071	***	-9.87%	-0.104	***
		(0.020)			(0.026)			(0.037)	
Lakefront	42.08%	0.351	***	29.33%	0.257	***	4.65%	0.045	
		(0.074)			(0.100)			(0.088)	
Cul-de-sac	2.34%	0.023		6.14%	0.060	**	1.47%	0.015	
		(0.019)			(0.027)			(0.035)	
Trees	4.15%	0.041	**	3.16%	0.031		1.38%	0.014	
		(0.019)			(0.030)			(0.033)	
C *(Intercept)*		250.698	***		281.035	**		326.052	*
		(81.204)			(121.094)			(171.067)	
Near Wind Farm	-5.82%	-0.060	*	-16.19%	-0.177	***	-7.71%	-0.080	
		(0.037)			(0.052)			(0.072)	
X		-0.002	***	-0.16%	-0.002	***	-0.20%	-0.002	**
		(0.000)			(0.001)			(0.001)	
Y		-0.001	***	-0.08%	-0.001	**	-0.09%	-0.001	*
		(0.0003)			(0.000)			(0.001)	
XY		4E-09	***		4E-09	***		5E-09	**
		(0.000)			(0.000)			(0.000)	
X^2		1E-09	***		2E-09	***		2E-09	**
		(0.000)			(0.000)			(0.000)	
Y^2		2E-10			4E-10	*		3E-10	
		(0.000)			(0.000)			(0.000)	
X^2Y^2		-8E-21	***		-9E-21	***		-1E-20	**
		(0.000)			(0.000)			(0.000)	
n		2,036			1,121			694	
Estimation Time Period		1/1/01 - 9/20/05			9/21/05 - 2/1/08			2/2/08 - 12/1/09	
Adjusted R-squared		0.6846			0.6684			0.6183	
Standard Error of Regression		0.2856			0.2970			0.3248	
Sum Squared Residuals		164.51			97.23			71.19	
Log Likelihood		-327.92			-220.24			-194.60	
F-statistic		246.42	***		126.43	***		63.36	***
Mean ln(Real Property Price)		11.63			11.61			11.60	
Std Deviation ln(Real Price)		0.51			0.52			0.53	
Durbin-Watson Statistic		1.93			1.97			1.83	

***denotes significance at 1% level **denotes significance at 5% level *denotes significance at 10% level

Notes: White Heteroskedasticity-Consistent Standard Errors & Covariance are in parentheses (White, 1980).

Base Group: Far from the wind farm.

Table E. 3. Full Separate Wind Farm Stage Estimation Results: School Districts

Dependent Variable: ln(Real Property Price)									
	$[e^{coeff}-1]*100$	Stage 1		$[e^{coeff}-1]*100$	Stage 2		$[e^{coeff}-1]*100$	Stage 3	
		(15.1)			**(15.2)**			**(15.3)**	
Square Feet *(1000s)*	41.32%	0.346	***	42.88%	0.357	***	33.65%	0.290	***
		(0.015)			(0.020)			(0.031)	
Garage	2.72%	0.027	***	2.61%	0.026	***	2.18%	0.022	***
		(0.005)			(0.007)			(0.008)	
Acre *(tenths)*	2.63%	0.026	***	1.86%	0.018	***	1.41%	0.014	*
		(0.004)			(0.006)			(0.008)	
Acres	7.48%	0.072	***	7.19%	0.069	***	9.24%	0.088	***
		(0.010)			(0.013)			(0.015)	
Age *(decades)*	-6.44%	-0.067	***	-7.28%	-0.076	***	-9.90%	-0.104	***
		(0.007)			(0.010)			(0.015)	
Age^2	0.24%	0.002	***	0.25%	0.002	***	0.45%	0.004	***
		(0.000)			(0.001)			(0.001)	
Fireplaces *(number)*	7.21%	0.070	***	6.38%	0.062	***	16.86%	0.156	***
		(0.016)			(0.023)			(0.025)	
Railroad Tracks	-10.32%	-0.109	***	-5.39%	-0.055	**	-7.93%	-0.083	**
		(0.020)			(0.025)			(0.037)	
Lakefront	39.33%	0.332	***	26.04%	0.231	**	1.69%	0.017	
		(0.074)			(0.097)			(0.085)	
Cul-de-sac	3.01%	0.030		6.23%	0.060	**	3.13%	0.031	
		(0.019)			(0.027)			(0.032)	
Trees	3.30%	0.032	*	3.33%	0.033		-0.78%	-0.008	
		(0.020)			(0.030)			(0.034)	
C *(Intercept)*		11.299	***		11.274	***		11.453	***
		(0.037)			(0.057)			(0.085)	
Near Wind Farm	-17.74%	-0.195	***	-19.14%	-0.212	***	-1.30%	-0.013	
		(0.042)			(0.060)			(0.080)	
Ridgeview CUSD 19	-21.76%	-0.245	***	-19.13%	-0.212	***	-26.85%	-0.313	***
		(0.034)			(0.049)			(0.076)	
Trivalley CUSD 3	0.70%	0.007		11.26%	0.107	***	18.89%	0.173	***
		(0.030)			(0.041)			(0.051)	
Gibson City CUSD 5	-25.08%	-0.289	***	-14.28%	-0.154	***	-11.95%	-0.127	**
		(0.029)			(0.044)			(0.060)	
LeRoy CUSD 2	-11.39%	-0.121	***	-0.06%	-0.001		3.07%	0.030	
		(0.026)			(0.039)			(0.047)	
Normal CUSD 5	3.63%	0.036		11.36%	0.108	***	4.73%	0.046	
		(0.026)			(0.039)			(0.049)	
Blue Ridge CUSD 18	-33.15%	-0.403	***	-24.63%	-0.283	***	-23.37%	-0.266	*
		(0.071)			(0.101)			(0.140)	
El Paso-Gridley CUSD 11	-15.77%	-0.172	***	-8.81%	-0.092	**	-20.54%	-0.230	***
		(0.033)			(0.046)			(0.065)	
Prairie Central CUSD 8	-26.00%	-0.301	***	-21.72%	-0.245	***	-26.52%	-0.308	***
		(0.034)			(0.048)			(0.067)	
Heyworth CUSD 4	-2.72%	-0.028		4.01%	0.039		-2.34%	-0.024	
		(0.024)			(0.039)			(0.048)	
n		2,036			1,121			694	
Estimation Sample Time Period		1/1/01 - 9/20/05			9/21/05 - 2/1/08			2/2/08-12/1/09	
Adjusted R-squared		0.6821			0.6702			0.6195	
Standard Error of Regression		0.2867			0.2962			0.3243	
Sum Squared Residuals		165.59			96.42			70.66	
Log Likelihood		-334.58			-215.60			-191.97	
F-statistic		208.90	***		109.40	***		54.72	***
Mean ln(Real Property Price)		11.63			11.61			11.60	

Standard Deviation ln(Real Price)	0.51	0.52	0.53
Akaike Information Criterion	0.35	0.42	0.62
Schwarz Criterion	0.41	0.52	0.76
Durbin-Watson Statistic	1.96	2.01	1.90

***denotes significance at 1% level **denotes significance at 5% level *denotes significance at 10% level

Notes: White Heteroskedasticity-Consistent Standard Errors & Covariance are in parentheses (White, 1980).

Base Group: Lexington CUSD 7.

Table E. 4. Full Separate Wind Farm Stage Estimation Results: Townships

Dependent Variable: ln(Real Property Price)									
	$[e^{coeff}-1]*100$	Stage 1		$[e^{coeff}-1]*100$	Stage 2		$[e^{coeff}-1]*100$	Stage 3	
		(16.1)			**(16.2)**			**(16.3)**	
Square Feet *(1000s)*	40.80%	0.342	***	42.77%	0.356	***	33.99%	0.293	***
		(0.015)			(0.020)			(0.030)	
Garage	2.77%	0.027	***	2.44%	0.024	***	2.12%	0.021	***
		(0.005)			(0.007)			(0.008)	
Acre *(tenths)*	2.80%	0.028	***	2.10%	0.021	***	2.06%	0.020	***
		(0.004)			(0.006)			(0.008)	
Acres	7.73%	0.074	***	7.30%	0.070	***	9.82%	0.094	***
		(0.011)			(0.014)			(0.015)	
Age *(decades)*	-6.27%	-0.065	***	-7.23%	-0.075	***	-9.29%	-0.097	***
		(0.007)			(0.010)			(0.015)	
Age^2	0.22%	0.002	***	0.24%	0.002	***	0.41%	0.004	***
		(0.001)			(0.001)			(0.001)	
Fireplaces *(number)*	7.04%	0.068	***	6.07%	0.059	***	15.00%	0.140	***
		(0.015)			(0.023)			(0.025)	
Railroad Tracks	-8.94%	-0.094	***	-4.60%	-0.047	*	-8.38%	-0.088	**
		(0.020)			(0.025)			(0.037)	
Lakefront	38.03%	0.322	***	26.81%	0.238	**	-0.63%	-0.006	
		(0.074)			(0.100)			(0.083)	
Cul-de-sac	3.87%	0.038	*	5.63%	0.055	**	2.14%	0.021	
		(0.020)			(0.027)			(0.032)	
Trees	2.75%	0.027		3.44%	0.034		-0.51%	-0.005	
		(0.021)			(0.031)			(0.034)	
C *(Intercept)*		11.296	***		11.301	***		11.404	***
		(0.039)			(0.059)			(0.086)	
Near Wind Farm	-18.24%	-0.201	***	-21.63%	-0.244	***	-0.79%	-0.008	
		(0.042)			(0.059)			(0.081)	
Chenoa Township	-26.14%	-0.303	***	-22.15%	-0.250	***	-21.22%	-0.239	***
		(0.036)			(0.048)			(0.066)	
Cropsey Township	-29.60%	-0.351	***	-49.46%	-0.682	***	-15.83%	-0.172	***
		(0.087)			(0.114)			(0.048)	
Dix Township	-33.26%	-0.404	***	-23.97%	-0.274	***	-12.99%	-0.139	
		(0.065)			(0.078)			(0.118)	
Downs Township	-3.40%	-0.035		4.07%	0.040		19.75%	0.180	**
		(0.037)			(0.050)			(0.075)	
Gridley Township	-16.14%	-0.176	***	-11.53%	-0.123	***	-19.48%	-0.217	***
		(0.034)			(0.046)			(0.066)	
Hudson Township	5.56%	0.054	**	6.92%	0.067		4.11%	0.040	
		(0.027)			(0.042)			(0.052)	
Lawndale Township	-9.54%	-0.100	*	-11.84%	-0.126	**	-0.48%	-0.005	
		(0.060)			(0.060)			(0.270)	
Money Creek Township	2.50%	0.025		1.91%	0.019		13.00%	0.122	

		(0.055)			(0.114)			(0.081)	
Peach Orchard Township	-41.08%	-0.529	***	-42.61%	-0.555	***	-49.08%	-0.675	***
		(0.065)			(0.100)			(0.124)	
Randolph Township	-2.93%	-0.030		1.04%	0.010		-0.54%	-0.005	
		(0.025)			(0.038)			(0.050)	
Sullivant Township	-41.22%	-0.531	***	-33.64%	-0.410	***	-24.06%	-0.275	***
		(0.087)			(0.139)			(0.106)	
West Township	11.94%	0.113		17.23%	0.159	**	No Obs	No Obs	
		(0.116)			(0.072)				
Yates Township	-27.58%	-0.323	***	-29.10%	-0.344	*	-59.38%	-0.901	***
		(0.085)			(0.203)			(0.170)	
Anchor Township	-34.44%	-0.422	***	-41.13%	-0.530	***	-45.51%	-0.607	**
		(0.084)			(0.105)			(0.255)	
Bellflower Township	-36.79%	-0.459	***	-29.20%	-0.345	***	-22.72%	-0.258	*
		(0.066)			(0.101)			(0.140)	
Blue Mound Township	-13.91%	-0.150	**	-18.87%	-0.209	**	-23.63%	-0.270	***
		(0.065)			(0.102)			(0.081)	
Drummer Township	-21.03%	-0.236	***	-13.22%	-0.142	***	-3.11%	-0.032	
		(0.031)			(0.044)			(0.064)	
Empire Township	-11.87%	-0.126	***	-3.73%	-0.038		2.95%	0.029	
		(0.026)			(0.038)			(0.048)	
Martin Township	-23.37%	-0.266	***	-19.71%	-0.220	***	-21.59%	-0.243	***
		(0.038)			(0.053)			(0.079)	
Oldtown Township	2.28%	0.023		10.54%	0.100	**	24.65%	0.220	***
		(0.034)			(0.044)			(0.053)	
Towanda Township	-6.20%	-0.064		5.73%	0.056		11.31%	0.107	
		(0.055)			(0.043)			(0.090)	
n		2,036			1,121			694	
Time Period		1/1/01 - 9/20/05			9/21/05 - 2/1/08			2/2/08 - 12/1/09	
Adjusted R-squared		0.6923			0.6786			0.6418	
Standard Error of Regression		0.2821			0.2924			0.3146	
Sum Squared Residuals		159.29			92.96			65.42	
Log Likelihood		-295.10			-195.08			-165.26	
F-statistic		139.77	***		72.66	***		39.80	***
Mean ln(Real Property Price)		11.63			11.61			11.60	
Std Dev ln(RealPrice)		0.51			0.52			0.53	
Akaike Information Criterion		0.32			0.41			0.57	
Schwarz Criterion		0.42			0.56			0.79	
Durbin-Watson Statistic		1.98			2.02			1.93	

***denotes significance at 1% level **denotes significance at 5% level *denotes significance at 10% level

Notes: White Heteroskedasticity-Consistent Standard Errors & Covariance are in parentheses (White, 1980). No Obs=No Observations.

Base Group: Lexington Township.

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Abstract

Potentially adverse effects of windfarm visibility on property values can represent real costs to communities, yet few studies exist on the subject. The studies that are available are contradictory, and suffer from statistical flaws. A clearer understanding of actual effects of existing wind facilities will inform future decisions. To explore this subject this report analyzes 280 arms-length single-family residential sales using a hedonic regression model. The sales took place from 1996 to 2005 and are within 5 miles of a 20 turbines - 30 megawatt (MW) windfarm in Madison County, New York. The report differentiates itself from previous studies by visiting all homes ("ground truthing") in the sample to ascertain the actual level of turbine visibility. The analysis finds an absence of measurable effects of windfarm visibility on property transaction values. This result holds even when concentrating on homes within a mile of the facility and those that sold immediately following the announcement and construction of the windfarm in 2001. These results dispel the proposition that effects, either positive or negative, are universal. The report concludes by making recommendations to stakeholders and outlining possible considerations for further research.

Key Words

Viewshed, view, vista, wind energy, windfarm, turbines, property values, transactions, hedonic, regression, review, GIS, ground cover

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1 Executive Summary

With federal renewable energy tax credits and a number of state incentive packages in place (AWEA, 2005b), U.S. states are increasingly relying on wind energy to mitigate risks related to resource scarcity, increasing costs of fossil fuel extraction, greenhouse gas emissions and other environmental hazards (CRS, 2005). This shift has caused wind energy development to grow at an unprecedented rate. In 2005 new capacity totaling 2,400 megawatts (MW) was installed in the U.S., an increase of 35% over 2004 U.S. capacity (AWEA, 2006).[1] At the same time windmill sizes have become increasingly large in order to capture greater efficiencies per turbine, and the numbers of turbines installed per windfarm has increased to capture economies of scale (AWEA, 2005c). Litigious conflicts between community members and facility developers have occurred (Adams, 2005) and are likely to increase if the industry trends of increasing size and number continue. Community attitudes regarding wind energy are often promoted by small groups of organized opponents or proponents, therefore the sentiments of the entire community on average may be missed. One way to measure the community's disposition is to use property transaction prices (transaction values) as a proxy. If the visibility of a windfarm is believed by the members of the community to adversely affect the view from the home, the transaction value, with all else being equal, will be lower as compared to other homes without a view. Alternatively, if residents find the view acceptable, no change in property values will be discernable.

Many opinions exist on the effects of wind development on surrounding property values. For example, the two largest studies completed in the U.S. reach contradictory

[1] The American Wind Energy Association (AWEA) estimates that 2,400 MW of wind energy will supply energy for 600,000 homes (AWEA, 2006)

results. Haughton (2004) predicts sizable negative effects from windfarm development on property values in Cape Cod, Massachusetts while Sterzinger (2003) concludes from his analysis of 10 communities around the U.S. there are strong positive effects. Despite these contradictory results no studies to date have rigorously analyzed the subject by using a large sample of arms-length home transaction values combined with a verification to what degree each home in the sample can see the wind farm or not. Instead, with each new wind development interested parties are forced to rely on poorly constructed or inconclusive studies (Jordal-Jorgensen, 1996; Grover, 2002; Sterzinger *et al.*, 2003; Poletti, 2005), or comparisons to inappropriately analogous research (Zarem, 2005a). For instance in 2004, the Public Service Commission (PSC) of Wisconsin heard opposing conclusions of studies conducted by experienced economists (Poletti, 2005; Zarem, 2005b). Both cited, in their testimony, their frustration with the lack of available evidence in this subject area.

