Preserving Agriculture through Wind Energy Development: A Study of the Social, Economic, and Land Use Effects of Windfarms on Rural Landowners and Their Communities

by

Sarah Banas Mills

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Urban and Regional Planning)
in the University of Michigan
2015

Doctoral Committee:

Associate Professor Richard K. Norton, Chair
Associate Professor Larissa Susan Larsen
Emeritus Professor Robert W. Marans
Professor Barry George Rabe

Dedication

To Francis, who insisted that I become the doctor in the family,

and Cecilia, whose arrival midway through sped me to completion.

Acknowledgements

Successfully finishing a Ph.D., not unlike raising a child, takes a village. In my case it took the 14 Michigan townships selected as my case studies, plus a smattering of colleagues from North and Central Campus, and of course a small contingent from my hometown—the Village of Maybee.

First and foremost, I'd like to thank the more than 1,200 farmland owners, township supervisors, planning commissioners, county commissioners, realtors, auctioneers, appraisers, and wind developers who graciously contributed their time to my project. Without their input, I would have had far less to say about the impacts of windfarms on rural communities.

I would also like to thank my dissertation chair Richard Norton for his guidance as well as his willingness to give me lots of leeway to take this research in my own direction. Committee members Larissa Larsen, Robert Marans, and Barry Rabe were also extremely supportive of my off-the-beaten-path research topic, and provided crucial feedback along the way. I am grateful to the Taubman College staff that helped me navigate the research process, particularly Barb Tietjen, Sandy Patton, and Lisa Hauser. Julie Steiff's editorial prowess helped transform my words into Ph.D.-worthy prose. I also appreciate the Center for Local, State, and Urban Policy (CLOSUP) team—Tom Ivacko, Bonnie Roberts, Michael Crawford, and Debra Horner—that gave me an office and cheered me to completion.

A number of friends provided feedback and comic relief when I needed it the most, especially Nick Rajkovich, my cohort-mates Justin Meyer, Josh Shake, Ian Trivers, and David Weinreich, and Missy Stults and my fellow Dow Sustainability Doctoral Fellows. Missy, along

with my parents Hank and Carol Banas, and my husband helped un-stuff and re-stuff 1,730 mail surveys after a printing error. This group also patiently listened to my grumbling about commercial printers and the not-so-glamorous parts of academic research. A number of family friends from my hometown graciously took a pre-test of my survey and suggested a number of improvements that significantly strengthened it.

This research would have been far more difficult and taken far longer to complete without the generous support of the Dow Sustainability Fellowship, as well as the Robert and Judy Marans & Kan and Lillian Chen Fellowship in Sustainability & Survey Methodology. This research was also facilitated with the moral and child-care support of my mother Carol Banas, mother-in-law Theresa Mills, and husband Francis Mills who each played a part in making sure that Cecilia was well cared for while I was away conducting interviews or holed up writing.

Table of Contents

List of Tables

List of Figures

List of Appendices

Abstract

This research tests the claim made by some rural officials that windfarms help to preserve farmland. Using a mixed-methods case study approach, I draw on evidence from four windfarm communities located in nine townships in two regions in Michigan to test three different mechanisms by which wind turbines might be altering the farmland conversion process, as derived from both the rural planning and wind energy literatures. Data from five nearby townships where there are no wind turbines were also examined. First, a large-scale (n=1730) mail survey of farmland owners is used to determine that landowners with turbines on their property invest significantly more in their farms than both their neighbors and farmland owners in a similarly situated non-windfarm community. Landowners with turbines are also more likely to have a succession plan in place for their farm and less likely than other landowners to believe their land will go idle in the future. However, the more indirect financial benefits of wind development—local jobs and increased property tax revenues—do not appear to have positive impacts on landowners who live in the windfarm community but who do not have a turbine sited on their property. Second, interviews with realtors and public officials in the four windfarm communities indicate that, rather than reduce demand for new homes in the vicinity of the windfarm, windfarm income may be inducing some landowners to build new homes within sight of the turbines. Finally, , I find that though farmland preservation is rarely considered when officials establish setback distances for wind turbines, the amount of land rendered undevelopable by the presence of the turbines is often substantial. These findings can inform officials and rural planners who might consider whether and how to welcome wind development

within their jurisdictions by providing information about the social and economic impacts of wind development to local communities. Research findings can inform wind developers and planners about the key benefits and drawbacks of wind energy as seen by landowners in communities with wind turbines.

Chapter 1. Introduction and Overview

1.1 Wind Energy and Rural Land Use

Since the advent of the interstate highway system in the 1950s, exurban development has been the key driver of growth in metropolitan areas, even in cities where the urban and suburban populations are in decline (Brookings Institution 2010). As has been the case for the last fifty years, most of the development on the urban fringe has occurred on previously farmed land. While much was written in the 1980s and 1990s of ways to discourage farmland conversion, the rural planner's agricultural preservation toolbox has remained essentially unchanged for the past two decades. Sliding-scale and agricultural zoning, purchase and transfer of development rights, and agricultural districts have produced impressive results in a number of communities (Pruetz 2012), but far too few fringe municipalities have been willing to adopt and implement policies to arrest exurban development. While some authors have argued that our current suite of policies is perhaps the best we can manage given decentralized land use regulation in the U.S. (Daniels 1990), I propose that it is time for a fresh look at farmland preservation and posit that wind energy development might offer a promising new tool.

Driven by federal production tax credits that offer tax breaks to renewable energy producers as well as state-level renewable portfolio standards that force utilities to increase the portion of their electricity coming from renewable sources, wind development in rural America

has exploded in the last decade. These wind developments have not been confined to 1000+ acre parcels, as were the earliest large-scale windfarms in the Western U.S. and Texas. Instead, especially in the Great Lakes region, windfarms are increasingly being sited community-wide, with dozens of landowners each hosting a single turbine on their land. Economic development, particularly the increase in local tax revenues and rents received by affected landowners, undoubtedly drive a community's decision to accept wind development proposals, but vague claims of preservation of farmland have also been cited by local officials and rural planners as public justification for the projects (Cudd 2011; Lundberg).

1.2 Research Objectives

The overall objective of my dissertation is to explore claims that wind turbines help to preserve farmland. I hope not only to uncover whether windfarms have actually impacted rates of farmland conversion, but also to begin to understand why it is that they might be having such an impact.

Though it is relatively straightforward, the first part of this question—whether wind turbines have preserved farmland—is the more difficult one to answer. This is because more than 80% of the wind capacity in the U.S. and 98% of the wind capacity in the Great Lakes region has been built since 2005—the same time period in which new home construction effectively ground to a halt as a result of the "Great Recession." Consequently, a statistical assessment that includes any of these newer windfarms is likely to be inconclusive since any "control" communities are likely to have had practically no residential development over that period. Furthermore, even if the quantitative assessment is limited to the small subset of windfarms built before the recent economic downturn, such an approach would not necessarily

be able to answer the second part of my question: *why* it is that windfarms reduce agriculture land conversion?

Instead, my study operationalizes this overarching research question by directly testing three different mechanisms by which wind turbines might be altering the farmland conversion process, as derived from both the rural planning and wind energy literatures. These mechanisms, which form the core of my research questions and hypotheses, are as follows:

1. Supply-side mechanism: Windfarms provide additional revenues to rural landowners—either directly through lease agreements or indirectly through increases in local jobs or property tax revenues—which reduce the financial need to sell land to residential developers (Zollinger and Krannich 2009).
2. Demand-side mechanism: Due to real and perceived impacts of wind development (e.g., noise, shadow flicker, aesthetics), the presence of turbines reduces demand for new residential development, even miles away (van der Horst 2007).
3. Zoning mechanism: Setback distances within zoning codes create a relatively large footprint surrounding each turbine which can be farmed, but where development is not permissible (Rynne et al. 2011).

Even in the absence of definitive proof that windfarms are reducing farmland conversion, by testing each of these mechanisms, this research aims to determine whether wind energy projects might indeed be a new tool to add to the rural planner's farmland preservation toolbox.

1.3 Analytical Approach

These mechanisms—and subsequently my research questions and hypotheses—explore the windfarm-farmland preservation question from very different angles—some lending themselves to quantification and others to more nuanced explanation. Rather than force-fit my research questions to a single method, I instead opted for a mixed methods research design. I utilize a large-scale (n=1730) mail survey of farmland owners to test the supply-side mechanism, determining whether landowners in communities with windfarms make more on-farm investments or have different long-term plans for their land than landowners in similarly situated non-windfarm communities. To test the demand-side mechanism, I employ semi-structured

interviews with realtors, appraisers, and auctioneers, as well as local government leaders, to document the possible impact of the windfarms on new home construction. Finally, I explore the zoning mechanism—the impact of setback distances on the availability of farmland for residential development—through geospatial analysis, looking at both existing and hypothetical zoning ordinances.

Because my overall research question is derived from practice but largely exploratory, I also opted for a research design that would allow me to test the generalizability of my wind energy-farmland preservation hypotheses by looking across a number of windfarms. Conducting the research on all 50+ utility-scale wind projects in the Great Lakes region, however, would be impractical. Instead, I selected four case study windfarms, using a diverse case approach to maximize the variation between cases (Seawright and Gerring 2008) as a way to test the limits of my hypotheses. Though all four windfarm cases are sited in Michigan and three are even built within the same county, they cover a wide spectrum of taxing structures, revenue-sharing arrangements, and historical population growth pressures—variables I expected might impact farmland preservation.

Even so, given that it is based upon case studies from a single state, there are limits to the generalizability of this research. While I make some remarks in Chapter 8 about how different state-level policies (e.g., property tax policy, wind siting regulations, etc.) or ownership arrangements (e.g., community/cooperative rather than investor-owned) might lead to alternate outcomes, there is no way of knowing whether my findings would hold in other states. Given the dearth of academic research about U.S. windfarms, additional research is certainly warranted to determine how the windfarm-farmland preservation connection plays out in other contexts.

Additionally, this research does not consider all possible social, economic, and environmental impacts of the selected case studies, but rather hones in on those issues directly tied to farmland preservation. Quantification of environmental impacts such as bird or bat fatalities or carbon emission reductions are beyond the scope of this study, as is an assessment of the impact of the windfarms on tourism in the region. Furthermore, while this study considers farmland owners' perceptions of the positive and negative impacts of wind development, it does not include the opinions of residents in the vicinity of the turbines who do not own farmland.

1.4 Findings and Conclusions in Brief

I found, in fact, that while there are some small differences between cases, there was much more commonality across these communities with regards to my research questions than I expected. In fact, there was perhaps *too much* commonality. While I selected cases that I thought represented a wide range of development pressures—ranging from a small (-4%) loss of occupied housing units to relatively large gains (11%) in the period from 2000 to 2010, all interviewees recounted that demand for new houses had historically been very low. Furthermore, only one interviewee saw residential development on previously farmed land as a concern. As a result, the premise of my research—that wind turbines might help preserve farmland by reducing the rate of farmland conversion—did not resonate with most local officials in my selected case studies. Even so, my research yielded a number of interesting findings regarding the mechanisms that I tested, which should also be relevant in rural areas where residential development is a concern.

With regards to the supply-side mechanism, I found that the payments wind developers make directly to landowners does appear to impact their investment decisions, as well as their long-term plans for their land. Landowners with turbines on their property invest twice as much

to improve their property as their neighbors and landowners in a matched case. Even when accounting for the size of the farming operation—a strong predictor of increased investment—landowners who farm the land and have turbines on their property invest more than all other landowners. Furthermore, landowners with turbines on their property were significantly more likely to say that their land would be farmed and less likely to say it would be idle or used for recreational purposes in the future. Interestingly, there is evidence that the supplemental drought-safe revenues from the wind turbine payments are making farming more attractive to young people who might otherwise leave the farming community for jobs in an urban area. According to most local officials in my study area, this is the primary benefit to local agriculture—ensuring that there is a younger generation willing to take over the family farm.

The financial benefits of wind development, however, do not appear to have nearly the same impact on landowners who live in the windfarm community but who do not have a turbine sited on their property. Only in communities where royalties are pooled—that is, shared with all landowners who were willing to host turbines on their property, even if a turbine was not ultimately sited there—report making higher investments in their farms than those in the matched case communities. In communities where only landowners with turbines on their property receive royalty payments, these neighboring landowners actually invest less in their farms than landowners in the matched case communities. In addition, very few landowners in windfarm communities—whether royalties are pooled or not—acknowledge that any indirect local economic benefits of wind energy, such as additional local jobs and increased property tax revenues, have impacted them.

The demand-side mechanism was particularly difficult to research because realtors, like others in the case study areas, insisted that there was no or very low new residential building

going on, even in Windfarm 4, which had seen double-digit housing unit growth from 2000 to 2010. As a result, there was no discernible change to report. However, asking about demand for new housing may have turned up an unexpected link between wind-related income and new home construction. Specifically, several interviewees asserted that landowners who are receiving wind income are building new houses on their property, either to replace an aging farmhouse or to use as a retirement home so that their heirs can move into the original farmstead. Data from my survey of landowners confirms that those with turbines on their property are investing more in home improvements. Building permit data for one of the nine windfarm townships show that landowners receiving wind revenues are nearly three times more likely to pull a permit to build a new home than farmland owners without turbines. However, an even greater number of new homes are being built by people who did not own farmable tracts, indicating that the wind turbines do not appear to be deterring non-farmers from moving to the area. Additional research is warranted, though, to determine whether these permits were for greenfield development or replacement of old homes.

Finally, in my geospatial analysis to look into the zoning mechanism, I found that, though farmland preservation considerations are rarely a motivating factor as officials establish setback distances for wind turbines, the amount of land rendered undevelopable by the presence of the turbines can be substantial. These land preservation benefits increase with larger setback distances, but large setbacks also make it more difficult for wind developers to site projects within communities and may effectively "zone out" wind turbines. My geospatial analysis found that though the number of turbines in a windfarm does have some bearing on the amount of land theoretically preserved, the specific setback distances have an even greater impact. Turbine spacing is also a determinant: the more space between turbines, the less overlap there is in the

setback distance circles between them; as a result, siting regimes in which turbines are widely spaced preserve more land per turbine than those in which the turbines are closer together.

These findings should be of interest to a range of policy makers and practitioners. At the local level, these findings can help inform officials and rural planners who might be considering whether and how to welcome wind development within their jurisdictions, by providing needed information about the social and economic impacts of wind development to local communities. Wind developers, in turn, can find in this research quantitative data on what landowners in communities with wind turbines see as the key benefits and drawbacks of wind energy. This data might, in turn, help wind developers better communicate the benefits and improve their practices to minimize the drawbacks, for example, with less disruptive turbine siting and construction practices, so as to encourage more rural communities to accept wind energy development.

This research, which tests practitioners' assertions of a connection between wind energy and farmland preservation, represents an initial analysis of an emerging phenomenon. In many respects it poses more questions than it answers, providing me and other researchers at the nexus of rural land use and energy policy with promising additional research projects.

Chapter 2. Literature Review and Research Questions

In some ways, my dissertation is not so different from other planning research: At its core, it explores how land use policies impact both landowners and their communities. However, because I focus on rural rather than urban jurisdictions and simultaneously engage with energy policy that is often beyond the planner's typical repertoire, I first need to set the stage for how this work draws from and contributes to existing scholarship. That is my goal in this chapter.

To lay the groundwork for this study, I first differentiate between two types of "rural" communities: those that are shrinking due to depopulation and those that are growing as a result of suburbanization. I then focus on the latter group, first summarizing the mechanisms that drive agricultural land conversion at the urban fringe and then presenting the most common strategies for preventing farmland conversion. I explain how these strategies should theoretically alter the conversion process and assess their relative success. Finally, I situate existing research on the impacts of windfarms within the framework of farmland conversion to demonstrate why wind development should theoretically be an effective tool for preserving agricultural lands; in so doing, I lay out the research questions and the hypotheses explored in the remainder of this thesis.

2.1 The Two Rural Americas

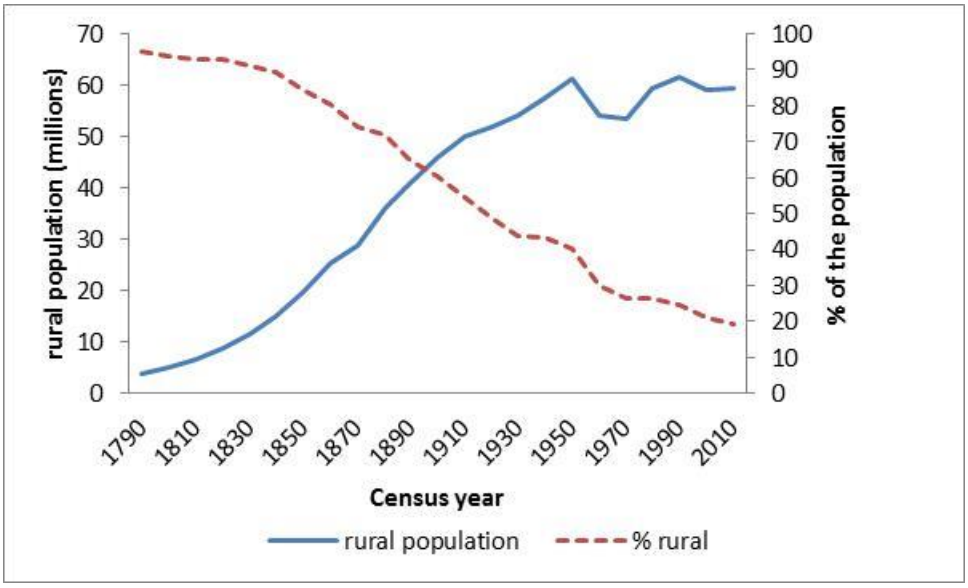
Though urban planners often see rural America as one homogeneous expanse of everything that is not urban or suburban, in reality, "the rural" includes such varied landscapes as the hills of Appalachia, the forests of the Pacific Northwest, the deserts of the Southwest, and the farmland of the Midwest, each with its own unique set of issues (Bryan 1986, 10). There are many typologies for "the rural" (see Marini and Mooney 2006), but I find Daniels and Lapping's (1996) concept of "Two Rural Americas," which categorizes land based on proximity to a metropolitan area, to be the best fit for my specific interest in the American Midwest.

The first rural America—the one driving U.S. Census reports that show a shrinking percentage of the population living in rural areas (see Figure 2-1)—is the remote or declining rural. These predominantly far-flung municipalities are usually tied to one industry—whether agricultural, extractive, or manufacturing—and face depopulation as that industry declines, or, in the case of agriculture, industrializes to require less labor (Salamon 1992). In an effort to retain population or adapt to dwindling numbers, the primary planning focus in these communities has been on economic development (Murray and Dunn 1995). This has traditionally taken the form of attracting a replacement industry, revitalizing Main Street, or investing in the service sector to attract tourists (Daniels 1989; Sears and Reid 1995).

The second rural America—the one that has prevented the overall rural population numbers from plummeting–is the fringe rural. Though referred to variously as the exurbs (Nelson 1992b), metropolitan fringe (Daniels 1999), urban fringe (Theobald 2001), or rural fringe (Sharp and Clark 2008), the fringe is characterized by urban-influenced parcels just beyond the suburbs. In the fringe, non-residential land uses have traditionally predominated, but the land is increasingly in demand for development, especially residential development. Thus,

the primary concern of planners in the fringe is managing land use change. Because agricultural lands are particularly attractive for development—they are already cleared and the soil typically allows for on-site septic systems—most literature about the fringe focuses on agricultural land conversion, or farmland preservation.

Figure 2-1. Rural population of the United States, by census year



Source: US Census Bureau.
Note: The downward shift in the rural population in 1960 does not reflect an actual decline so much as a change in the Census Bureau's methodology. Additional changes were made in 2000 and 2010.

While, as John Fraser Hart notes, "rural" and "farm" are no longer synonymous, many of the changes in both of these rural Americas can be attributed to changes in the agricultural sector and farmer demographics (1995). The industrialization of agriculture means that significantly fewer farmers are needed to cultivate the same number of acres, and far fewer young people are choosing farming as their occupation (D'Souza and Gebremedhin 1998). There are now 1 million full-time farmers in the nation (roughly half of all working-age Americans), down from 4.5 million (and 6.4% of the working population) in the 1960s (Ilg 1995). The 2012 Census of Agriculture further found that the average age of farmers is now 58.3 years, up from 57.1 years in 2007 "continuing a 30-year trend of steady increase (US Department of Agriculture 2014)."

This report also found that the number of new farmers was down 20% from 2007-2012. The aging of the farming population and decreases in absolute numbers of farmers not only directly contributes to decline in remote rural areas reliant on agriculture, but also a smaller contingent of farm families is less effective in combating urbanization in agricultural communities at the urban fringe (Smithers, Joseph, and Armstrong 2005).

Within my own area of interest in the American Midwest, both of these rural Americas are present. You can certainly find farming communities in which decades of changes in agricultural practices have led to devastating population loss, closure of rural schools and abandonment of small towns. At the same time, other rural communities in the Midwest are facing an equally devastating influx of people and find themselves struggling to hold on to agricultural land in the face of urbanization. Though both situations constitute a threat to the rural community, only the second is really a threat to farmland itself. Because this research explores claims that wind energy preserves farmland, the next two sections focus on previous research about the second rural America—that is, the communities on the metropolitan fringe that are facing urbanization. First, I look at what drives agricultural land conversion in these communities; then, I examine the traditional planning response to help preserve farmland.

2.2 Agricultural Land Conversion

Agricultural land conversion—the shift of a parcel from active farmland to some other use—is the primary planning concern in rural municipalities at the metropolitan fringe. In a setting where farmers and residential developers compete for farmland, economic theory holds that the highest bidder—in nearly every case, the developer—wins, and the land is converted to a non-agricultural use (Plantinga and Miller 2001; Logan and Molotch 1986). The following

sections detail first what drives residential demand for farmland, and then what impels the current landowner to sell.

2.2.1 Residential Demand for Farmland

Research aimed at understanding what drives exurban development has largely pointed to systemic rather than individual-level factors, particularly the perverse outcomes of governmental policies (Raup 1975; Nelson 1992b). At the federal level, the interstate highway system makes it possible to live in far-flung residential suburbs and still commute to jobs in the city (Lapping 2006). State and federal policies that encourage homeownership effectively subsidize single-family homes (Daniels 1999). Furthermore, local municipalities have traditionally failed to pass on to developers and, subsequently, new homebuyers the cost of extending infrastructure to more remote sites (Ford, Lopach, and O'Donnell 1990). As a result, greenfield development at the metropolitan fringe is often cheaper than redevelopment at the urban core.

Of all land types on the metropolitan fringe, farmland has been the prime target for development for two main reasons. First, farmland is particularly attractive to developers because it is already cleared, which saves on the cost of excavation to remove trees and level slopes (Esseks et al. 2009). Second, the same well-drained soils that are ideal for farming can also accommodate on-site septic systems on plots beyond the reach of municipal sewers (Marcouiller, Clendenning, and Kedzior 2002). As a result, the cost of land preparation on farmland is significantly less than on alternative sites, so developers are often willing to pay more for the land than its market value as farmland.

Though governmental policies effectively subsidize farmland conversion in general, homebuyer preferences largely drive which specific parcels are developed. In an early study in Portland, Oregon, Davis and colleagues (1994) found that residents moved to the metropolitan

fringe to gain a closer connection to rural landscapes while remaining within commuting distance of urban jobs. Subsequent literature, however, has largely split on whether rural scenic amenities or metropolitan accessibility are more important to homebuyers. Vogt and Marans (2004), for example, used survey and focus group data to find that transportation access and good schools were more important than natural features and open space, while a cross-study analysis of 30 different studies by Irwin et al. (2010) found that proximity to open space was much more important to current fringe residents than it was to fringe residents in the past. In summary, while there may be disagreement about their importance relative to more practical considerations like job accessibility, scenic amenities do appear to be non-trivial factors in the real estate decisions of exurban homebuyers.

2.2.2 Why Landowners Sell Farmland

Just as it is important to understand the demand for farmland on the metropolitan fringe, it is necessary to understand why current owners of farmland choose to sell their land. Found and Morley (1973) underscored the complexity of the motives underlying such a decision: All farmland owners must weigh economic considerations and emotional attachment to the land; those who are practicing farmers must also weigh career considerations, since their livelihood is tied to their property.

A number of more recent willingness-to-sell studies have looked at which of these numerous factors are most influential. In two studies of farmland real estate transactions in exurban Minnesota, Pyle found that non-economic motives were highly significant in determining which landowners put their land up for sale. She found that willingness to sell decreases with length of ownership (1986), and that older landowners and those with family ties to their land are less likely to sell (1989). Furthermore, Pyle's 1986 study found that farmers

were less likely to sell than non-farmers (i.e., those whose land was farmed by others) even when accounting for other factors; this finding demonstrates that the intertwining of agricultural landownership and career affects willingness to sell.

As a result, a number of later willingness-to-sell studies focused only on differences among farmers themselves. These studies largely highlight the importance of farm viability to farmland conversion decisions. Zollinger and Krannich found that farmers' willingness to sell increases with "perceived negative change (particularly difficulty in obtaining and retaining rental land and in purchasing land)…lack of a child who will take over the operation, and declining profits from the operation" (2009, 442). In the same year, Esseks et al. (2009) found that farmers who believed that local government sided with non-farmers were more likely to consider selling part of their land for development. As development and the number of non-farmers increases, then, more and more farmers are likely to consider selling their farms.

This last finding highlights the self-perpetuating, if incremental, nature of farmland conversion. Within rural planning, the theory of the impermanence syndrome holds that as neighboring parcels urbanize, remaining farmers will refuse to invest in their own farming operations, accepting as inevitable that their own land will be sold to a developer. While this seems accurate intuitively, the evidence that the impermanence syndrome actually exists is mixed. Both Lopez et al. (1988) and Adelaja et al. (2011) argued that the impermanence syndrome is real. Lopez et al. based this conclusion on econometric data from New Jersey farms showing that farmers become less responsive to agricultural price signals as suburbanization intensifies, while Adelaja et al. argued that the impermanence syndrome is confirmed by evidence that farmers on the fringe shorten their planning horizon as a result of increasing land values. On the other hand, Lockeretz (1986) and Heimlich (1989) used county-level data to

refute the impermanence syndrome, finding that farmers in fringe counties adapt their operations rather than throw in the towel. Lockeretz found that farms in metropolitan counties were smaller but more productive per unit area than non-metropolitan farms. Heimlich similarly found that metropolitan farms have higher-value products, leave less land idle, and sell more goods directly to the public than non-metro farms. Rather than viewing these seemingly contradictory studies as a referendum on the impermanence syndrome, I see them as evidence that only farms that adapt to urbanization will survive.

2.2.3 Summary

Agricultural land conversion is the result of high residential demand for new homes on the metropolitan fringe, coupled with the willingness of current farmland owners to sell their property. Residential demand for farmland is facilitated by governmental policies that subsidize exurban development, and it reflects consumer preferences for rural landscapes within commuting distance of urban jobs. As a result, residential developers are willing to pay more for farmland than its market value as farmland, especially for parcels with scenic views. These buyers often find willing sellers among farmland owners who don't farm their own land or farmers with less profitable farming operations. Once neighboring fields are developed into residential estates, remaining farmers begin to see urbanization as inevitable and disinvest in their own farming operations.