Compounding the lack of data problem, changes in property values are not likely to be taken into consideration by the developer and the community. These “hidden costs” or “externalities” are not weighed against the benefits of a project. Without proper analysis of these potential costs or externalities and a thorough understanding of when and how they affect property values, facilities may be either needlessly delayed or inappropriately approved. This report studies property values and windfarms with the hope of shedding light on these issues.

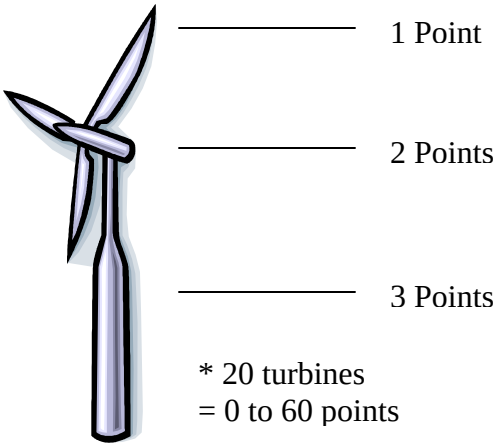
First the report reviews the existing literature on property values and windfarms finding in most cases a lack of rigor and insufficient detail to capture the complex relationship between home transaction prices and views, such as those found in research of high voltage transmission lines (HVTL) and property values (e.g. Des-Rosiers, 2002). Then

using data from a Madison County, New York community surrounding a 20 turbine windfarm, the report analyses home transaction values in an effort to ascertain if effects exist and to create a potential blueprint for future analysis of other communities. The data contains 280 arms-length single-family residential home sales which took place between 1996 and 2005; 140 occurred after facility construction began in 2001. None of the home sales were on properties that contained turbines, or received compensation from the operation of the turbines. Two methods of measuring the degree to which each home can see the turbines are developed, a simulated method and one involving field visits. Ultimately, as is discussed below, the method involving field visits was used for the regression model. The simulated method uses a geographical information system (GIS) model to predict visibility. Ten meter digital elevation model (DEM)[2] data provided by the United States Geological Survey (USGS) is combined with 10 meter ground-cover data by estimating heights of ground cover types and adding these heights to the surface elevations. The ESRI 3-D analyst viewshed algorithm, which is included in the Arc Map product, is used to analyze visibility. Then, GIS predictions are compared to field collected data. Although it incorporates techniques not previously used and reaches an accuracy rate of 85%, which is higher than the 50% accuracy rate found in the literature (Dean, 1997; Maloy and Dean, 2001), it is deemed an unsatisfactory level of accuracy for this report's hedonic analysis which requires greater than 95% accuracy. Therefore, the second, field visit method is used.

[2] The DEM is a digital representation of the elevation of locations on the land surface. A DEM is often used in reference to a set of elevation values representing the elevations at points in a rectangular grid on the earth's surface.

For this method, each home in the sample is visited and the degree to which each of these homes can see the windfarm is quantified using a scoring method which attempts to minimize bias. From each home each of the twenty turbines is given a 0 (no view) to 3 (full view) score, which are then totaled resulting in a 0 to 60 score specific to that property.[3]

Figure I: Turbine Visibility Scoring Method



As well, a GIS is used to quantify the exact distance from each home to the nearest turbine. These two characteristics, view of and distance from turbines, are combined with a number of house and neighborhood characteristics. The combination of characteristics is then used in a hedonic regression model to investigate the marginal effect that the view of and distance from turbines has on home sale prices. The hedonic pricing model is well established in its usefulness in investigating the effects environmental characteristics have on home values (e.g. Dale *et al.*, 1999).

The report finds that the model significantly predicts home values (f-value 49-56, p-value 0.000, R^2 0.792), and on average that there are no measurable effects on property values based on the view of and distance from turbine characteristics (p-value 0.410 and

[3] The actual range of scores for the sample set used in this report is 0 to 43.

0.679 respectively). This finding holds both temporally and spatially. In other words, homes which sold in the year the project was announced and constructed (2001), and had a clear view of the turbines, are not affected uniquely (p-value 0.742); and no measurable effect is found for homes located within a mile of the facility (p-value 0.656)[4].

Additional tests are run to see if the township of Fenner in which the turbines are located, and to which payments are made by the facility owner, is accordingly perceived to have a positive value in the eyes of home purchasers as compared to the other townships. If the payment to the township is considered to be a distinct advantage by home purchasers, by adding needed dollars to the town budget, for example, it might be found the homes in Fenner are priced at a premium to other townships, all else being equal. In our analysis no measurable premium is found (p-value 0.689).

These results are important to policy makers and other stakeholders because they dispel the supposition that windfarm development has universally negative effects on home values. They support the results previously collected via surveys which find that a majority of residents in communities surrounding other wind facilities not only perceive the turbines to be "acceptable" (Warren *et al.*, 2005), but also "relatively nonexistent," by rarely (< 3.0%) spontaneously mentioning them in descriptions of their surroundings (Braunholtz and MORI-Scotland, 2003).

[4] A p-value is a measure of statistical significance, which can be reported in a number of ways in studies (e.g. margin of error, probability, or significance). They all report the same thing, the degree of confidence that the results were not reached by simple chance. As sample sizes grow, and variation among them becomes more predictable, more confidence can be had that "statistically significant" results from the analysis of the sample set can be transferred to the entire population. Conversely, if sample sizes are small, and variation among them is less predictable, results can not be validated against an average, and therefore present difficulties in being extrapolated to the population. In these cases results should be taken anecdotally or should not be transferred outside of the sample set.

With a paucity of research on the subject of effects of wind facilities on property values and a great deal of speculation regarding the actual effects, policy makers are forced to rely on poorly constructed studies and opinions. This report attempts to move the discussion toward the facts. Its research finds that in this community of 280 homes no effect is found. To the degree that these results are corroborated by further analytical research in other communities, the issue of negative impacts of windfarms on property values might take a lower priority in the decision making process. This report makes policy recommendations to stakeholders based on the results of this study and outlines possible areas for consideration which should be explored in future research.

2 Introduction

With federal renewable energy tax credits and a number of state incentive packages in place (AWEA, 2005b), the States are increasingly relying on wind energy to mitigate risks related to resource scarcity, increasing costs of fossil fuel extraction, green house gas emissions and other environmental hazards (CRS, 2005). Because wind energy, "is one of the lowest-priced renewable energy technologies available today" (USDOE, 2005, p. 1) and its resources are well distributed around the country, it has enjoyed an average annual growth of almost 20% over the last decade (GWEC, 2005) and is expected to continue its growth into the future (EIA, 2006). In the United States, twenty-one states have implemented a Renewable Portfolio Standard (RPS) which requires a percentage of retail sales to be from renewable sources (AWEA, 2005b). The American Wind Energy Association (AWEA) forecasts a 7-fold increase in the use of wind energy in the U.S. by 2020 (AWEA, 2005e). In 2005 alone roughly 2,400 MW (or 1666 turbines[5] in 140 "windfarms"[6]) have come online in the U.S. (AWEA, 2006).

Not only have the amount of windfarms been increasing but the number of turbines in each development has increased to capitalize on economies of scale. Additionally the sizes of the structures over the last 20 years have changed dramatically in order to increase turbine efficiency. As the height and rotor diameter of turbines increase, the power generated from the turbines grows exponentially (AWEA, 2005c). In 1980 when the Altamont Pass wind facility was erected outside of San Francisco in California (CA),

[5] Estimated by using an average turbine size of 1.5 MW and farm size of 100 MW. Using this same estimate, if New York State is to meet its RPS goals of 25% by 2013 (NYSDPS, 2004) 30 new windfarms will have to be sited.

[6] These wind energy production facilities usually contain groupings of 10 or more turbines referred to as a "windfarm, " because they are laid out, "as a farmer might approach…a field" (Gipe, 2002).

turbines averaged 30 meters in height (Pasqualetti, 2002). Now land based turbines sit on towers as high as 90 meters, and have blade lengths of 45 meters (AWEA, 2005c) totaling 135 meters (442 feet) from base to tip.[7] While increasing efficiency, this difference in heights makes them considerably more visible from long distances.

With the high number of windfarm installations expected to occur in the U.S. to meet RPS goals over the next decade and the ever increasing size of the facilities and the turbines themselves, it is inevitable that there will increasingly be conflicts between developers and members of the communities in which the windfarms are sited. Often these clashes revolve around environmental "aesthetics," or how well the turbines fit into the surrounding environment in the eyes of community members. Findings suggest that respondents prefer smaller turbines over larger ones (e.g. Wolsink, 1989; SEI, 2003) and fewer structures rather than more in each group (e.g. Devine-Wright, 2004). Accordingly, homeowners have often claimed a proposed wind facility will ruin or "mar their view" (e.g. AP, 2006).

How can this claim be tested? When property owners say windmills will "ruin" their view, they are claiming both that there is some intrinsic value of "vista" (or view)[8] from their home, and that if the proposed windmills can be seen from the home this value will be diminished. It follows that if you can analyze home sales that have visual contact with the windmills in comparison with ones that do not, all others things being equal, an average effect can be verified. In other words, community attitudes of a wind development

[7] Offshore turbines can be even bigger ranging up to 165 meters from base to tip.

[8] For this report, a distinction is made between "vista" and view or viewshed. "Vista" will always refer to the value of a home that is derived from a "good view" from the property. "View" or "Viewshed" will refer to the degree to which a property can see the windmills. In other words, "A property not only had a beautiful vista, but had a view of the windmills too."

can be translated into home values, just as, for instance, the perceptions of a safe neighborhood or good quality public schools are translated into sale prices. This correlation of community attitude and property values has been confirmed in studies of other environmental attributes such as open space (e.g. Irwin, 2002), high voltage transmission lines (HVTL) (e.g. Des-Rosiers, 2002) and environmental stigmas (e.g. Dale *et al.*, 1999).

What are the ramifications to the community or society of such potential connections? If the effect of visibility of wind facilities on property values is universally highly negative, these costs might be very high. Haughton (2004), in his study of the proposed Cape Cod windfarm forecasts depreciation of property values in the billions! Yet, often changes in home values are outside the normal transactions of a developer and a community and are thus "hidden costs" or "externalities" of a project. These externalities are often grouped together and termed "environmental impacts" (EMC, 2005). Windfarm developers are often required, depending on the state or local laws, to investigate the nature and magnitude of these externalities by preparing an environmental impact statement (EIS) or something similar[9] often modeled after the Federal requirements as directed by the National Environmental Policy Act (NEPA)[10] regulations. An EIS is a report describing the investigations conducted by the developer of potential effects the facility will have on the surrounding environment. The report has a number of functions. First, it allows interested parties and stakeholders an opportunity to peel back, investigate and in some cases challenge the development's declared environmental impacts. Secondly, it provides a record that can be later challenged if assertions are found to be incorrect. Lastly, it provides

[9] More often than not, local laws will permit development to take place without a full environmental review (GAO, 2005), but often some type of impact assessment is required.
[10] National Environmental Policy Act (42 U.S.C. & 432l)

a schedule of expected environmental costs that can be compared against the proposed benefits any project will provide. In order for a project to proceed, "it must be demonstrated that the need for the proposal outweighs all adverse impacts" (EMC, 2005, p. 10).

Because of the importance of understanding actual effects on property values as costs to be weighed against benefits, it may be expected that this issue has been widely studied. However, this is not the case. Some studies exist using actual real estate transaction prices, but have made critical errors which weaken the results (e.g. Sterzinger *et al.*, 2003; Poletti, 2005), as explained in section 3. In the absence of actual prices, studies have used surveys of real estate professionals and homeowners as a proxy (e.g. Jordal-Jorgensen, 1996; Grover, 2002; Haughton *et al.*, 2004). Yet none of these studies reported their results accompanied by levels of significance.[11] Accordingly decision makers are forced to make educated guesses as to the predicted effects of a proposed windfarm. One controversy was played out in Wisconsin as two experts argued over the potential effects of the proposed Forward Wind Facility (Zarem, 2005b) and (Poletti, 2005) with each reaching distinctly different conclusions. Without well-designed studies with solid conclusions to work with, planners, developers, and potentially impacted communities will continue to needlessly delay or inappropriately rule on projects that might otherwise be decided differently.

This report examines whether property values were affected by a windfarm installed in Madison County in 2001. 280 home sales, which took place between three quarters and

[11] Refer to discussion of "significance" in footnote 4 on page vii.

five miles of a 20 turbine windfarm, are analyzed using a hedonic pricing model[12] to establish the degree of impact that a view of windmills might have had on the transaction values of these homes. The report first outlines previous studies on the subject. Next the report presents methodology and results. Lastly the report discusses conclusions and makes policy recommendations to interested parties and research recommendations concerning decisions on siting wind facilities.

[12] A hedonic pricing model, as discussed in section 5.1, is a statistical device which allows market goods to be broken into their component characteristics. It is often used to value individual characteristics of cars, such as the value of a sunroof, and homes, such as the value of a pool.

3 Overview of Previous Studies

The literature on wind energy facilities and surrounding property values can be grouped into three categories of increasing order of relevance for our research: survey-based studies (Jordal-Jorgensen, 1996; Grover, 2002; Haughton *et al.*, 2004; Khatri, 2004), transaction-based studies of analogous high voltage transmission lines (HVTL) structures (e.g. Delaney and Timmons, 1992; Hamilton and Schwann, 1995; Des-Rosiers, 2002), and transaction-based studies of windfarms (Sterzinger *et al.*, 2003; Poletti, 2005).

3.1 Survey based studies

When transaction data are not available either because a windfarm has only been proposed or data are not recorded or available for public use,[13] surveys can be used to estimate values of viewshed impacts. Surveys specifically asking questions regarding values can be directed at assessors and real estate agents who have professional knowledge of how values can be impacted by a change in the surrounding environment (Grover, 2002; Haughton *et al.*, 2004; Khatri, 2004) or to residents who can offer their value judgments (Jordal-Jorgensen, 1996; Haughton *et al.*, 2004). Both of these methods can suffer from inflated and unrealistic values (Kroll and Priestley, 1991), and therefore it would be inappropriate to use these values as a replacement for actual economic impacts, as is discussed below. In the absence of other data, and if the surveys are taken using random and unbiased methods, they can be illustrative of community attitudes and indicate areas for further study.

Jordal-Jorgenson (1997) conducts two types of surveys using contingent evaluation methods. Contingent evaluation methods attempt to establish in monetary terms "non-

[13] In the U.K., for example, residential transactional values are not public information.

market" environmental values by asking people how much they are willing to pay for an environmental amenity or to have an environmental nuisance removed.[14] Jordal-Jorgenson surveys 342 homeowners living "near" windmills in Denmark, inquiring if they find the turbines a nuisance and, if so, what they would be willing to pay to have them removed. 13% of the homeowners find them a nuisance and are willing to pay $140 per household per year on average to have them removed.[15] Additionally, Jordal-Jorgensen asks respondents what they would be willing to pay to not live near the windmills. The study finds that people are willing to pay between $2,314 and $13,429 dollars to <u>not</u> live "near" a single or a group of turbines respectively.[16] The term "near" is not defined. The study points out that because the result is an average, a wide variety of impacts could be found among the homes, with individual homes experiencing potentially large impacts. Additionally, the author admits that the small number of houses, 26 out of 342, available for analysis near the turbines did not provide a statistically significant result, and that therefore the results could be "due to coincidental factors" (p. 2).[17] This is a problem, as well, with a number of other studies outlined below. Without a reported level of confidence in the results, readers are recommended to use the findings anecdotally.