2.3 Traditional Farmland Preservation Strategies

While widespread agricultural land conversion began with the rise of the interstate highway system in the late 1950s, local concern over loss of farmland dates back to the 1970s and garnered national attention in 1981 with the publication of the National Agricultural Lands Study (1981) which aimed to quantify farmland conversion, understand what was causing

conversion, and explore options for preventing future loss of productive lands. Since that time, planners in the metropolitan fringe have developed a number of strategies to prevent farmland conversion. Duke et al. (2006) identified and evaluated 28 farmland retention techniques that are essentially variations of five basic strategies: agricultural zoning, purchase of development rights, urban growth boundaries, use-value taxation, and right-to-farm legislation. While many handbooks (Daniels 1999; Getzels and Thurow 1979; Lapping, Daniels, and Keller 1989; Pruetz 2012) provide more in-depth looks at the mechanics of each strategy, the following paragraphs summarize the theory behind each of these approaches and evaluate their effectiveness at curbing farmland conversion.

2.3.1 Agricultural Zoning

Agricultural zoning, which encompasses large lot and sliding scale zoning, is the most commonly employed farmland preservation technique. Agricultural zoning aims to preserve farmland by requiring minimum lot sizes larger than non-farming residential landowners would desire. In theory, this reduces residential demand for farmland and retains parcels that are large enough to viably farm. The theoretically most effective lot size varies from place to place depending upon the preferences of residential consumers, the type of crop grown, and the crop's attendant land needs.

As Coughlin (1991) noted, however, the agricultural zoning policies that are actually implemented are rarely based entirely on effectiveness; they must also take into account political acceptability. According to most studies, farmers fear that zoning will reduce their property value, so they tend to advocate for smaller minimum lot sizes and thereby effectively water down the technique's effectiveness at curbing farmland conversion (Adelaja and Gottlieb 2009; Schnidman, Smiley, and Woodbury 1990). Deaton et al. (2007) found that farmer support for

agricultural zoning was largely a function of landowners' plans for their farms. Farmers planning to sell off some of their farmland were, indeed, generally unsupportive of zoning, but farmers who were planning to expand their farming operations by purchasing more farmland were generally supportive of agricultural zoning.

The agent-based model developed by Magliocca et al. (2012) shows that the effectiveness of agricultural zoning is chiefly a result of the chosen lot size. Smaller "large lots," while often more politically acceptable to current landowners, do little to deter additional residential development. As a result, existing agricultural zoning policies have been less than effective. Diaz and Green (2001) found that in Wisconsin, agricultural zoning was only marginally successful at reducing new residential development, especially as compared to municipal tax rates. Healy and Short (1979) found that agricultural zoning, when controlled by non-farming residents, was much more effective at retaining rural character and open space than it was at preserving economically viable farmland.

2.3.2 Urban Growth Boundaries (UGBs)

Urban growth boundaries (UGBs) and urban service boundaries (USBs) are a special type of agricultural zoning in which zoning is used to draw a hard line between urban and rural lands. Urban growth boundaries aim to reduce land conversion by establishing dramatically different minimum lot sizes inside and outside the UGB. Urban service boundaries, on the other hand, make it clear to would-be fringe developers that municipal services will not be extended to them.

Like agricultural zoning, however, UGBs as implemented rarely live up to their theoretical expectations in thwarting farmland conversion. While generally supportive of Portland, Oregon's UGB, Nelson (1986) noted that its effectiveness is attributed to its strict adherence to very large lot sizes in rural areas and little lenience in granting variances or

rezoning. In California, Newburn and Beck (2006) found the rural zoning outside the UGB to be very effective at reducing the density of housing in rural areas, but rather than conserving farmland, it led to high-priced, low-density development.

2.3.3 Purchase of Development Rights (PDR)

PDRs are based on notion that it is possible to decouple development rights (i.e., the right to build) from the other rights of land ownership (i.e., the rights to occupy, use, sell, and exclude others). In PDR programs, municipalities or land trusts buy the development rights to a parcel from the landowner with the expectation of holding it in perpetuity, effectively halting any future development on that land. The owners are compensated for the difference between the land's market value as a developable property and its value as farmland; since they retain all of the other rights, they can continue farming and eventually sell the property. Any future landowners, though, would also be unable to develop. PDR programs encourage landowners who still want to farm but are tempted to sell while market values are high to sell just the development rights instead. Though far less common, transfer of development rights (TDR) programs work in a similar way, with the development rights from one property being transferred to increase development density on another property.

Because PDR programs are based upon the voluntary sale of development rights and compensate landowners for loss of potential development value, farmers are generally more supportive of PDR programs than agricultural zoning (Norris et al. 2002). Even so, most municipalities dominated by farming interests cannot garner enough support to fund a PDR program until substantial development has already taken place (Poor and Brule 2007). Furthermore, there is some evidence that in those circumstances, it is not the farmers but the new non-farming residents who are responsible for instituting a PDR scheme (Kline and Wichelns

1994); as a result, PDR programs tend to favor the preservation goals of non-farmers, particularly the preservation of open space rather than viable agriculture (Daniels 1999). Indeed, Kline and Wichelns' focus-group participants indicated that "preserved farmland provides a public benefit even if it is not actually farmed" (1996, 424).

Research on the effectiveness of PDR programs has generally found them to be more successful at farmland retention than agricultural zoning. Liu and Lynch's (2011) study of Mid-Atlantic states found that having a PDR program decreases a county's rate of farmland loss by 40-55%. Some research indicates that the preservation effect extends beyond the parcels in easement. Towe et al. (2008) found evidence in Maryland that development is less likely on parcels that are eligible for PDR, even if the rights have not yet been purchased. Pruetz's case study research revealed that PDR programs initiate a virtuous cycle whereby "farmers become more optimistic about the future of local agriculture when their neighbors permanently preserve their land. As a result, agriculture thrives, and more land is placed under permanent easement" (2012, 8). However, other studies indicate that PDR purchases can inadvertently increase residential demand on neighboring parcels (Nelson 1992a). Most authors agree that because PDR programs are expensive and require voluntary participation by landowners, they have limited effectiveness unless coupled with agricultural zoning (Daniels 1997; Esseks et al. 2009).

2.3.4 Use-value Taxation

Use-value taxation, or use-value assessment, taxes farmed property only on its value as agricultural land and not on its potential market value for development. In so doing, it lowers property taxes to make farming more economically viable. This, in theory, reduces the pool of

willing sellers by offsetting the financial need to sell property. Forty-nine of the fifty US states have some form of use-value taxation, with Michigan being the exception (Esseks et al. 2009).[1]

Despite its widespread use, there is little academic research on the effectiveness of use-value assessment to prevent farmland conversion. In a report for the Michigan Department of Environmental Quality, Norris et al. (2002) asked whether Michigan experienced more farmland conversion as a result of not using use-value assessment. They concluded that while use-value taxation is viewed as more equitable by rural landowners, Michigan's land conversion rate was comparable to that of other states, and "the level of agricultural taxes does not appear to impact the rate at which agricultural land is converted" (20). Though anecdotal accounts have pointed to increased land values and the resultant increasing property taxes in urbanizing areas as one of the factors leading landowners on the fringe to sell to developers (Healy and Short 1979), the study by Norris and colleagues suggests that property taxes are a relatively small expense compared to other agricultural expenses, so a change in tax rates makes little difference in a farmer's willingness to sell.

2.3.5 Right-to-farm Legislation

Much of the farmer/non-farmer conflict in fringe municipalities arises from some of the externalities associated with farming operations: noise, dust, odors, and slow-moving farm vehicles on the roads. When such nuisance cases are brought to court, non-farmers have traditionally won because under common law, the argument that non-farmers "moved to the nuisance" is an insufficient defense for farmers. In response, state and local governments may enact right-to-farm laws, which shield pre-existing farming operations from nuisance suits. In theory, by protecting the rights of remaining farmers to conduct their business, right-to-farm

[1] Michigan has a voluntary farmland preservation program that allows enrollees to deduct a portion of their property tax bill from their state income taxes in exchange for a 10 year (or more) commitment to not sell the land for development.

legislation should prevent farmland conversion by reducing the impermanence syndrome in fringe municipalities.

However, despite widespread use of right-to-farm legislation, very little is known about its actual effectiveness at preserving farmland. Adelaja and Friedman (1999), in perhaps the most comprehensive scholarly study of right-to-farm laws, found that farmers were the key supporters of their enactment. As the political clout of farming interests in a municipality decreased with development, however, right-to-farm laws were weakened or revoked entirely. This suggests the marginal effectiveness of such a preservation technique. Furthermore, Esseks and colleagues (2009) found that farmland owners generally see right-to-farm legislation as less effective at preserving farmland than zoning, PDR, or use-value assessment.

2.3.6 Summary

All five traditional approaches to farmland preservation theoretically aim to influence either the supply or demand side of the land conversion equation but have limited effectiveness in practice. While agricultural zoning and urban growth boundaries aim to reduce demand for farmland by requiring unaffordably large residential lot sizes, political compromises with current landowners have led to weakened zoning regulations that result in lot sizes that are affordable—and highly desirable—to the wealthy. On the supply side, PDR programs have provided a desirable alternative to willing sellers, but they are extremely expensive and can lead to increased development on unpreserved neighboring parcels. Use-value taxation, another widely utilized supply-side intervention, aims to reduce property tax costs for farmers, but the limited research on its effectiveness indicates that the tax reduction is not substantial enough to impact a practicing farmer's willingness to sell. Right-to-farm legislation provides legal protection for the remaining farmers in urbanizing municipalities, theoretically minimizing the disinvestment and

eventual exit that come with the impermanence syndrome, but there is no evidence that it actually achieves that goal.

In summary, no single technique is a silver bullet for preventing farmland conversion. Recognizing the policy flaws, most authors recommend combining techniques to help balance their pros and cons (Daniels 1997; Esseks et al. 2009; Nelson 1992a; Sokolow 2006), but few rural municipalities have the planning expertise or the political will to create a comprehensive farmland preservation strategy. Thus, a single tool capable of simultaneously reducing demand and discouraging supply could fill an important niche. The next section discusses whether wind energy projects might provide such an alternative.

2.4 Wind Energy and Rural Communities

In the absence of research on the effectiveness of wind energy projects at curbing farmland conversion, rural planning practitioners have relied primarily on their intuition that such a relationship ought to exist. In my preliminary interviews with rural planners prior to developing this research project, they often cited arguments that wind projects should theoretically both reduce residential demand for farmland and reduce the supply of farms for sale by providing land owners with additional revenues, and that wind zoning regulations themselves restrict development on the land in the immediate vicinity of the turbines. The following sections explore whether existing literature on the impact of wind energy on rural communities supports such theories. On the demand side, I explore wind energy as an undesirable land use. I then turn to the supply side and consider the revenues wind energy projects bring to host communities, both directly to leaseholders and more indirectly through community-wide revenue-sharing. Finally, I consider elements often included in wind turbine zoning regulations that might impact ability to develop the farmland surrounding the turbine. I begin, though, by

giving a short primer on wind development, especially as it intersects with rural land use in the Midwest.

2.4.1 A Primer on Utility-scale Wind Development in the United States

Though there are a number of good resources to introduce the public and even land use planners to the wind energy industry more generally (US Department of Energy 2014; Rynne et al. 2011), here I focus on the aspects of wind development that are most salient to the context of this particular study: utility-scale wind development in the American Midwest.

Utility-scale turbines have two defining characteristics: their size and the end-user of the power they generate. Specifically, utility-scale turbines are the largest modern wind turbines with generating capacity exceeding 1.5 MW (US Department of Energy 2014), which roughly translates into turbine blades that are at least 100 feet long. The power that is generated, like that from any other electric power plant, is fed into the electric grid via high-voltage transmission lines. This marks a distinction from distributed or community grid projects, which may also generate power through large turbines but use the electricity locally, in the lower-voltage distribution line system. Though a single large wind turbine connected to the transmission line can constitute a utility-scale wind energy system, most often a group of turbines within the same general vicinity is installed at once in what is referred to variously as a windfarm, wind project, or wind park.

Though utility companies buy the power generated by the turbines, few electric utilities own the turbines themselves. Instead, the windfarm is often owned and operated by a wind developer who puts together the capital to pay for the up-front investment in the turbines, arranges for the power to be sold to the grid, and is responsible for planning and receiving all

necessary permits for siting the windfarm. Windfarms can be sold from one wind developer to another, and occasionally an electric utility also acts as a wind developer.

Though wind developers own the turbine itself, they very rarely own the land on which it is sited. Instead, they enter into long-term leases or buy a permanent easement to site the turbine on the landowner's property. Again, because the power generated enters the transmission grid rather than the local distribution lines, the landowners with turbines on their property do not directly receive the electricity that those turbines generate. Instead, they are compensated through annual lease or easement payments. At a minimum, these payments are intended to compensate the landowners for the land taken out of agricultural production as a result of the windfarm (i.e., for the value they would have received by planting corn on the acreage that currently hosts the wind turbine and its attendant infrastructure). As in oil and gas leases, though, the wind developer commonly agrees to pay a fixed per-acre lease or easement amount plus a royalty: a fixed percentage of the profits from the energy that is produced and sold to the electric utility, which can fluctuate from year to year based on the amount of wind, the price of electricity, and other factors.

Because the earliest windfarms in the U.S. were sited on vast tracts of land, that is the persistent image in most people's minds. In the Midwest, though, most windfarms are sited amidst a rural community, with multiple landowners each hosting one turbine or perhaps a handful of turbines. In siting a windfarm, the wind developer will first go to the community and get exploratory leases or easements for the land, paying a very minimal per acre fee; this buys the wind developer time to test the wind resource and amass enough contiguous land for a viable project. Once these early leases are signed, the wind developer determines the optimal turbine locations and decides which leases will be extended and which will be terminated. In the

traditional model, only those landowners with wind turbines or other project assets (e.g., underground cables, access roads) on their property were entitled to royalties from the turbines. However, some wind developers are beginning to pool royalties with all landowners who signed an exploratory lease, whether they ultimately receive a turbine on their property or not.[2] In these pooling arrangements, the royalty share of the lease payment is diluted as it is shared among more landowners, but a higher proportion of community members receive direct payments from the wind developer.

2.4.2 Wind as an Undesirable Land Use

Though engineering and economic challenges were previously the primary obstacles to widespread adoption of wind energy, recent advances on both of these fronts mean that community acceptance is now the most common stumbling block in successfully implementing wind projects. Both the popular and academic literatures are filled with stories about the contentious public hearings that arise in windfarm siting (van der Horst 2007; Toke 2005; R. D. Kahn 2000). Because of the size of current utility-scale wind turbines—which commonly stand 400+ feet tall—opposition is not limited to residents within the same country block, or even the same municipality as the proposed wind project, but can include detractors who live miles away.

Much of the social science research into windfarm siting has focused on factors that influence an individual's attitude toward wind development. Van der Horst (2007) found that while opposition on average increased with proximity to a wind project, community-level contextual factors and the individual's relationship to the land greatly impacted any particular response. Landowners who believed the project would improve their community's environmental image were more supportive of windfarms, as were landowners who valued the

[2] Because this has not yet been studied in an academic setting and wind developers largely require leaseholders to keep lease terms confidential, it is unclear how widespread royalty pooling is.

rural landscape more for its utility (e.g., as a working landscape) and less for its scenic value. Park and colleagues (2011) similarly found that people less attached to rural landscapes were more supportive of changes to the landscape. Both of these studies suggest that families moving to the metropolitan fringe for its scenic qualities might be deterred by wind development.

To the extent that residential demand is reflected in property values, one would expect that wind development would lower property values. Indeed, Bidwell's (2011) research indicated that anticipation of adverse economic impacts, particularly on personal property values, underlies most opposition to wind. However, research findings on the impact of wind development on neighboring property values have been mixed. Hoen et al. (2011), who analyzed the results of 23 previous studies in conjunction with their own hedonic model using a nationwide sample of properties within view of a windfarm, found that these properties tend to retain their market value. The notion that property owners anticipate adverse impacts but ultimately experience no reduction in property values is supported by Warren and colleagues' (2005) public opinion research. They found that prior to windfarm construction, local residents are often quite leery of wind energy, but following construction, the residents nearest to the wind turbines actually have the most positive attitudes towards them.

Notably, all of the research on property values and local attitudes towards wind energy has focused on the residents and landowners who currently live in communities with windfarms; it is silent on how the presence of the wind turbines might affect potential new residents of these places—that is, people who might have previously considered moving to the area. In an early scoping interview, a planning commissioner in Michigan whose agricultural municipality had accepted a wind project commented that it is the perception of an impact that matters. He acknowledged, "The research says that land prices aren't affected by windfarms. We hope,

though, people think it [wind development] lowers their property values. We don't want [residential] developers here" (B. Dickens, personal communication, August 17, 2012).

2.4.3 Wind as a Direct Source of Farm Income

Each wind turbine requires roughly two acres of land for the tower (i.e., the base of the turbine) and the service road used to access it. To compensate the landowner for taking this land out of production, wind leases typically amount to anywhere from $1,000 to $4,000 per turbine per year (Rynne et al. 2011), a sum that often exceeds the agricultural yield on the same acreage for all but the best farmland. In addition, the landowner—and, in windfarms that pool royalties, the neighbors—are also paid royalties for the energy generated. The size of the royalty payment is highly dependent upon how many landowners are in the royalty pool, the amount of power generated, and the wholesale price of electricity, but these royalty payments can amount to as much as $10,000 per turbine per year. This wind income diversifies farmers' income streams with a guaranteed revenue source that helps them weather the year-to-year variability in crop yields (Rynne et al. 2011; Union of Concerned Scientists 2003).

There has not, however, been any research on the impact of wind income on farm viability and subsequent willingness to sell. In anecdotal evidence from preliminary research, I found that farmers with wind leases for only one or two turbines were using the revenue to invest in new equipment, even in a summer in which drought had decimated crop yields (B. Dickens, personal communication, August 17, 2012). It would follow, then, that they were not planning to put their farms up for sale anytime soon. However, as I will soon explain, additional research is needed to determine whether this anecdotal evidence applies more broadly to wind leaseholders, and whether it also extends to landowners who do not have turbines on their property but are part of the royalty pool.

2.4.4 Wind as an Indirect Source of Income

The economic benefits of wind developments often extend beyond the landowners participating in wind leases themselves to the entire agricultural community in which the wind development is located. Opportunities for job creation are the most commonly cited benefit, and have been a key determinant in eliciting a broader base of support for state-level renewable energy policy (Rabe 2006). Most authors have acknowledged that the longest-lasting job creation benefits are at the state or regional scale, in the form of manufacturing jobs to make turbine and tower components (Carlson, Loomis, and Payne 2010; Lantz and Tegen 2008). While some temporary local jobs are created during construction, far fewer rural communities gain more than one or two full-time positions once the windfarm is in operation (Munday, Bristow, and Cowell 2011). Even so, in rural communities with few other employment opportunities, any job growth is often welcome (Black et al. 2014).

Another indirect financial impact for communities that host windfarms is through tax revenues. In the U.S., taxes assessed on energy production equipment are usually collected by local rather than state governments. Thus, wind companies might provide direct benefits not only to landowners through lease payments but to the whole community through additions to local coffers. These in turn may be directed to improve locally funded public services (e.g., roads, parks, human services), or they may be used to reduce the local property tax burden on all landowners. Because most wind energy research has been conducted in Europe where property taxes, if collected at all, are not kept at the community level, there has been very little written about the local impacts of taxes paid by wind developers. A recent study from Texas, however, did find that the schools in counties with windfarms "have improved over time based on expenditure per-capita increasing and the student–teacher ratio decreasing" (M. E. Kahn 2013,

804), even as property tax rates in those windfarm counties fell, resulting in lower tax rates than in similar non-wind counties. Not all states tax wind turbine machinery, and the allocation of property tax revenue varies from state to state, so more research is warranted to ascertain the impact of wind energy in other states' property tax regimes.

2.4.5 Land Use Regulation of Wind Energy Projects

Given the size of modern utility-scale turbines, it is not surprising that wind projects are subject to land use regulation, just as other large structures in the built environment are. Most often, this regulation is aimed at ensuring that turbines are safely sited in case of a catastrophic failure (i.e., loss of a turbine blade) or shedding of ice, as well as minimizing the noise and visual impacts to neighboring landowners. Such regulations usually take the form of minimum setback distances from roads, property lines, or inhabited structures; noise controls; and requirements for vegetative screening to reduce both noise and shadow flicker (Andriano 2009).

In establishing appropriate limits for each of these standards, local planners must negotiate a number of competing interests: "provision of adequate land area for wind development, predictability and stability for developers, protection of the financial and health interests of residents, and protection of the local environment" (Watson, Betts, and Rapaport 2012, 782). Disputes arise largely between non-participating property owners who urge larger setbacks that shield themselves from impacts, and developers and participating landowners who argue for smaller setbacks that would enable them to site more turbines in the same area (McGowan and Connors 2000). There are no hard and fast rules for "safe" setbacks; as a result, required setbacks vary widely from jurisdiction to jurisdiction, ranging from as little as the height of one turbine[3] to 1,500 feet or more (Watson, Betts, and Rapaport 2012). While some zoning codes permit landowners to sign waivers allowing turbines to be sited closer to a

[3] Turbine height is generally measured from the ground to the tip of a blade in its most vertical position.

dwelling, most jurisdictions require turbines to be at least 1 to 1.5 turbine heights away from any homestead. Given the size of today's turbines, even a modest 1 turbine height setback would result in 17 acres of safety zone for each turbine. Increase the setback to 1,500 feet, and the result is 162 acres per turbine.

It is important to note that these setbacks are not intended to be no-man's lands. Landowners usually can cultivate crops or graze livestock right up to the base of the turbine. Accessory buildings such as barns or garages may also be permitted within the setback area. Setbacks apply primarily to residences. To the extent that residential development is the key threat to fringe farmland, a wind turbine that makes 17 to 162 acres off-limits to developers accomplishes what may have cost tens of thousands of dollars to achieve through a PDR program or may have been politically infeasible to accomplish with large-lot agricultural zoning. Because much of the land affected by the setback will be on a turbine leaseholder's property, the wind developer will essentially be providing revenue to compensate the affected landowner (D. Schurr, personal communication, August 8, 2012).

2.4.6 Summary

While the existing literature on wind energy has not looked specifically at its impact on agricultural land conversion, we can anticipate a connection by piecing together what is known about wind energy and rural communities. Though public hearings to site windfarms often attract vocal opposition from neighboring landowners who anticipate adverse impacts on their property values, research has not conclusively shown market price reductions on properties within view of windfarms. Thus, it is unclear what impact windfarms might have on residential demand for farmland (i.e., for new homes). On the supply side, the literature suggests that farmers with wind leases should benefit from a dependable revenue source that diversifies their

income stream. Anecdotal evidence from preliminary research shows that soon after signing a wind lease, farmers make substantial investments in their farms, which suggests that they do not anticipate selling their property to a developer in the near future. Furthermore, the benefits from tax revenues and job creation (even temporary job creation) should be felt community-wide, as long as state and local laws call for assessing taxes on the wind turbine and keeping a significant proportion of those revenues within the local jurisdiction. Finally, the common practice of regulating setback distances of wind turbines from inhabitable structures means that some amount of land is rendered undevelopable, at least during the duration of the windfarm's operation. Which setback distances are chosen, however, can lead to an order-of-magnitude variation in the amount of acreage preserved.

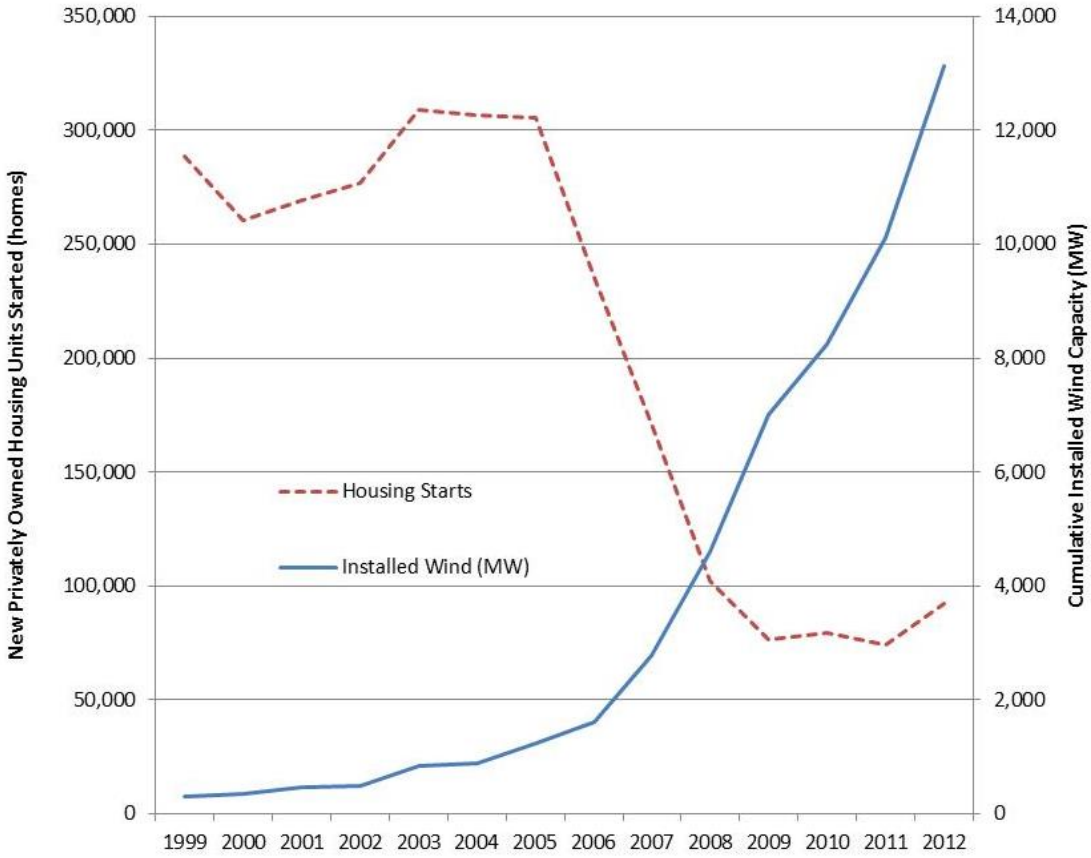
Agricultural land conversion results when high residential demand for farmland finds willing sellers, especially among farmers with less profitable farming operations and those who believe development is inevitable. Existing approaches to farmland preservation typically try to alter this dynamic by approaching either the supply or demand side of the equation, but in so doing, they create perversions in the other side of the equation that ultimately limit the effectiveness of the intervention. On paper, wind energy development appears to provide an alternative approach that simultaneously reduces residential demand and provides farmland owners with revenues that increase profitability and reduce the need to sell farmland. This research project is designed to determine if the theory holds in practice.

2.5 Research Questions and Hypotheses

My overarching research question is deceptively straightforward: Do commercial wind energy projects preserve farmland, and if so, how? Theoretically, at least the first part of this question could be measured directly by comparing data on new housing construction in

comparable municipalities with and without windfarms, using statistical analysis to see if the presence of a windfarm reduces farmland conversion. However, more than 80% of the wind capacity in the U.S., and 98% of the wind capacity in the Great Lakes states, has been built since 2005. In that time period, new home construction effectively ground to a halt, not because of the wind turbines but because of the "Great Recession" (see Figure 2-2). As a result, a statistical assessment that includes any of these newer windfarms is likely to be inconclusive, since any "control" communities are likely to have experienced practically no residential development over that period. Furthermore, even if the quantitative assessment is limited to the small subset of wind energy developments built before the recent economic downturn, such an approach would not necessarily answer the second part of my question: How do windfarms reduce agricultural land conversion?

Figure 2-2. Wind energy and residential home development trends in the Great Lakes states



Sources: Wind Data: Wind Powering America. Yearly Wind Installed Capacity.
http://www.windpoweringamerica.gov/wind_installed_capacity.asp
Housing Data: U.S. Census Bureau. New Residential Construction.
http://www.census.gov/construction/nrc/pdf/startssa.pdf

Instead, my study operationalizes this overarching research question by directly testing three different mechanisms by which wind energy development may lead to farmland preservation:

1. Do the revenues rural landowners receive as a result of wind energy projects change their on-farm investments or long-term succession plans, especially whether they expect to sell their land to a developer? (I will refer to this as the supply side mechanism.)
    1.1 Does it matter whether the landowner receives revenues directly through a lease agreement with the wind developer, or indirectly through other financial benefits such as an increase in local jobs or an increase in local property tax revenues?

2. How does proximity to a windfarm impact residential demand for farmland? (I will refer to this as the demand side mechanism.)

3. How do zoning ordinances affect the availability of developable land in the area surrounding a windfarm? (I will refer to this as the zoning mechanism.)

Given what is already known about rural land conversion and the local impacts of wind energy development, I hypothesize that my research will find:

H1. Landowners in communities with windfarms are more likely to make investments in their farms and to anticipate that the next owner of the property will also keep the land in agriculture than landowners in rural communities without windfarms.

H2. In municipalities with windfarms, landowners who hold wind leases are even more likely to make investments and anticipate longer farm viability than neighboring landowners without leases, though both groups will have longer planning horizons than landowners in communities without windfarms.

H3. Proximity to a windfarm reduces residential demand for farmland, particularly for buyers who are moving to exurbia to enjoy its scenic amenities, not to be involved in the agricultural sector.

H4. The impact of the windfarm on residential demand for farmland is felt most acutely in areas with higher overall demand for new residential housing.

H5. The number of acres rendered ineligible for residential development is a function not only of the size of the windfarm but also, importantly, the zoning regulations adopted by the municipality.

Chapter 3. Research Design: Data and Methods

The last chapter ended with three research questions and five hypotheses that this dissertation aims to test. In this chapter, I explain my choice of a mixed methods case study research design, specifically how the diversity of my research questions and exploratory scope of this project lend themselves to such an approach. I then describe the implementation of each of my data collection instruments and explain how the data I collected corresponds to each of the research questions and hypotheses, setting the stage for the analysis of this data in the next four chapters.

In summary, this chapter outlines a mixed methods case approach, looking at the impact of wind energy on farmland conversion in four communities with windfarms. The supply-side mechanism (research questions 1 and 1.1, and hypotheses H1 and H2) is tested using a mail survey of owners of farmland in these windfarm case study communities, as well as in matched cases without wind turbines. The demand-side mechanism (research question 2 and hypotheses H3 and H4) is tested through semi-structured interviews with local officials and realtors. Finally, the zoning mechanism (research question 3 and hypothesis H5) is explored through geospatial analysis of existing and hypothetical zoning ordinances.

3.1 A Mixed Methods Case Study Design

3.1.1 The Rationale for Mixed Methods

Though they are all intended to inform a single overarching question—whether wind energy development helps to prevent farmland conversion—my research questions and hypotheses look at the issue from varying angles, asking what impact the presence of wind turbines has on existing landowners, potential homebuyers, and availability of developable farmland. Some of my questions are aimed at quantifying this impact (e.g., "How many acres are no longer eligible…"). Others aim to capture a more nuanced explanation of the windfarm-farmland preservation connection (e.g., "How does proximity to a windfarm…"). As a result, rather than force-fit my research questions into a single method, I chose a mixed methods approach, in which "the inductive results from a qualitative approach can serve as inputs to the deductive goals of a quantitative approach, and vice versa" (Morgan 2007, 72).

This choice complements my own tendency toward more pragmatic modes of inquiry. While constructivist or positivist epistemologies tend to focus on context-specific investigation followed by generalization, the pragmatist "investigates the factors that affect whether the knowledge we gain can be transferred to other settings" (Morgan 2007). Likewise, mixed method research is particularly adroit at answering research questions aimed at understanding "how different dimensions and scales of social existence intersect or relate" and "assembling data and argument that can be woven into meaningful and empirically well-founded social theory" (Mason 2006, 15). Specifically, employing mixed methods allows me to better tailor my data collection and units of analysis to the research question or hypothesis at hand, but within a

framework that allows the various components of my research to inform each other.[4] For this dissertation I employ three research methods, which largely correspond to the three broad mechanisms implied by my research questions. Table 3-1 presents a summary of each of these methods, mapped to the research questions they address. Each method is described in more detail later in this chapter.

Table 3-1. Research design summary

Method	**Mail survey**	**Semi-structured interviews**	**Geospatial analysis**
Research Question / Hypothesis	Supply-side mechanism (research questions 1 & 1.1, hypotheses H1 & H2)	Demand-side mechanism (research question 2, hypotheses H3 & H4)	Zoning mechanism (research question 3, hypothesis H5)
Unit of Analysis	Agricultural landowner within a case study or matched case	Realtors / officials within a case study	Case study
Analysis	Statistical (ANOVA, Chi-Square)	Qualitative, using coded transcripts	Buffer area
Also informs	Demand-side mechanism Zoning mechanism	Supply-side mechanism	

3.1.2 The Rationale for the Diverse Case Approach

Because my overall research question is derived from practice but largely exploratory, I also opted for a research design that would allow me to test the generalizability of my wind energy-farmland preservation hypotheses by looking across a number of windfarms. Conducting the research on all utility-scale wind projects in the Great Lakes region, however, would be impractical.[5] As a result, I chose a case study design, selecting four windfarms from

[4] For example, I use a mail survey of landowners primarily to inform the quantitative analysis of whether wind income alters landowner investment and land use expectations, while an open-ended question also invites landowner input on how the windfarm might be impacting the market for new homes in the area.

[5] First, there is no easy way to identify and contact a group of people crucial to my research on the supply-side mechanism—the landowners with wind turbines on their property. Even after limiting the scope of my research to four wind projects, it took over a month to collect parcel-level landowner data and construct a list of landowners with turbines on their property. Second, a region-wide study would be impractical because my hypotheses aim to understand "why" and "how"—e.g., how does proximity to a wind farm impact the residential demand for

among the 53 possible sites in my areas of interest (see Table A-1). Because the number of selected case studies was very small in comparison to all of the windfarms in the Great Lakes region, I would have gained very little assurance of representativeness by selecting these cases through probability sampling (Teddlie and Yu 2007). Instead, I opted for purposive sampling, choosing the diverse case approach to maximize the variation between cases (Seawright and Gerring 2008) as a way to test the limits of my wind energy-farmland preservation hypotheses.

In the diverse case approach, cases are selected based on criteria—i.e., independent variables—that are expected to have some bearing on the dependent variables of interest but are relatively easy to assess for the full range of potential case study sites. By choosing cases with diverse (though not necessarily extreme) values of the independent variable, I aim to see how the dependent variable reacts in a range of situations. My study as a whole has a number of independent and dependent variables (i.e., they vary for each hypothesis), and so I selected three criteria that both theory and early interviews suggest may impact the windfarm-farmland preservation connection: recent housing unit growth rate, royalty arrangement, and property tax policy (see Appendix A for more for more discussion on why these criteria were selected).

3.1.3 Selecting Cases

Among these criteria, property tax policy is the most challenging because it is usually a state-level policy and therefore varies not from project to project but from state to state. Using multiple states, however, introduces additional logistical complexity and a host of complicating differences that are not entirely germane to my topic of interest (e.g., some states in the region are civil township-based while in others, county government oversees all rural activities). Michigan, however, is a bit of a regional exception; it currently requires a uniform tax structure

---

farmland? Thus, they lend themselves to "an open-ended, inductive approach" (Maxwell 2005, 75). It would have been impossible to do the deep dive required by inductive research in all 53 Great Lakes windfarms. (See Appendix A for a list of these windfarms.)

for all wind projects, but the first two projects in the state were given tax abatements. Both projects are located in Huron County, which hosts six of Michigan's 16 utility-scale windfarms (more than any other county in the state).[6] Because multiple wind developers work in Huron County, there is also a wide array of royalty arrangements. As a result, choosing cases from Huron County takes advantage of a natural experiment in which development pressures are similar, but royalty arrangements and tax policy vary.

Using the diverse case selection criteria, I therefore selected three cases from Huron County. The obvious first choice was one of the projects that received a tax abatement: Michigan Wind 1. Because this is the only case in my study with a full abatement, I refer to it as the "Developer-friendly" case (#1). This project had a non-pooled royalty arrangement. The next project selected was the only other project in the county that paid full taxes but did not pool royalties: Harvest II. Because I hypothesize that this represents a mixed bag for neighbors—they benefit indirectly from the tax revenues but do not share in direct royalty payments—I refer to this case as "Mixed-benefit" (#2). Of the remaining projects fully operational at the time, I opted for the only project not in the same municipalities as another project: Sigel. This project received no tax abatement and had substantial royalty pooling, so I refer to it as "Neighbor-friendly" (#3).

While these cases provide diversity across the royalty and tax policy criteria, they lack diversity in housing unit growth. Within the townships of the three selected case studies, housing unit change over this period ranged from -4% to +4% (see Table 3-2). In keeping with the diverse case approach, for a fourth case study, I sought a project in an area with an increase in population. Among all Michigan counties with wind projects, Missaukee County had the

[6] This includes only the projects that were fully operational in November of 2013. At that time, there were four additional projects under construction in the state, three of which were in Huron County.

highest housing unit growth rate over the last decade at 7%. The Stoney Corners project saw housing unit growth of +2 and +11% in the two townships in which it is located. I refer to this as the "High-growth" case (#4).

Table 3-2. Summary of cases, with expected findings from each

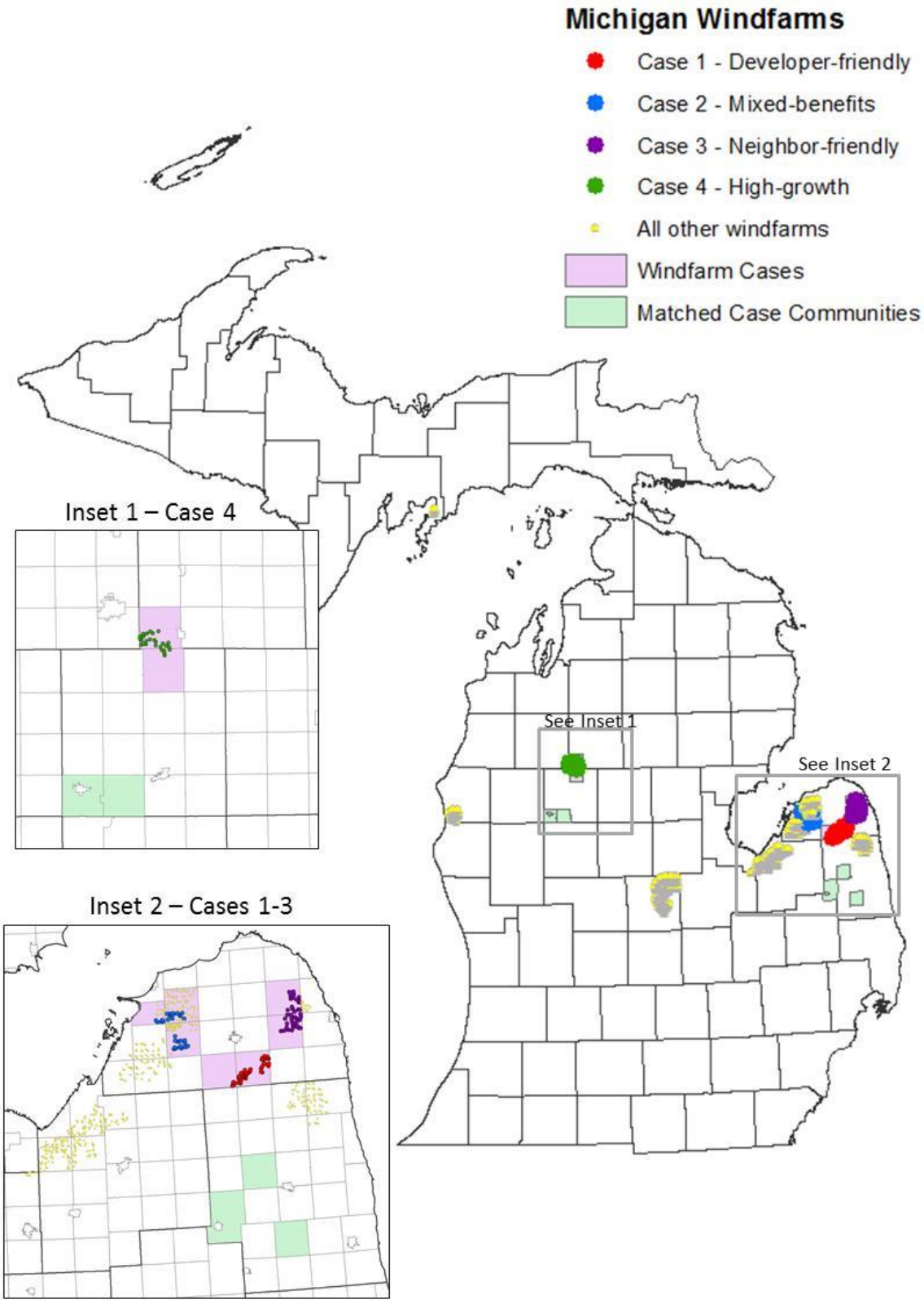
Case	Developer-friendly (#1)	Mixed-benefit (#2)	Neighbor-friendly (#3)	High-growth (#4)
Tax abatement	yes	no	no	partial
Pooled royalties	no	no	yes	yes
2000-2010 cccupied housing unit change	2% / 4%	3% / -1% / -4%	-2% / -4%	11% / 2%
Expected findings	Neighbors make fewest investments	Neighbors make more investments than in Case 1, but not as much as in Case 3	Neighbors make most investments	More evidence of change in housing demand

Together, these four projects represent a diverse array of contexts for my research (see Table 3-2), even though they are all sited within the same state. Among the projects, I would expect High-growth (#4), the case with the highest historic housing unit growth, to have landowners who are most concerned about farmland conversion and as a result are more aware of any changes to farmland conversion rates as a result of the wind project. In Neighbor-friendly (#3), the only case in which royalty payments are made to a large number of landowners who do not host turbines and there was no tax abatement, I would expect that a larger percentage of landowners are investing in their farms as a result of direct payments from the wind developer. And in Developer-friendly (#1), where there is an abatement and no royalty pooling, I would expect to find the smallest demand for new residential construction, since there is little financial benefit to landowners without a turbine on their property.

As described in more detail in Section 3.3, one of my three methods is based on comparing the results of a landowner survey in these four windfarm communities to how

respondents might have answered had the windfarm not been built. In experimental research, one would choose a "control case" for that purpose. Because the presence of a windfarm is not randomly assigned to a community, and, indeed, was determined prior to my research, I do not have a true control case. Instead, I selected matched case (non-windfarm) communities that are as similar as possible to my wind cases, except for the absence of a wind project; these matched sites are intended to model what might have happened in my wind cases if the wind turbines had not been built. Details about how these matched case communities were chosen and analysis about the suitability of their selection is provided in Appendix A. Ultimately, my study area included 14 townships: nine with wind turbines and five without turbines (see Figure 3-1).

Figure 3-1. Map of Michigan's windfarms, with selected case studies highlighted



3.2 Context of the Selected Cases

While the following chapters provide more detail about each of the chosen cases as they relate to my research findings, in this next section I provide a general overview of wind energy and agriculture in these communities. I begin by outlining wind energy development and policy in Michigan, drawing comparisons to regional and the national trends to better understand the extent to which generalizations might be drawn from these cases. I then turn to the case studies themselves.

3.2.1 Wind Energy Development and Policy in Michigan

As of mid-2014, Michigan ranked fifteenth in the nation for the number of utility-scale wind turbines, with 680 turbines (American Wind Energy Association 2014). Much of this wind energy development can be attributed to the state's Clean, Renewable, and Efficient Energy Act of 2008, which requires all utilities in the state to generate 10% of their electricity from renewable sources by 2015. This renewable portfolio standard (RPS) requires energy projects to be physically located either in Michigan or within the utility's service territory (i.e., northeastern Indiana) to count toward the target. While wind belongs to the standard suite of technologies that count toward the goal, the Michigan RPS gives bonus credits to solar photovoltaic projects but not to wind energy. Even so, given the relative cost effectiveness of wind, wind energy is expected to make up 98% of the state's renewables portfolio by 2015 (SNL Energy 2011) .

As in 27 of the 50 states, land-use regulation of wind turbines in Michigan is left to local units of government (Rynne et al. 2011). As a result, the state's 1,700+ local municipalities have considerable say in where windfarms are sited. The majority of the wind turbines in Michigan are in "the Thumb"—the agricultural region north of metro Detroit that boasts the state's greatest onshore wind potential. The state's largest windfarm, however, is in Gratiot County in mid-

Michigan, where wind resources are more modest but local officials and landowners proactively sought wind development.

In contrast to neighboring states that exempt wind development from property taxes but allow local governments to assess discretionary fees on wind development, [7] in Michigan there is more uniformity to property tax treatment of wind energy generation equipment. As with all classes of property tax in Michigan, local governments set their own property tax rates, but the State Tax Commission (STC)—a three-member body appointed by the governor—sets statewide rules for how the tax base is to be calculated.[8] The current rules set the taxable value for each wind turbine based on its original construction cost, but they apply a multiplier table that adjusts that number downward each year for the first ten years. This multiplier table has been modified twice in the last two years (see Section 5.2.3 for more details). Furthermore, prior to the passage of the state's RPS, wind developers could ask local governments for a partial tax abatement on the turbine's taxable value.

3.2.2 Huron County (Cases 1, 2, and 3)

Huron County, where three of my four case studies are located, hosts nearly as many wind turbines as the rest of Michigan combined: 328 of the state's 680 turbines (48%). However, it isn't just a state leader in wind energy. Huron County also ranks number one in the state for the total value of agricultural products sold—and ranks 83rd of 3,079 counties nationwide (US Department of Agriculture 2012). The county is the state's top producer of corn, beans, sugar beets, and wheat. It is also the state's top producer of cattle and milk.[9]

[7] This occurs in both Ohio and Wisconsin. Indiana exempts property taxes entirely. It was beyond the scope of this study to look at property tax treatment of turbines nationally, though the American Wind Energy Association offers a national database of property tax information to dues-paying members.
[8] Taxes are calculated by multiplying the tax base by the tax rate.
[9] This section and the next draw heavily upon the USDA's Census of Agriculture, which goes out to all farms and ranches in the U.S. every five years. I have presented this data in aggregate at the county level because that is the smallest reporting unit provided by USDA.

While the number of farms in Huron County decreased 14% from 2007 to 2012, the average farm size increased by 19%, and an additional 1,400 acres of land were put into active agricultural use over the same time period (see Table 3-3). That time period also saw a 75% rise in the market value of agricultural products produced in the county, and a similar (67%) rise in the value of land and farm buildings. Over half of farm owners are full-time farmers, a statistic that may reflect recent farm consolidation.

Table 3-3. Select agricultural statistics from windfarm case study counties

	Huron County	Missaukee County	Osceola County
Number of farms (change 2007-2012)	1,205 (-14%)	433 (+11%)	750 (-9%)
Land in farms, in acres (change 2007-2012)	452,370 (+3%)	99,510 (+13%)	110,562 (-9%)
Proportion of land area in farms	85%	28%	31%
Average farm size, in acres (change 2007-2012)	375 (+19%)	230 (+2%)	147 (-1%)
Market value of products sold (change 2007-2012)	$654M (+75%)	$126M (+78%)	$46M (+51%)
Value of land / buildings, $/acre (change from 2007-2012)	5,202 (+67%)	3,025 (+4%)	2,536 (-5%)
Full-time farmers (% of all farm owners)	669 (56%)	209 (48%)	269 (36%)
Average age of farm owner	56.2	53.6	56.9

3.2.3 The McBain area (High-growth case #4)

The fourth case study, High-growth (#4), is located just west of the town of McBain; it straddles Missaukee and Osceola Counties. In sharp contrast to Huron County, these counties have only one windfarm, and their agricultural sector is substantially less dominant. While Missaukee County is the state's top producer of cut Christmas trees and ranks fourth in milk production, Missaukee and Osceola Counties combined have 50% less farmland and 74% less farm revenue than Huron County (see Table 3-3).

Though they share a windfarm, Missaukee and Osceola Counties have very different agricultural sectors. From 2007 to 2012, Missaukee County saw an increase in both the number of farms and acres farmed, while Osceola County saw decreases in both. As a result, there is very little indication of farm consolidation over that time period, with average farm size growing by only 2% in Missaukee County and shrinking by 1% in Osceola County. Furthermore, while the value of farmland and buildings has been on the rise in Missaukee County, it has been decreasing in Osceola County.

3.3 Landowner Mail Survey

One of my three research methods is a mail survey aimed specifically at testing the supply-side mechanism, by which the additional revenues that windfarms bring to rural communities both directly and indirectly reduce farmers' financial need to sell land to residential developers. Research questions 1 and 1.1, as well as hypotheses H1 and H2, aim to compare the on-farm investments and long-term succession plans of different groups of landowners, which makes them variance questions. As Maxwell notes, "Variance questions are normally best answered by quantitative approaches, which are powerful ways of determining *whether* a particular result was related to one or another variable, and *to what extent* these are related" (Maxwell 2005, 75, emphasis in original).

I constructed the sample frame for the survey from tax rolls of agricultural landowners in each of my 14 case study townships—both those with wind turbines (the windfarm cases) and those without (the matched cases).[10] Because sampling from small populations can lead to greater error than sampling from larger populations (Isaac and Michael 1981), I opted to conduct a census and send the survey to all households in the sample frame. For most household surveys,

[10] The rationale and details about survey design are included in Appendix B.

the unit of analysis is an individual, and secondary sampling is necessary to select one member of the household to take the survey. My unit of analysis, however, is the farmland owner, an entity that is sometimes a single person but more often a group (e.g., spouses, siblings, parent and child, or business partners). As a result, while randomization of final unit selection is a concern for most mail surveys (Gaziano 2005), my survey cover letter explicitly instructed that "the survey should be answered by the person (or people) that makes decisions about your farmland." (See Appendix C for the full text of the survey cover letter.)

I drafted the questionnaire (see Appendix C) specifically for my particular area of study. It was informed by cognitive interviews with farmland owners in my hometown (Maybee, Michigan) and refined through pre-testing and feedback from my faculty advisors. Formatting and survey administration were conducted according to best practice (Dillman, Smyth, and Christian 2009), with multiple contacts,[11] personalized communications, a pre-paid incentive (Groves and Couper 1998), and strategic timing based on the schedules of my target population (Pennings, Irwin, and Good 2002). My final response rate of 71.9% (AAPOR RR2) is exceptionally high for mail surveys, which I largely attribute to my innovation of sending along a $2 bill,[12] though it was probably due to a combination of best survey practices.

As a way to validate the data entry, the closed-ended questions on each survey were keyed in by two different research assistants. Before analyzing the data, I also cleaned it, flagging and removing from analysis survey responses where an error might have occurred. Coding for the open-ended questions was facilitated with the NVivo software package.

[11] Each household on the sample frame was contacted up to four times over a six-week period. These contacts included 1) a pre-notification letter, 2) the questionnaire with a pre-paid incentive, 3) a postcard or letter reminder, and 4) a replacement questionnaire.

[12] Previous research has shown that including a small pre-paid cash incentive is more effective at boosting response rates than post-paid incentives because it evokes in potential respondents a sense of reciprocation (Groves and Couper 1998). My decision to use $2 bills as opposed to two $1 bills was a bit eccentric, but it did not go unnoticed—there were 11 unsolicited comments on the survey about the $2 bill. In the future, I would like to do a test to see if using a single $2 bill as opposed to two $1 bills has any impact on response rate.

Most of the closed-ended responses in the survey were analyzed using statistical methods: linear regression models for continuous/ordinal values and Chi-squared contingency tables for categorical variables. Though very few questions investigated a truly continuous dependent variable, some of the multiple-choice questions clearly indicated a continuum that could be treated as continuous.[13] Most often, my null hypothesis tested whether the mean of the dependent variable remained constant across three types of respondents: those with turbines on their property, landowners in windfarm communities who did not have turbines on their property, and landowners in the matched case (no windfarm) community. These independent variables appeared as factors within the linear model. In addition, I frequently included other independent variables to increase the fit of the linear model: number of acres the respondent owned, number of acres the respondent farmed, whether anyone within the respondent's household was a full-time farmer.

Where the dependent variable of interest was more categorical, I constructed a contingency table and tested the null hypothesis that each of the respondent groups (turbines, neighbors, and matched case) would respond to the question with the same distribution. When some of the cells in the contingency table had frequencies under five, I used Fisher's Exact Test rather than a Chi-squared (χ^2) statistic to determine statistical significance. Where Fisher's Exact Test indicated statistically significant differences in the observed data from the expected counts ($p<0.05$), I used a test of proportions of the observed and expected percentages in each cell to determine which cells were contributing to the difference.

[13] For questions about investment, for example, I treated the midpoint of the range as a continuous rather than categorical response. I also treated responses to a 5-point Likert scale as continuous for the purposes of analysis.

3.4 Interviews with Realtors, Local Officials, and Wind Developers

In addition to the largely quantitative landowner mail survey, my research also employs a more qualitative method: semi-structured interviews.[14] In interviews with realtors, assessors, and land auctioneers—those with the best knowledge of the market for farmland—my primary aim was to understand the effect that windfarms are having, or are expected to have, on the demand for farmland, especially as building sites for new residential construction. These interviews are the primary source of data to answer research question 2 and hypotheses H3 and H4 about the demand-side mechanism. As noted in Chapter 2, a number of recent studies have looked at the impact of windfarms on nearby home values, most commonly using hedonic price models. My research, in contrast, asks the "how" question: *how* does proximity to a windfarm impact new home buyers' location decisions? "[B]ecause…these types of questions involve situation-specific phenomena, they do not lend themselves to the kinds of comparison and control that variance theory requires. Instead, they generally involve an open-ended, inductive approach" (Maxwell 2005, 75). My use of semi-structured interviews, then, is a logical choice.

In addition to conducting interviews with real estate professionals, I also interviewed a variety of local officials in each of my wind case study communities: township supervisors, planning commission chairpersons, and county commissioners. The purpose of these interviews was to better understand the historic land use issues at play in the jurisdiction, how wind energy intersected with longer-term issues, and how planning decisions related to the wind project were made. I also conducted interviews with the developers of each of the wind projects. In these interviews, my primary goals were to understand whether farmland preservation factored into

[14] More details about the design and procedures used in these interviews are provided in Appendix E.

siting decisions or communications with potential leaseholders, and to better understand the rationale for their varying approaches to community engagement and pooling of royalties.