Similarly, Grover's (2002) survey results of 13 county tax assessors around Kittitas County, Oregon should also be used anecdotally because he both uses a very small sample size, and implies causality where only correlation has been found. Of the 13 county assessors that are interviewed, 6 state that their county's residential properties have views of

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[14] Surveyors use various techniques to improve the predictive power of this method. For further reading on this subject, Bateman (2002) is a good resource.
[15] Converted from Dutch Kroners (DKK) using 1996 exchange rates.
[16] Converted from Dutch Kroners (DKK) using 1996 exchange rates.
[17] Refer to footnote 4, on page vii, for a brief discussion on statistical significance, and how results which are reported without measures of significance should be used anecdotally and not empirically.

turbines, and 5 out of 6 report no complaints from residents. The report declares, "There is no evidence indicating that views of wind turbines decreased property values." (p. 4). Technically this is true, but with only 6 assessors reporting it is not possible to have a great deal of confidence in the results. Additionally, the fact that residents did not complain (correlation) does not mean conclusively that property values are not affected (causation). It is possible other reasons intervened, such as either ignorance of residents that a reduction in assessed values could be requested, that the process would be futile, or perceptions that evidence warranting a decrease would be difficult to collect on their own.[18]

Although previous studies leave much room for criticism, the work by Haughton *et al*. (2004) is more solid because it largely uses accepted rigorous techniques of sampling and survey construction. Yet, predicting actual effects on property values based on these results would be risky because the results are descriptive,[19] not analytic, no significance values are reported, and survey responses might be influenced by other variables. Despite these limitations the results are illustrative of a community searching for solid answers to questions of property value impacts. As part of an economic analysis of the proposed offshore windfarm in Nantucket Sound, Haughton *et al*. (2004) conducts a survey of 546 real estate agents (n=45) and residents (n=501). It is the first large scale survey concerning wind energy in the U.S. since the late 1980s (Pasqualetti and Butler, 1987; Thayer and Freeman, 1987; Thayer and Hansen, 1988). The report concludes that there is an adverse expectation about the proposed windfarm on property values from both residents (21%) and realtors (49%). Homeowners believe that average values will decrease by 4.0% with losses

[18] Grover (2002, p.5) states that in Lincoln WI, the assessor asked a complaining resident to show that nearby properties had diminished in value. This most likely is outside the abilities of the average homeowner.
[19] Descriptive results describe the distribution of variables without regard for causal or other hypothesis. Analytic studies are designed to examine these associations. (Last, 1995)

of 10.9% expected for waterfront properties. Realtors expect losses to total 4.6% on average. To extrapolate from these results is risky though. In a comparison of survey and hedonic approaches Brookshire *et al.* (1982) caution that, "biases due to lack of experience must be considered" (p. 176). The responder's estimates for anticipated impacts might be higher than those actually experienced. For example, the results of a survey in Scotland of 1,810 adults living near 10 windfarms with 9 or more turbines (Braunholtz and MORI-Scotland, 2003, p. 10) found that:

> "Of those that lived in their homes prior to the construction, concerns about specific problems that might arise as a result of the windfarm do not seem to have materialized in many cases…Furthermore, while around half (54%) anticipated no problems over a range of issues associated with the windfarm development, as many as eight in ten (82%) say that there actually have been no problems."

This is corroborated by Warren (2005), in a study of residents surrounding windfarms in South-West Ireland who stated, "73% of residents across all [spatial] zones feel that their fears have not been realized" (p. 864). Finally, the predicted amount of value degradation as reported by Haughton *et al.* could be confounded by other variables, such as whether the respondent's home has a view of the sound, if they believe wind energy to be necessary, to what degree they believe it might contribute to positive environmental change, or if they had seen an actual windfarm. Yet Haughton does not report these interactions between these variables.

Despite these weaknesses, their results are important in other ways. They illuminate a belief that the brunt of the effects will be felt by residents on the water in full view of the sound. Haughton found that 69% of realtor respondents believed the effects of the windfarm would be felt to a greater extent on ocean front houses, with only 2% expecting the effects to be distributed evenly (29% no opinion). The reasoning for this follows the

logic that the "vista" of the sound provide value to the houses (e.g. Rodriguez and Sirmans, 1994; Seiler *et al.*, 2001). Incorporated with the belief that the addition of windmills will decrease the beauty of that "vista," it follows that the values of these homes will be diminished. Further, it might be the case that *ceteris paribus*, home values more dependent on "vista" will experience an effect where others will not. There might be some threshold where an effect begins such as that found with HVTL in Des-Rosiers (2002) study where he found effects (positive and negative!) completely disappear outside of 500 feet from the transmission line. All told, it would be difficult to entirely dismiss the results of Haughton *et al.* as the musings of the inexperienced or the hysterias of those in fear. The proposed windfarm will consist of 130 turbines, and as mentioned above, people have a preference for smaller windfarms over larger ones (Wolsink, 1989; SEI, 2003). It seems likely that house values in that region will react in concert to some degree with resident dislike; the question will be in what amount.

The results of Khatri's (2004) survey, for reasons similar to Haughton (2004) are illustrative of perceptions rather than actual values. Khatri mailed 1,942 surveys to licensed surveyors in Great Britain (U.K.); 405 voluntarily responded, and roughly 80 were surveyors who had experience with residential transactions near windfarms. The report finds that a majority (60%) of surveyors reported that property values will be adversely affected, though closer inspection finds dilutions to the results in three ways. The experienced respondents were concentrated in Wales and Scotland, where 43% of U.K. wind projects are located,[20] yet the percentage of Welsh (45%) and Scottish (55%)

[20] from www.bwea.org as cited by Khatri (2004)

respondents reporting decreased values is below the survey's national average (60%).[21] This implies that the national average is not appropriate to use as a final result. Secondly, because responses were voluntary, there might be a selection bias as the sample was unlikely to represent the population (Heckman, 1979).[22] Lastly the actual survey is not provided so it is difficult to assess the quality of the research, for example the nature of the questions.[23]

3.1.1 Conclusions drawn from survey studies

The survey studies do not give a clear indication as to whether there is an actual decrease in value. Even Haughton's (2002) study suffers from the likelihood that without actually experiencing what windmills look like in Nantucket Sound, respondents will overestimate the impacts. Haughton does elucidate, though, the possibility of thresholds of sensitivity for price devaluation. The results of these studies reinforce the need for more research and lead us into the next category of studies that are often used as a proxy for windfarm property value analysis: transaction-based studies of analogous HVTL structures.

3.2 Transaction based studies of analogous HVTL structures

With little to go on from existing research of wind energy and property values, interested parties have turned to property value studies of high voltage transmission lines (HVTL) in an attempt to make a benefits transfer from these structures to windfarms. It has been found that HVTL structures are perceived negatively and often adversely affect property values

[21] A decrease in experienced effects is more recently corroborated by Warren (2005, p.853) "inverse NIMBYism"

[22] It is possible that only those that were bothered by the wind farms responded because they cared the most. If that is the case, than the results are skewed and in actuality less assessors feel there will be a decrease in property values.

[23] The report results "60% agreeing" imply that a leading question was used such as, "Do you agree the windfarms hurt property values?"

(e.g. Kroll and Priestley, 1991; Des-Rosiers, 2002). Because newer windmills are larger, and often more noticeable because of moving parts than HVTL, the temptation is there to assume turbines will have an equal or greater effect on property values (e.g. Zarem, 2005a).

3.2.1 Are HVTL structures and windmills viewed similarly?

Research conducted in 2003 in Ireland, based on a survey of 1,200 people indicated that windfarms were preferred over HVTL towers (as well as cellular towers and fossil fuel stations) (SEI, 2003). Why is this? Thayer and Hansen (1988) found that perceptions of windfarms were based on symbolic aspects in addition to aesthetic ones. Devine-Wright (2004) concurs, stating that symbolic aspects "could include the degree to which turbines are associated with wider environmental concerns such as climate change and feelings of personal responsibility to address such problems" (p. 129). This more complicated view of turbines is echoed in Warren (2005). When respondents living around windfarms were asked to rank the most positive and most negative aspects of the turbines, their presence in the landscape topped both categories (34% and 44% respectively). People either love them or loathe them.[24] It follows that if the U.S. effort in building windfarms is increasingly perceived as a reduction of risks, and therefore a solution to problems of energy scarcity and security, reaction to them will improve. Conversely, it is unlikely that HVTL would ever be perceived as offering a greater good. In fact, however unfounded,[25] electromagnetic radiation from HVTL is still a concern for individuals.[26] Because of these differences in

[24] This turn of phrase has been used often to describe public sentiment (e.g. Bishop and Proctor, 1994; Freris, 1998).
[25] Goeters (1997) reports that no study has provided scientific evidence of a relationship between cancer and HVTL proximity.
[26] Delaney (1992) reports that, "Even appraisers who had not appraised such property [near HVTL] believe that power lines contribute negatively to property values [for health reasons]." (p. 315).

perception between windmills and HVTL it would be imprudent to make a one for one comparison between the two.

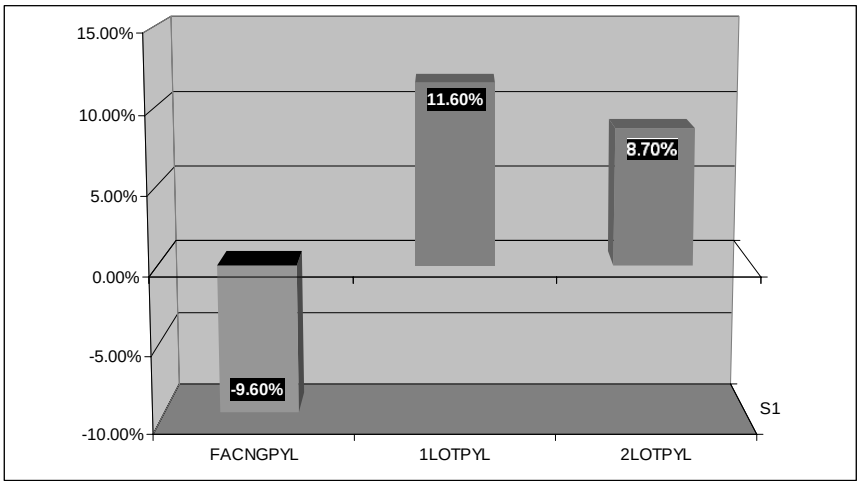
3.2.2 Are spatial property value effects of HVTL similar to windfarms?

Des-Rosiers (2002) found that effects from HVTL and their accompanying easements[27] disappeared outside of 500 ft. Additionally his results show a very sensitive interplay between proximity to the tower structure and proximity to the easement. Des-Rosiers (2002) found both an unambiguous negative effect due to towers and an unambiguous positive effect due to easement of HVTL on house values. In his review of the HVTL literature Des Rosier's (2002) finds that most studies conclude that, "Other physical as well as neighborhood attributes prevail [over proximity to HVTL] in the price determination process." (p. 277). This conclusion is also borne out in his findings that the negative effects of a view of a tower from a house immediately adjacent to it are overwhelmed by the positive effects of living near a HVTL easement just a few doors away (Figure I).

If HVTL and windmills exhibit similar effects on values, can it be assumed that property value effects of windmills will entirely disappear outside of 500 ft? Perhaps they will disappear, but at what point; one tenth of one mile, a half of one mile, or some other distance? Additionally, what effect will some overriding positive attribute, such as "vista" of sunsets, a bucolic field, or a mountain range, have on the potentially adverse effects of a view of windmills in close proximity?

[27] In the case of HVTL easements are clearings through which transmission lines pass. They have benefits, for example, in that ensure a development free zone and can provide access to green space.

Figure II: Property Value Effects of HVTL and Distance



Source: (Des-Rosiers, 2002, p.293) Effects on houses adjacent to towers (FACNGPYL), are negative (-9.60%). Those on lots 1 or 2 away (1LOTPYL & 2LOTPYL) are positive (11.60% and 8.70 % respectively).

Lastly, it is interesting to consider Warren's (2005) theory "inverse-NIMBYism" that there is an increased appreciation for wind turbines as you move closer to them, and the findings of Braunholtz (2003) which show largely ambivalent and positive reactions of residents to nearby turbines. Braunholtz finds that of the people living within 5 km (3 miles) of turbines 45% had largely positive views (with 6% having negative views and 49% ambivalent/no opinion), which differed significantly from those residents living outside of 10 km (6 miles) of which 17% had positive views (with 6% negative and 77% ambivalent/no opinion). The logical extension of inverse-NIMBYism on property values would have values increasing as distance from turbines decreases! Despite this possibility the report assumes the conventional stance that windmills will either decrease values or not change them at all.

3.2.3 Are temporal property value effects of HVTL similar to windfarms?

Kroll (1991) finds that where newly installed HVTL have effects on property values, they tend to fade away entirely over four to ten years. This is similar to results of some studies conducted near wind energy facilities. Exeter-Enterprises-Ltd (1993) found via its longitudinal study of facilities in the U.K. that negative perceptions diminish over time. "The results show that any change of attitude…is toward thinking that wind power is better." (p. 53) On the other hand, Devine-Wright (2004) believes the opposite. His re-analysis of Krohn's (1999) results show that negative perceptions of development can increase over time. Is this because older turbines are often decommissioned yet are not removed? Thayer (1988) believes so, finding that community sentiment is correlated with the number of turbines in operation, and if turbines are standing idle, negative perceptions increase. Given these contradictory results, a generalization of the similarities of HVTL and windfarm's temporal effects is not appropriate.

3.2.4 Conclusions drawn from analogous HVTL studies

The comparisons of HVTL effects on property values and those of windmills seem unclear. HVTL structures are not viewed the same as windmills, and windmills can even take on positive connotations. Moreover the interplay between HVTL and property values is both tenuous and very sensitive to distance and other neighborhood characteristics. There are spatial and temporal thresholds for HVTL property value effects which also could exist for windmills. As with the survey study analysis above, a careful look at HVTL studies reinforce the need for more research. Possibly other structures, for instance offshore drilling platforms, could be used as a more appropriate proxy as will be discussed further in the recommendations section. The studies conducted using actual property transaction

values surrounding wind facilities offer more empirical data, but are also inconclusive as to the effects of windfarms on these values.

3.3 Transaction based studies of windmills

To date only two studies have been conducted using actual transaction values of homes surrounding wind facilities. The results of these are varied. Sterzinger *et al.*, (2003) conclude that property values rise in the area of windfarms, and Poletti (2005) comes to the conclusion that no effect exists.

Sterzinger *et al*., (2003) analyses roughly 24,000 transactions near 11 windfarms in the U.S., and compared average transaction values for houses in a control area outside the viewshed of the windfarm with transactions occurring within the viewshed (a 5-mile radius). The study comes to the conclusion that, "There is no support for the claim that wind development will harm property values." (p. 9), and even declares, "For the great majority of projects [windfarms] the property values rose more quickly in the viewshed than they did in the comparable community." (p. 2). Although this study is often quoted,[28] its methods have been criticized (e.g. ECW, 2004) for four reasons. First, the authors attempt to calculate a value for the variable "view of windmills," without properly controlling for it. There is no attempt to discern which properties within the ten different 5-mile viewsheds can see the windfarm or not. In effect, the study makes the erroneous assumption that all properties in the 5-mile radii can see the windfarm, when many houses' views in fact are obstructed by geological features, trees, and other houses (RBA, 1998a; Poletti, 2005).[29]

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[28] A "Google" internet search using all of the following words, "REPP", "wind" and "property" generates 18,600 results. [tested 2-20-06]

[29] Sterzinger *et al* analyze the community surrounding the Madison County windfarm, which is the subject of this report. We found 66% of the homes sampled in the 5 mile radius could not see the windfarm at all.

Secondly, the analysis does not control for distance to the turbines, thereby making the assumption that the "viewshed" effect is the same, on average, for homes five miles from the windfarm and those in immediate proximity to the turbines. Third, there are problems with how the study validates its results. The report provides readers with only R^2 (or goodness-of-fit) values for its outcomes, and this is problematic, since, by itself, the R^2 statistic is a poor indicator of explanatory power (Halcoussis, 2005). Compounding this problem, the report gives R^2 values which are very low, for instance 0.02 for some models, which is saying in essence the model describes only 2% of the actual movement of property values. Despite this somewhat flagrant disregard for rigor it treats these models as it does models where the statistic is high, for example 0.85. This inconsistency is not addressed by the report. The last reason this research is often criticized is that no attempt is made to sort out inappropriate transactions. Sales that are not arms-length (divorce, sales between family members, estate sales etc.) are included. By doing so the report includes transactions that do not represent the agreement between a willing buyer and a willing seller, a requirement for accurate analysis. Combined, these four omissions in rigor render the results of the report extremely weak, if not entirely misleading.

The analysis by Poletti (2005) improves on that of Sterzinger *et al.* (2003) by culling out transactions that were not arms-length. As well, it excludes sales of homes built before 1960, in an effort to control for house-specific characteristics such as construction quality, amenities and condition. Poletti looks at roughly 300 sales that occurred in and around two windfarms in Wisconsin and Illinois. He comes to the conclusion that there is not sufficient evidence in the data to warrant rejection of the claim that windfarms have an effect on property values. Poletti compares average values of properties surrounding the windfarms,

which he entitles “target area” with those in a “control area,” which is outside the view of the windfarm. However, Poletti does not attempt to measure to what degree, if any, homes can see the windfarm. The author describes the area surrounding the windfarms as rolling with potentially obscuring features, so the implication is that some of the properties have no view of the windfarm. Further, no effort is made to control for distance. Although statistically sound techniques were used to compare the control area to the target area, by not properly controlling for view and distance, the study results are inconclusive at predicting the effects of the windfarm on property values.

3.3.1 Conclusions drawn from transaction studies

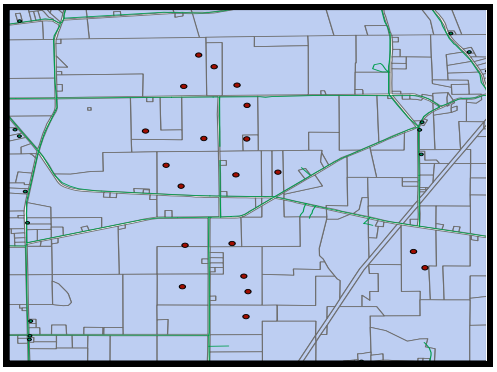
Taken together, the two studies using transaction values still leave open to conjecture the question as to the actual effects of windfarms on property values. By not appropriately sorting out misleading data, empirically establishing the degree to which houses could see the windfarm, and not factoring in distance, these studies most likely miss the potentially subtle interaction between view and value that has been found with other environmental stigmas (Des-Rosiers, 2002).