The unit of analysis for this portion of my research varies. For the realtor/auctioneer/appraiser interviews, the unit of analysis is the region. This is because the geographic reach of most of these real estate professionals is quite large—often multiple counties. As a result, the three case studies in Huron County (Cases 1, 2, and 3) are all served by the same realtors. While I have multiple observation points (i.e., individual realtors) within a particular county, I aggregate my data to compare interviews in the Huron County "Thumb" region with those in the McBain region. In contrast, the local officials spoke largely in terms of their jurisdiction: a township or the entire county. The township as a unit of analysis is sub-case-study level (i.e., there are multiple townships within a case study). Interviews with Huron County officials cross three case studies, while the interviews with Missaukee and Osceola County officials all pertain to the same High-growth (#4) case study. The discussions with wind developers provide data that corresponds to a specific case study.

In order to identify realtors to interview, I used online real estate listings to find realtors with active listings of vacant farmland parcels. I then used snowball sampling to identify additional realtor interviewees in each region until I had reached the point of saturation or redundancy (Kuzel 1999), when I began to hear the same responses over and over again and/or I had run out of suggestions for knowledgeable interviewees. In total, I interviewed six realtors/auctioneers: four in the Thumb region, and two near McBain.

Identifying the remainder of interviewees—local officials and wind developers—was a largely formulaic process. I used publicly available listings of local officials to contact the township supervisor, planning commission chairperson, chair of the county Board of

Commissioners, and the chair of the county Board of Commissioners finance (or tax) committee. In the end, only two people in this list refused to be interviewed, both of them township supervisors. This resulted in 14 interviews with local officials. I also contacted the project manager for each of the case study windfarms. Though they were initially reluctant, I succeeded in talking to developers in two of the four projects.[15] In place of the developer who refused, I spoke to an environmental consultant who works for a variety of developers and did much of the feasibility analysis and community outreach on Mixed-benefit (#2). Finally, I interviewed the Program Manager for the Michigan Department of Agriculture and Rural Development's Farmland Preservation Office.

I developed a semi-structured interview guide for each type of interviewee (e.g., realtor, local official, and wind developer), which I refined with comments from my faculty advisors and slight tweaks after my first couple of interviews. As the transcripts show, my interviews rarely followed the interview guide. Most often, we talked about the same questions but in a different order, and I sometimes introduced previously unasked questions.

To aid in the analysis of the interview data, I coded the transcripts from each of the interviews using NVivo. I began by developing a rubric based on the interview guides for each of the questions, and on some of the common themes that emerged as I conducted the interviews. As I conducted the coding, if I felt that a theme was not properly captured by the existing rubric, I would add another code (or set of codes) and return to the interviews that I had already transcribed to recode them as necessary.

Most of the analysis of the interviews focuses on the words of the interviewees themselves. In some situations, I compare the opinions of interviewees within the same case,

[15] The Developer-friendly (#1) and Mixed-benefit (#2) cases were done by the same developer, who refused to be interviewed, citing legal concerns.

while in others I contrast opinions across different cases. While I rarely look for an actual count of the number of times a given word came up within an interview or the amount of time spent talking about a specific topic, in some situations I do quantify the number of interviewees who discussed a particular topic, especially if it was in response to a question posed to all interviewees.

3.5 Geospatial Analysis of Zoning Regulations

The third method used in this research is geospatial analysis, which I employ to quantify the acreage rendered off-limits for residential development by the zoning applied to each windfarm case study. I also use geospatial tools to build scenarios to determine the impact of changes to the existing regulation. This analysis provides insights into research question 3 as well as hypothesis H5.

Geographic Information Systems (GIS) are commonly used in the turbine siting process to determine where turbines can legally be sited. These analyses consider not only land use regulation (zoning), but also proximity to sensitive species, microwave corridors, and land that is not under lease. After identifying all of these constraints, the wind developer can determine where to place the turbines and the infrastructure that connects them.

The geospatial analysis that I use in the project, however, is much closer to a build-out analysis in that it applies alternate regulatory regimes to the existing land use to understand how zoning regulations impact the availability of land for development. As its name implies, this approach assumes that all available land will be built out to the maximum extent possible. This tool is often used in communities worried about urbanization, either to determine whether existing infrastructure could handle the theoretically allowable population growth or to determine what impact regulation changes might have on managing growth (Godschalk 2006).

For this project, rather than determining changes in the number of people as a result of wind turbine siting regulation, I look at the number of acres impacted because the farmland itself is my primary concern.

In order to match this component of the research project to the other two, the unit of analysis for the GIS component of my research is the windfarm. Each windfarm in this study straddles at least two local jurisdictions (Mixed-benefit (#2) straddles three). Therefore, where regulation varies across a project, I applied those regulations at the jurisdiction level and then aggregated the analysis at the case study level for comparative purposes.

At a minimum, geospatial analysis requires knowledge of both existing land use—specifically, the location of turbines—and existing regulation. Both of these pieces of information were relatively easy to obtain. I obtained latitude/longitude data for all turbines through a database maintained by the Federal Aviation Administration, and I asked township supervisors for copies of their zoning ordinance during our interviews. To demarcate township boundaries, I used US Census shapefiles.

I used ArcGIS to conduct the geospatial analysis for this project, primarily relying on the "Buffer" and "Measure a Feature" tools. In the analysis to answer research question 3, I selected turbines by township and set the buffer distance around those turbines equal to the existing setback distance in the jurisdiction's zoning ordinance. I then used the measurement tool to determine the sum of the area of the resultant buffers, reporting this both in aggregate and on a per-turbine basis for each case study. In testing hypothesis H5, I selected all turbines in my study and applied, in turn, three different setback distance buffers. Similarly, I then used the measurement tool to determine the sum of the area of the resultant buffers, reporting this both in aggregate and on a per-turbine basis for each case study.

Chapter 4. The Supply Mechanism: Direct Payments

Recall that in Chapter 2 I hypothesized that the revenues that wind developers pay to landowners who host turbines on their property would decrease their financial need to sell their property (H1), effectively reducing the supply of developable land in communities with windfarms. The evidence to support this, I asserted, would be not only landowners' own assessments of what would happen to their land far into the future, but also their reinvestment of wind income to improve their farm.

In this chapter, I discuss evidence supporting this hypothesis. I first use interviews with local officials to establish that the increase in farm income through direct payments by wind developers to those who host turbines on their property is the primary connection they see between wind energy and farmland preservation. I then turn to the survey of landowners to find that landowners with turbines on their property are more likely to believe that their land will be farmed in the future and less likely to say it will be idle or used for recreational purposes than are their neighbors without turbines on their property and landowners in the matched case communities. Landowners with turbines also report investing significantly more in their farms and buying more land than their neighbors. I further discuss differences between the four windfarm cases and the impact of pooling royalty payments on investment, finding that pooling has no impact on neighbors' investment behavior but does significantly improve their opinion of wind energy, leading to less conflict between those with and without turbines on

their properties. Lastly, I connect survey respondents' reports of damage done to farmland during windfarm construction to a possible explanation for increased investment in field drainage.

4.1 Prevalence as a Stated Goal: Interviews with Local Officials

In my interviews with local officials and wind developers, the connection between wind energy and increasing farm incomes was the most common response to my question about whether wind turbines helped preserve farmland, with eight of 18 non-realtor interviewees (44%) mentioning such a connection. These included local officials from Huron County as well as the McBain area, two of the three wind developers that I interviewed, and the Program Manager for the Michigan Department of Agriculture and Rural Development's Farmland Preservation Office.

Contrary to my hypothesis (H1) that wind-related incomes would reduce the financial need to sell, only one interviewee explained that these revenues deterred the landowner from selling land for a non-agricultural purpose. Instead, interviewees more often portrayed revenues from wind turbines as a way to make farming more attractive to younger family members, thereby keeping the land in the family. Wind energy, I was told, "adds a little stability for the land owner" in an otherwise cyclical or unpredictable commodities market. One wind developer recounted that in one of his windfarms, "a few of them [i.e., farmers] have been able to solidify their succession planning to the next generation of farmers because and only because of the security of the revenue they're receiving from the wind energy, the royalties." This relationship also seemed to be significant in the state's determination that wind energy is compatible with its PA 116 farmland preservation program. The program manager recounted:

> We know that having additional income from the wind turbines would have a—the farmers can make money, will keep their land in agricultural use, and will encourage our [their] kids to get involved in agriculture if you can make money on it.

This, he added, seemed to counterbalance the few acres per turbine that were taken out of agricultural production for the turbine base and access road.

This refining of my hypothesis—to focus on family succession rather than conversion to non-agricultural conversion—clearly highlights how rural communities face very different land use related changes. Under my original hypothesis, I assumed that, since all of my selected case studies were in communities where the population was remaining steady or growing, suburbanization is the key threat to farming. I expected to find, accordingly, that additional income would make development less financially attractive. In contrast, most of the local officials that I interviewed believe that the loss of young people—a common problem in declining rural areas—is the key threat to agriculture in these case study communities, and that additional income makes farming more attractive to young people. If wind energy can address both threats—suburbanization and youth flight—it would be unique among farmland preservation tools (I discuss this in more detail in Chapter 8).

In the next two sections, I turn to the landowner survey data to learn the farmer's perspectives on what impact wind income may be having on their farm budgets and long-term plans. First, I find evidence to support local officials' perceptions that wind energy incomes may be encouraging more young people to stay and farm. In the second section, I find that wind energy income is being reinvested on the farm, which would also seem to help forestall farmland conversion in areas where suburbanization is the key threat.

4.2 Long-term Land Use Expectations

One way to determine if wind energy is changing landowners' plans is to ask them directly how they expect their farmland will be used when they sell it. If the wind income has no effect on these plans, you would expect landowners with turbines on their property to answer in roughly the same way as both their neighbors without turbines and landowners in a matched case community.

In order to facilitate quantitative analysis comparing different types of future plans, the mail questionnaire asked a multiple-choice question with six response categories (see Appendix C, question 3.3). I collapsed these into 3 categories to minimize the degrees of freedom of my model (and thus increase the likelihood of detecting statistical differences): "Farmed by a family member" and "farmed by a non-family member" were collapsed into a "farmed" category; "converted to a housing development / subdivision" and "Converted to an industrial, commercial, or retail use" were collapsed into a "developed" category. Some respondents selected the "other" category, saying that their land would be used for recreation or hunting. Those responses were combined with the "idle—neither farmed nor developed" responses to form an "idle/recreation" category.

For all valid survey responses for this question (n=1104), Fisher's Exact Test indicated significance ($p<0.001$), and the test of proportions found that two cells statistically differed from the expected values (see Table 4-1). Specifically, respondents with turbines on their property were significantly more likely to say that their land would be farmed and less likely to say it would be idle or recreational in the future.

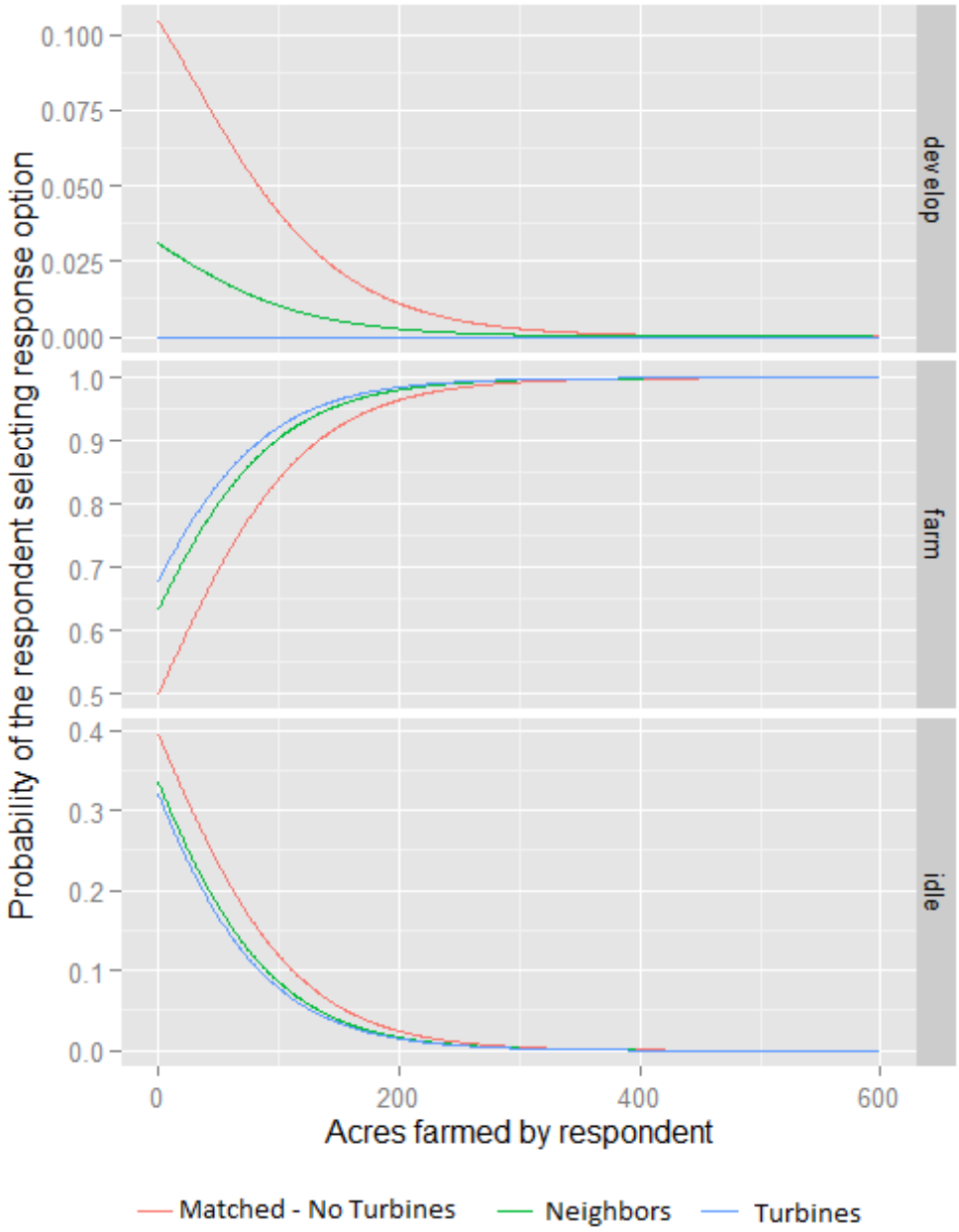
Table 4-1. Percentage of survey respondents answering the question "How do you think most your land in [x] county will be used when you sell it?"

	Developed	Farmed	Idle or Recreation
Matched case	4% (16)	84% (376)	12% (55)
Neighbors	1% (5)	90% (476)	9% (48)
Turbines	0% (0)	98% (125)**	2% (3)*
Expected / Total	2% (21)	89% (977)	10% (106)
Numbers of respondents in each category given in parentheses ().			
p-values significant: *** <0.001 ; ** 0.001 - 0.01; * 0.01 - 0.05			

Because future expectations might well be linked to the size of one's landholdings or to the size of the farming operation, I also employed multinomial logistic regression to see if these factors better predicted future land use expectations. The number of acres owned by the landowner was significant in the model. As Figure 4-1 shows, farmers who own more land are more likely to think that their land will continue to be farmed, with 95% of landowners with 150 or more acres believing that their land will be farmed. The model also shows, however, that even after I account for acres owned, landowners with turbines on their property are still significantly more likely to say that their land will be farmed, and less likely to say that it will be developed or left idle.

Figure 4-1. Multinomial logistic regression of future land use expectations

The three graphs show the probability of the respondent selecting each of three possible response options. As the number of acres farmed (x axis) increases, all respondents are more likely to say their land will be farmed in the future. However, at small acreages, respondents in the matched (no turbine) communities are more likely to say their land will be developed or remain idle and less likely to say it will be farmed, as compared to the respondents in the windfarm communities.



Analysis at the case study-level shows that this finding holds true in the windfarms both in Huron County and in the McBain area. Running the same contingency table analysis on the respondents in Huron County (Windfarms 1, 2, and 3, and their matched case communities; n=905) produced similar results to the sample as a whole (see Table 4-2, Fisher's Exact Test p = <0.001). The test of proportions showed significant differences in the same two cells as the analysis as a whole, though the test of proportions p-values were less significant, likely because of the reduced sample size. A look at the observed and expected frequencies for the High-growth (#4) windfarm (see Table 4-3) shows that 85.4% of landowners overall believe that their land will be farmed, as compared to 89.2% of landowners in Huron County. All respondents in High-growth (#4) with turbines on their property indicated that their land would be farmed in the future—the highest percentage of any subgroup in the study. However, because there were only 12 such respondents, the contingency table analysis was not statistically significant, with a Fisher's Exact Test p-value of .2305. Even so, because over half (12 of 21 = 57%) of the landowners in High-growth (#4) with turbines on their property responded to the survey, it is not unreasonable to look at the raw numbers rather than relying on statistics (see the rationale for this argument in Appendix B).

Table 4-2. Percentage of survey respondents answering the question "How do you think most your land in [x] county will be used when you sell it?" in ONLY Windfarms 1, 2, and 3, and the corresponding matched case communities

	Developed	Farmed	Idle or Recreation
Matched case	3% (11)	85% (299)	11% (40)
Neighbors	1% (3)	90% (395)	9% (41)
Turbines	0% (0)	97% (113)*	3% (3) *
Expected / Total	2% (14)	89% (807)	9% (84)
Numbers of respondents in each category given in parentheses ().			
p-values significant: *** <0.001 ; ** 0.001 - 0.01; * 0.01 - 0.05			

Table 4-3. Percentage of survey respondents answering the question "How do you think most your land in [x] county will be used when you sell it?" in ONLY High-growth (#4) and the corresponding matched case community

	Developed	Farmed	Idle or Recreation
Matched case	5% (5)	79% (77)	16% (15)
Neighbors	2% (2)	90% (81)	8% (7)
Turbines	0% (0)	100% (12)	0% (0)
Expected / Total	4% (7)	85% (170)	11% (22)

Numbers of respondents in each category given in parentheses ().

p-values significant: *** <0.001 ; ** 0.001 - 0.01; * 0.01 - 0.05

4.2.1 Change in Plans Attributed to Wind Energy

As a follow-up to the survey question about future land use expectations, I asked residents whether their expectations had recently changed and, if so, why. I constructed the question specifically to ask about changes in expectations in the last five years to capture a time before the first of my case study windfarms were constructed. Note, however, that this question did not specifically mention wind energy.

Very few respondents (n=55, 4.2% of the total respondents) noted a recent change in their expectations, and only 44 respondents explained why their expectation had changed. The coding of these responses shows that most (84%) attribute the change in expectation to something unrelated to wind energy (see Table 4-4). Most commonly, respondents cited a change in their own health (e.g., "I probably would have farmed it myself but now I have a terminal illness and am unable to farm anymore") or changes in succession plans (e.g., "At that time my daughter and her husband were not interested in farming"). Other respondents cited increasing farmland prices that make it difficult to obtain enough land to farm, and changes in farming that favor larger tracts than they currently own.

Table 4-4. Coding of open-ended question about changes in expectation of future land use: "If you had been asked Q3.3 [how your land will be used when you sell it] five years ago, do you think you would have answered the same way? If no, why not?"

Explanation for change	Number of responses
Change in health or family plans	28
Wind turbine-related	7
Change in farmland prices	6
Change in farming	3
Total open-ended responses	**44**

Of those responses that mentioned wind energy, all seven implied that they were unhappy with the change (see Table 4-5). Four of the seven made some mention of wind turbines not being pleasant to live near. Notably, three of these comments were from respondents who owned less than 60 acres of farmland, and they indicated that they now thought their land would be idle in the future (presumably rather than being developed for housing). The fourth respondent who noted that the turbines were unpleasant owned between 60 and 259 acres and anticipated that the land would remain farmed, but not by a family member.

The responses from the landowners who owned the most land are more difficult to decipher. One of the respondents was clearly upset with the wind developer and its contractors, but it is not clear how this would change his expectation of future land use. The other noted that "the windmills are negative to our farming communities" but suggested that he expected his land to be farmed by a family member in the future, so, again, it is unclear what his previous expectation was.

Most curious is the response from a landowner in Developer-friendly (#1), who wrote "The land could have remained farmland before windmills," and indicated that the land would likely be converted to some sort of non-farming use (he checked both "converted to a housing development/subdivision" and "converted to an industrial, commercial, or retail use").

According to the respondent's other answers on the survey, he does not have a turbine on his property and owns 20-59 acres, a plot that is on the small side for the area but likely large enough to farm. There are no other clues as to what he expects might be built on his land now that might have not been built before, or why farming is not a feasible future option.

While local officials may be concerned that these landowners are displeased by the windfarms and their impact on the future use of their farmland, from a farmland preservation perspective, it is good news that most of these respondents believe that the wind turbines make their land less likely to be developed. Three of the seven believe that their land will remain idle, but they also own some of the smallest tracts, which may be too small to farm. Three more of the seven, notably those with the largest landholdings, believe that their land will remain farmed. Overall, this would seem to indicate that, at least for a small group of landowners, the wind turbines are indeed helping to stop farmland conversion, even if that outcome is against their wishes.

Table 4-5. Open-ended responses that wind energy had changed expectations for future land use, arranged by increasing number of acres owned by respondent.

Explanation of change in expectation [open-ended]	Current expectation [multiple choice]	Acres currently owned
"Turbines are not desirable to live or farm near. They belong in areas far away from housing. Land value plummets near wind farm."	Idle – neither farmed nor developed	0 - 19
"I would have passed the land onto my kid, but I will not encourage them to live here because of the negative health effects of the nearly turbines."	Idle – neither farmed nor developed	0 - 19
"Didn't know they were going to shove 10,000 turbines down our throats. They have destroyed the landscape. Who the hell wants to move next to a windmill."	Idle – neither farmed nor developed	20 - 59
"The land could have remained farmland before windmills."	Converted to some sort of non-farming use	20 - 59
"One of our children had mentioned [moving] here from Town when their children were grown, but forget that now with this noisy windmill running day and night 24/7 365"	Farmed by a non-family member	60 - 249
"The windmills are negative to our farming communities."	Farmed by a family member	250 - 499
"Had not been lied to and screwed yet. Had not yet met subcontractor with their attitude."	Farmed by family member or non-family member	500+

4.2.2 Wind Turbine Impact on Succession Plans

Recall that many of my interviewees—both wind developers and local officials alike—directly linked wind energy income and succession planning, arguing that the additional revenue was making farming more attractive to young people. None of my landowner survey respondents explicitly made such a connection, though respondents did separately mention the presence of wind turbines or a change in their child's career choice as having recently altered their future land-use expectations.

When asked whether they "have a succession plan in place for their land," overall 62% of respondents indicated in the affirmative, but there is a large difference based on whether or not

the landowners have a turbine on their property (see Table 4-6). Among those with turbines on their property, 80% have a succession plan in place, compared to only 62% of their neighbors and 57% of landowners in the matched case community. Using binomial logit regression, I find that the likelihood of having a succession plan increases with each additional acre farmed (see Table 4-7). However, even after I account for the size of the farming operation, landowners with turbines on their property are significantly more likely to have a succession plan in place than their counterparts in the matched case community. Neighboring landowners in windfarm communities are also more likely than matched case landowners to have a succession plan, but this is not nearly as statistically significant.

Table 4-6. Prevalence of succession plans among survey respondents

				Wind Respondents	
	All Respondents		Matched Case Respondents	Neighbors	Turbines
Yes	62%		57%	62%	80%
No	38%		43%	38%	20%
Number of respondents	1164		471	559	134

Table 4-7. Binomial logit model of having a succession plan in place

For all respondents, as the numbers of acres they farm increases, so does their likelihood of having a succession plan in place. But the presence of the wind farm is also predictive. Those with turbines on their property are 2.5 times as likely to have a succession plan in place as respondents in the matched case (no-turbine) communities who farm just as many acres. Succession plans are also 1.34 times more prevalent among the neighbors in the windfarm than in the matched case community.

	Probability of having a succession plan	Significance
As acres farmed increases	1.00	***
If "Neighbor" rather than "Matched Case"	1.34	*
If "Turbine" rather than "Matched Case"	2.49	***
p-values significant: *** <0.001 ; ** 0.001 - 0.01; * 0.01 - 0.05		

My research did not ask landowners when they created a succession plan, so I cannot definitively confirm that windfarm revenues are helping landowners to solidify succession plans,

as my interviewees implied. An alternate explanation for the difference in succession planning is that those landowners who had pre-existing succession plans may have been more inclined to diversify farm income and therefore would have proactively sought out wind leases. This theory, however, conflicts with the fact that in all of my chosen case studies, it was the wind developer and not the farmland owners who initiated the windfarm leasing process. Furthermore, while this alternate explanation may explain differences in succession planning between landowners with turbines and their neighbors, it does not adequately explain differences between the turbine group and their matched case counterparts who have not (yet) been approached by a wind developer but include a number of landowners who—my survey reveals—would welcome wind development.

4.3 On-farm Investment

The analysis up to this point has looked at whether landowners who receive direct payments from wind developers say that their land will remain actively farmed for longer than the land of those who do not receive these direct payments. However, previous survey methods research has found that people are not always able to predict their own future actions, especially actions that would take place far into the future. Therefore, my survey was designed to test this same hypothesis using an alternate approach: asking them about recent investments in their farm. The rationale is that farmers who invest more in their farms expect to be farming longer than those who do not invest in their farms; it is unlikely that someone would build a brand-new barn or lay drainage tile only to sell the land to a developer shortly thereafter. As a result, farm investment should be a proxy for longer-term land use expectations.

In the following subsections, I look at the survey responses on questions related to farm-related improvements and buying additional farmland (another type of investment). I also look

at what impact direct payments from wind developers are having on farm budgets, in the words of the landowners themselves. Throughout, I compare the data from each of the four windfarm cases to look at the impact of royalty pooling—sharing the royalties more broadly with neighbors who do not have turbines on their property—on investments of neighbors within each case study. Finding little evidence of additional investment by these neighbors, I also discuss whether pooling royalties might have other benefits for rural communities.

4.3.1 On-farm Investment

In order to capture the investments that owners of farmland have been making to their property, the survey sent to landowners asked four parallel questions: "Since 2008, about how much money have you spent on improvements to your [… home? …outbuildings? …drainage and irrigation? …new or used farm equipment including trucks, tractors or other farm machinery?]" The purpose of breaking this overall question into pieces was twofold. First, it made it easier for respondents to accurately answer the question, ensuring that they included each of the investments of interest but did not have to add these numbers in their heads. Second, breaking the question into parts enabled me to see if wind development differentially impacts certain types of investments.

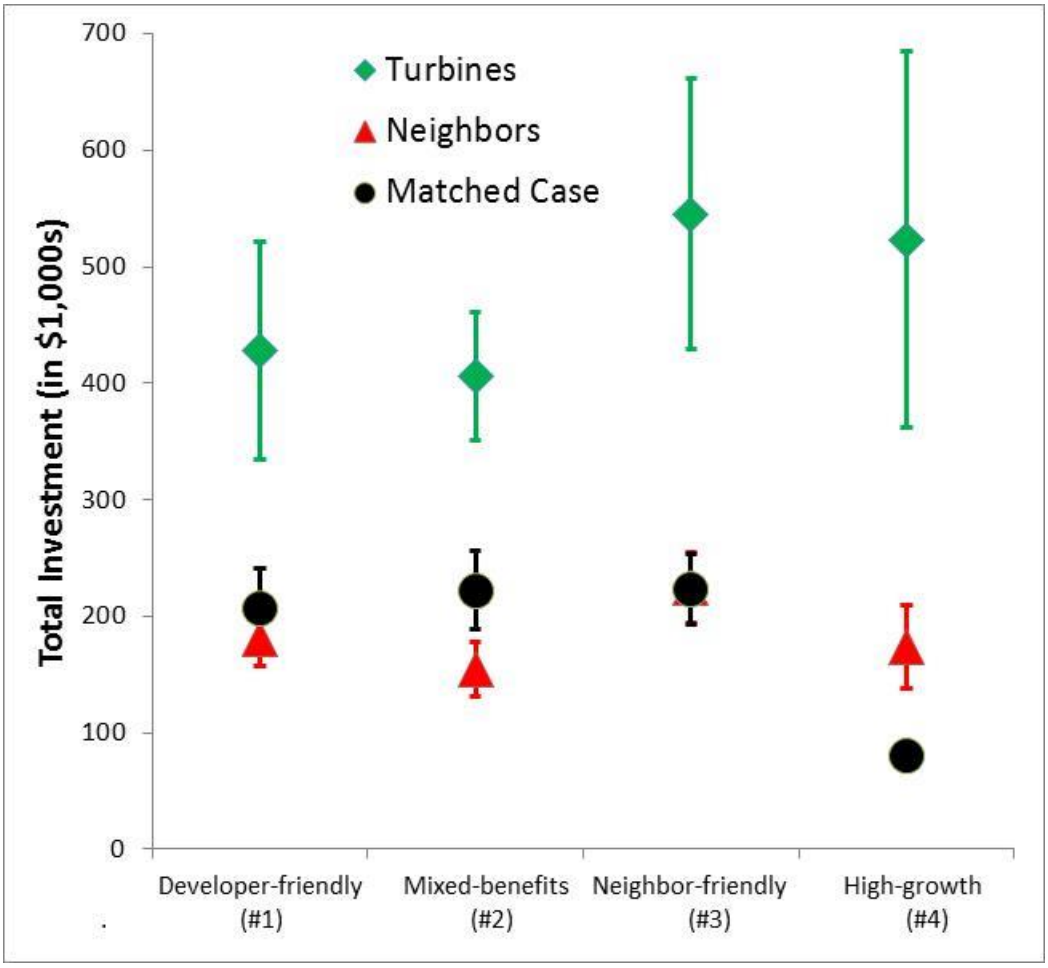
When looking at the data from all respondents, I find that the average investment per landowner is consistently higher in communities with wind turbines than in the matched case communities. This is true for all types of investments, though most pronounced for investments in farm equipment. Landowners in communities with windfarms spend on average $29,813 more on farm equipment than their counterparts in communities without windfarms (see Table 4-8). When all investment types are combined, the difference in spending between landowners in matched case and windfarm communities is $47,456 over this five-year period.

Table 4-8. Mean landowner investment in home and farm

				Wind Respondents	
Type of Investment	All Respondents	Matched Case Communities	Wind Communities	Neighbors	Turbines
Home	$ 26,897	$ 24,035	$ 28,829	$ 25,681	$ 41,970
Outbuildings	$ 36,521	$ 29,639	$ 41,118	$ 33,786	$ 71,780
Drainage / Irrigation	$ 25,321	$ 22,105	$ 27,474	$ 20,236	$ 57,863
Equipment	$ 125,027	$ 107,208	$ 137,021	$ 102,901	$ 279,539
Total Investment	$ 215,433	$ 186,899	$ 234,355	$ 183,593	$ 449,087
Number of respondents*	1096	437	659	533	126
* The number displayed is the number of respondents who answered all four investment-related questions.					

There are even larger differences, though, when we differentiate between respondents in windfarm communities with turbines on their property ("turbines") and those without ("neighbors"). This differentiation makes it clear that the landowners with turbines on their property are largely driving the difference. In most of the investment categories, landowners with turbines invest nearly twice as much as their neighbors. Furthermore, landowners with turbines reported spending over $250,000 more than both their neighbors and the landowners in the matched case communities on improvements to their properties over the five-year period. In contrast, in all but High-growth (#4), landowners in wind communities who do not have turbines on their property invested less than landowners in the matched case community, though not statistically significantly so (see Figure 4-2).

Figure 4-2. Average total investment by owners of farmland, by respondent group and case study (in $1,000s)



Note that some of these "neighbors" in the windfarm communities are part of royalty pools; they originally leased some of their land to the wind developer, and though a turbine was not placed on their property, they receive some of the profits from the energy that is produced each year. If we compare the investments of this group to the investments of neighbors outside of the pool (i.e., neighbors who receive no wind-related income) and the investments of neighbors with turbines on their property, it becomes clear that landowners in the pool are much more similar to their uncompensated neighbors than to those with turbines on their property (see Table 4-9). Because there is no statistically significant difference in the investments of neighbors who receive wind royalties and those who do not, they are treated as one—simply as

"neighbors"—for the rest of this analysis. (I will return to the impact of pooling royalties later in this chapter.)

Table 4-9. Mean landowner investment of landowners in communities with windfarms, comparing neighbors in and out of the royalty pool and those with turbines on their property

	Windfarm Respondents		
Type of Investment	Neighbors outside of pool	Neighbors in pool	Turbines
Home	$ 25,782	$ 25,349	$ 41,970
Outbuildings	$ 32,842	$ 36,914	$ 71,780
Drainage / Irrigation	$ 19,552	$ 22,540	$ 57,863
Equipment	$ 103,210	$ 101,855	$ 279,539
Total Investment	**$ 180,878**	**$ 192,642**	**$ 449,087**
Number of respondents	410	123	126

Recall that landowners with turbines on their property tend to own and farm more land than their neighbors. Since many of the improvements that the survey investigated were directly related to farming (i.e., drainage and irrigation, farm equipment), the size of the respondents' farming operation is also likely to play a role. Using a linear ANCOVA model to factor acres farmed and acres owned into the model shows that acres farmed is a significant predictor for all investments except home improvements (see Table 4-10). The ANCOVA model also indicates that the presence of a turbine alone is rarely a significant predictor of additional investment (except in the case of drainage and irrigation; see Section 4.4 for a possible explanation). However, there is a significant interaction between acres farmed and having a turbine: for every additional acre farmed, landowners with a turbine invests more in their property than do their neighbors and landowners in communities without wind energy (see Figure 4-3). This means that while the differences in investment are small for landowners who do not farm or farm very

small acreages, as the size of the farming operation grows, so does the difference between those with turbines and those without.

Table 4-10. ANCOVA model coefficients for investment

The numbers in this table represent the slope of the regression lines modeling the connection between acres farmed, type of respondent, and a range of on-farm investment categories. These values can be interpreted as "additional dollars per acre farmed."[16]

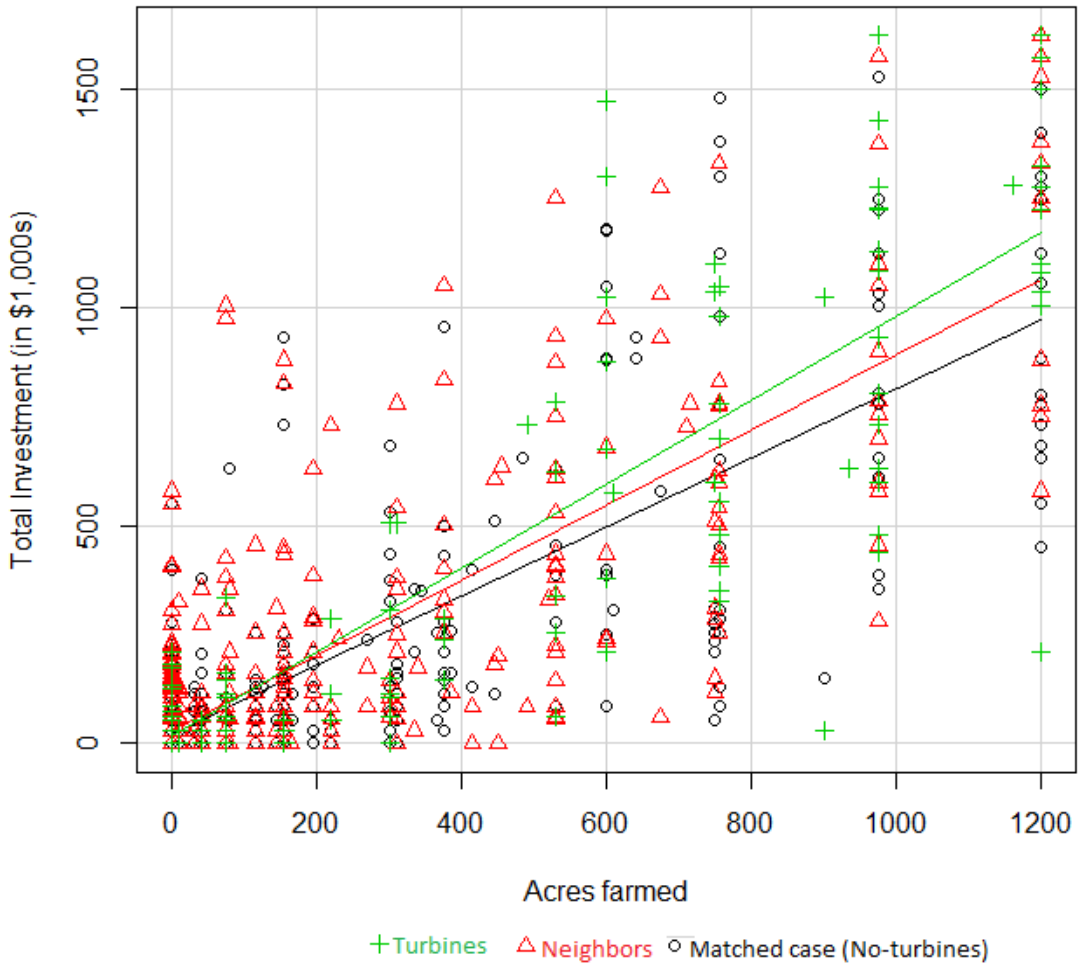
	Home Improvements	Outbuildings	Drainage/ Irrigation	Farm Equipment	Total Investments
Increasing acres farmed (for "Matched Case")	7	121***	113*	523***	791***
"Neighbor" rather than "Matched Case"	-1835	1452	1709	1924	7886
"Turbine" rather than "Matched Case"	2927	-137	10351*	-16093	-4566
Increasing acres farmed & "Neighbor" rather than "Matched Case"	20*	35**	n/a	44	70
Increasing acres farmed & "Turbine" rather than "Matched Case"	31*	30*	n/a	134***	172**
p-values significant: *** <0.001 ; ** 0.001 - 0.01; * 0.01 - 0.05					

[16] The first row demonstrates that for every additional acre farmed, a respondent in the matched case community invests an additional $791 in the farm as a whole, including $121 in the outbuildings, $113 in drainage or irrigation, and $523 in farm equipment (home improvement is not significant). [Note that each column was an independent ANCOVA model using all data available. Because of item-missing data, each is based on a different number of observations. Total investment was calculated only for respondents who answered all four of the investment-related questions, which explains why the number in the total investment column is not equal to the sum of the preceding numbers (i.e., 7+121+113+523≠791).]

The fifth row shows that for respondents with turbines on their property, for every additional acre of land farmed, the respondent invests an additional $172 across all categories, for a total of $963 more [$791+$172] per acre.

As a result, though the investment figures are similar across respondent types for respondents who do not farm or who farm small acreage, the differences grow with the size of the farming operation.

Figure 4-3. ANCOVA model for total investment, all respondents



Looking at each pair of matched case studies, we see that the trends are similar. In all case studies, the number of acres a landowner farms is the strongest predictor of total investment (see Table 4-11), and having a turbine alone does not have a significant impact on investment. However, in Neighbor-friendly (#3) and High-growth (#4), there is a positive interaction between the number of acres farmed and being in a community with a windfarm. In these cases, landowners both with and without turbines invest more than their counterparts in areas without wind energy for each additional acre farmed (see Figure 4-4).

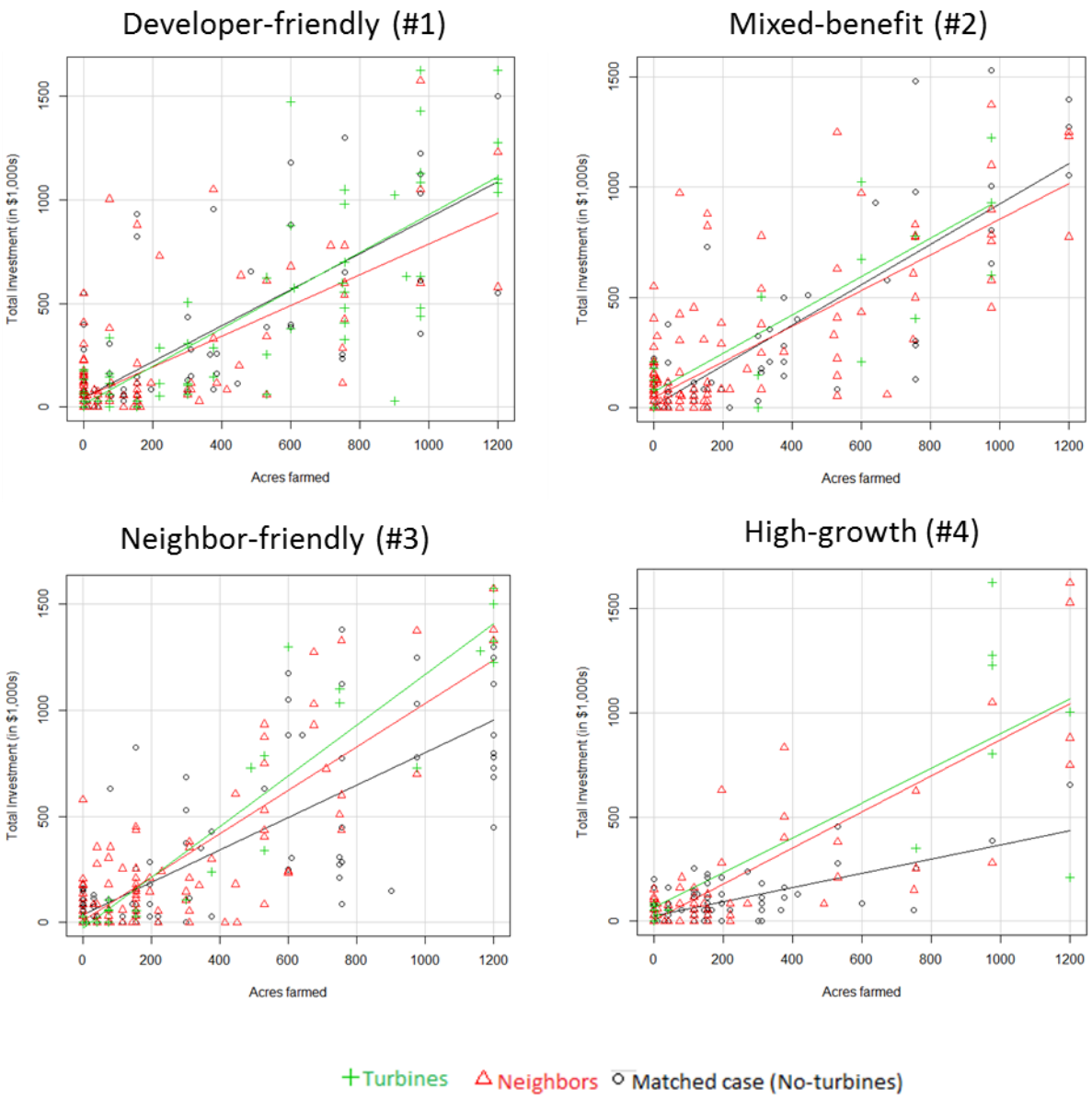
Table 4-11. ANCOVA model coefficients for total investment, by case study

The numbers in this table represent the slope of the regression lines modeling the connection between acres farmed, type of respondent, and total investment. These values can be interpreted as "additional dollars per acre farmed." See footnote on page 72 for assistance in interpreting this table.

		Developer-friendly (#1)	Mixed-benefit (#2)	Neighbor-friendly (#3)	High-growth (#4)
Increasing acres farmed (for "Matched Case")		917***	866***	763***	341***
"Neighbor" rather than "Matched Case"		36829	-3420	-26124	-23049
"Turbine" rather than "Matched Case"		63299	-34275	-60677	38679
Increasing acres farmed & "Neighbor" rather than "Matched Case"		-106	-123	261***	525***
Increasing acres farmed & "Turbine" rather than "Matched Case"		-43	50	432***	495***
p-values significant: *** <0.001 ; ** 0.001 - 0.01; * 0.01 - 0.05					

It is not immediately clear why this does not also hold true for Developer-friendly (#1) and Mixed-benefits (#2). Recall that pooling wind royalties is not as widely practiced in Developer-friendly (#1) and Mixed-benefits (#2), so the wind income is concentrated in the hands of fewer landowners. This, you might expect, would actually lead to more differentiation between those with turbines and their neighbors or those in the matched case community, but the data actually show the opposite. Another explanation is that this could be the result of a poor choice in matched case. Recall from Chapter 3 that Neighbor-friendly (#3) and High-growth (#4) appear to be a poorer match, with more full-time farmer landowners and higher percentages of household income coming from farming in the windfarm communities than in their respective matched case communities. While adding these factors to the model does not statistically improve the fit in any of the case study pairs, it is possible that these underlying differences may be indirectly impacting on-farm investments.

Figure 4-4. ANCOVA model for total investment, my case study



4.3.2 Buying Land

One common investment in rural communities that is missing from the preceding analysis is the purchase of land itself. In my survey, rather than asking about the dollar value of land purchases as with other investments, I asked instead about the number of acres purchased, since over the last five years—my time period of interest—land values have nearly doubled in some of

my study areas. Having data reported in acres helps to account for this change in value. I was also interested in gauging the size of parcels transacted, as larger tracts tend to be more suitable for farming. Overall, nearly 21% of landowners reported purchasing additional farmland in the last five years. Landowners in windfarm communities were slightly less likely to buy land than those in the matched case communities, though they did report more purchases of the largest parcels (see Table 4-12). Within communities with windfarms, there are vast differences between landowners with turbines on their property and those without. Landowners with turbines were much more likely to buy land (34.3% bought compared to only 15.5% of their neighbors), and they were significantly more likely to buy large tracts of 80 acres or more.

Table 4-12. Percentage of respondents who bought (or did not buy) land

					Windfarm respondents	
	All respondents		Matched case	Windfarm respondents	Neighbors	Turbines
Did not buy	79.1		76.9	80.6	84.5***	65.7***
Bought <40	4.3		5.0	3.8	3.7	3.6
Bought 40 - 79	4.4		6.2	3.1	2.3***	5.8
Bought >80	12.2		11.9	12.4	9.5*	24.8***
p-values significant: *** <0.001 ; ** 0.001 - 0.01; * 0.01 - 0.05						

Like other on-farm investments, farmland purchases are closely linked to the number of acres that the landowner farms. Using a binomial logistic regression model, after accounting for the number of acres farmed, I find that landowners with turbines on their property may be less likely to buy additional farmland than those in the matched case community, though this relationship is not statistically significant (see Table 4-13).

Table 4-13. Binomial Logit Model coefficients, representing the probabilities of a landowner buying additional farmland, using all survey respondents

Probabilities greater than 1 indicate increased likelihood of buying additional farmland, while probabilities below 1 indicate decreased likelihood of buying additional farmland.

	Probability of buying additional farmland	Significance
As acres farmed increases	1.005	***
"Neighbor" rather than "Matched Case"	1.023	
"Turbine" rather than "Matched Case"	0.845	
Increasing acres farmed & "Neighbor" rather than "Matched Case"	0.998	*
Increasing acres farmed & "Turbine" rather than "Matched Case"	0.999	
p-values significant: *** <0.001 ; ** 0.001 - 0.01; * 0.01 - 0.05		

Because of the very small numbers of landowners who reported buying land, statistical analysis at the case study level is relatively limited. Even so, summary statistics within each case study pair show much the same pattern as the overall data (see Table 4-14). Overall, respondents in areas with windfarms are less likely to buy, though landowners with turbines tend to buy at a higher rate than their neighbors. In High-growth (#4), however, this is not the case, with residents in the matched case communities buying less land than respondents in the townships with the windfarm. Again, this is likely a result of the matched community not being a particularly good choice for this case study. After I use binomial logit regression to include acres farmed into the model for each of the case studies, the impact of having a turbine on one's property completely disappears (see Table 4-15).

Table 4-14. Percentage of respondents who reported buying additional farmland, by case study

				Windfarm respondents	
	All respondents	Matched case respondents	Windfarm respondents	Neighbors	Turbines
Developer-friendly (#1)	19	25	16	16	23
Mixed-benefit (#2)	22	25	21	13**	36**
Neighbor-friendly (#3)	23	28	19	16	33
High-growth (#4)	17	12	22	19	46**
p-values significant: *** <0.001 ; ** 0.001 - 0.01; * 0.01 - 0.05					

Table 4-15. Binomial logit model coefficients, representing the probabilities of a landowner buying additional farmland, by case study

Probabilities greater than 1 indicate increased likelihood of buying additional farmland, while probabilities below 1 indicate decreased likelihood of buying additional farmland.

	Developer-friendly (#1)	Mixed-benefit (#2)	Neighbor-friendly (#3)	High-growth (#4)
As acres farmed increases	1.004***	1.005***	1.007***	.003**
"Neighbor" rather than "Matched Case"	0.673	0.791	1.115	1.108
"Turbine" rather than "Matched Case"	0.269	1.055	0.597	0.987
Increasing acres farmed & "Neighbor" rather than "Matched Case"	0.999	0.999	0.997*	1.001
Increasing acres farmed & "Turbine" rather than "Matched Case"	1.000	0.999	0.997	1.163
p-values significant: *** <0.001 ; ** 0.001 - 0.01; * 0.01 - 0.05				

4.3.3 Impact on Farm Business: Open-ended Responses

The analysis so far in this section has used self-reported investment data to test the hypothesis that revenues received from hosting a wind turbine on one's property increase on-farm investments, which in turn extend the planning horizon for a farm and reduce farmland conversion. But another way to test this hypothesis is to ask directly what impact wind income has on the finances of a farm family. The survey sent to landowners did just that. First, a screening question asked whether the respondent "received any royalties from a wind energy project in 2013." Respondents who answered in the affirmative were further asked how much

money they received (in a multiple-choice format) and were then asked the open-ended question "How does this royalty income affect your farm business?"

A total of 198 respondents answered this open-ended question. Less than half (41%) indicated that this wind income had a positive impact on their farming business, and the majority said that the income had little (20%) or no (35%) impact. Four of the respondents—both of whom are leaseholders in windfarms that neighbor Mixed-benefit (#2) and Neighbor-friendly (#3) but are still under construction—said that it was too soon to tell what impact the royalty income would have. Four more landowners said that the royalty income has had a negative impact on their farm.

The perceived impact seems at least partially correlated to the size of the royalty check. Those who report a positive impact, for example, had the highest overall average annual royalty at $2,751, while those who said the royalty had no impact received on average nearly $1,000 less per year (see Table 4-16). Interestingly, three of the four respondents who noted that the royalty had a negative impact on their farm business reported an annual royalty exceeding $3,000—the highest category on the survey.

Table 4-16. Categorization of open-ended comments to the question "How does this royalty income affect your farm business ?"

	Overall	Turbines	Paid neighbors	Average royalty*
Positive impact	41%	56%	31%	$ 2,751
Little impact	20%	13%	25%	$ 1,931
No Impact	35%	26%	41%	$ 1,754
Negative impact	2%	3%	2%	$ 2,750
Too soon to tell	2%	3%	2%	$ 283
Number of responses	198	78	120	

* Note that this is definitely an underestimate since 49% of respondents who answered this question fell into the last category ($3,000 or more). In calculating the mean, I assumed (conservatively) $3,500 for these respondents, though I have heard that some landowners receive in excess of $10,000 per turbine per year. Landowners with multiple turbines on their property would receive even more.

Most of the positive comments about wind energy royalties note that it simply adds another source of income. "Helps add to revenue generated," wrote one landowner. Another noted, "This is added income for our family farm. It is like receiving rent for your property but still being able to use it." Five respondents noted that one advantage of wind royalty payments is that they help diversify farm income: "Helps out a little bit when crops are poor or prices are weak," and "Gives us an income that is more reliable than the commodity market." Some respondents (n=12) wrote that they used the royalty income to pay property taxes; others (n=6) noted that it would help to fund their retirement. Only three of the respondents made direct links between wind income and on-farm investment. Just one directly linked wind royalty income to a change in future plans, noting that it "Makes it easy to pass farm to next generation."

Many of the remaining responses—those that I classified as "little" or "no impact"—were very terse, which made it difficult to understand what they meant. However, a couple of the longer responses might shed light on why over half (55%) of respondents say there is little or no impact when they are receiving, on average, over $1,700 per year. For many of these

landowners, especially those for whom farming is a full-time occupation, $1,700 is just a drop in the bucket. One landowner wrote, "Very little effect as it is a small percentage of income compared to the gross farm income." Even so, some acknowledged that even a small increase is helpful: "Very little but what we receive does help a lot with property taxes."

Overall, there were few differences between the four windfarm case studies, either quantitatively or qualitatively. If we treat the classification of responses like a contingency table, only two of the cells differ statistically from the expected / average values (see Table 4-17). Specifically, more landowners in High-growth (#4) believe that their wind royalties positively affect their farm business, while a higher percentage of landowners in Neighbor-friendly (#3) believe that the royalties have little impact. This is noteworthy since the windfarms in both of these case studies utilize a pooling arrangement. If pooling alone is impacting the size of the royalty and its subsequent impact on farm budgets, landowners would respond similarly in both cases—but clearly that is not the case.