If results of studies of property values and windfarms can be confidently applied in windfarm siting decision making, the above analysis makes clear the importance of using large samples (>30), of measuring the actual visibility of and distance from turbines from each house, and of testing the results for significance. The following analysis attempts to do this. First there will be a brief discussion of the study area, then methodology, results, conclusions and recommendations.

4 Study Area

The Fenner windfarm was announced near the end of 2000; construction commenced in the spring of 2001 and was completed in the fall of 2001 (Moore, 2005). The 30 megawatt (MW) installation consists of 20 turbines, each 218 feet tall, with a rotor radius of 110 feet, making the top of the turbine blade's sweep roughly 328 feet above the ground. The windfarm sits atop 14 different parcels over 2,000 rolling acres. The Fenner Township receives $150,000 as a payment in lieu of taxes (PILOT) from the project owner which goes to increased road maintenance and schools (Cary, 2005). As is required under the New York State Environmental Quality Review Act (SEQRA) an Environmental Assessment Form (EAF) was prepared and submitted to the lead agency which was the Town of Fenner Board. It issued a Negative Declaration on the project based on the EAF, citing adverse impacts as insignificant. The public was given a number of opportunities to participate in the decision making process at town board and planning board meetings, which were characterized as both numerous and without much opposition (Moore, 2005). Larger maps of the study area are included in Appendix B.

Figure III: Fenner Turbines & Parcels



Source: Madison County Tax Office
(Large dots are windmills, rectangles are parcels, parallel lines are HVTL, and the dark lines are roads.

5 Methodology

The general purpose of this case study is to test if the view of the Fenner windfarm from homes inside of 5 miles from the windfarm has any significant effect on transaction values. "View" is defined using a continuous variable from 0 (no view) to 60 (a full view of all 20 turbines). The study additionally investigates how this effect varies with distance (spatially), time (temporally) and house value. Lastly, the effect and degree of the PILOT payment to Fenner Township is investigated.

The hedonic pricing model is well suited to dissect these issues revolving around windfarm acceptance. The rigor of the instrument in measuring the marginal contribution housing and neighborhood characteristics have on home transaction values is well supported in the literature for assessment purposes (Brookshire *et al.*, 1982; Malpezzi, 2002; Sirmans, G.S. *et al.*, 2005a; Sirmans, G. Stacy *et al.*, 2005b), in establishing effects of HVTL (Kroll and Priestley, 1991; Delaney and Timmons, 1992; Hamilton and Schwann, 1995; Des-Rosiers, 2002), in valuing the contribution "vista" has to value (Rodriguez and Sirmans, 1994; Benson *et al.*, 2000; Seiler *et al.*, 2001; Bond *et al.*, 2002), and in determining the effect of open space (Irwin, 2002) and environmental stigmas (Dale *et al.*, 1999). The model, given enough data, is sensitive enough to allow sales to be grouped temporally (e.g. by year), spatially (e.g. by distance from an amenity such as a body of water), and economically (by the value of the home). Once these divisions are made, variables of interest (e.g. the marginal contribution of fireplaces to homes values) from one group can be compared to other groups, both in terms of significance and the level of contribution.

5.1 The non-linear hedonic model

The non-linear hedonic pricing model in its present form is often attributed to Sherwin Rosen (1974) for his contribution to its utility in deciphering housing prices. A number of reviews (Malpezzi, 2002; Sirmans, G. Stacy *et al.*, 2005b) validate his construction in its ability to rigorously predict changes in residential transaction values based upon characteristics of the homes.

The model takes the form:

Log (Sale_Price) = *f* (Physical Characteristics, Other Factors).

"Physical Characteristics" often used include square footage of the home, lot size, number of bathrooms, number of bedrooms, type of construction, etc. "Other Factors" often include proximity to amenities, school district, local tax rates, and in this case study, "view" of and distance from turbines.

5.2 Variable selection

Although inclusion of the most commonly significant variables as taken from the literature (e.g. Sirmans, G. Stacy *et al.*, 2005b) is important and necessary, often local conditions can direct the proper construction of the model more than convention. Local assessors, realtors, and residents often have considerable insight into how prices are affected by changes in characteristics and other factors. Therefore in constructing the model used for this report Sirman's (2005b) recommendations for variables were included as well as those cited by a survey of two local assessors and two real estate agents. The results of the two inquiries are listed in Table I and Table II.

Sirman's list included all of the variables on the local expert list except School District, the distinction between distance to I90 and distance to State Route 20, local tax rates and building styles. All of the available variables from both the Sirman list and the local expert list were included.

Table I: Sixteen Most Significant Hedonic Variables in Housing Studies

Variable	Appearances	# Times Positive	# Times Negative	% Time Significant
Square Feet (SFLA)	69	62	4	96%
Central Air	37	34	1	95%
Age at Time of Sale	78	7	63	90%
Pool	31	27	0	87%
Acres	52	45	0	87%
# of Full Baths	37	31	1	86%
# of Stories	13	4	7	85%
Deck	12	10	0	83%
# of Fireplaces	57	43	3	81%
# of Garage Spaces	61	48	0	79%
# Rooms	14	10	1	79%
Basement Type	21	15	1	76%
# of Bedrooms	40	21	9	75%
Brick or Stone Extr.	13	9	0	69%
Distance	15	5	5	67%
Time On Market	18	1	8	50%

Source: (Sirmans, G. Stacy et al., 2005b)

5.3 Data collection

The data concerning transaction values and assessor information is collected from Madison County Real Property Tax Office. From January 1, 1996 through June 1, 2005, 452 sales took place that were coded "arms-length" transactions by county assessors, and were within 5 miles of the windfarm. Of these, 152 were removed as land-only sales[30], and upon closer inspection 20 sales (15 land-only and 5 non arms-length) were found to have been coded incorrectly and were removed. For the remaining 280 sales, assessor records from the

[30] "Land Only" sales refer to sales of parcels that did not contain a house at the time of sale.

closest preceding inspection were collected providing information about structural characteristics and location.

Although most of the recommended variables were included in the Madison County records, there were many gaps in the records for the following variables which made them unusable: Pool, deck, number of stories, number of rooms, and garage spaces.[31] Data for time on the market was not available, and therefore was not included.[32]

Table II: Twelve Most Influential Characteristics Recommended by Local Experts

Variable	Percent of the 4 Local Experts Recommending this Variable
# of Full Baths	100%
# of Bedrooms	100%
Overall Condition	100%
Basement Type	75%
# of Fireplace	75%
Acres	75%
Square Feet (SFLA)	75%
Age at Time of Sale	75%
Building Style	50%
Distance to I90	50%
School District & Taxes	50%
Distance to State Route 20	50%

Source: Joel Arsenault, Century 21 Real Estate; Jenny Chapin, Don Kinsley Real Estate; Priscilla Suits, Assessor Fenner & Nelson Townships, Madison County; Tanya Pifer, Assessor Lincoln Township, Madison County

Sale price was adjusted to 1995 dollars by using the Department of Labor's CPI for Rural New York (SALE_PRICE_95) and then converted to its natural log

[31] During field analysis decks and pools were rarely present, and the number of rooms and stories was expected to be highly correlated with the square feet, so their exclusion was not expected to compromise the results. The County is conducting a reassessment of every house in its records, which should be completed in 2006, which is expected to fill in the gaps of these characteristics.

[32] Although time on the market generally has the effect of lowering the price it has in some cases produced higher prices. It is assumed that this is because buyers can wait for the price that they want, or that the market slowly appreciates up to their asking price (Sirmans, G. Stacy *et al.*, 2005b).

(LNSALE_PRICE_95).[33] The thoroughness of this adjustment was tested by including a continuous variable (DEED_YEAR) to account for a potential linear escalation in market price which exceeded the CPI inflation rate. Four binary variables (WINTER_SALE, SPRING_SALE, SUMMER_SALE, and FALL_SALE) were included in the model to account for seasonality in the housing market. Descriptive statistics for all non-viewshed variables are given in Appendix A: Tables IX and X.

A geographic information system (GIS) was used to calculate distance from the houses to the nearest turbine (DIS_TO_MILLS). Elevation and spatial location layers were populated using the 10 meter digital elevation model (DEM) provided by the United States Geological Survey (USGS), ortho-imagery was provided by New York's Department of Environmental Conservation (NYDEC), and roads, windmill locations and parcels were provided by the Madison County Planning Department. Parcel shapefiles did not contain actual house location, so a housepoint file was constructed using the ortho images overlaid with the parcel map, for each parcel that sold during the study period.

All layers were projected using the NAD 1983 Coordinate System and the New York State Plane Central projection. Where possible, shapefiles were corroborated with ortho-images, as was the case with the windmills, to ensure locational accuracy. Distances to major roadways (Route 20: DIS_TO_RT20 and U.S. Route 90: DIS_TO_I90) were calculated using linear distance. Although this is not a measurement of actual driving time

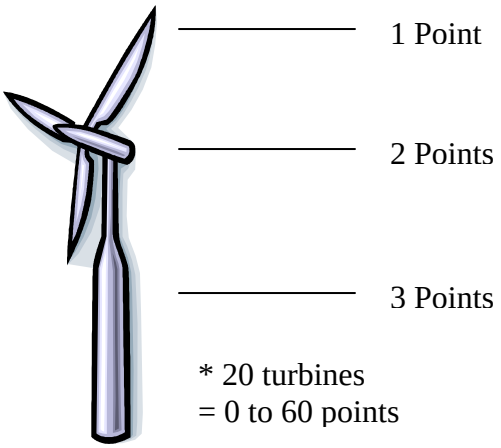
[33] To account for the "bubble" in the housing market binary variables for all years were tested but were found to be insignificant, so the CPI 1995 adjusted prices were used without these variables.

to these arteries, field experience indicated that the high density of roads in this area allowed residents a fairly direct route to the arteries at roughly the same speed.[34]

5.4 Construction of viewshed variables

To populate the variables for windfarm viewshed (VIEW) two methods were developed: a GIS simulated method and one involving field visits, and one method was ultimately used: the field visit method. The GIS method, as discussed in Appendix C, achieved an accuracy rate of 85% which improved on previous studies (Dean, 1997; Maloy and Dean, 2001) but did not meet accuracy requirements for this report's analysis of greater than 95%. Therefore the second method involving field analysis was used to ensure complete accuracy of the "view" variables. Visits were made to each of the 280 homes which sold after Jan 1, 2001 and were within 5 miles of the windfarm (138 homes visited) to assess the degree to which the home could see the windfarm. By standing at or near the house a rating of 1 to 60 was established for each home. This rating was based on the degree to which viewers could see each of the 20 windmills in the Fenner windfarm (Figure III).

Figure IV: Turbine Visibility Scoring Method



[34] A more accurate measurement would be a shortest elapsed time traveled incorporating speed limits of roads, and distance traveled on them. This is similar to the algorithms used by, for instance, Mapquest.

If the viewer could see only the top 1/3 of the turbine blades one point was given for that turbine, visibility of the nacelle (or hub) was a second point and visibility below the sweep of the turbine blades a third. Therefore a total of 3 points per turbine were possible, with a total of 60 points for the 20 turbines. No distinction was made for the direction the house faced because it was assumed purchasers were likely to walk around the house and inspect all views. If the turbines were clearly in view from the property surrounding the house, and the purchasers had a strong reaction to their visibility, it was assumed they were not likely to make a distinction between front, back and side windows at the time of purchase. Inspections were done on October 30 and 31, 2005 when deciduous trees had partially dropped their leaves. A slight distinction between winter (leaves off) or summer (leaves on) sale dates could be made from some properties; therefore visibility was calculated using the appropriate condition. Finally photographs of the house and of the predominant view were taken to corroborate results at a later time if needed.

Table III: Description of Viewshed Variables

DIS_TO_MILLS	The distance from the home to the nearest turbine as calculated by the GIS.
VIEW	The view of the turbines as recorded from the field analysis with possible range from 0 to 60. If house sold before Jan 1, 2001 the value is 0.
VIEW1MILE	The VIEW of the home if 0>DIS_TO_MILLS<=1, otherwise 0
VIEW2MILE	The VIEW of the home if 1>DIS_TO_MILLS<=2, otherwise 0
VIEW3MILE	The VIEW of the home if 2>DIS_TO_MILLS<=3, otherwise 0
VIEW4MILE	The VIEW of the home if 3>DIS_TO_MILLS<=4, otherwise 0
VIEW5MILE	The VIEW of the home if 4>DIS_TO_MILLS<=5, otherwise 0
VIEW2001	The VIEW of the home if the year of sale was 2001, otherwise 0
VIEW2002	The VIEW of the home if the year of sale was 2002, otherwise 0
VIEW2003	The VIEW of the home if the year of sale was 2003, otherwise 0
VIEW2004	The VIEW of the home if the year of sale was 2004, otherwise 0
VIEW2005	The VIEW of the home if the year of sale was 2005, otherwise 0

5.5 Discussion of Descriptive Statistics

Of the 280 properties in the sample, the mean value of homes was $102,384, the mean number of acres was 8.8 and the mean age of the home at the time of sale was 42 years old. Approximately 28% of all the houses in the sample could see the windfarm; of the 149 sales that took place after January 1, 2001, 43 were from homes which could see the windfarm. A full description of all the variables is included in Appendix A.

5.6 Testing for violations of OLS assumptions

After the model had been constructed the data were tested in accordance with the ordinary least squares (OLS) assumptions which govern hedonic regression models. These assumptions include: multicollinearity, the independence of the error term and the independent variables, homoskedasticity and temporal autocorrelation.[35]

5.6.1 Multicollinearity

The assumption of multicollinearity posits that the independent variables are in fact independent and not highly correlated with each other. If one variable is highly dependent on one or a combination of variables, the *p*-values will be inappropriately increased. This assumption can be tested for by regressing each independent variable on the others and then looking at the unadjusted R^2 values. Convention holds that R^2 values less than 0.75 indicate a multicollinearity low enough to allow results to be largely undisturbed (Halcoussis,

[35] A fifth assumption which is commonly considered in OLS models, but rarely in hedonic literature is simultaneity, when the dependent variable affects the independent variables. This was not directly tested for, but its effect on coefficient significance is to increase it. In the case of this report, this does not alter our results.

2005).[36] In our case all R^2 values were under this threshold, and most (80%) were considerably under it (in the .5 to .2 range).

During initial analysis of the variables, a correlation matrix was generated. It was found that the number of bedrooms (NBR_BEDROOMS) was highly correlated (0.746) with square feet (SFLA), but the number of bathrooms (NBR_BATHROOMS) (0.474) and the number of half baths (NBR_HALF_BATHS) (0.361) were acceptably correlated with square feet and each other (0.044), so bedrooms was dropped from the model and half baths was added. Additionally it was found that distance to I90 (DIS_TO_I90) was highly negatively correlated to distance to Route 20 (DIS_TO_RT20) (-0.977) because they run roughly parallel to each other. Therefore, I90 was dropped from the model.

5.6.2 Independence of Error Term and Independent Variables

Independence of the error term and the independent variables is important in assuring that the variables are the best predictor of the dependent variable. To test this assumption, the residuals were regressed on the independent variables. None of the independent variables were significant (*p*-value range from 0.138 – 0.913) and the model itself is non- significant (*f*-value 0.258, *p*-value 0.999, adjusted R^2 -0.059).

5.6.3 Homoskedasticity

Homoskedasticity of the variables assumes that the error terms of any range of values of a continuous variable are similar. The values of the variables are ordered in ascending or descending order and divided into thirds. The Levine test statistic compares the variances

[36] Actually the measure used is the Variance Influence Factor (VIF) which is calculated as follows: $1/(1-R^2)$. A VIF of 4 or below is appropriate to reject the claim of a high degree of Multicollinearity. An R^2 more than 0.75 will result in a VIF more than 4.

of the thirds. If that statistic falls outside the acceptable range (*p*-value > 0.05) the assumption holds. In our case all continuous variables returned values exceeding 0.05 therefore the OLS assumption of homoskedasticity was met.

5.6.4 Temporal Autocorrelation

The existence of temporal autocorrelation violates the OLS requirement that the residuals are independent of each other. If temporal autocorrelation exists, the values of the dependent variable, and therefore their residuals, are affected by the value in the previous temporal term. By arraying the residuals in chronological order and testing the correlation of any residual against its preceding residual their autocorrelation can be determined. The Durbin Watson test statistic ranges from 0 to 4. Within a range of 1.5 to 2.5 there is considered to be no autocorrelation. A statistic either more or less than that range is considered to have either a positive or a negative autocorrelation respectively. All of the models had a Durbin Watson test statistic between 1.798 and 2.047, therefore no autocorrelation was detected.[37]

[37] Spatial autocorrelation was not tested for, yet it is possible that it would exist within the data, following the logic that a neighbor's transaction value affects the surrounding transactional values both on the sellers and buyers side of the transaction.

6 Analysis

Results of the six models that were run are reported in Appendix F. Initially, the model was run with all potentially significant variables (Model #1), as recommended by the literature (Table I) and the local experts (Table II). Many building styles and school districts did not meet initial significance criteria (*p*-value < 0.75). As well, the variable for air conditioning (CENTRAL_AIR) was found to be insignificant. These variables were removed. As expected these changes improved the model's overall significance (Model #2). Model #3 is further refined with all non-significant (*p*-value > 0.1) variables removed except those for seasonality (e.g. FALL_SALE). This model (Model #3) had an F-value (63.764) considerably higher than that of Model #2 (39.185) indicating the removed variables created undue "noise" in the model. All variables had the expected sign except for the Fenner Township binary variable, which is discussed below. Model #3 was then used to test the significance of the viewshed variables.

Initially the variables for distance to the windmills (DIS_TO_MILLS) and view of the windmills (VIEW) were added to the model (Model #4). The coefficients for these variables were both positive yet non-significant at both the 95% or 90% levels of confidence (0.679 and 0.410 respectively). Models #5 and #6 explore the potential micro-spatial and temporal effects of view in 1 miles bands (VIEW1MILE thru VIEW5MILE) and subsequent years (VIEW2001 thru VIEW2005) respectively. Although both models are significant in general, all 10 variables did not meet the significance criteria (*p*-value < 0.10), therefore interpretation of the coefficient value or sign is not appropriate.

As mentioned above the sign (coeff. -0.083) and significance (*p*-value 0.018) of the binary variable for the Fenner Township (FENNER) is surprising. This variable measures

the marginal change in value for homes in Fenner Township as compared to all other townships. We included this variable to explore if the payment the township receives in lieu of taxes from windfarm operations (PILOT) has had an effect on the values of homes in the township all else being equal. The assumption is that if the payments, which largely go to the school system in the township, are considered to have significantly improved conditions in the township in the eyes of home purchasers, this variable would be both positive and significant. But, in our model the coefficient was negative and quite large (the coefficient -0.083 corresponds roughly to a decrease of 8%). Therefore, to further explore we added binary variables for all townships including Fenner (Smithfield was the omitted township). The results of this test indicated that none of the townships had a significant influence on price when taken together. This indicated that the influence of Fenner was being spread among the townships. Therefore, finally we omitted the Fenner variable and included all of the other township variables and found both Cazenovia (coeff. 0.106, *p*-value 0.095) and Nelson (coeff. 0.105, *p*-value 0.081) were significant and positive. Results for these variables are in Table IV. The positive sign implies that in relation to Fenner *ceteris paribus* the placement of the house in Cazenovia and Nelson adds value. We explored whether this had to do with the wind energy facility by adding view variables to the model. Because distance to turbines can be largely explained by the township variables[38] we only included the variable VIEW [of turbines]. We found that neither the magnitude nor the significance for the township variables changed when we took view into account. This implies that the decreased value of homes in Fenner is not related to the wind facility. To investigate the effects of township further we contacted a local realtor (Arsenault, 2006).

[38] Regressing distance on the township variables produced adj. R^2 of 0.579 and a *p*--value of 0.000.

He believed there was a correlation between the township (Fenner) and the value of homes, in that homes of higher values were not being built in the Township. He attributed this to the windmills, and believed that there was a correlation between values of home and the

Table IV: Testing for the Influence of Township on Home Value

	Coeff.	p-vlu	Coeff.	p-vlu	Coeff.	p-vlu.	Coeff.	p-vlu	Coeff.	p-vlu
CAZENOVIA	0.077	0.301	0.106	0.095	0.117	0.141	0.113	0.077	0.118	0.076
LINCOLN	0.009	0.880	0.056	0.505	0.073	0.404	0.072	0.405	0.067	0.456
NELSON	0.095	0.115	0.105	0.081	0.109	0.147	0.105	0.079	0.109	0.071
SULLIVAN	0.038	0.564	0.079	0.290	0.100	0.244	0.097	0.215	0.092	0.250
SMITHFIELD			0.029	0.628	0.036	0.567	0.035	0.566	0.032	0.616
FENNER	-0.023	0.689								
DIS_TO_MILLS					-0.002	0.930				
VIEW					0.001	0.428	0.001	0.411		
VIEW1MILE									0.001	0.716
VIEW2MILE									0.000	0.913
VIEW3MILE									0.006	0.113
VIEW4MILE									0.002	0.676
VIEW5MILE									-0.002	0.711
Model R^2		**0.791**		**0.806**		**0.790**		**0.790**		**0.789**
F/Significance	**53.921**	**0.000**	**51.184**	**0.000**	**46.524**	**0.000**	**48.827**	**0.000**	**41.132**	**0.000**

Note: Non viewshed variables were included in the model but were not shown above. Coefficients roughly correspond to percentages (e.g. 0.100 ≈ 10% increase), and p-values correspond to the likelihood that this result was reached by chance (e.g. 0.100 ≈ 10%).

affect "view of the turbines" had on them. He said, "Higher priced homes were not being built in the Fenner area because of the view of the turbines." To analyze this claim we broke sample set of home sales into thirds and investigated whether the variable for view was affected. In so doing we tested the claim that homeowners of higher priced homes care more about the view than those of lower value. Table V contains the results. We found that view did not have a significant effect at any price range. We also found that although splitting the groups did not affect the significance of the overall model, it did dramatically decrease the R^2 statistic as compared to previous models (roughly 0.80 to 0.23). A portion of this decrease can be explained by the decrease in the number of cases in each group (*n)*,

Table V: Testing for Significance of View among 3 Price Levels

Price Level	**Lower 3rd**		**Middle 3rd**		**Upper 3rd**	
	Coeff.	**p-value**	**Coeff.**	**p-value**	**Coeff.**	**p-value**
DIS_TO_MILLS	-0.009	0.773	0.023	0.132	-0.022	0.285
VIEW	0.003	0.313	0.002	0.361	0.000	0.918
***n*/Adjusted R^2**	**92**	**0.472**	**93**	**0.226**	**92**	**0.627**
F/Significance	**6.13**	**0.000**	**2.507**	**0.003**	**9.605**	**0.000**

Note: All non-viewshed variables were included in the model but are not shown above. Coefficients roughly correspond to percentages (e.g. 0.100 ≈ 10% increase), and p-values correspond to the likelihood that this result was reached by chance (e.g. 0.100 ≈ 10%).

but not all. It could reflect the variance between the income levels, and indicates a need for further research into how each income level makes home buying decisions, based on the non-viewshed variables that were included in the model (i.e. number of bathrooms, square feet, and number of acres).

7 Conclusions

Our analysis of 280 home sales within 5 miles of the Fenner windfarm, in Madison County, New York failed to uncover any statistically significant relationship between either proximity to or visibility of the windfarm and the sale price of homes. Additionally, the analysis in this report failed to uncover a relationship even when concentrating on homes within a mile or that sold immediately following the announcement and construction of the windfarm. Therefore it is safe to conclude, in this community, a view of the windfarm does not produce either a universal or localized effect, adverse or not. To the degree that other communities emulate the Fenner rural farming community, these results should be transferable. But, to be safe in these conclusions, let us first consider the possibility that: 1) effects exists, but the instruments which were used in this study were not effective in measuring them, and 2) effects exists but because those effects are situated outside the sample area our analysis did not discover them.

First we investigate the possibility: whether the instruments were not effective in measuring an effect. The instruments in question are 1) the hedonic pricing model and 2) the methods used to calculate turbine visibility. The hedonic model is appropriate as it has been well tested in various applications including, but not limited to, assessments, in valuing nearby open spaces and in valuing the effects of HVTL and environmental stigmas. It is particularly effective at discerning universal influences, and the question of effects on property values is not whether one or two houses are affected but rather if groups of houses are affected in a predictable universal way. The construction of the model, used in this report, follows the convention described as “test, test, test” (Kennedy, 2003), which refers to a model construction method that, “discovers which models of the economy are tenable,

and to test rival views." (p. 83) By carefully testing the assumptions behind the model, as were described in section 5.8, the model that was ultimately chosen can be considered to be, "the best estimated regression line" (Halcoussis, 2005).

In regards to the tests of "visibility" from each of the homes, the method chosen was intended to reduce bias and allow for a robust set of measurements (0 to 60). View was measured not in a subjective way, but rather by counting the numbers of points seen from the house. The distance was measured by linear calculations produced by a GIS. Because the range of the two measurements is relatively large, a small miscalculation of "view" (0-60 scale) or distance (0.00 to 5.99 miles) will not adversely affect the ability of the model to explain variations in sale price. It is therefore safe to say that the instruments this report used are both appropriate.

The second possibility of error concerns whether effects exist outside the sample area and therefore were not measured by our analysis. In other words, is it possible that a house inside of 0.76 miles, outside of 5 miles or that will sell after June 2005 will be affected differently than what our sample describes? The possibility should be investigated in other studies, but in the case of Fenner it is unlikely unless the situation on the ground changes.[39] Our sample set includes *all* arms-length transactions of single family homes which occurred from January, 1996 to June, 2005 within 5 miles of (and as close to 0.76 miles from) the windfarm. If one is to attempt to address the question of whether effects exist, a sample set containing all transactions cannot be improved upon.[40] If houses were

[39] For example, if the turbines are taken out of operation yet are not decommissioned or removed. Thayer (1987) found a strong negative reaction to just such a situation in California in the 1980s.
[40] The sample data is normally distributed as would be expected of 280 transactions. See Appendix F.

measurably affected outside the sample set, it seems unlikely that concurrently no effect, weak or strong, would be found inside the sample set.

If the potential inadequacy of the instruments has largely been ruled out, and we are confident that the study area represents an adequate sample we can conclude no effect exists for this community, or, if they do, the effects are random and therefore, by definition, unpredictable. The result of "no effect" has been corroborated by peer-reviewed large sample survey studies. Warren (2005) found, on average, windfarms were of little concern to residents stating, "The data reveal a clear pattern of public attitudes becoming significantly more positive following personal experience of operational windfarms" (p. 866). Further, Braunholtz (2003) finds,

> "It is extremely rare for people to spontaneously mention their local windfarm as either a positive [<3.0% of sample] or negative [0.3% of sample] aspect of their area. This fact that suggests that, for most at least, [the windfarm] is not foremost in their minds when thinking of, and describing, the area" (p. 5).

A rural setting with a history of farming, these townships might accept harvesting wind energy as an extension of the use of their land. The wind farm does not seem to have been in contest with the sense of place that is mentioned in Devine-Wright's (2004) discussion. Possibly the non-linear layout is desirable. It is rather undulating as is the landscape itself. There are many opportunities for hide and reveal[41] in this landscape, which might allow viewers to keep an emotional distance from the turbines if they are in opposition to them, or to look at them more affectionately if they are in favor of them.

[41] "Hide and reveal" or "miegakure" (jap.) is a phrase used in landscaping where even in small spaces portions screening of features (the "hide") encourages viewers to see what lies just around that bend (the "reveal").

Thayer (1987) found that public sentiment was strongly tied to the bureaucracy behind the decision to erect the windfarm (local officials, developer). This is echoed by Wolsink (1989) and Krohn (1999), who states “decision making over the heads of local people is the direct route to protest” (p.959). In the case of Fenner the developer was required to prepare and submit for public review an EAF. And the Town of Fenner was the lead agency overseeing the approval of permits. Therefore, to the degree that the EAF process effectively addressed and corrected negative concerns, the community might not have retained much negative sentiment toward the project going into construction. Possibly the research of Devine-Wright (2004) offers an explanation. He states, “the opinions of significant others such as friends and family living in the local area are important in determining public perceptions of wind farms” (p.130). In Fenner, one civically involved couple who leased their land to the developer is not only a proponent of wind energy, but also talks with great pride of the Fenner Township and surrounding area. They host tours and offer t-shirts and hats for wind farm visitors. They might have influenced the community positively. In fact an imminent windfarm expansion in Fenner from 20 to 29 turbines has been met with no opposition. This matches with Warren’s (2005) results. He samples residents both with and without experience living near windfarms and found those with experience are much more likely to favor expansion of them.

To the degree that other similar communities exist in the US, in that they have similar land uses, median home prices, and homeowner profiles, these results should be transferable. Extrapolation of these results to communities which do not fit this description, without careful consideration, is not recommended until more research is conducted. Specific recommendations for further research are outlined below.

8 Policy Implications and Recommendations

Contrary to the notion that adverse effects are universal, this report did not produce any significant relationship between distance from, or visibility of the windfarm and the sale prices of homes. These results fit with those reported in other empirical studies that surveyed public attitudes, which found that people living near turbines find them "acceptable" and, in fact, rarely spontaneously mention them (Braunholtz and MORI-Scotland, 2003). Together these studies suggest that in communities similar to the one surrounding the Fenner windfarm, the question of property value effects should be lessened in importance in the decision making process. Further, if these results are substantiated in further research as discussed below, the implications for stakeholders are significant.

Specific recommendations for many of the stakeholders in the windfarm planning process are as follows:

- Town Officials/Planners: Town planners should realize that the methods for facility approval can greatly contribute to placating community concerns. A transparent process which allows residents to address siting concerns such as the size of the project, the placement of the turbines as it relates to dwellings, and the provisions for dealing with maintenance and decommissioning are very important. If steps such as these are followed, local decision makers should be able to enjoy favorable community sentiment and avoid property devaluation.
- Community Members: This research should provide some confidence to community members that a windfarm siting does not guarantee a devaluation of property values, and that assertions to that effect should be thoroughly investigated. In fact, if more studies corroborate these findings devaluation might be considered unlikely. If residents

believe their community is similar to Fenner's, factors other than property devaluation should be concentrated on. These could include the level of payments in lieu of taxes (PILOT), the quality of decommissioning assurances and the level of transparency in the planning process. Based on the findings of this study these factors could play a more important role than potential property devaluation in a community's proposed windfarm evaluation process. Additionally, urging local, state and federal policy makers to promote continuing research into public attitudes surrounding other wind energy facilities will allow for greater understanding of upcoming development proposals, and a larger area of transferability of results.

- State lawmakers: This report's findings of "no effect" might indicate that the planning process used for the Fenner windfarm should be used as a model. Currently some state laws allow the review process to be entirely avoided (GAO, 2005), yet an environmental review and subsequent community involvement can help ensure that appropriate decisions are made and development is accepted by the community going forward. State regulations should require all wind developments to participate in the EIS process, to ensure that the planning process is transparent, and that community involvement is encouraged. Additionally, through an intense effort to research and disseminate findings, such as reactions of other communities to wind development in the U.S., lawmakers can give local officials the tools needed to weigh real costs and benefits. In so doing, decision makers can avoid having to rely on insufficient information and speculation.

- Wind industry representatives: Although these findings seem to show that property devaluation did not occur in the community surrounding the Fenner windfarm, it should

be clear that property value effects are strongly tied to public attitudes, a cooperative planning process, and might be influenced by characteristics not present in the Fenner community. These are discussed below and include the number of second homes, the proximity to the wind turbines, and the percentage of "vista" included in the home value. Accordingly, encouraging further empirical research of public attitudes and property transaction values surrounding wind developments might provide decision makers with the information needed to make appropriate decisions regarding development proposals going forward.

8.1 Future research considerations

For communities, especially ones that are not similar to Fenner, there is an intense need for more research. With this, policy makers and other stakeholders will have better answers to this contentious issue. More information is needed regarding the following categories:

- Other windfarm communities: Roughly 90 sites in the U.S. are larger than the Fenner site (AWEA, 2005d), and many of them would be appropriate for study. Sites should be chosen with a variety of socio-economic characteristics, windfarm sizes, and population densities. Studies should analyze homes closer than 4000 feet, and include variables for "vista,"[42] level of community cooperation in approval process, degree that farming matches sense of place (such as the percentage of large tract vs. small), and whether homes are the primary or secondary residences.
    - Distance: This study contains homes only as close as 0.75 miles or 4000 feet to the turbines. HVTL studies have found effects exist only inside 500 feet

[42] As discussed in footnote 8 on page 2

(Des-Rosiers, 2002). Future studies should find communities with homes closer than 0.75 miles, and preferably as close as 500 feet if they exist.[43]

- Vista: This study does not include a separate measurement for “vista” (or good view) in its analysis. For example, Haughton (2004) finds that homes with a high percentage of "vista" represented in their value (such as might be found in homes on the coast) might be affected differently by wind development.
- Cooperative Process: The community studied in this report was at least partially involved in the planning process, in so far as they were invited to attend and submit comments at a number of meetings (Moore, 2005). The degree to which the project developer includes the community in the planning process of other communities might influence results (Warren *et al.*, 2005) and should be studied.
- Sense of Place: Anecdotal evidence implies that this community still largely embraces the farming nature of its past. How well wind energy “harvesting” fits with other community’s sense of appropriate land use might also alter outcomes (Devine-Wright, 2004). Using an average tract size for a sample might be a proxy for this variable.
- Size of Project: The Fenner windfarm is 20 turbines. Because there is evidence that community’s prefer smaller windfarms over larger ones

[43] Homes within 500 feet of the turbines, in this study area, were situated on the same parcels that had turbines, and therefore the homeowners received income from the windfarm owners. This coincidence could present complications in analysis of sale prices. Additionally, none were sold during the study period.