Table 4-17. Categorization of open-ended comments about royalty income, by case study

	Overall		Developer-friendly (#1)	Mixed-benefit (#2)	Neighbor-friendly (#3)	High-growth (#4)
Positive impact	41%		52%	35%	32%	65%*
Little impact	20%		6%	20%	36%**	12%
No Impact	35%		42%	39%	30%	19%
Negative impact	2%		0%	3%	0%	4%
Too soon to tell	2%		0%	3%	2%	0%
Number of responses	198		31	97	44	26
Average annual royalty payment	$ 2,210		$ 3,184	$ 1,925	$ 1,907	$ 2,731
Test of proportions p-values significance: *** <0.001 ; ** 0.001 - 0.01; * 0.01 - 0.05						

Comments made by two different respondents from Neighbor-friendly (#3) might begin to explain why the responses in Neighbor-friendly (#3) and High-growth (#4) are so dissimilar. The first respondent, a landowner with a turbine on his property in Neighbor-friendly (#3), specifically blamed the pooling arrangement used there for reducing his royalties. He wrote, "Revenue is spread around to all landowners in windfarm even if they have no turbines." This may suggest why opinions are lower than average in Neighbor-friendly (#3). But the second respondent, a landowner who is part of the pool in Neighbor-friendly (#3), notes that the developer of High-growth (#4) offers landowners higher royalties than the other wind developers in my study. The landowner wrote, "[the developer of Neighbor-friendly (#3)] weaseled out on the price [the developer of High-growth (#4)] agreed to. Royalty is very low." Both of these wind developers acknowledged this difference in royalty payment in my interviews with them, but because a wind lease is usually an exclusive arrangement, few landowners know the terms of other contracts.[17] According to the royalty payments reported by landowners in the survey, the lease payments in High-growth (#4) are significantly (43%) higher than in Neighbor-friendly (#3) (see Table 4-17).[18] It is therefore perhaps less surprising that respondents in High-growth (#4) would be pleased with their royalty income, even if pooling does slightly dilute it.

The hypothesis that large, less-diluted royalty payments lead to more positive impact on farm budgets is also supported by qualitative evidence from landowners in Developer-friendly

[17] Neighbor-friendly (#3) is a rare exception. The developer of High-growth (#4) originally leased the land but then sold the contracts to the developer of Neighbor-friendly (#3). In order to remain consistent and treat all landowners within the project equally, the developer of Neighbor-friendly (#3) renegotiated the contracts. The developer of Neighbor-friendly (#3) acknowledged that some landowners were originally reluctant, but said in his interview with me, "In the end it worked out. We're clearly happy with it. I think they [landowners with renegotiated contracts] will be relieved knowing that everybody's going to be treated equally. And even the ones that had the better agreements recognized the need to have everybody on the same playing field."

[18] The average royalties reported are definitely an underestimate, since 49% of respondents who answered this question fell into the largest category ($3,000 or more). In calculating the mean, I conservatively assumed royalties of $3,500 for these respondents, though I have heard that landowners with multiple turbines on their property may receive more than $40,000 per year and, in Windfarm 1 where there are very few leaseholders, I have heard that a single landowner may be receiving upwards of $80,000 per year. Again, though, this is all hearsay, and most of the wind contracts prohibit disclosing the financial terms to outside parties.

(#1). Recall from case study selection (Section 3.1.3) that royalty payments appear to be more concentrated (or less pooled) in Windfarm 1 than in any other windfarm in this study. As a result, each landowner receives a larger share of revenue per turbine than in the other wind projects, all else being equal. As Table 4-17 demonstrates, leaseholders in Developer-friendly (#1) receive 44% more than the average of all leaseholders in the study. Correspondingly, over half of the survey respondents noted that these payments had a positive impact on their farm budgets, and none noted a negative impact.

4.3.4 The Impact of Pooling

In Section 4.3.1, my analysis showed that there is little evidence that landowners who are part of the royalty pool but who do not have a turbine on their property invest more in their land than other landowners in the windfarm community who receive no wind income. Furthermore, as just reported, these landowners are much more likely to report that the income has little or no impact on their farm business, and there is some indication that the dilution of royalty payments due to pooling makes all leaseholders—those with and without turbines on their property—less likely to see an impact on their farm's budget. So, at least through the supply-side mechanism, pooling would seem to be counterproductive to farmland preservation.

The interviewed wind developers who have used pooling arrangements reported that the primary motivation for doing so is to expedite the project. While none of the developers explicitly said it was to help "buy" local support for the project, all of them agreed that having contiguous leasing not only gives them more flexibility as they try to site turbines and access roads, but also helps to reduce some of the opposition that might delay construction. As one developer noted, "We wanted everybody together because really what counted was getting the wind farm built and then we could get the real cash flow [royalty payments rather than

comparatively lower lease payments] to move to the landowners." The other developer, who extends payments even to landowners of smaller tracts, reported:

> Everybody in the footprint has an opportunity to participate and be compensated…. [If, for example,] I got a nice little two-acre cottage and now all of a sudden five wind turbines are surrounding it and I'm not getting a penny and the farmers around me are getting thousands of dollars, I'm gonna be a little irritated…. [If I include them in the royalties, these landowners] are getting more and more stake in it [the windfarm].

No interviewee recounted a situation where the lease terms—specifically, being pooled versus unpooled—made the difference between the project being viable or not. To take their reasoning to its logical conclusion, however, pooling may make wind energy palatable in more communities. This, of course, is true only if the wind developers are correct that these lease arrangements significantly increase public acceptance of wind.

While my survey of landowners did not ask a standalone question about acceptance of wind energy, it did ask a battery of 10 questions about the landowner's level of agreement with a range of commonly cited (though not scientifically substantiated) impacts of wind energy. These range from job creation and revenue creation to disruption of weather patterns and human health problems (see Table 4-18). For all but one of these questions[19], landowners who live in communities with windfarms but who did not participate in a wind royalty pool more strongly believed in the negative impacts and less strongly believed in the positive impacts than landowners with turbines on their property. For most questions, neighbors outside of the pool answered similarly to landowners in the matched case communities, though the former group

[19] Note that the majority (69%) of landowners surveyed disagreed that "wind turbines help limit climate change." This is true both in the communities with turbines and in the matched case communities, and there were no statistically significant differences between more pro-wind respondents and those who (according to their answers to other questions) were decidedly anti-wind energy. This issue, which is beyond the scope of this dissertation, is nevertheless worth exploring. The survey results suggest that although the environmental argument is often invoked to increase support for wind energy, it may be less effective in the very rural areas in which turbines are to be sited. If the goal is to sway opinion in rural communities, it might be more effective to focus on economic impacts, citing some of the more concrete numbers included in this dissertation.

was less convinced of the job creation benefits and more convinced that turbines cause human health problems. In contrast, landowners in the windfarm communities who are part of the royalty pool but do not have turbines on their property had answers that were more similar to those of landowners with turbines on their property. For three questions—job creation, providing revenues to landowners, and preserving rural land—these two groups had statistically indistinguishable answers. On two other questions—noise pollution and disruption of local weather patterns—the responses of this group were the same as both the matched case respondents and those neighbors who were not part of the pool. For the rest of the questions, their responses fell somewhere between the more positive reports of the landowners with turbines on their property and the more negative assessments of neighboring landowners who were not included in the pools. Thus, these findings seem to support the wind developer's intuition that pooling makes for happier neighbors.

Table 4-18. Landowners' opinions on potential impacts of wind energy, by whether or not they receive wind-related income

Wind turbines…	Matched case	Neighbors outside the royalty pool	Neighbors in the royalty pool	Turbines
Provide revenues for land owners	1.13^{ab}	1.03^{a}	1.24^{b}	1.25^{b}
Create jobs	0.91^{b}	0.63^{a}	0.95^{bc}	1.17^{c}
Reduce nearby property values	0.10^{a}	0.11^{a}	-0.26^{b}	-0.91^{c}
Produce visual or aesthetic problems	0.09^{a}	0.14^{a}	-0.02^{b}	-0.84^{c}
Create noise pollution	-0.12^{a}	0.00^{a}	-0.24^{a}	-0.65^{b}
Preserve rural land	-0.22^{ab}	-0.42^{a}	0.05^{bc}	0.26^{c}
Disrupt bird migration	-0.34^{a}	-0.38^{a}	-0.83^{b}	-1.30^{c}
Help limit climate change	-0.51^{a}	-0.58^{a}	-0.51^{a}	-0.47^{a}
Cause human health problems	-0.89^{b}	-0.67^{a}	-0.90^{b}	-1.36^{c}
Disrupt local weather patterns	-1.02^{a}	-0.98^{a}	-1.05^{a}	-1.32^{b}
Mean is calculated by assigning numbers to the response categories:			Strongly Agree = 2	
			Agree = 1	
			Disagree = -1	
			Strongly Disagree = -2	
Values in rows with the same superscript are not statistically different ($p<0.1$)				

In their open-ended responses, landowners also echoed the idea that sharing the royalty income more broadly results in far fewer complaints. As one respondent said, "People who have leased, or plan to lease, are in favor of the energy producing windmills, while those who may live in an area that may not be leased are strongly against it." Another noted, "When people receive a check [from the wind developer], it can make noise go away and other annoying things like traffic and flickering of blades in the sunlight disappear." Notably, three-quarters (15 of 20) of such comments—i.e., that receiving wind income changes one's perception of wind energy—came from landowners in windfarm communities who were not part of a royalty pool (see Table 4-19). While there were comments from landowners in each of the windfarms, there were more

comments from landowners in Developer-friendly (#1) and Mixed-benefits (#2) than in Neighbor-friendly (#3) and High-growth (#4), where pooling is used more extensively.

Table 4-19. Count of open-ended responses related to the inequity of royalty payments or its consequences

			Windfarm respondents		Wind Cases			
	All respondents*	Matched case	In royalty pool (with or without turbine)	Not in royalty pool	Developer-friendly (#1)	Mixed-benefit (#2)	Neighbor-friendly (#3)	High-growth (#4)
Different perceptions of those who are and are not paid	23	3	5	15	7	6	4	3
Leads to tension in community	9	1		8	4	1	1	2
Greed of those who are getting paid	5	1	1	3	1	2	1	
Jealousy of those who aren't getting paid	2	0		2			1	1
* Exceeds the total number of responses related to the inequity of royalty payments (31) because some commenters made multiple points within their statements.								

Landowners in Developer-friendly (#1), where the fewest landowners receive direct wind payments, also more commonly reported that wind energy was causing tension in the community. Their comments include, "This type of energy has ripped apart farmland and communities, neighbors and families," and "Wind turbines have created a strong divide (and rightfully so) between people owning large tracts of land and those owning small parcels." This tension was mentioned by at least one landowner in each case study, but there is a notable divide regarding whom the landowners blame. In Developer-friendly (#1) and Mixed-benefits (#2), where pooling is less frequently used, survey respondents attributed this tension to the greed of landowners who were receiving royalty checks. One respondent in Developer-friendly (#1) wrote:

> Greed has led to the deterioration of the landscape and relationships with total disregard to anyone but themselves. There is absolutely no benefit to these monstrosities to anyone but the landowners that have signed leases and the wind power companies that receive huge subsidies for them.

Another implored, "Put greed aside and be logical!!! This is not good for our community." In contrast, one respondent in Neighbor-friendly (#3) and another in High-growth (#4) noted that this tension is motivated by jealousy on the part of those not being paid. The respondent in Neighbor-friendly (#3) wrote, "Here in Huron County we have a very vocal minority against wind energy. I believe they are motivated by several things: 1) jealousy: if I'm not getting the money and controlling everything, I'm against it…."

In summary, though the survey's quantitative data demonstrates that wind income has little discernible impact on the on-farm investments of neighboring landowners who participate in the royalty pool, these landowners do seem to have a higher opinion of wind energy. They believe more strongly in the positive impacts and less strongly in the negative impacts of wind energy than landowners who are not part of the royalty pool. Furthermore, the qualitative data seem to suggest that there is less tension in communities where royalty pooling is used more extensively. While the supply-side hypothesis considers only increased investments as a means of retaining farmland, all else being equal, leasing arrangements that help to keep the peace within a rural community are arguably far better for that community than those that pit neighbors against one another. As a result, I would not go so far as to dismiss royalty pooling as non-beneficial for rural communities.

4.4 Countervailing Effects: Damage to Farmland

An underlying assumption of the supply-side mechanism is that farmers who receive wind-related income are using the money to make improvements in their farm that are otherwise unrelated to the wind development. They might be renovating their house or building a new barn—things that they perhaps have long wanted to do but could not have done without additional resources. A number of survey respondents, however, made comments on their

questionnaires that challenged this assumption, suggesting that investment may not simply be opportunistic, but rather is required to correct damage done to their fields during turbine construction.

Though most outsiders think primarily of the impacts of a fully operational windfarm (e.g., noise, aesthetic changes, etc.), most of my interviewees and survey respondents in locations with wind turbines recounted that the construction phase of the project is significantly more disruptive to the farming operation than the long-term nuisance of farming around the turbine once it is operational. The cranes and heavy machinery used to erect the towers can compact dry soil or leave deep ruts in soft soil, making planting difficult. Grade changes to accommodate access roads and cover tower foundations can change surface water flow, leading to ponding. Perhaps the most common complaint, mentioned by 20 survey respondents, is broken field tile[20], which is crushed by heavy cranes or disturbed when crews bury underground cables connecting the turbines to each other and, ultimately, to the substation.

In theory, the wind developer, not the landowner, would pay to correct any damage done. All of the wind developers that I interviewed noted that their contracts with landowners compensate landowners not only for long-term use of land taken out of production (i.e., where the turbine base or access road sits), but also for temporary disturbances during construction. Commonly, wind leases hold the developer liable for paying to de-compact soil and replace or repair broken runs of field tile. The developers also noted that they try to schedule construction activities based on soil conditions to make minimal impact on fields, and that they try to use existing roads in order to minimize moving cranes across the fields.

[20] Field tile or drain tile is used to remove excess water from cropland, preventing crop damage from waterlogged soil or standing water (i.e., puddles) in the field. Field tiles—typically clay or perforated plastic pipes—are buried roughly three feet deep and arranged in parallel rows throughout the field to collect excess water and channel it to nearby ditches or creeks.

Even so, a number of survey respondents with turbines on their property commented on damage that they had paid to repair, particularly damage to field tile. One respondent wrote, "Subcontractor ruined my tile drainage system--some of it cost about $800 per acre." Another noted that he expects that it will "maybe take 10-20 years to correct [the damage done]" and assumes that he will have to shoulder the burden. Still another notes that addressing the damage with the wind developer takes "more time with additional paperwork for filing a loss claim," so he pays out of pocket for small claims.

Because I did not anticipate such a finding, I did not ask directly whether on-farm investments were made to repair damage from wind turbine construction. Of all the investment categories—home, outbuildings, irrigation/drainage, and farm equipment—the category most likely to include corrective action is irrigation and drainage. Notably, as first reported in Section 4.3.1, investment in irrigation and drainage differs from the other types of investment in that there is no significant interaction between the presence of the turbine and the number of acres the landowner farms. Additional research might help explain whether this difference is related to uncompensated construction-related damage or some other factor.

4.5 Answering Research Questions and Testing Hypotheses

The first of my overarching research questions asks whether wind turbines alter the supply side of the farmland conversion equation. Specifically, "Do the revenues rural landowners receive as a result of wind energy projects change their on-farm investments or long-term succession plans, especially whether they expect to sell their land to a developer?" According to the data presented in this chapter, the answer is that it depends on whether or not the landowners have a turbine sited on their property.

Among those with turbines, the answer is a resounding "yes." Landowners with turbines on their property invest twice as much to improve their property as their neighbors and landowners in a matched case. Even after I account for the size of the farming operation—a strong predictor of increased investment—I find that landowners who farm the land and have turbines on their property do invest more than all other landowners. Additional research is warranted to determine if a portion of these investments—specifically investments in drainage and irrigation—are pure improvements, or necessary to remedy damage done during the construction of the windfarm. However, even if the latter were true, it would not negate the sizeable increase in investment these landowners make to their homes, outbuildings, and farm equipment. Furthermore, to directly answer the second half of the question, landowners with turbines on their property were significantly more likely to say that their land would be farmed and less likely to say it would be idle or in recreation in the future. It should be noted, however, that very few landowners in my study thought that their land would be developed in the future, and there is no difference in this opinion between landowners with and without turbines on their property.

Other landowners do not have a turbine sited on their property but still receive direct payments from wind developers for being part of the royalty pool. These landowners have investment patterns similar to those of the neighbors in the windfarm community who are not part of the royalty pool; as a result, the supply-side mechanism does not appear to apply to this group of landowners. This is interesting since royalty pooling seems to be increasing in popularity, with wind developers saying that pooling makes siting a project easier because more community members directly benefit and are therefore more likely to be receptive to the project. Survey responses of landowners confirm this, finding that those neighbors who are part of the

pool believe much more strongly in the positive impacts of wind energy and believe less strongly in the negative impacts than neighbors not in the pool or landowners in the matched case communities. Furthermore, landowners in communities where there is no or less pooling (Developer-friendly (#1) and Mixed-benefits (#2)) report more community conflict as a result. Therefore, pooling seems important to help gain community acceptance for wind. It might ultimately make more communities willing to accept windfarms, with their knock-on farmland preservation benefits; it might also help to keep the peace among neighbors, which should not be dismissed as an unimportant goal.

In addition to providing overall insight into the supply-side mechanism, the data presented in this chapter also allow me to test hypotheses 1 and 2. On the first of these (H1), the data suggests that I should reject the null hypothesis—that is, my original hypothesis has a high probability of being correct. Because the financial benefit of wind income is so great to landowners with turbines on their property, in aggregate, landowners in communities with windfarms *are* more likely to make investments in their farms than landowners in rural communities without windfarms. Landowners in communities with windfarms are also more likely to anticipate that the next owner of the property will keep the land in agriculture than are landowners in rural communities without windfarms. However, these effects are largely limited to landowners with turbines on their property and do not apply, even to a lesser extent, to their neighbors, as I hypothesized in H2. While neighbors without turbines in Windfarms 3 and 4 make more investments in their farms than those in the matched case communities, the opposite is true in Developer-friendly (#1) and Mixed-benefits (#2). Furthermore, there is no statistical difference between the future land use expectations of landowners without turbines in windfarm communities and those of landowners in the matched case communities. As a result, I suggest

rejecting my hypothesis that there are measurable supply-side farmland preservation benefits for those in windfarm communities who do not receive direct payments from wind developers.

Though my original hypotheses relating to the supply-side mechanism do not appear too far off base—wind income *is* altering on-farm investment and long-term land use plans, at least for landowners with turbines on their property—the use of multiple research methods provided an important correction to my initial assumptions about how these effects translate into farmland preservation. Building on rural planning theory, I assumed that increased farm investment would reduce the landowner's financial need to sell to a developer—effectively keeping more land in production. In my interviews with local officials, however, they insisted that the additional income was "saving the farm" by increasing the likelihood that the landowner's children would take it over the farm, as opposed to selling it to a neighboring farmer. Clearly, the threat these officials see as most pressing is not the loss of farmland to residential development, but rather the loss of a tradition of family farming and its subsequent impact on the rural community. The evidence for both of these phenomena is the same—increased investment, future land use expectations—but under which conditions a rural planner might employ wind energy as a farmland preservation tool is clearly different.

Though I selected cases based on population trends that I believed would indicate a threat of growth, in fact, most local officials seemed to classify themselves as "the other rural America," in which the threat of decline is the more pressing concern. The fact that the supply-side mechanism, theorized as a solution to combat urbanization, also appears to be effective at combatting depopulation would make it unique among rural planning tools, which tend to be designed for one purpose or the other. It would be worthwhile to test the efficacy of the supply-side mechanism in alternate communities where the key threat is, indeed, suburbanization.

Chapter 5. The Supply Hypothesis: Indirect Benefits

In the last chapter, I found evidence that the direct payments made to landowners with turbines on their property are translating into benefits closely linked to farmland preservation. These landowners expect their land to be farmed longer into the future, and they are investing more in improvements to their farms. I also found, however, that the impact is much less noticeable when those direct payments are smaller—as they are for neighboring landowners who participate in a royalty pool but have no turbine sited on their property. What the last chapter did not address was why the second part of my supply-side hypothesis (H2) failed. That is, it did not explain why the financial benefits of the windfarm were not also evident in the future land-use expectations and increased investments of landowners without turbines on their property. Recall from Chapter 2 that I based this hypothesis on the reasoning that all landowners in the windfarm communities benefit indirectly through increased economic activity, especially during the construction of the turbines and via the local property taxes paid by the wind developer. In this chapter, I look at what impact the windfarms have had on property tax revenues and job creation in my case studies, finding that far fewer positive impacts can be attributed to the former than the latter. I then speculate as to why these positive property value benefits have not *(yet)* altered landowner expectations and family budgets.

5.1 Job Creation

The job creation benefits of wind energy are often touted, especially when wind developers are trying to appeal to audiences where the environmental benefits of renewable energy might not resonate. Reportedly, the new jobs are not only in manufacturing the components of the turbine, but also in constructing and maintaining the turbines once they are built. Wind proponents often cite manufacturing-related jobs when asserting that windfarms will promote statewide economic development or even benefit urban areas, but the latter two categories—construction and maintenance jobs—are often seen as benefitting the rural communities that host the turbines.

To gauge what impact wind development has had on local job creation in my windfarm case studies, I asked farmland owners directly about this through a Likert-scale question on the survey. A number of landowners also mentioned the issue in their open-ended survey responses, and it frequently came up unsolicited in my interviews with local officials. Overall, landowners in windfarm communities were disappointed by how few local jobs had been created, and local officials noted that the primary job-creation benefits were not in technical or construction fields, but in the lower-paying hospitality industry.

5.1.1 Survey Data

The very first question in my survey of landowners asked about wind turbines and job creation. Overall, a strong majority (84%) agreed that the wind energy industry does create jobs. However, landowners in the matched case communities were statistically more convinced of the job-creation benefits than were landowners in communities with windfarms (see Table 5-1). Similarly, while the majority of respondents in all wind cases agreed that wind turbines create

jobs, landowners in High-growth (#4) were stronger in this conviction than landowners in Developer-friendly (#1).

Table 5-1. Landowner response to the question "How strongly do you agree or disagree...that wind turbines create jobs?"

				Windfarm cases			
	All respondents	Matched case respondents	Windfarm respondents	Developer-friendly (#1)	Mixed-benefit (#2)	Neighbor-friendly (#3)	High-growth (#4)
Strongly disagree	4%	3%	4%	7%	2%	5%	0%
Disagree	12%	10%	14%	13%	14%	16%	12%
Agree	64%	66%	63%	62%	65%	60%	64%
Strongly agree	20%	21%	20%	18%	19%	19%	24%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Number of respondents	1170	472	698	202	222	167	107
Mean		0.91	0.8	0.70[a]	0.85[ab]	0.72[ab]	1.00[b]
Standard deviation		0.94	1.03	1.12	0.97	1.08	0.86
p value		0.05		0.0655			
Mean is calculated by assigning numbers to the response categories:				Strongly disagree = -2			
				Disagree = -1			
				Agree = 1			
				Strongly agree = 2			
The superscripts next to the mean scores indicate whether means across case studies are statistically different.							
Where columns share a letter, they are statistically indistinguishable.							

A look at respondents' open-ended comments helps to explain some of these differences. Overwhelmingly, respondents in areas with wind turbines were much more likely to comment on the job-creation aspects of wind energy; of the 17 comments on the job-creation aspects of wind energy, 88% were made by respondents in areas with wind turbines (see Table 5-2). By far the most common comment refuted the idea that wind development means more local jobs. As one respondent recounted:

> One of the main arguments for wind energy is that it brings jobs to communities. They do bring jobs, but it is not permanent local jobs that they bring. I had an opportunity to witness a wind turbine being installed about a mile away. A parade of pickup trucks escorted the turbine carriers as they went past. Not a single truck was a local contractor. Technicians stay on an installation site, then they move on to the next site. This does not benefit the local job market whatsoever.

Additionally, four respondents in Huron County commented that wind development actually resulted in a loss of jobs. Specifically, they linked the rise of wind power in the area to the closure of a coal-fired power plant in nearby Harbor Beach, which led to employee layoffs.

Table 5-2. Count of open-ended survey responses related to job creation

					Windfarm respondents			
	All respondents*		Matched case respondents	Windfarm respondents	Developer-friendly (#1)	Mixed-benefit (#2)	Neighbor-friendly (#3)	High-growth (#4)
Jobs, but not local	11		2	9	2	5	2	
Job loss from Harbor Beach coal plant closure	4			4	1		3	
Temporary hospitality-sector jobs	3			3		2	1	
Wind lease-related	2			2			2	

* Exceeds the total number of responses related to job creation (17) because some commenters made multiple points within their statements.

In contrast, five of the 17 responses about job creation noted that jobs were created as a result of wind development, but perhaps the jobs were not directly linked to wind energy. Three respondents noted that the hospitality industry, in particular, saw an increase in business to accommodate out-of-town contractors during the construction phase. One wrote: "Have the windmills added jobs? Motels and restaurants [have]… but these are temporary at best." Another noted that there are also impacts beyond the hospitality industry, since "a few local truckers are used to haul sand and gravel," but that these also represent only a short-term boost for local employment.

Only two respondents, both in Neighbor-friendly (#3), noted that the windfarms indirectly create local jobs through their payments to local landowners. As one explained, "Farmers spend money locally more than any other group of people. This is where the improvement to our economy will come from. Building the project will put money in [their]

pockets." Another respondent tied this benefit directly to the fact that leases in his project are pooled: "Farmers receive payments for being part of the pool. And when farmers have money, they spend it, which boosts the local economy."

Returning to the differences in opinion on job creation between landowners in windfarms and those in matched case communities, we see from Table 5-2 that there are far more opinions among those in communities with windfarms than in the matched case communities (18 versus 2). While the only comments from landowners in the matched case communities were negative, in areas with windfarms, the number of negative comments well exceeds the number of positive comments; moreover, the comments tended to be stated with much more fervor. Table 5-2 shows that no respondents from High-growth (#4) made any comments about job creation—positive or negative. In contrast, the only comments from respondents in Windfarm 1 refuted claims that windfarms create local jobs. This might help to explain the statistically significant differences between these two groups of landowners on the multiple-choice survey question.

5.1.2 Interview Data

Though wind energy's impact on job creation was not a topic that I brought up in my interviews with local officials, it is something that came up unprompted in six of the 14 interviews (43%). Most of the local officials presented information consistent with what landowners had written on their surveys: that outside contractors do much of the windfarm construction, which leads to short-term benefits to the hospitality industry, but long-term benefits may result from landowners spending wind income at local businesses. While the majority of landowners' comments were negative, four of the six local officials portrayed wind development as a local economic benefit (see Table 5-3).

The interview with one Huron County official was especially helpful in reconciling the conflicting opinions of those who see large job creation benefits and those who see them as more modest. This official (Interviewee 4 in Table 5-3) admitted that wind development had some impact on local jobs: the developer did hire "a tiling company and a few people got some contracts to help them out—and the quarry makes out well." He emphasized, though, that many of the non-local contractors were doing jobs that could have been filled locally:

> You can't just hire somebody off the street to do a windmill project. I can understand that, but they also went as far as bringing in concrete batch plants. We have vendors in the county that deal with concrete. And then also excavating equipment to build roads and so forth. There's a lot of that equipment and personnel to do the entire development. A very small percentage of any of that work was given to companies in Huron County or people in Huron County.

He further commented that job creation was touted as one of the benefits of hosting wind turbines, and he believes that this argument influenced voters to pass a referendum on the wind zoning ordinance. Now, however, having seen "what jobs they create and just the general look and so forth that they're changing the county," he thinks that the majority would no longer support additional wind development. This may help explain why, as the landowner survey suggests, those in communities without windfarms believe there are greater job creation benefits than those where wind development has already taken place.

My interview with the county official in the McBain area (Interviewee 6 in Table 5-3) may further explain why landowners in High-growth (#4) felt most strongly that wind energy has job creation benefits. Ironically, this interviewee was the most emphatic in his assertion of the opposite viewpoint. As he noted, "From an economic development standpoint it has zero impact." However, he also pointed out that no promises of direct employment had been made to the community. Instead, he said, "If you go ahead and talk to a wind developer, they will talk about x people getting payments," which would then make their way back into the economy.