(Wolsink, 1989; SEI, 2003) studies conducted using homes surrounding facilities larger than 20 might reach different results.

- Primary Residence: This study does not include a separate variable describing if homes are primary residences or not. It is possible that homeowners of non-primary residences might be more sensitive to changes in their viewshed. Future studies should include this variable.

- Other potentially analogous structures: Although the research from HVTL is helpful in establishing potential effects of windfarms on property values, research concerning other infrastructures might be more applicable. For instance, investigating transaction value effects on coastal homes having views of offshore drilling platforms could shed light on the property value effects when a high "vista" value is present.

- Comparisons of hedonic and survey results: Because survey results are often used as a proxy for actual effects, studies to determine the appropriateness of these methods as it applies to windfarms would be very fruitful for policy makers. If combined hedonic and survey studies were conducted in communities with existing windfarms, which started before announcement and continued well after construction, policy makers and stakeholders could determine the applicability of using surveys to determine present and future property value effects.

- GIS visibility determinations: By continuing research into this area, and using the most up to date data, such as that being newly collected by light detecting and ranging (LIDAR) radar techniques, policy makers and stakeholders may find a very inexpensive method for determining visibility and therefore conducting analysis on communities.

By conducting and disseminating further research, policy makers and other stakeholders can more fully understand the subtle interaction between a view of windfarms and property values. As a result, they will have more appropriate tools to make well informed decisions regarding wind energy siting proposals. For now, it is safe to say property value effects are not guaranteed, and in fact, in the case of Fenner, do not seem to exist at all.

Appendix A: Definitions and Descriptions of Variables

Table VI: Definitions of Non-Viewshed Variables

ACRES	The number of acres in parcel
AGE_AT_SALE	The age of home at time of sale. Calculated by subtracting year built from Deed_Year.
BLDSTYL-AFRM	Building style binary variable equal to 1 for A Frame houses and 0 otherwise
BLDSTYL-CAPE	Building style binary variable equal to 1 for Cape houses and 0 otherwise
BLDSTYL-CNTMP	Building style binary variable equal to 1 for Contemporary houses and 0 otherwise
BLDSTYL-COLNL	Building style binary variable equal to 1 for Colonial houses and 0 otherwise
BLDSTYL-CTTG	Building style binary variable equal to 1 for Cottage houses and 0 otherwise
BLDSTYL-LOG	Building style binary variable equal to 1 for Log Cabin houses and 0 otherwise
BLDSTYL-OLDSTYL	Building style binary variable equal to 1 for Old Style houses and 0 otherwise
BLDSTYL-RANCH	Building style binary variable equal to 1 for Ranch houses and 0 otherwise
BLDSTYL-RSRNCH	Building style binary variable equal to 1 for Raised Ranch houses and 0 otherwise
BLDSTYL-SPLIT	Building style binary variable equal to 1 for Split Level houses and 0 otherwise
CAZENOVIA	Binary variable equal to 1 if township is Fenner, otherwise 0.
CENTRAL_AIR	House has central air conditioning
DIS_TO_I90	Distance from home to Interstate I 90 in miles
DIS_TO_RT_20	Distance from home to State Route 20 in miles
DIS_TO_TOWN	Distance from home to nearest town center in miles
DEED_YEAR	Year of sale as recorded on the deed.
DEED_YEAR_SQRD	Year of sale as recorded on the deed - Squared
FALL_SALE	Binary variable equal to 1 for transactions in quarter 4 and 0 otherwise
FENNER	Binary variable equal to 1 if township is Fenner, otherwise 0.
LINCOLN	Binary variable equal to 1 if township is Lincoln, otherwise 0.
LNSALE_PRICE_95	Natural Log of Sale Price in 1995 dollars
NBR_BEDROOMS	Number of bedrooms house contains
NBR_FIREPLACES	Number of fireplaces house contains
NBR_FULL_BATHS	Number of full bathrooms house contains
NBR_HALF_BATHS	Number of half bathrooms house contains
NELSON	Binary variable equal to 1 if township is Nelson, otherwise 0.
OVERALL_COND	Overall condition of home at time of last assessment
RBSMNT_TYP_DUM	Binary variable equal to 1 for full or finished basement and 0 otherwise
SALE_PRICE_95	Sale price converted to 1995 dollars
SCHDIS-CAZ	School district binary variable equal to 1 for Cazenovia school district and 0 otherwise
SCHDIS-CHTNGO	School district binary variable equal to 1 for Chittenango school district and 0 otherwise
SCHDIS-CNSTO	School district binary variable equal to 1 for Canastota school district and 0 otherwise
SCHDIS-MORS	School district binary variable equal to 1 for Morrisville school district and 0 otherwise
SCHDIS-ONIEDA	School district binary variable equal to 1 for Oneida school district and 0 otherwise
SCHDIS-STKBRDG	School district binary variable equal to 1 for Stockbridge school district and 0 otherwise
SFLA	Number of square feet in the home
SMITHFIELD	Binary variable equal to 1 if township is Smithfield, otherwise 0.
SPRING_SALE	Binary variable equal to 1 for transactions in quarter 2 and 0 otherwise
STONE_WALL_MAT	Binary variable equal to 1 for stone or brick exterior and 0 otherwise
SULLIVAN	Binary variable equal to 1 if township is Sullivan, otherwise 0.
SUMMER_SALE	Binary variable equal to 1 for transactions in quarter 3 and 0 otherwise
WINTER_SALE	Binary variable equal to 1 for transactions in quarter 1 and 0 otherwise.

Table VII: Definitions of Viewshed Variables

DIS_TO_MILLS	The distance from the home to the nearest turbine as calculated by the GIS.
VIEW	The view of the turbines as recorded from the field analysis with possible range from 0 to 60. If house sold before Jan 1, 2001 the value is 0.
VIEW1MILE	The VIEW of the home if 0>DIS_TO_MILLS<=1, otherwise 0
VIEW2MILE	The VIEW of the home if 1>DIS_TO_MILLS<=2, otherwise 0
VIEW3MILE	The VIEW of the home if 2>DIS_TO_MILLS<=3, otherwise 0
VIEW4MILE	The VIEW of the home if 3>DIS_TO_MILLS<=4, otherwise 0
VIEW5MILE	The VIEW of the home if 4>DIS_TO_MILLS<=5, otherwise 0
VIEW2001	The VIEW of the home if the year of sale was 2001, otherwise 0
VIEW2002	The VIEW of the home if the year of sale was 2002, otherwise 0
VIEW2003	The VIEW of the home if the year of sale was 2003, otherwise 0
VIEW2004	The VIEW of the home if the year of sale was 2004, otherwise 0
VIEW2005	The VIEW of the home if the year of sale was 2005, otherwise 0

Note: This table also appears in the main text

Table VIII: Description of Viewshed Variables

VIEWSHED VARIABLES	**Mean**	**Minimum**	**Maximum**	**Frequency**
DIS_TO_WNDMILS	3.50	0.76	5.98	280
VIEW	3.09	0	46	43
VIEW1MILE	0.60	0	40	5
VIEW2MILE	0.81	0	46	15
VIEW3MILE	0.46	0	46	6
VIEW4MILE	0.84	0	32	11
VIEW5MILE	0.38	0	38	6
VIEW2001	0.60	0	39	11
VIEW2002	0.55	0	40	9
VIEW2003	0.79	0	46	8
VIEW2004	1.03	0	46	12
VIEW2005	0.11	0	17	3

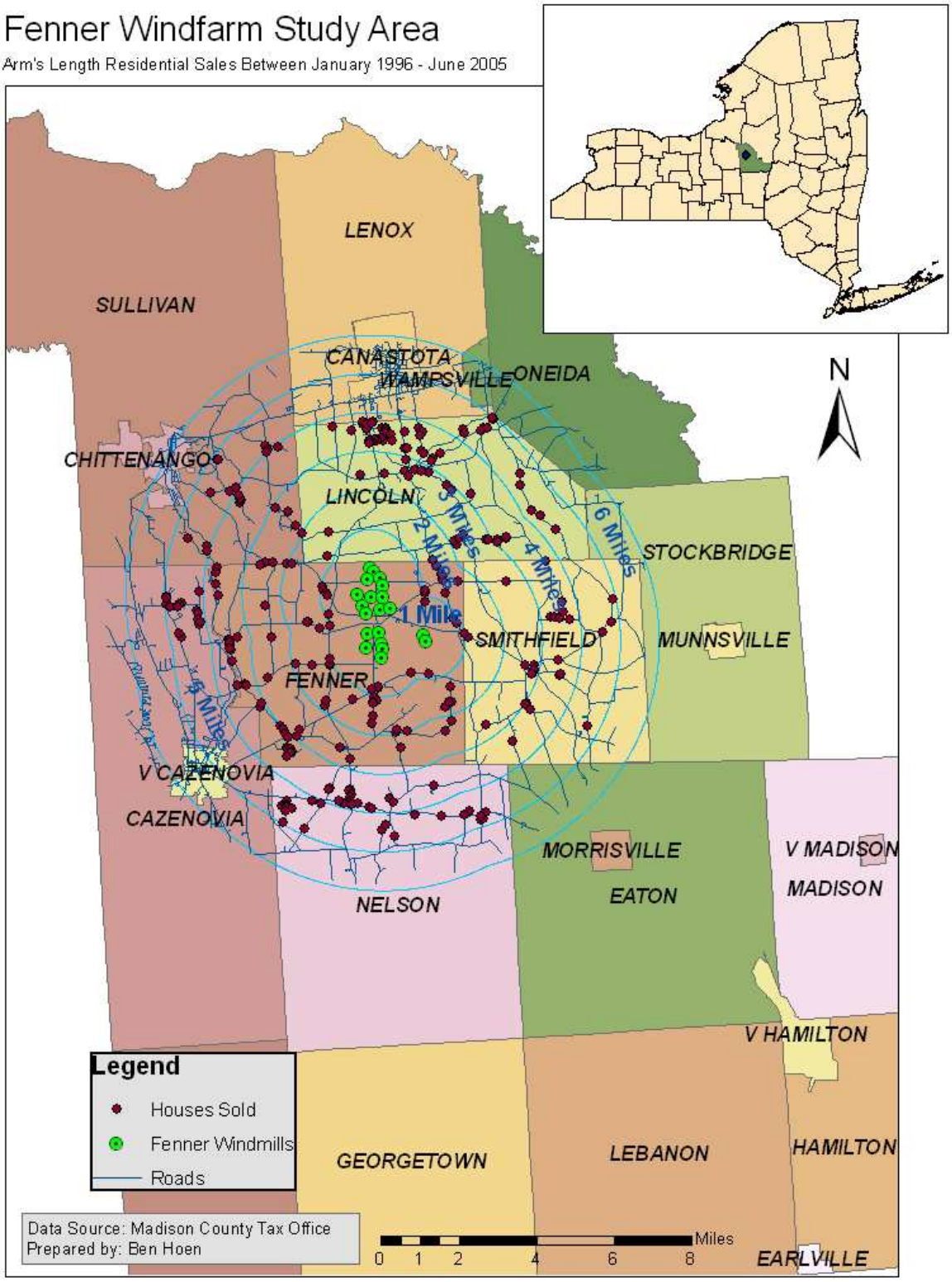
Table IX: Description of Binary Variables

	Median	Mean	Minimum	Maximum	Frequency
BINARY VARIABLES					
BLDSTYL-CAPE	0	0.07	0	1	20
BLDSTYL-CNTMP	0	0.11	0	1	30
BLDSTYL-COLNL	0	0.15	0	1	41
BLDSTYL-CTTG	0	0.01	0	1	2
BLDSTYL-LOG	0	0.04	0	1	10
BLDSTYL-OLDSTYL	0	0.21	0	1	59
BLDSTYL-RANCH	0	0.34	0	1	96
BLDSTYL-RSDRNCH	0	0.04	0	1	11
BLDSTYL-SPLIT	0	0.03	0	1	9
CENTRAL_AIR	0	0.06	0	1	280
FENNER_DUM	0	0.29	0	1	80
RBSMNT_TYP_DUM	1	0.80	0	1	224
STONE_WALL_MAT	0	0.01	0	1	2
SCHDIS-CAZ	0	0.47	0	1	131
SCHDIS-CHTNGO	0	0.14	0	1	39
SCHDIS-CNSTO	0	0.18	0	1	51
SCHDIS-MORS	0	0.15	0	1	43
SCHDIS-ONIEDA	0	0.03	0	1	8
SCHDIS-STKBRDG	0	0.03	0	1	8
SPRING_SALE	0	0.28	0	1	78
SUMMER_SALE	0	0.34	0	1	94
FALL_SALE	0	0.24	0	1	67
WINTER_SALE	0	0.15	0	1	41

Table X: Description of Continuous Variables

CONTINUOUS VARIABLES	Median	Mean	Minimum	Maximum	Frequency
SALE_PRICE_95	$91,293	$102,371	$10,049	$284,935	280
LNSALE_PRICE_95	11.42	11.41	9.215	12.560	280
ACRES	2.26	8.61	0.13	237.26	280
AGE_AT_SALE	20.5	42.36	0	205	280
DEED_YEAR	2001	2001	1995	2005	280
DEED_YEAR_SQRD	49	54.40	1	121	280
DIS_TO_RT20	4.66	4.69	0.01	10.17	280
DIS_TO_TOWN	3.68	3.78	1.51	6.87	280
NBR_FIREPLACES	0	0.51	0	5	116
NBR_FULL_BATHS	2	1.63	0	4	278
NBR_HALF_BATHS	0	0.39	0	1	110
OVERALL_COND	3	3.09	1	5	280
SFLA	1715	1804	420	5194	280

Appendix B: Map of Study Area



Appendix C: Technique for Creating GIS Viewshed Prediction Algorithm

A predicted view from each home was calculated using GIS techniques. The accuracy of the best performing predicted view was 85% as compared to actual view measurements. Since this did not meet confidence requirements, it was not used in the model.

To create a viewshed that effectively mimics the reality of a landscape the ground surface elevations as well the ground cover need to be simulated. In our case the 10 meter USGS DEM was used for surface elevations. The DEM was converted to a 3 dimensional ESRI raster file with the ARCGIS 9 "DEM to RASTER" algorithm using float and no z-value conversion. 10 meter data from the Multi-resolution Land Characterization (MRLC) Consortium[44] depicted the ground cover. Then by estimating heights for each ground cover type in our sample area, and reclassifying the raster fields to these heights, a raster addition was possible between the DEM and the MRLC. Four sets of heights for deciduous, conifer, and mixed forests, shrubs and grass (cultivated land) were tested (See Table IV). All other groundcover types were given a height of 0.

Table XI: Description of Heights for Ground Cover Raster Files (in feet)

Set	Conifer	Deciduous	Mixed	Grass & Shrubs
WINTER	100	0	50	5
80 NO-GRASS	80	70	75	0
80	80	70	75	5
100	100	90	95	10

[44] Partners include the USGS (National Mapping, Biological Resources, and Water Resources divisions), USEPA, the U.S. Forest Service, and the National Oceanic and Atmospheric Administration

Road and turbine location shapefiles were provided by the Madison County Tax Office, and a river shapefile was provided by the USGS National Map. House locations were derived as described in section 5.3. Because MRLC raster cells often spanned roads and covered houses and turbine locations, buffer shapefiles were created around each. 10 foot buffers were created around roads and houses, and 30 foot buffers surrounded turbines. To improve viewshed algorithm performance each raster grid (both DEM alone and DEM/MRCL additions) was converted to a triangulated irregular network (TIN) (Dean, 1997; Reeves, 2004). Z coordinates were not provided for the road, river, turbine, house shapefiles and accompanying buffers so these were derived from the DEM TIN. Buffers were added to the DEM/MRLC TINs using hard replace, and rivers were added using hardline which effectively erased all ground cover in the buffer areas and along the lines of the rivers. A map depicting the landscape is provided in Appendix D.

To calculate the viewsheds that simulated the 3 point score used in field analysis, three values for OFFSETA[45] were used corresponding to the heights on the turbines. The top height was 430 ft, the middle height was 328 ft and the lowest height was 210 ft. Additionally a value for OFFSETB of 10 ft was used.[46] Then the viewshed algorithm was run for the 20 “observation” points of the

[45] OFFSETA is the field name used by ESRI Arc viewshed algorithms of values of vertical distance in surface units that are added to the z-value of each cell as it is considered for visibility.
[46] OFFSETB is the field name used by ESRI Arc viewshed algorithms of values of vertical distance in surface units that are added to the z-value of the observation point.

turbines at each of the three heights (top, middle, lowest). This produced three 10 meter raster grids with values from 0 to 20 possible. All were added together to produce a grid with values from 0 to 60 possible. These raster values were extracted using the house point locations giving a discrete value (from 0 to 60) for each home in our sample set. Of the four sets of heights used to create the ground cover raster values originally (see Table IV) the 80 No-Grass set was best at neither over nor under predicting visibility (See results in Appendix C) but still did not meet confidence threshold of 95% that we had hoped for.

Suggestions for improving GIS viewshed predictions

The reasons we believe our estimates are off is because of inherent errors in the DEM which then transferred to our TIN surface. We test this theory by using 63 geodetic markers from the USGS which were within our study area. Roughly 15% (10/63) of the two elevations differ by more than 1%, which in some cases is more than 5 feet (max = 7 feet). The direction of the errors are 60/40 peaks to pits[47] ("peaks" = 37, "pits" = 26). Errors are smaller for the largest 26 peaks (mean =1.51 feet) versus the largest 26 pits (mean = -2.76 feet). The errors in the viewshed calculations are well distributed between over predicting the homes' view of the turbines and under predicting it. Therefore, we conclude if the surface of the entire study area is similar in inaccuracies to the test points, predicted

[47] "Peaks" refers to points on the TIN that are at a higher elevation than the geodetic markers, and "pits" refers to the opposite, where the TIN surface is at a lover elevation than the marker.

viewshed inaccuracies could be entirely based on pits and peaks in the DEM. A 5-foot peak in the TIN surface could obscure a large portion of the landscape a few miles away from predicted visibility. Concurrently an observer on a 5-foot peak could be predicted to see a great deal more than actually can be seen. Methods for correcting or smoothing these errors were not investigated, and therefore additional research in this area would be important.

Another contributing factor for viewshed inaccuracies might be ground cover representation. It is observed in field analysis that canopy heights are not similar across all forests of the same type. For instance some deciduous forests have been planted in the last 15 years and have not grown to a mature height, while other forests are in late stage progression with mature heights. We use the same height for all forests of the same type. Further, square raster cells do not accurately depict non-uniform patterns of forest growth, and are particularly bad at depicting lines of trees that cross diagonally to the raster grid. Lastly the depiction of the top of the canopy is flat, but in reality the top is non-uniform. Field analysis proves it was possible to view turbines through the variation of the canopy. Combined these inaccuracies could add to the errors in our visibility prediction results. A smaller grid than 10 meters for the ground cover layer and access to ground cover data that includes z-values would greatly improve depiction and therefore viewshed analysis.

Appendix D: Results of GIS Viewshed Prediction Algorithm

Table XII: Description of Heights for Ground Cover Raster Files (in feet)

Set	Conifer	Deciduous	Mixed	Grass
Winter	100	0	50	5
80 No-Grass	80	70	75	0
80	80	70	75	5
100	100	90	95	10

Table XIII: Results of Viewshed Predictions for 4 Sets of Ground Cover Heights

	Winter	**OBSERVED**		
PREDICTED		See	No See	**Total**
	See	42	47	**89**
	No See	3	37	**40**
	Total	**45**	**84**	**129**

	Winter	**OBSERVED**			
PREDICTED		See	No See	**Total**	**Correct**
	See	33%	36%	**69%**	61%
	No See	2%	29%	**31%**	**Incorrect**
	Total	**35%**	**65%**	**100%**	39%

	80 No-Grs	**OBSERVED**		
PREDICTED		See	No See	**Total**
	See	36	10	**89**
	No See	9	74	**40**
	Total	**45**	**84**	**129**

	80 No-Grs	**OBSERVED**			
PREDICTED		See	No See	**Total**	**Correct**
	See	28%	8%	**36%**	85%
	No See	7%	57%	**64%**	**Incorrect**
	Total	**35%**	**65%**	**100%**	15%

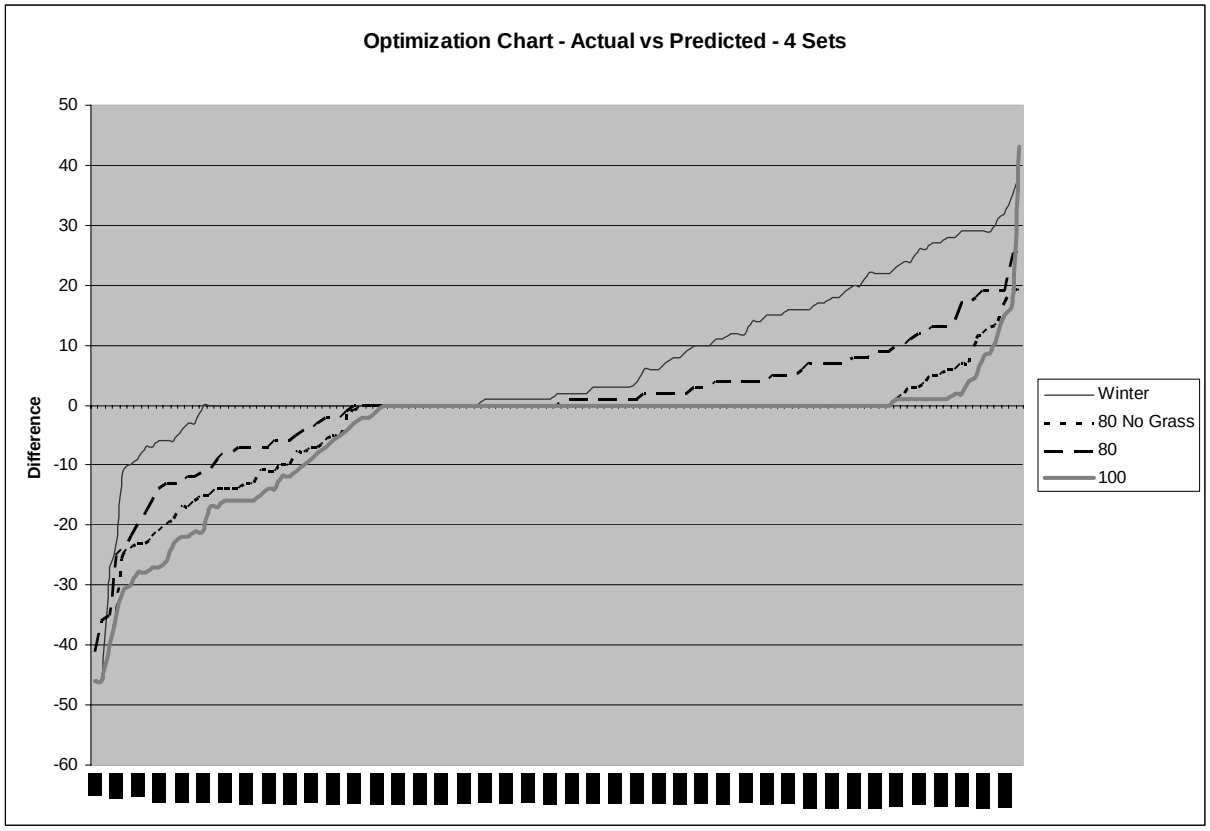
	100	**OBSERVED**		
PREDICTED		See	No See	**Total**
	See	26	13	**89**
	No See	19	71	**40**
	Total	**45**	**84**	**129**

	100	**OBSERVED**			
PREDICTED		See	No See	**Total**	**Correct**
	See	20%	10%	**30%**	75%
	No See	15%	55%	**70%**	**Incorrect**
	Total	**35%**	**65%**	**100%**	25%

	80	**OBSERVED**		
PREDICTED		See	No See	**Total**
	See	42	55	**89**
	No See	3	29	**40**
	Total	**45**	**84**	**129**

	800	**OBSERVED**			
PREDICTED		See	No See	**Total**	**Correct**
	See	33%	43%	**75%**	55%
	No See	2%	22%	**25%**	**Incorrect**
	Total	**35%**	**65%**	**100%**	45%

Figure V: Four Sets of Predicted Views versus the Actual Readings



Note: Results for each set are arrayed in ascending order without regard to house location. Therefore the amount of difference for one set for a particular house might not be similar for another set. Results are for 129 separate view readings. It is important to note the relatively even distribution of differences between positive and negative implying that the predicted viewshed models were most likely effected by forces outside the model such as random errors in the DEM

Appendix E: Landscape Constructions for Viewshed Prediction

Figure VI: Depiction of the Study Area without Ground Cover

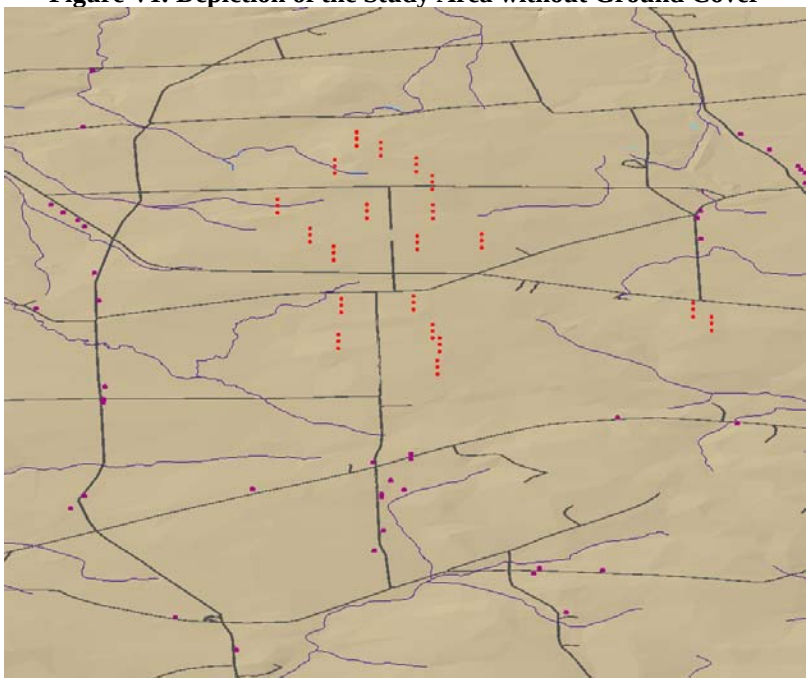


Figure VII: Depiction of the Study Area with Ground Cover

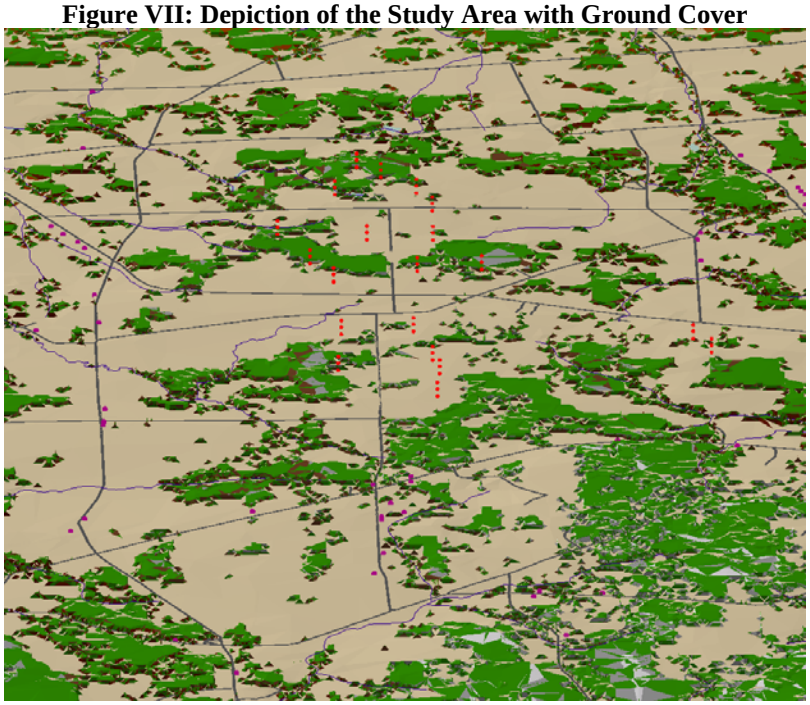
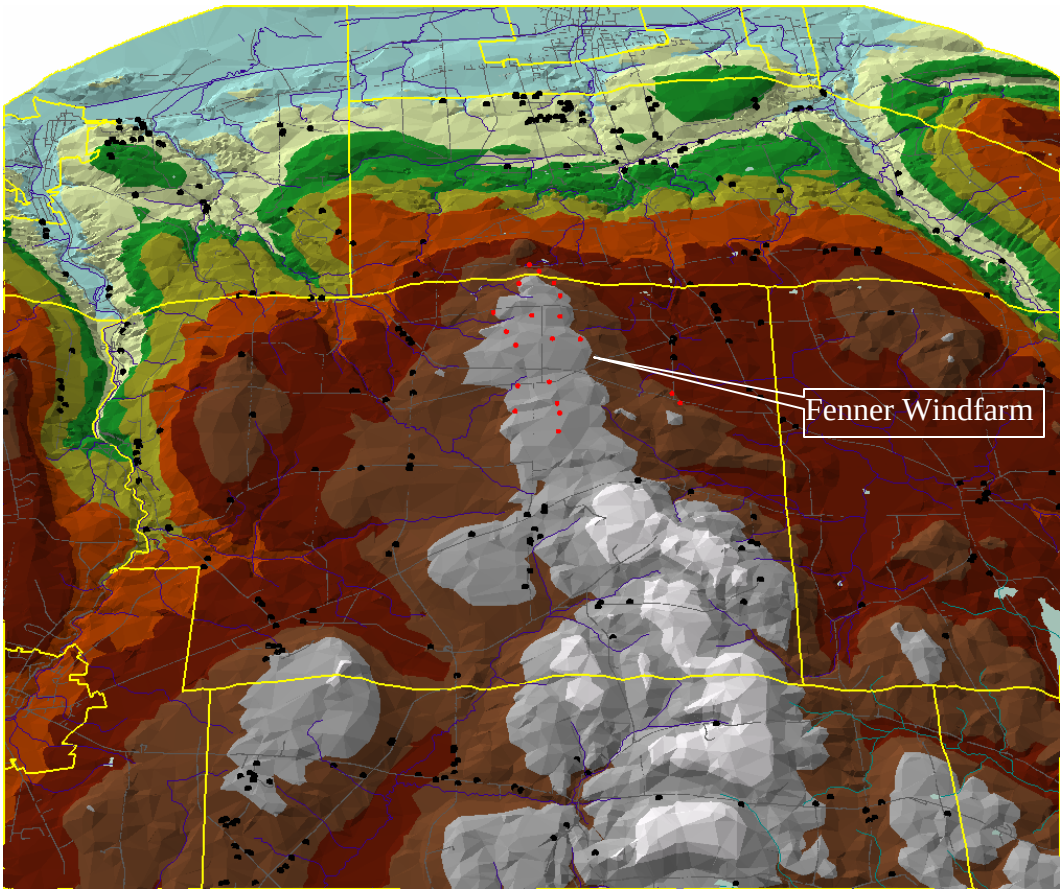


Figure V and VI notes: Groups of three red dots are top, middle and low heights of turbines, randomly spaced purple dots are houses sold after 2001, heavy grey lines are roads, thin blue lines are rivers and raised green areas are depictions of ground cover

Figure VIII: 3D Rendering of Study Area



Note: Depiction has elevation exaggerated 10 times. Except for where indicated dots are houses which sold after 1996, and lines are township borders. If possible rendering should be viewed in color.