This might have lowered residents' expectations of local employment, leading them to experience to higher satisfaction if they did ultimately experience this indirect benefit.

Table 5-3. Quotations from local officials about the impact of wind development on local jobs

Interview 1	Local official Developer-friendly (#1)	**Construction-related jobs:** "While they [wind turbines] were going up, they [contractors] spent a lot of money at … the bars, the gas stations, the restaurants." **Wind lease benefits:** "My neighbor's got it [a turbine on his property.] I cannot tell you exactly what he's getting off of that windmill, but I know he's doing a lot of improvements around his farm and they're [people in town with wind leases] all driving new vehicles. So it has helped the economy that way. There's no doubt about it, they've helped the economy."
Interview 2	Local official Mixed-benefit (#2)	**Wind lease benefits:** "[If you are part of the pool] you're going to be getting a check every year…. We're not going to count on it but that's something that's there that will be coming in so we can utilize it. … So it's going to help. It will help with farm improvements, whatever. The money's going to pretty much stay in the—here in the county."
Interview 3	County official Windfarms 1, 2, 3	**Construction-related jobs:** "There is no recession in this county. We are booming. A big piece of the reason we're booming…is that one energy company [alone was] talking to me about [spending] two million dollars a month…on goods, services, and housing in the county. And [they] spent two million dollars a month for the last two years." **Wind lease benefits:** "Most of the land owners are farmers. Most of those farmers, if you do your survey and you ask them they will tell you, 'The vast majority of the money that I'm getting for those [wind leases] goes into improvements on my projects or is spent back in our community…. I increased my tile. I hired local people to work. I built a new building that I hired local contractors to work. And I'm spending that money in this county adding to the value of the county. And that's because those [turbines] came and are here on my property.'"
Interview 4	County official Windfarms 1, 2, 3	**No local jobs:** "They [wind turbines] brought jobs to the county, but they brought jobs to the county from outside people, hired very few people from inside the county. And let's say they have to be skilled or—you can't just hire somebody off the street to do a windmill project. I can understand that, but they also went as far as bringing in concrete batch plants. We have vendors in the county that deal with concrete… they never hired anyone or very few, maybe like a tiling company and a few people got some contracts to help them out with—and the quarry makes out well and so forth, but other than that, nothing."
Interview 5	County official Windfarms 1, 2, 3	**Construction-related jobs:** "We have a big stone quarry. Was talking with them yesterday. Their production since the windmills came in went from 300,000 ton one shift to 800,000 two shifts." **Construction-related jobs:** The other day I went to downtown Pigeon.... I stop at a restaurant and get a salad…. And you can't find a place to park. I can't find a place to sit down…. Ah, phooey, I'll grab a pizza and go home. Well the pizza place, they're all sold out. Well, we got another pizza place right over there. They're sold out. I thought, "What the heck's going on?" And they [restaurant employees] said, "Well it's like this every noon now"…construction workers!
Interview 6	Local official High-growth (#4)	**No local jobs:** "From an economic development standpoint it has zero impact. Maybe they haven't been here long enough. If you go ahead and talk to a wind developer, they will talk about x people getting payments. It hasn't brought in any growth."

5.2 Property Tax Revenue

In Michigan and other states that levy property taxes on wind turbine equipment, there is another opportunity for an indirect benefit to the community at large, and not just those landowners receiving direct payments from the wind developer. These additional revenues, I hypothesized, could be used to stabilize or reduce tax rates, which should have a direct impact on the family budgets of all taxpayers. Alternately, this additional revenue could be directed towards schools, roads, or other locally funded public services, allowing improvements in these services without increasing tax rates.

Better understanding how local governments were using the additional tax revenues from wind turbines was a key goal of my interviews with local officials. Though I did not pose the question directly to landowners, this topic also emerged in a number of their open-ended responses. Overall, it seems that these revenues have been a huge boon to the tax base of townships with windfarms, even in jurisdictions that granted partial tax abatements to wind developers. However, recent statewide changes in property taxation rules have significantly reduced the amount of tax revenues that local governments will be able to collect from wind developers in the future. Local officials worry that the state might make further changes to the taxation of wind turbines; thus, they have been reluctant to lower tax rates. As a result, while wind developers have paid millions of dollars of additional tax revenue to rural communities, there has been no discernible improvement in the household budgets of taxpayers throughout these windfarm communities.

5.2.1 Impact on Township and County Budgets

Township officials were overwhelmingly positive about the impact of the additional tax revenue generated by the wind turbines in their jurisdictions. That is perhaps unsurprising given

that most of these jurisdictions have relatively small tax bases with limited commercial or industrial development. For them, any additional revenue makes a significant impact. In contrast, only two of the three county officials I interviewed thought there was any noticeable positive impact on their local budgets, and even then they were less than emphatic about the benefits. This is understandable since the tax base in counties is much larger and more diverse, at least in part because it includes more urbanized and industrialized jurisdictions. The only officials interviewed who said that there was no discernible impact on tax revenues were in jurisdictions (Township 4A and County C in Table 5-4) with only five turbines, two of which had received tax abatements. Even so, the first of these officials did note that the local school district was benefitting from increased tax revenues.

Looking at the tax records filed with the State of Michigan helps to put this impact in context.[21] For two of the nine wind-energy townships in my study, the taxable value in the jurisdiction has more than tripled in the last six years following the construction of the wind turbines (see Table 5-5), with the tax base increasing over 400% (five-fold) in one of these townships. In three others, the total taxable value has nearly doubled. In the remaining jurisdictions, the smallest saw an 11% increase in taxable value, and the supervisor I interviewed was not at all disappointed with this additional revenue. Instead, he recounted that it allowed the township to purchase a new ambulance and a new fire truck, worth "close to $400,000." In contrast, three of the five matched case communities without wind turbines saw their total taxable value decrease in the last six years, and only one had double-digit growth—largely a result of a quarry that had recently expanded.

[21] Determining exactly how much of the industrial personal property tax revenue is related to wind turbines rather than other equipment (e.g., dairy operations, light manufacturing machinery, etc.) would be a very time-intensive process for (often part-time) township staff to carry out. Even so, these numbers support—and better put into perspective—the impact reported by local officials.

Table 5-4. Officials' views on the impact of wind tax revenue, by jurisdiction

	Jurisdiction	Abatement	Impact of wind tax revenue, from local official
Developer-friendly (#1)	**Township 1A**	50% for 12 years on all turbines	Would we survive without them? Absolutely, but we're surviving better with them.
	Township 1B	50% for 5 years on all turbines	It helps...anything helps.
Mixed-benefit (#2)	**Township 2A**	None (though 50% for previous project)	It's just something that we as a township never had to look at that kind of increase in such a short span. It's--all of a sudden it--we're looking at how to set up accounts so that we've got money available for future contracts and everything else.
	Township 2B	None	Being a small township we don't generate that terribly, terribly much money. So that's a…big impact. Positive impact.
	Township 2C	None (though 50% for previous project)	It's been a nice shot in the arm for us.
Neighbor-friendly (#3)	**Township 3A**	None	[n/a]
	Township 3B	None	It will be over double [previous tax revenues], but some of that's to do with ITC and we've had a big substation and the ITC line coming through and that's as big for our township as what the windmills are probably.
High-growth (#4)	**Township 4A**	50% for 5 years on 2 (of 5) turbines	It goes to the school. As far as the township, no, we ain't getting anything.
	Township 4B	Unknown	[n/a]
Windfarms 1, 2, 3	**County A**		Plugged some holes in our budget.
High-growth (#4)	**County B**		It's appreciable for our county but nothing in comparison to the two big counties down south [Huron and Gratiot].
	County C		Little to no discernible impact

Table 5-5. Change in tax base of case study communities, 2008 to 2014

		Industrial personal property as a percentage of total property tax base		Increase in total property tax base (2014 vs. 2008)
		2008	2014	
Developer-friendly (#1)	Township 1A	3%	4%	11%
	Township 1B	0%	14%	39%
	Matched township	0%	0%	-10%
Mixed-benefit (#2)	Township 2A	0%	72%	415%
	Township 2B	0%	37%	94%
	Township 2C	13%	41%	87%
	Matched township	0%	0%	-3%
Neighbor-friendly (#3)	Township 3A	0%	39%	99%
	Township 3B	0%	31%	249%
	Matched township	0%	1%	5%
High-growth (#4)	Township 4A	0%	17%	31%
	Township 4B	0%	39%	95%
	Matched township A	9%	17%	46%
	Matched township B	4%	5%	-3%
Counties	County A (Cases 1, 2, 3)	2%	17%	32%
	County B (Case 4)	2%	7%	9%
	County C (Case 4)	7%	7%	2%

Source: Michigan Department of Treasury (2014). Taxable Value Reports 2008-2014. Retreived from http://www.michigan.gov/treasury/0,1607,7-121-1751_2228_21957_45818---,00.html

Because the tax bills paid by wind developers are not differentiated from other property tax revenues, few of the interviewees could point to specific projects made possible by the additional wind revenue. In the words of one interviewee, "It goes all over, just the same as any other tax money." Most of these townships offer few public services and, with or without wind turbine revenue, spend nearly all of their money on roads. As a result, four interviewees mentioned that they planned to increase road maintenance with the additional money. Two of these four were putting the money toward graveling unpaved roads, while the other two planned to resurface paved roads. None had plans to pave previously unpaved roads, citing very high

costs of such an activity as a poor use of the funds compared to maintaining the existing roads that are "past due" for resurfacing. As noted above, one township official said that they used the tax revenue to purchase a new ambulance and new fire truck, and one county official said that they used a portion of the money to upgrade their financial accounting software system.

Though I did not bring up the issue in all interviews, in four of my early interviews with local officials I asked whether there were any plans to reduce tax (millage) rates. Though three of the four were not surprised by such a suggestion, they had not yet made any changes to millage rates and did not have any intention to do so in the future. As one noted, because the taxable value of the wind turbines decreases every year (regardless of the recent change in the multiplier table, which accelerates this depreciation[22]), "right at this point we're at the all-time high," and so a reduction in millage rates would only make sense if it were temporary. In the township where the idea appears to have been most seriously considered, the supervisor noted that Michigan tax law requires that a reduction in the millage rate apply not just to landowners, but also to the taxable value of the wind turbines. As a result, any tax rate reduction "is going to benefit the wind companies a lot more than a person with a house [who] might save 30, 40 bucks [a year]." He said that instead, his township was contemplating keeping the tax rate where it is and adding additional urban services, for example, "pay[ing] for garbage pickup or provid[ing] another service that they [landowners] are currently having to pay [for] themselves."

None of my interviewees implied that the additional tax revenues factored into their decision to adopt a zoning ordinance that was conducive to wind development, though three interviewees mentioned that they believe it does impact how landowners without wind leases feel about wind energy. One said that while he wouldn't go so far as to say that the tax revenues

[22] In 2013, the State Tax Commission (STC) altered the multiplier table (sometimes referred to as the depreciation schedule), in effect lowering the tax liability for each turbine over its usable life, and thereby lowering expected property tax revenues for host jurisdictions. This is discussed in more detail in Section 5.2.3.

are key to community acceptance, he believed they were "right close to the top." The other noted that while most of his constituents are farmland owners who receive direct wind-related income, he feels that he has a responsibility to ensure that the benefits are more widely distributed. He believes that "if we can show that through the added increase that some dollars are coming in for road improvement and the like, why, it all helps." In contrast, another local official said that wind developers led residents to believe that they would see the same sort of tax benefits as in Alaska[23]—"they have oil reserves and people that live in Alaska get paid to live there, they don't pay property tax." This, of course, has not come to pass, so he believes that residents without wind leases, in particular, are less keen on any additional wind development in the area—a theme that echoes the idea of unmet expectations related to job creation.

5.2.2 Abatements

As Table 5-4 shows, three of the nine windfarm townships included in this project have given a tax abatement on at least some of the wind turbines within their jurisdiction. Under previous tax code, officials in local jurisdictions were enabled to vote to offer abatements (more colloquially, "tax breaks") to development projects that meet requirements set by the state. In order to receive the abatement, the wind developer needed to petition the township's board, which would hold a public hearing and then decide whether to offer the abatement and for how long (e.g., 50% of all taxes for 5 years, 25% for 12 years). As part of the state's property tax restructuring, these abatements were discontinued in 2008, although any abatements that had previously been approved were honored. In the case of the townships in Mixed-benefits (#2), this abatement was for the very first windfarm in the area, though four more projects have subsequently been built without any abatement. In High-growth (#4), because the windfarm was

[23] For more information about taxation in Alaska, former Governor Jay Hammond (2012) has an interesting essay on the establishment of the Alaska Permanent Fund, which pays residents an annual dividend through levying a severance tax on oil extraction.

built in phases over the course of four years, some of the first turbines in the windfarm were abated, though later turbines were not.

However, if we look at the comments of local officials (see Table 5-3) as well as the tax revenues generated by the turbines (see Table 5-5), it is very difficult to distinguish which of these townships offered an abatement and which did not. In the words of one official, "This is a big project. We're still going to get a nice chunk of change."

In describing the public hearing where the abatement was granted, and their rationale for agreeing to abate a portion of the property taxes on turbines, many officials raised the issue of fairness. The official from township 1A, which approved arguably the largest abatement, was unapologetic about the township's decision. He recounted the most contentious public hearing as follows:

> [The wind developer] approached us for a tax abatement, and we gave it to them. The room was full, and everyone that was in there was against the windmills. But we gave all the factories, everybody, we gave them—anybody that came and qualified for a tax abatement, we gave it to them and we did the same with the windmill…. [Typically] nobody shows up when we give an abatement. These factories have got bigger abatements than they got, nobody showed up for that. They [the people in attendance] were just against the windmills.

In other townships, I heard echoes of this rationale for granting the abatement: "We had done this with the co-op elevator," and "It seemed like the right thing to do."

Others said that they granted the abatement because they feared that without it, wind development would not come to their township and would instead go to another township that would approve the abatement. This, they feared, would upset the landowners who had signed leases with the wind developers and would stand to gain from turbines being built. One township supervisor recounted, "Some of them [township board members] were afraid that, well, if we didn't give them this tax abatement they wouldn't put no more windmills in here." Three

local officials who cited similar reasoning added that, "in retrospect [this was] not a very good move because they would have put them there anyway."

Conversations with officials who had granted abatements suggested that if they had known that the state would change the multiplier table for wind turbines, thereby reducing the overall amount of taxes paid by wind developers, they might not have so readily agreed to the abatement. One interviewee said so explicitly: "At that point in time we were looking at—our great State Tax Commission had a multiplier table that was set up to handle how we value the turbines and the like. And it was—it was something that we could live with. It seemed to make sense." Though other interviewees were less explicit, they commonly used my question, "If you could do it over again, would you still offer an abatement?" to talk about the state's wind turbine tax multiplier table.

5.2.3 State Tax Commission changes

Perhaps the most consistent theme in my interviews with local officials—on any topic—is their dissatisfaction with recent state changes to the property tax treatment of wind turbines. Eleven of the 14 local officials that I interviewed mentioned this change, some even before I started asking questions about property taxes.

While property taxes in Michigan are used to fund local government (e.g., county, township/city/village, and school districts) and these local units set the tax rate, the State Tax Commission (STC) sets statewide rules about how the taxable value of a property is calculated (see Table 5-6). Prior to 2013, the multiplier table (sometimes referred to as the depreciation schedule) for wind generation equipment set each turbine's tax liability as 100% of the original cost for the first year, depreciating over 15 years to 30% of the original cost. The change for the 2013 tax year reduced the first-year liability to 80% of the original cost, with depreciation over 6

years to 30%. A revision for the 2014 tax year is a compromise between the earlier tables: the tax liability is 100% of the original cost for the first year and depreciates to 30% over 10 years. This change lowered the tax liability for each turbine over its usable life, thereby lowering expected property tax revenues for host jurisdictions. Through the interviews, I learned that most of the local governments in the state with taxable wind turbines—including all of those I interviewed in Huron County, but not the townships in the McBain area—jointly hired an attorney to press the STC to revoke the change. In the midst of data collection, the STC compromised by revising the table once again.

Table 5-6. Comparison of Michigan State Tax Commission Wind Energy System multiplier tables

To calculate the taxable value, the original cost of the turbine is multiplied by value in the applicable cell based on the age of the turbine.

	Alternate Tax Tables		
Turbine age (in years)	**Pre 2013**	**2013**	**2014**
1	1.00	0.80	1.00
2	0.95	0.75	0.80
3	0.90	0.70	0.75
4	0.85	0.60	0.70
5	0.80	0.50	0.60
6	0.75	0.40	0.50
7	0.70	0.30	0.45
8	0.65		0.40
9	0.60		0.35
10	0.55		0.30
11	0.50		
12	0.45		
13	0.40		
14	0.35		
15	0.30		

Still, the latest revision does not negate the core concern of many local officials—that the fate of this large revenue stream is entirely in the hands of the state. Some interviewees were

concerned that, since the STC changed the multiplier table once, it could happen again. One said, "Quite frankly, I don't know if that revenue stream is going to be there two or three years down the road." Officials in two other townships noted that fear of future changes was hampering their ability to make any long-range plans for the increased revenue.

Local officials were even more concerned that these changes seemed capricious. One interviewee noted,

> To this day I still do not understand how the state tax commission could—well I know how they did it—but how it was allowed to happen? And while everybody agrees it doesn't make any sense, nobody seems to have the power to override them. And that one there has got me buffaloed. That scares the living daylights out of me that someone can have that kind of power that would influence something that dramatically.

To three of the interviewees, however, it was clear how this change occurred: at the request of utility companies. In fact, though most local officials generally had good things to say about the wind developers and utility companies (if not their construction sub-contractors), a number noted that the change in the multiplier table showed that the developers were clearly reneging on earlier promises of long-term tax benefits. One county official said it most colorfully:

> When they [wind developers] came in here, they had took [sic] full page ads out in the paper saying "we're going to do this" and "we're going to do that" and "you're going to have these tax dollars" and everything. And now [our wind turbines are] online and, "Oh, by the way, now we're filing a lawsuit. We're going to fight this tax structure." Huh? What happened to old buddy, old pal?

Regardless of who initiated the change, it seems to have soured at least one interviewee to additional wind development. "I've got a bad taste in my mouth about these things," he said. "If they would have been forthright and stuff it would have been a little bit different, but it's like they have a plan out there that they're trying to implement that we don't know about."

5.2.4 Landowners' Perceptions

The potential property tax benefits associated with windfarms were not mentioned within the landowner survey, but even so, 15 respondents wrote comments related to property taxes on the back cover where open-ended responses were solicited. Six of these comments were critical of the recent change to the depreciation table, five comments praised the positive impacts of the property tax revenue generated, and four more suggested that either the turbines hurt the tax base or the additional tax revenues were not enough to make up for negative impacts on the community.

Four of the 15 responses came from landowners in jurisdictions that had granted at least a partial abatement. Much like the views of the local officials, the landowners' views on tax benefits received did not appear to have been soured by the abatements. While one of the respondents was critical of the STC, the other three wrote very positive comments about the tax benefits that have accrued to the community. One landowner from Developer-friendly (#1) wrote, "The money brought into the township in the taxes paid by our wind company allowed us to purchase a new ambulance and fire pumper truck in the last 2 years that would not have been possible without the wind turbines!!!" Another in High-growth (#4) noted, "The township tax base has been greatly enhanced and is really showing up in different township projects. When can we have more turbines??"

Only two of the four landowners who talked about negative tax impacts of windfarms were landowners in communities with turbines. Neither of these respondents has a turbine sited on his property, though the first of these respondents did report receiving some royalty revenues because he is part of the pool in Neighbor-friendly (#3). This respondent's comment speaks less to the lack of tax revenues generated by the wind turbines, and more to the wind turbines'

indirect impact on the closure of the nearby coal plant, which caused "a significant tax base issue for the town." The other respondent, who was from Mixed-benefits (#2), suggested that the windfarms primarily benefit the county and do not lead directly to local benefits. To remedy this, he suggested that surrounding property owners "should receive a tax deduction." The other two respondents were landowners in the matched case communities, who presumably have less direct experience with wind turbines. Both had rather lengthy open-ended comments that were critical of wind energy, and both thought that the current amount of taxes paid by wind developers was insufficient, since "every member of a community has to look at the non-natural structures of the windfarms" or experience a "nighttime horizon filled with red lights, blinking on and off in unison."

5.3 Answering Research Questions and Testing Hypotheses

This chapter has been devoted entirely to better understanding a corollary of my first research question: Whether the supply-side mechanism's farmland preservation benefits are felt differently by those who receive direct payments from the wind developer, and those who potentially benefit more indirectly through an increase in local jobs or local property tax revenue. The answer, as established in the last chapter, is a definite "yes." This chapter has explored why evidence of these potential indirect benefits is not appearing in landowner investment behavior and future land use expectations.

Most landowners, both in communities with windfarms and in those without, agree that wind development is associated with job-creation benefits. A number of landowners and some local officials noted, however, that the majority of the jobs during the construction phase of a wind project are filled by contractors from outside the area, so the primary boost to the economy is in the hospitality sector, which hosts these visitors. Notably, though these hospitality jobs

might be in the vicinity of the windfarm, they are most likely in adjacent villages and not in the actual township where the windfarm is located. A smaller number of landowners and local officials also noted that the payments made by wind developers to landowners (in the form of leases or royalty payments) make their way back into the local economy, thereby indirectly boosting employment in the area. Again, though, because most of this commercial activity takes place beyond the township boundaries—in cities and villages—it is no surprise that I did not detect a change in the economic fortunes of *all* windfarm landowners included in my survey. Had I surveyed owners of area restaurants, hotels, or even farm equipment suppliers, I might have better captured the benefits.

My interviews with local officials suggest that the way that the wind developer frames job creation benefits might affect the community's expectations. In places where claims of direct job creation were made, as in Huron County, once the project has been built, landowners are actually *less* convinced of such benefits than landowners in areas without windfarms, presumably because they are disappointed that so much of the construction work was done by outside contractors. In contrast, when job creation is portrayed by the developer as an indirect benefit that results in leaseholders spending wind income on farm improvements, landowners in these communities have an even higher opinion of the job creation benefits of wind energy. Additional research directed specifically at this framing question is warranted to confirm this assertion.

Regarding property tax revenues, the majority of local officials believe that the additional revenues associated with wind energy have a noticeable positive impact on their local budgets. This is especially true among township officials who have traditionally had relatively small tax bases. In these jurisdictions, the property tax base has grown by anywhere from 11% to 415%

since the introduction of wind energy. The impact is far less noticeable at the county level, likely because the tax base was much larger and more diverse.

As of winter 2014 when I conducted my interviews, most of this additional tax revenue had been used to fill holes in budgets or to provide additional funding for road maintenance. While three townships mentioned that they had considered reducing property tax rates, none of them have done so. As a result, the taxpayers in these jurisdictions who do not participate in wind leases, while perhaps benefitting from improved roads and services, have not seen any direct financial benefit from the wind turbines. This might explain why so few landowners mentioned the impact on property taxes and why I could not find evidence for my hypothesis that these landowners are investing more in their farms than landowners in the matched case communities. Even if officials in these windfarm communities do not lower tax rates in the coming years, it is possible that as more time passes, the effect of wind energy tax revenues might become more apparent. For example, the matched case communities may increase tax rates to maintain their current level of service, while the revenue provided by the wind turbines might allow windfarm communities to hold tax rates steady. It may be useful to test this research question a few years from now.

Chapter 6. The Demand-side Mechanism

The last two chapters have explored the evidence for the hypothesis that wind turbines help to prevent farmland conversion by reducing the current landowners' willingness to sell farmland. In this chapter, I look at the demand side of the farmland conversion equation, to understand whether wind turbines are making the farmland surrounding them less attractive as potential building sites for new homes.

Though I specifically selected my case study communities in areas where recent census data have shown growth of housing units, interviews with realtors and auctioneers in these areas reveal that there has historically been very little new home construction on previously farmed land. Furthermore, contrary to my hypothesis, these interviewees suggested that new homes were being built in the shadows of the wind turbines, notably not by newcomers to the community but primarily by landowners who had turbines on their property. Using my survey of landowners and analysis of building permits, I find evidence to support this claim, although I propose additional research exploring this in more detail. I conclude the chapter by examining evidence—primarily anecdotal at this point—that the presence of wind turbines impacts the property value of the farmland surrounding them, finding that while it may reduce its value as a building site, there is no negative impact—and perhaps even a positive one—on its value as farmable land.

6.1 Prevalence as a Stated Goal: Interviews with Local Officials

In each of my interviews with local and county officials, I asked a very open-ended question about what connection they saw between wind energy and farmland preservation. Only three of 14 (21%) mentioned that wind energy could reduce residential demand. Two of these interviewees—one a local official in Mixed-benefits (#2) and the other a county official in High-growth (#4)—explicitly said that wind energy might have that effect in some communities but not in their jurisdictions, since demand for new residential development has historically been so low there.

A third interviewee made it clear, however, that discouraging new residential development was not only one of the *possible* effects of wind energy development, but that this deterring effect was a primary motivation for adopting a zoning ordinance that would allow wind development into the community. He reasoned, "We frankly and flat out assumed that if you build wind turbines, they will not come. And therefore, it will stay as agriculture and you will have less development that takes place, and that's what we wanted." He went on to add, though, that this was rarely explicitly stated:

> When the ordinance went in and we had the first hearings, the people that would talk about property values had nothing to base it on. And we really had very little response to give back to them other than the fact of—and we had—you had to be very careful what your response and how you say it because for us to say, "You're right. People won't build houses there. We don't want people to build." You can't say that. In a public hearing that you're doing for land preservation all you can say is, "Our ordinance is put in place and developed for agricultural land preservation. That's one of the pieces that we feel is important for this county."

In my initial research in 2012 to scope out this dissertation, an academic researcher observed that the reduction in new housing demand is the "dirty little secret" connecting windfarms and farmland preservation. In communities where owners of farmland are hoping to earn a profit someday by selling their land for development, knowingly taking

actions to reduce the desirability of that land as a building site would be politically unpopular, at best.

If windfarms really do reduce demand for new home construction in their vicinity, then perhaps it is unsurprising that so few local officials openly discussed such an impact in my interviews. An alternate explanation, of course, is that windfarms do not impact the market for new homes, or at least not in the majority of my selected case study communities.

6.2 Realtor Interviews

My primary method of determining if there is, indeed, an impact on the market for new homes in my selected cases was to interview realtors and auctioneers familiar with the market for farmland in each of my case study communities. These interviews included a historical understanding of the demand for new homes in each of these areas, whether new homes tend to be built by newcomers or by long-time residents, and what impact the presence of wind turbines might be having.

6.2.1 New Home Demand in Huron County: Windfarms 1, 2, and 3

Recall from Chapter 3 that Windfarms 1, 2, and 3 are located within 20 miles of each other in the same county. My discussions with four real estate professionals familiar with this market confirmed that, in fact, there are few distinctions between them. The topography surrounding Developer-friendly (#1) is significantly less flat than in Mixed-benefit (#2) and Neighbor-friendly (#3), and there is more variability in the soils, but this would likely have more of an impact on agricultural land uses than on new home construction.