Appendix F: Model Results

Table XIV: Results - Models 1-3

	Model # 1		Model # 2		Model # 3	
	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
(CONSTANT)	-32.240	0.632	-30.185	0.647	9.830	0.000
CONTINUOUS VARIABLES						
ACRES	0.005	0.000	0.005	0.000	0.005	0.000
AGE_AT_SALE	-0.001	0.053	-0.001	0.003	-0.002	0.000
SALE_YEAR	0.021	0.532	0.049	0.456		
SALE_YEAR_SQR	-0.002	0.523	0.110	0.090		
DIS_TO_RT_20	-0.012	0.198	-0.013	0.156	-0.009	0.072
DISTOTOWN-MILES	-0.021	0.198	0.090	0.093		
NBR_FIREPLACES	0.051	0.058	0.050	0.059	0.053	0.041
NBR_FULL_BATHS	0.151	0.000	0.152	0.000	0.153	0.000
NBR_HALF_BATHS	0.054	0.170	0.060	0.123	0.088	0.014
OVERALL_COND	0.205	0.000	0.202	0.000	0.197	0.000
SFLA (in 1000s)	0.233	0.000	0.234	0.000	0.261	0.000
BINARY VARIABLES						
BLDSTYL-CAPE	0.101	0.703	0.022	0.688		
BLDSTYL-CNTMP	0.187	0.476	0.199	0.001	0.158	0.003
BLDSTYL-COLNL	0.082	0.752				
BLDSTYL-CTTG	-0.003	0.992	0.004	0.984		
BLDSTYL-LOG	0.287	0.287	0.297	0.000	0.287	0.000
BLDSTYL-OLDSTYL	0.003	0.991	0.052	0.461		
BLDSTYL-OTHR	-0.076	0.836				
BLDSTYL-RANCH	-0.009	0.972	0.020	0.542		
BLDSTYL-RSDRNCH	0.052	0.846	-0.001	0.542		
BLDSTYL-SPLIT	-0.089	0.743	-0.020	0.206		
CENTRAL_AIR	0.008	0.915				
FENNER_DUM	-0.060	0.129	-0.058	0.142	-0.083	0.018
RBSMNT_TYP_DUM	0.239	0.000	0.241	0.000	0.268	0.000
STONE_WALL_MAT	0.372	0.043	0.377	0.036	0.363	0.037
SCHDIS-CHTNGO	0.050	0.457	-0.143	0.214		
SCHDIS-CNSTO	0.048	0.508	-0.068	0.790		
SCHDIS-MORS	0.024	0.676				
SCHDIS-ONIEDA	-0.151	0.197				
SCHDIS-STKBRDG	-0.437	0.000	-0.437	0.000	-0.489	0.000
SPRING_SALE	0.055	0.278	0.054	0.287	0.058	0.239
SUMMER_SALE	0.027	0.596	0.026	0.597	0.026	0.587
FALL_SALE	0.085	0.101	0.086	0.091	0.097	0.052
ADJUSTED R2		**0.793**		**0.793**		**0.793**
F/SIGNIFICANCE	**32.857**	**0.000**	**39.185**	**0.000**	**63.764**	**0.000**

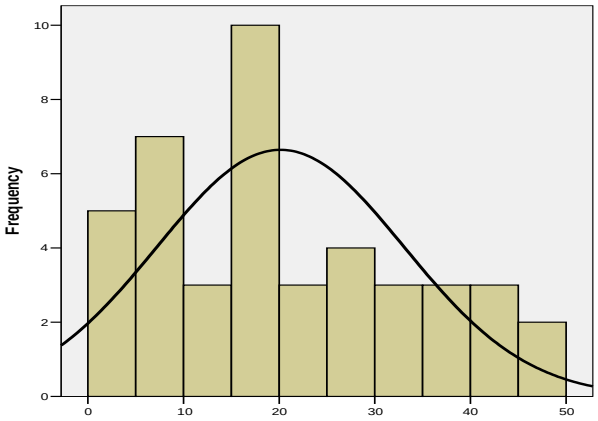
Table XV: Results - Models 4 - 6

	Model # 4		Model # 5		Model # 6	
	Coeff.	**p-value**	**Coeff.**	**p-value**	**Coeff.**	**p-value**
(CONSTANT)	9.803	0.000	9.826	0.000	9.840	0.000
CONTINUOUS VARIABLES						
ACRES	0.005	0.000	0.005	0.000	0.005	0.000
AGE_AT_SALE	-0.002	0.000	-0.002	0.000	-0.002	0.000
DIS_TO_RT20	-0.009	0.082	-0.009	0.066	-0.010	0.046
NBR_FIREPLACES	0.050	0.053	0.048	0.071	0.051	0.048
NBR_FULL_BATHS	0.153	0.000	0.157	0.000	0.152	0.000
NBR_HALF_BATHS	0.085	0.018	0.091	0.012	0.084	0.022
OVERALL_COND	0.196	0.000	0.196	0.000	0.196	0.000
SFLA (in 1000s)	0.263	0.000	0.262	0.000	0.263	0.000
BINARY VARIABLES						
BLDSTYL-CNTMP	0.154	0.004	0.161	0.003	0.162	0.002
BLDSTYL-LOG	0.286	0.000	0.286	0.000	0.287	0.000
FENNER_DUM	-0.076	0.108	-0.092	0.015	-0.094	0.010
RBSMNT_TYP_DUM	0.271	0.000	0.273	0.000	0.268	0.000
STONE_WALL_MAT	0.359	0.041	0.366	0.037	0.367	0.035
SCHDIS-STKBRDG	-0.491	0.000	-0.485	0.000	-0.482	0.000
SPRING_SALE	0.056	0.260	0.058	0.243	0.055	0.270
SUMMER_SALE	0.026	0.592	0.024	0.624	0.029	0.550
FALL_SALE	0.094	0.060	0.093	0.063	0.095	0.061
VIEWSHED VARIABLES						
DIS_TO_WNDMILLS	0.007	0.679				
VIEW	0.001	0.410				
VIEW1MILE			0.001	0.656		
VIEW2MILE			0.000	0.936		
VIEW3MILE			0.006	0.115		
VIEW4MILE			0.001	0.881		
VIEW5MILE			-0.001	0.764		
VIEW2001					-0.001	0.742
VIEW2002					0.006	0.175
VIEW2003					-0.002	0.613
VIEW2004					0.003	0.224
VIEW2005					0.001	0.906
ADJUSTED R2		**0.792**		**0.791**		**0.792**
F/SIGNIFICANCE	**56.822**	**0.000**	**48.990**	**0.000**	**49.210**	**0.000**

(Coefficients roughly correspond to the percentage change of sale price for each unit of change of the underlying variable. For example, adding an additional full bathroom to a house (coeff. = 0.153) adds roughly 15% to the value of the home, for homes that are near the sample mean value of $91.293.)

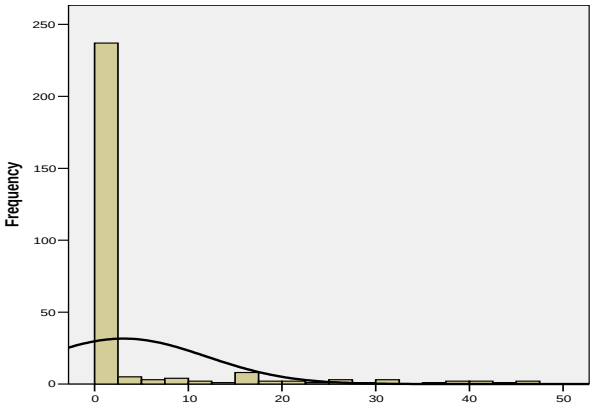
Appendix G: Histograms

Figure IX: Histogram of VIEW >0



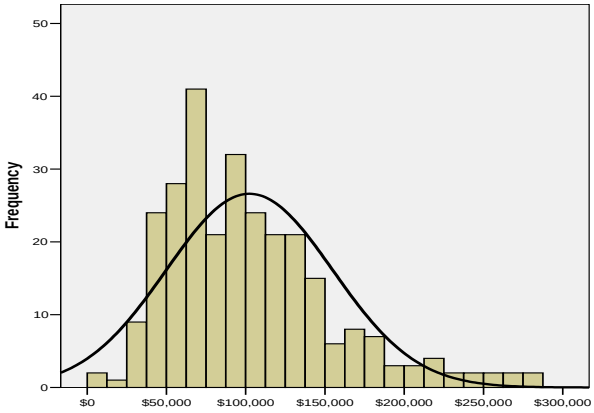
Notes: Line represents normal curve. n=43

Figure X: Histogram of VIEW



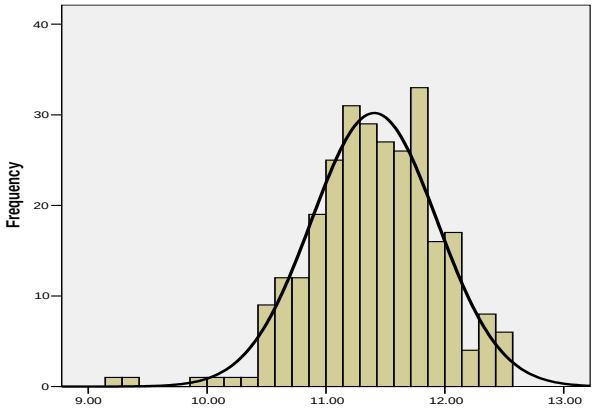
Notes: Line represents normal curve. n=280

Figure XI: Histogram of SALE_PRICE_95



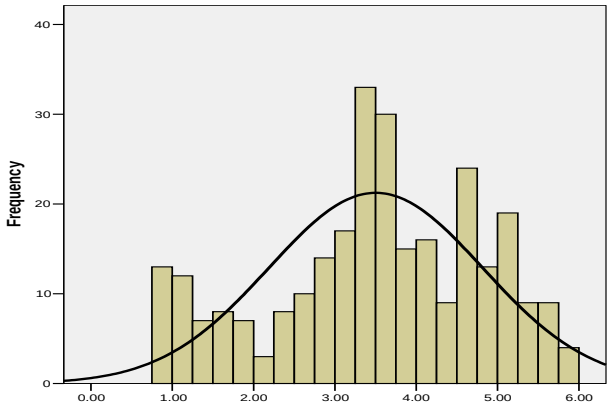
Notes: Line represents normal curve. n=280

Figure XII: Histogram of LogSALE_PRICE_95



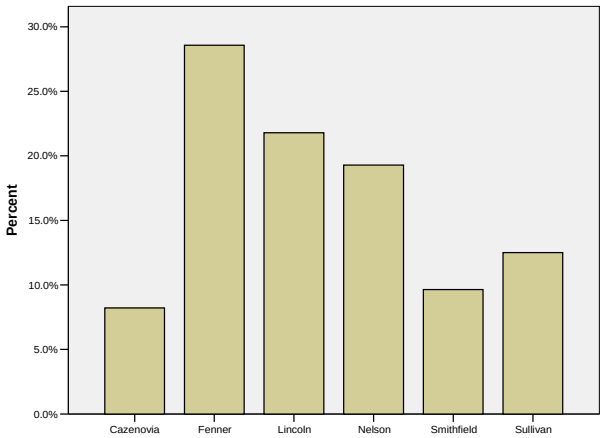
Notes: Line represents normal curve. n=280

Figure XIII: Histogram of DIS_TO_MILLS



Notes: Line represents normal curve. n=280

Figure XIV: Histogram of TOWNSHIP



Notes: n=280

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Kewaunee, Red River and Montfort landowners reflect on living next to a wind farm

By Mark Hirsch

Emerging from the corn and soybean fields like a row of majestic trees, 20 wind turbines dominate the horizon along Highway 18 in Montfort, Wis. In this small town historically supported by agriculture, a wind farm is harvesting a different type of crop.

Don Leix farm, Montfort Wind Energy Center, WI

Owned by FPL Energy, the Montfort Wind Energy Center produces enough electricity to power approximately 9,000 average Wisconsin homes. When they went online in 2001, they were among the largest turbines manufactured in the U.S.

Sitting at the lunch counter of the Tower Junction Restaurant across from the wind farm, Laverne Clifton reflects on the impact the FPL Energy wind farm has had on this small community in Southwestern Wisconsin. “When they first came to me about installing windmills on my property, it seemed too good to be true. Now it’s just another good cash crop you don’t have to worry about. You don’t plant it, and it uses little land,” said Clifton, a retired farmer who has three turbines on his property.

Whether they have turbines on their property or not, Clifton’s neighbors share a similar sentiment. Evelyn Mueller, 82, lives next to three of the Montfort Wind Energy Center turbines and says, ”I’m all for it. We should use our natural resources. They are not noisy. I don’t think anyway. At night when it’s quiet, it’s a quiet swish. It almost lulls you to sleep.”

From her patio, Evelyn Mueller can see three of the Montfort Wind Energy Center turbines. Mueller said, “It has absolutely no impact on my quality of life.

The Montfort site generated little controversy. Clifton could only remember one person initially opposed to the project because they were concerned it would scare their horses when riding near them. Seven years later, Clifton can think of no one who opposes them.

According to FPL Energy, owners of the Montfort Wind Energy Center, wind is the fastest growing renewable energy resource in the world. Supporters promote wind energy as a nonpolluting resource that

can supplement other energy sources reducing our dependence on fossil fuels.

Montfort residents like Larry Johnsen understand and appreciate the value of wind energy. Johnsen who has three turbines on his property says, “Everyone wants to turn on a light switch and have electricity. I mean do we want another coal plant? Look at how many electrical devices we use today, cell phones, ipods, you name it.”

Down the road from the Johnsen farm, Jen Thomas moved next to the wind farm in 2005.
“I can see the windmills from all four sides of my house and I’m not getting a paycheck from the power company so I don’t have to say nice things, but the windmills don’t bother me,” said Thomas. Visiting homes along the wind farm site, it was difficult to find anyone who opposes or has any concerns about its impact on their quality of life.

Turbines at the Montfort Wind Energy Center blend in well with the Larry Johnsen farm. Johnsen has three of the wind turbines on his property and farms up to the base of each tower.

Jonas Gingerich, an Amish farmer who operates a goat dairy operation beside the wind farm currently has his farm listed with a local real estate company. Gingerich does not use electricity supplied by the public power grid. Because of rules dictated by his Amish lifestyle, his electricity comes from a diesel-powered generator that operates belt driven equipment. Regarding his proximity to the windmills, he said, “The windmills won’t have anything to do with my farm sale. In fact, I wish I had one on my land.”

Horses on the Jonas Gingerich farm graze in a pasture near the Montfort Wind Energy Center. Commenting about the windmills, Gingerich said, “I seldom hear them. They make no noise hardly at all. I hear the highway more than the windmills.”

Acceptance of wind farm projects across the country has varied greatly. While the Montfort Wind Energy Center went up without much fanfare; other Wisconsin sites have generated more controversy. Two wind farm projects in Kewaunee County, Wis. initially generated significant opposition.

Visual impact as well as health and safety issues are among the concerns raised by wind energy opponents. Additionally, flicker, noise concerns and perceived reduction in real estate values dominate arguments against wind farms.

For residents of Red River and Lincoln in Kewaunee County, Wis., the meetings leading up to passage of conditional use agreements were divisive. Jule Famaree, 81, a Red River board member for 41 years said at the meetings, “Some was for it, some was against it. But now, eight years later, most are ok with it.”

Life near wind turbines is what you make of it according to Rich Lohrey. Lohrey's home is the only residential dwelling on Cedar Road and sits in the middle of the 14 Wisconsin Public Service wind turbines at the Lincoln Wind Energy Facility.

Mary and Rich Lohrey, Algoma, Wis. Live in the only residential dwelling on Cedar Road near the WPS wind farm. They purchased their home after the wind farm was in operation and say they are very comfortable living beside the wind farm.

In the five years they have lived in the shadows of the Lincoln wind farm, they have responded to questions about all of the usual wind farm complaints. “Lots of folks stop to ask us about them if they will have them in their area. They want our thoughts about them,” Rich said, adding, “The wind farm doesn’t bother me, I think it’s great.”

Rich and Mary have heard all the horror stories about problems associated with windmills from noise issues to reduced property value. “They can’t say they make that much noise because they don’t. We lived next to Lake Michigan for nine years; if you want to hear noise, live next to the lake. We wanted a country place with buildings for our toys. The windmills had no impact on our purchase price, none at all,” Mary said.

The issue of flicker or strobing caused by sunlight passing through the rotating blades is a very real problem depending on location of the turbines. It is also a problem that can be avoided when turbine installations are properly sited. For some residents, flicker is tolerable, for others, it can cause serious concerns.

“We have it very early in the morning in our bedroom. It’s only like twice a year for a very short time. I can’t even complain about that,” says Mary Lohrey.

The impact of wind farms on wildlife, specifically bats and birds is often identified as another problem. Rich Lohrey is quick to dispel the fear of bird deaths saying, “As far as killing birds, I’ve walked around them many times and never seen a dead bird yet.”

An access road leads to turbines in the WPS wind farm off of Pheasant Road at the Town of Lincoln in Kewaunee County, Wis. The turbine roads double as field access for farm equipment.

For wind farm construction, there are currently no standard guidelines for setbacks from dwellings. Many opponents feel there should be a minimum setback of 1000’ from an occupied dwelling.

Another concern raised by opponents involves doing business with the energy companies. According to residents around the Montfort, Red River and Lincoln energy sites, the power companies have been responsible business partners and good neighbors.

Lonnie Fenendael operates a 700 head dairy operation near the Lincoln wind farm. He also has five of the WPS wind turbines on his property and rents additional cropland from Jeff and Wallace Pelnar who have the other nine WPS turbines on their property. He plants crops right up to the base of all 14 WPS turbines.

When his family was approached by WPS, Lonnie said, "They were a local company and wanted a contract. There were a lot of things I wanted too, like putting the turbines in a line if possible. They were very good about working it out. We negotiated on price and any land damage. They pay for damage to crops, etc. They are very good about it."

Several miles away at the MG&E Kewanee County Wind Farm, Kevin LeFevre had a similar experience. "They treated us good on everything. It was a good business deal for us. They altered the access road to satisfy us."

A turbine at the Montfort Wind Energy Center is framed by buildings on the Don Leix farm. Leix operates a 450 cow dairy operation, and is very happy with his business relationship with the owner of the wind farm.

Opponents fear the impact construction of wind farms will have on roads and infrastructure. As a town board supervisor, LaVern Clifton is very happy with his experience. During construction of the Montfort wind farm, "They were very good about correcting any damage to roads, land, etc. The company paid the township for the cost of road repairs, etc. They bent over backwards to make things right." said Clifton.

As a landowner, Clifton has no regrets about his business relationship with the owner of the wind farm. "As neighbors, we don't even know they are around."

Wisconsin is rated as one of the top 20 states with the highest wind energy potential. Based on a report published by FPL Energy, Wisconsin is capable of producing 58 billion kilowatt-hours annually. Despite opposition, the growth of wind power as an alternative to fossil fuel energy will continue in Wisconsin.

Don Leix, a farmer with three wind turbines on his property operates a 450 cow dairy operation near Montfort. Leix said, "We were skeptical at first, with the dairy and stray voltage, but we've had no problems." As far as impact on local real estate,"They have not affected anything here, its all good farm land."

When people ask Leix what he thinks about the wind turbines, he likes to ask them this question. "Do you use electricity?" Leix adds emphatically, "Nobody has told me no yet."