All of my interviewees insisted that there has been very little demand for new homes in the area, not just in recent years, but for the past couple of decades (see Table 6-1). None could

think of any recent platted developments ("subdivisions") beyond incorporated cities or villages, though one interviewee mentioned a higher-than-average concentration of large-lot rural residences in the townships immediately surrounding Bad Axe. (These townships do not have utility-scale wind turbines and therefore were not within my area of interest.[24])

Table 6-1. Realtor responses to questions about new the home construction market in Huron County

	Demand for greenfield residential development	**Who is building new homes?**	**Impact of wind turbines on market for farmland**
Realtor 1	"Even going back a decade…development pressure was almost nil."	"Maybe we saw some transition where some recreational property became second homes or ma and pa farmer built a new house and junior moves into the homestead."	Agricultural: "Positive income stream" but also obstacle "to farm around."
Realtor 2	"Nothing was being developed here. We are almost immune because of our, like I said, [Huron County is a] peninsula on the peninsula."	"Primarily new construction is …an expansion of farm in terms of junior's house or senior's house because junior got the farm house and I'm building a retirement house."	Much too soon to tell, but "I haven't had a single conversation where the windmill has played a part."
Realtor 3	"Building is really down [in the 2000s, compared to the 1970s]."	"People buying those new homes are definitely top growers, building big homes…. Even doctors aren't building new homes. It's the farm grower that's putting the homes up."	Agricultural: "It's income—income they didn't have before."
Realtor 4	"There has not traditionally been much development at all."	"Only new houses are retiring farmers who give the farmstead to son and they live in the new house."	"It's really too soon to tell."

All of the interviewees independently observed that rather than posing a threat to agriculture, most of the new homes constructed on previously farmed land were built to house someone directly related to the farmland owner. A farmer might also parcel off an acre or two to build a retirement home for himself so that successors could move into the farmstead. Alternately, the son or daughter of the farmer might build a new house to be within easy reach of his or her parents on the farm.

[24] Note that some parcels within Colfax and Verona Townships are under lease to wind developers. Though I am unaware of any plans to develop windfarms in these areas, they could be developed in the future.

This lack of demand for new homes seems linked to both geography and geology. As one interviewee pointed out, Huron County is surrounded on three sides by Lake Huron, isolating it from the rest of the state. The county's largest city, Bad Axe, is home to only 3,070 people, and most of the county is beyond commuting distance to large employment centers in Bay City or Saginaw. Even so, interviewees did not cite the lack of job opportunities as the real deterrent for new residents. Instead, they all commented that demand by farmers for Huron County's rich soils was so high that, in one realtor's words, "the highest and best use changes from potential for development…to agriculture."

Huron County, I was told again and again, has some of the richest soil in the state, yielding more crops per acre than most other counties. Consequently, this farmland is highly prized even when crop prices are relatively low. When prices for agricultural commodities are high, as they have been for the last several years, the demand increases even more as local farmers with more money in their pockets often desire to reinvest it in nearby land. As a result of this demand, the price for tillable land in Huron County is among the highest in the state, having reached an all-time high of $12,000 to $13,000 per acre within the last year.

These high land prices make it difficult for a very weak market for new homes to compete. One realtor recounted that, rather than taking land out of agriculture to build a new home, people are "tearing down old farmsteads so that they can farm the land." Two other interviewees noted that while wooded land used for deer hunting and other recreational purposes previously fetched higher prices than farmland, given high demand for farmland in recent years, even some of the area's marginally fertile woodlots are now being clear and tilled.

Unsurprisingly, then, when I asked these interviewees what impact the wind turbines were having on the market for farmland, none of their responses had anything to do with the

land's suitability as a future building site (see Table 6-1). Two realtors spoke specifically of the impact on the property value but focused on attributes that directly relate to agricultural use: the presence of additional income in the form of a wind lease that might be conferred along with the title, but also the negative impact of adding an obstacle to the field (in the form of a wind turbine and access road). The other two realtors said that it was too soon to tell what impact the turbines might have but gave no indication that they would affect new home building one way or the other.

6.2.2 New Home Demand in the McBain Area: Windfarm 4 (High-growth)

In the McBain area, my interviews with realtors revealed similar findings. Demand for new homes in the area has historically been very low, but the recent recession seems to have had a particularly severe impact on the McBain area. One interviewee recounted, "There has not hardly been a new house built in the last ten years after the downturn." The other interviewee agreed: "You get out west of town here, if there's a wooded piece, it would be a great building site. You just don't see people selling it or building on it. I haven't really seen—I can't think of much at all in the last five years that have really gone on."

I pressed both of these interviewees (as well as the local officials in the McBain area) on this issue, noting that Census data shows that both population and number of occupied housing units in the area had grown from 2000 to 2010. The interviewees did not seem particularly surprised by this information, nor did they disagree with it; however, they attributed most of this growth to young adults who had previously moved away and decided to move back to the area. Some of these young people, they suggested, acted much like those in Huron County—parceling off an acre or two from their parents' homestead to build a new house. Others interviewees

suggested that, especially recently, most of these returning young people have been living in previously unoccupied homes.

One of the realtors I interviewed in McBain also thought that much of the population growth in the area could result from changes in farming practices. In the last decade, he recounted, many of the dairy operations have seen dramatic increases in herd size. "We've got farmers now that are milking over 1,000 cows that ten, fourteen years ago in 2000 were probably milking 200." As a result, a number of year-round migrant workers have moved to the area. Rather than building new homes, "farmers have bought several of the homes in the area that they've either refurbished or whatever. But they rent those or it's part of their pay."

Whereas most of Huron County has prime agricultural soils, northwestern lower Michigan is predominantly forested. In fact, some of the best farmland in the area is on the high ground near McBain where the windfarm is sited. Because the region's relatively small agricultural sector reduces competition for land, and the soils are more varied than in Huron County, farmland values in the McBain region are less than a third of the price of parcels in Huron County (both realtors quoted a price of $3,500 per acre). One realtor who has sold land across the state noted that "farm ground in this greater McBain area is still a pretty good bargain for a lot of people."

As in Huron County, the realtors I interviewed near High-growth (#4) believe that the impact of the windfarm on the market for farmland is linked more to its use as tillable agricultural land than to its development potential. Regarding what impact the turbines might have on its agricultural use value, both interviewees agreed that they have not seen it factoring in at all. One commented, "It [the windfarm] makes no difference. I mean, if they're looking to expand their farm and it happens to be close to a windmill, believe me, I can—it will still get

sold for probably $3,500 an acre." The other realtor commented, "I think the vast majority of the change in values and demand and all that type of thing out there has been more of a reflection of the changes in the ag market than to say the turbines have had much of an impact in this area specifically."

6.3 Additional Evidence of Windfarm Impact on New Home Construction

The topic of windfarms' impact on new home construction also arose unexpectedly in my interviews with two non-realtors. Significantly, they both suggested that if there was any impact, it was that existing farmland owners—especially those with income from wind leases or royalties—were using this money to build new homes, a distinction that I had not anticipated in my original hypothesis. A local official in Developer-friendly (#1), when asked about any new construction in his township, made this case directly: "If you can believe it or not, the windmills created a couple new ones [homes]." He then went on to talk about the large royalty checks that landowners with multiple turbines on their property have been receiving.

Even the planning official who made a direct, if not public, connection between the windfarms and a reduction in new home construction (see section 6.1, page 116) alluded to this. When asked whether he believed that the farmland preservation goal of the zoning code had proven effective, he admitted, "New houses are going up, they are. New houses are going up in the country[side], they are. Primarily the new houses that are going up in the country are new houses that are owned by the landowners that are there, not that they sold a 10-acre lot off." Here, while not directly tying the new construction to windfarm-related income, this official is clearly making the distinction between new construction that is compatible with farming (i.e., built to house the farmer's family) and new construction that threatens agriculture (i.e., carving out large lots for non-farming residents).

Because my research questions were not set up to test this specific finding, I have no direct way of definitively verifying that the impressions of these two interviewees hold true, nor can I determine whether they apply more broadly across the four case study windfarms. One of the questions on my landowner survey did, however, ask about expenditures on home improvements, which could potentially capture some evidence of new home building. I also acquired building permit data from all 14 jurisdictions—both windfarm and matched cases—within my study to assess the feasibility of analyzing these records. As described in more detail below, both of these analyses give some credence to the idea that new homes are being built primarily by landowners with wind-related revenues. However, analysis of the building permit data for one township also suggests that more than half of the new homes built in that township are not being built by owners of farmland, but additional analysis is required to determine if these landowners are related to the owners of the surrounding property.

6.3.1 Survey Data

As described in Chapter 4, in order to test my hypothesis (H1) that landowners with turbines on their property were putting more money into their farms, I asked a series of investment-related questions including one about home improvements. The text of the question—"Since 2008, about how much money have you spent on improvements to your home (even if that home is not in [autofill] County)"—never explicitly mentions new home construction costs, which limits my ability to tie the responses directly to the claim that those with turbines on their property are building new homes. Even so, at least one respondent noted next to her response for this question that she had "built [a] new home," so there is some reason to believe that some respondents interpreted the question to include new construction expenses, though others might not have reported such expenditures.

ANOVA analysis of the 1,144 valid responses shows that landowners with turbines on their property have invested significantly more money in improvements to their homes in the last five years (see Table 6-2). In contrast, landowners in windfarm communities without turbines on their property are statistically no different from their counterparts in a matched case. This holds even after I account for the number of acres the landowner farms (see Table 6-3). While investment in one's home increases with each additional acre farmed, those with turbines on their property are likely to invest $11,135 more in their home than a neighbor who farms just as much land but doesn't have a turbine, and $13,240 more than a similarly situated neighbor in an area without turbines. This relationship holds true in both Huron County and the McBain area.

Table 6-2. Landowners' investments in their homes since 2008

	Turbines	Neighbors	Matched case
Less than $10,000	39.4	53.0	50.3
$10,000-49,999	36.4	35.4	39.3
$50,000-99,999	13.6	5.8	5.9
$100,000-149,999	3.8	2.4	2.2
$150,000-199,999	2.3	1.5	1.3
$200,000-249,999	2.3	1.1	0.4
$250,000-299,999	0.8	0.4	0.4
More than $300,000	1.5	0.5	0.2
Number of respondents	132	551	461
Mean*	$41,969	$25,680	$24,030
Standard Deviation	63,045	46,945	40,290

*Calculated using mid-point of range for each response category, $0 for first category and $325k for last category

Table 6-3 Linear model of home improvements

*This table demonstrates that acres farmed and having a turbine are both important predictors of home improvement investment. Per the model, "Matched case" and "Neighbor" respondents who do not farm invest $19,513 in their farm, while "Turbine" respondents who do not farm invest $32,753 ($19513 + 13240). For all respondents, with each additional acre farmed, home improvement investments increase by $21, so a "Turbine" respondent who farms 100 acres would be predicted to invest $34,853 ($32753 + 21*100). The Multiple R-squared value, however, indicated that this model has very low predictive power (3.6%).*

Linear model terms	Coefficients (in $)	p-value
Intercept (base amount of investment for "Matched case" respondents)	19,513	<0.001
Acres farmed (additional investment for each acre farmed, in $/acre)	21	<0.001
Additional base investment for "Neighbors" compared to "Matched case" respondents	2,105	0.47237
Additional base investment for "Turbines" compared to "Matched case" respondents	13,240	0.0047
Multiple R-squared	0.036	

Again, because this question was not specifically designed to determine which landowners constructed new homes, it is impossible to know which of the respondents are reporting improvements to an existing home and which are reporting new home expenses. One way to account for this is to assume that the largest expenditures might be for new home construction as opposed to remodeling or routine improvements. While a higher percentage of respondents with turbines reported at least $250,000 of home-related expenses (2.3% compared to 0.9% of their neighbors and 0.6% of respondents in matched case communities; see Table 6-2), these numbers are not statistically different because of the overall low number of respondents (11) who reported such high expenditures.

In summary, while responses to the survey question about home improvement expenditures do support a claim that landowners with turbines are investing significantly more than average in their residences, there is no definitive evidence that it is for new construction.

6.3.2 Analysis of Building Permits

When I first heard the claim that new residences being built in windfarms were on the property of landowners who also hosted wind turbines, I requested building permit data for each of the 14 townships in my study area, in communities with and without a windfarm. My original plan was to closely investigate the permits in windfarm communities to determine if the homeowner also had a turbine lease, as well as to compare the total number of building permits for new homes in windfarm communities with their matched case counterparts. After sorting through the data, I determined that neither of these approaches would be sufficient to better understand whether windfarm income was encouraging rather than discouraging new home construction, and what impact that might have on farmland preservation.

One of the key hindrances to using building permit data is inconsistencies between jurisdictions in both record-keeping practices and the level of detail about permits that they make available to the public. Because building permits were administered through a county department, there was consistency between townships within the same county, but no two of the four county-level reports contained the same information or level of detail. For example, the report from one county provides a full description of the project, including floor space dimensions and construction value. In the neighboring county, the only report that I was able to obtain does not even distinguish between new residences and new accessory buildings—the latter of which far outnumber the former. Furthermore, some counties provided only lists of the permits that were issued, and so there is no way to tell if the structures had actually been built. Thus, without more data, it is impossible to make direct comparisons between case studies.

Another problem with looking only at building permit data is that there is no way to determine if the new home was built to replace an old home, or if it was built on farmland that

had recently been in active use for agriculture. If the former, there would appear to be little or no negative impact on farmable acres. If the latter, though, this would appear to have a detrimental effect on farmland preservation, unless, as some of my interviewees suggested, the new home was built to house a family member (e.g., an adult child or niece/nephew) who would be part of the farming operation. Many of my interviewees saw carving off a couple of tillable acres for relatives as a positive sign for the farm because it suggests that a younger generation will be there to take over. But because that family member may not have the same last name as that of the farmstead owner, there is no easy way to definitively establish whether there is a familial tie between the owner of the new house and the owner of the farmland on which it was built without asking one of them directly.

Despite these limitations, I wanted to determine whether I could use building permit data to at least probe the claim made by the local official in Developer-friendly (#1) that landowners with turbines on their properties were the ones building houses. According to building permit data, permits were issued for seven new homes in this official's township from January 2008 through March of 2014 (see Table 6-4). Only one of the seven of the new homes is definitively owned by someone who also hosts a turbine. Another was owned by someone who is a participating landowner in the windfarm but does not host a turbine. A third was built by a landowner who owns farmland in the township but does not receive any income (through either leases or royalties) from Windfarm 1. The remaining four owners of these new homes were not listed by name on the sample frame of agricultural landowners, though one of these four built on the land of someone who shares his last name (likely a relative).

Table 6-4. Relationship between wind lease and new home building, part of Windfarm 1

	Owned ag land in 2014	Hosts turbine	Is a participating lease holder
New Home 1	X		X
New Home 2			
New Home 3			
New Home 4			
New Home 5	X	X	X
New Home 6			
New Home 7	X		
Total ag landowners in township	160	22	37
% of sample frame with new home	1.9%	4.5%	5.4%

The analysis for this one township shows that 5.4% of owners that receive some income from wind developers (either royalties or lease payments) built a house from 2008-2014, compared to 1.9% of all agricultural landowners in the township. Because this finding is based on non-sampled data, there is no need for statistics and so these numbers can be treated as absolute differences. Therefore, the interviewee's assessment that those with revenues from wind turbines are building new homes appears to have some merit, though a higher likelihood of building a new home is linked to landowners who receive any sort of revenue from a wind developer and is not limited to those who host turbines. However, four of the seven (57%) new homes built in the last six years appear to be built by people who do not own farmland and may not be associated with a farm.

Again, given the limitations of the available data, this conclusion is only speculative. However, further analysis of building permits and interviews of owners of newly built homes would allow for a clearer understanding of who is building new homes in these windfarm communities, and how much land these new homes are taking out of production, especially compared to the impact of new residences in matched case communities.

6.4 Wind Impacts on Property Values

There is a growing body of research on the impact of windfarms on property values of existing homes, some of which makes the case that home values decline around windfarms because few people want to live near them. The same reasoning might logically be applied to agricultural land prices: if demand for new housing drops in areas with wind turbines, agricultural land values might drop as well. Of course, this line of reasoning is based on the traditional assumption that a greenfield agricultural parcel is most valuable as a residential building site. Indeed, use-value taxation or use-value assessment, a nearly ubiquitous farmland preservation tool[25], is based on the very assumption that taxing a property at its value as farmland rather than its potential development value will reduce a farmer's tax burden, making farming more economically viable. However, as Section 6.2 explained, the demand for farmland for residential development has been very low in all of my selected case studies—not just recently as a result of the economic downturn, but also historically.

6.4.1 Realtor Explanations

All of the realtor interviewees told me that farmland prices in my study areas have historically followed commodity prices—particularly that of corn. When commodity prices rise, so do farmland prices, most recently to unprecedented levels: $12,000 per acre in the Thumb and $3,500 per acre in the McBain area, compared to $4,000 and $2,500, respectively, a decade ago. In both areas, the parcels that fetch the highest prices are those with rich well-drained soils and those that are easier to farm: square or rectangular parcels with few obstructions (e.g., trees, rocks, utility poles). Furthermore, parcels with larger patches of tillable acreage typically fetch a

[25] This tool is used in all states except Michigan. Instead, Michigan has a term-based farmland development rights program (P.A. 116) that allows owners of farmland to voluntarily enroll eligible lands for 10 to 90 years, receiving a property tax credit and exemption from urban infrastructure special assessments in exchange for agreeing to keep the land in an agricultural use.

higher per-acre price than smaller tracts. Thus any negative impact of wind turbines on agricultural land values might be tied to reductions in the ease of farming.

Both of the realtors I interviewed in the McBain area told me that the presence of a windfarm was immaterial to an agricultural parcel's value. One noted: "It makes no difference. I mean, if they're looking to expand their farm and it happens to be close to a windmill, believe me, I can—it will still get sold for probably $3,500 an acre [the going rate for ag land in that area]." The other noted, after first saying that the presence of the wind turbines has not impacted the market price for land, "So I think if anything, maybe it's had maybe a little more positive effect on farm ground from that perspective in terms of cash flow [from a wind lease]."

In Huron County, realtors expressed much the same sentiment, with all four interviewees noting that if there had been any impact on property values, it was negligible. In the words of one realtor, "I haven't had a single conversation where the windmill has played a part, to be honest." One of my interviewees in the Thumb, in addition to having a realty company, was an appraiser specializing in farmland. Though he agreed that he hasn't seen any impact on property values, he laid out arguments about how the presence of the turbines might both increase and decrease property values. On one hand, when considering wind leases, he noted, "Any time that you have a positive income stream you're creating value." On the other hand, higher values are associated with regularly shaped farm tracts without obstacles, so the nuisance of having to farm around a turbine or access road in the middle of a field could reduce the land's value.

Four of the six realtors had recently been party to the sale of property with a wind lease or wind easement attached to it. In two of the transactions, the seller retained the wind lease; in the other two, the lease was transferred to the buyer. All indicated that although the buyer knew there was a wind lease, they did not believe it impacted the selling price. One realtor who

represented a buyer who would not be getting the wind lease as part of the land transaction said, "I didn't see a change in the price from it [not getting the rights]. Maybe he [the buyer] thought it privately, but it's not something he ever talked to me about." Another realtor who represented the seller in a transaction where they buyer received the rights recounted:

> Realtor: They [the buyers] did ask about it [the wind lease]. It was not going to be a make it or break it part of the deal on that for them. They prefer that they get all the rights, which who doesn't? But if they didn't they weren't going to say, we're out.
> Interviewer: Got it. And it didn't—
> Realtor: Didn't change what they were willing to offer or anything like that.

To reiterate, in both the McBain area and the Thumb, the value of agricultural parcels is driven largely by their value as tillable land and not by their development potential. Realtors did mention, however, that turbines might have an impact on the marketability of existing residential properties. While all interviewees acknowledged that windmills might dissuade some potential buyers from moving to the area, I was most commonly told that the turbines were having no impact on the value of existing homes. The most common explanation was that buyers from afar might be deterred by the turbines, but local buyers were the primary market for homes, and they did not seem as bothered by the potential impacts.

6.4.2 Landowners' Perspectives

The survey of landowners directly asked about the impact of the windfarm on property values. As Table 6-5 shows, opinion is split roughly evenly between those who agree and disagree that wind turbines reduce nearby property values. There is, however, a significant difference of opinion between landowners in communities with wind farms and those in the matched case communities, with the former group less convinced of a negative impact on property values. There is also a difference across the wind communities themselves: landowners in Developer-friendly (#1) are significantly more likely to say that wind turbines

reduce property values than landowners in High-growth (#4).

Table 6-5. Survey responses to the question "How strongly do you agree or disagree that wind turbines reduce nearby property values?"

					Wind cases			
	All respondents	Matched case	All windfarm		Developer-friendly (#1)	Mixed-benefit (#2)	Neighbor-friendly (#3)	High-growth (#4)
Strongly disagree	12%	8%	14%		10%	19%	14%	14%
Disagree	42%	40%	44%		44%	42%	42%	50%
Agree	31%	36%	28%		28%	27%	28%	29%
Strongly agree	14%	15%	14%		19%	13%	16%	7%
Total	**100%**	**100%**	**100%**		**100%**	**100%**	**100%**	**100%**
Number of respondents	1140	457	683		200	216	160	107
Mean		0.1	-0.16		0.02^{a}	-0.27^{ab}	-0.11^{ab}	-0.36^{b}
Standard Deviation		1.3	1.35		1.37	1.36	1.37	1.23
p value		<0.001			0.065			
Mean is calculated by assigning numbers to the response categories				Strongly disagree = -2				
				Disagree = -1				
				Agree = 1				
				Strongly agree = 2				
The superscripts next to the mean scores indicate whether means across case studies are statistically different.								
Where columns share a letter, they are statistically indistinguishable.								

Relatively few (n=10) respondents provided additional comments about property values in the survey, though the comments were again largely split. Like many of the realtors I interviewed, two respondents noted that there were differential impacts on residential and agricultural parcels: reduction in home values but no impact on agricultural land values. Three respondents discussed across-the-board reductions in property values in rural areas (two of the three live in windfarm communities but do not have turbines on their property). Another respondent specifically noted that turbines reduce the value of agricultural land "if it was intended for future development" and also pointed to possible reductions in value where underground transmission lines cross a property. In contrast, four respondents—one of whom had a turbine on her property and three others in the matched case communities—believed that

the value of agricultural land might increase as a result of having wind farms in the area. As one respondent noted, "a wind turbine on our property has made the property more valuable because of the increased cash flow."

6.5 Answering Research Questions and Testing Hypotheses

The data collected for this chapter was intended to test the hypothesis (H3) that proximity to a windfarm reduces residential demand for farmland, as well as a follow-up hypothesis (H4) that this impact would be felt most acutely in areas with higher demand for new residential housing. Although three of the four case study sites selected for this project had seen growth in both the number of occupied housing units and population from 2000 to 2010, interviewees in all case study sites insisted that there was no—or at least very little—demand for greenfield building sites, even before the recent recession. This observation holds true even in High-growth (#4), which saw an 11% rise in occupied housing units from 2000 to 2010. As a result, I must reject my null hypothesis (H3 and H4), but I suggest replicating this study in a windfarm community that *has* been experiencing development pressure.

Though these hypotheses proved to be difficult to test, my overarching research question about the existence of a demand-side mechanism connecting wind energy and farmland preservation did turn up some interesting findings. Specifically, the data point to a potentially unanticipated relationship between wind energy income and new home building. Notably, many interviewees made the distinction between development on farmland by outsiders and houses built by family members associated with the farm. They saw the former as a threat to agriculture but perceived the latter as good for the community, a sign of vitality and an increased likelihood that there will be someone around to pass the farm onto. A couple of interviewees also asserted that landowners who are receiving wind income are building new houses on their property, either

to replace an aging farmhouse or as a retirement home for themselves so that their heirs can move into the original farmstead. Data from my survey of landowners confirm that those with turbines on their property are investing more in home improvements. Building permit data for one of the nine windfarm townships show that landowners receiving wind revenues are nearly three times as likely to pull a permit to build a new home as farmland owners without turbines; however, a greater number of new homes were built by people who did not own farmable tracts (i.e., those building rural estates) than by those who owned farmland. Additional research is warranted to determine what relationship, if any, the owners of these new homes have to farmers and to see whether these new homes were replacing old homes or not.

Chapter 7. The Zoning Mechanism

While the previous chapters have considered whether wind turbines alter the motivations of sellers and buyers of farmland, this chapter looks at the impact of zoning regulations on the availability of developable land. As with other zoning regulations, the premise behind my zoning mechanism hypothesis (H5) is that even if sellers desire to sell their land for development and buyers are not deterred by the presence of a turbine nearby, the setbacks established by the zoning ordinance effectively render some land surrounding the turbines off-limits for development. This chapter not only quantifies this impact in each of the windfarm case studies, but also explores the competing interests local officials must balance in establishing zoning regulations. I find that although larger setbacks theoretically preserve more land and are preferable to neighboring landowners who wish to be buffered from the turbines, setbacks that are too large may make wind development infeasible and upset farmland owners who wish to site turbines on their property.

In later sections of this chapter, I introduce evidence from my landowner survey that contradicts the zoning hypothesis and suggest additional research that utilizes geospatial analysis to further quantify land use change in windfarm communities. First, I find that in the last five years, more farmland has been lost to non-agricultural uses in windfarm communities than in their matched case counterparts. Geospatial analysis could help determine whether these losses are occurring within the vicinity of the turbines, which would directly contradict the zoning hypothesis; or if they were distant from the turbines, which would essentially transfer farmland

loss from one area of the township to another. Furthermore, survey responses suggest that some of this loss is for infrastructure to support the windfarm itself: access roads, transmission lines, and electrical substations. I explain how quantifying this impact and determining whether this impact is minimized through alternative turbine siting practices—e.g., placing turbines and access roads on property lines rather than in the middle of fields—would provide local officials with additional information as they establish wind zoning ordinances.

7.1 Prevalence as a Stated Goal

In my interviews with local officials and wind developers, only one interviewee—a wind developer—mentioned zoning setback requirements when asked to think about the connection between wind development and farmland preservation. Because this interviewee's position involves researching local ordinances at the early stage of wind development to see if a project would be feasible, it is perhaps unsurprising that he would mention it. In his words:

> I don't know how it [the windfarm] can do anything but preserve farmland, just because the ordinances are in place so you can't put houses…. Areas 1500 feet around a wind farm can't be developed [according to some zoning ordinances]. So to me that's—I think that's probably gonna help preserve the farmland. And generally if you got a windfarm you're gonna have a whole slew of them, you're gonna have probably a minimum of 10 and up to 100 [turbines]. …So that's a big area that really you're not going to be able to do a whole lot of development.

Since this language echoes that of my own hypothesis (H5), it seems that my hypothesis has some merit, at least in the experience of this one practitioner.

It may seem curious, though, that no local officials mentioned a connection between zoning ordinances and farmland preservation, especially given that eight of the nine townships in my study area regulate wind turbines within their zoning ordinances with setbacks ranging from 720 to 1,320 feet. However, as noted in previous chapters, most of these officials do not believe that development has posed a threat to farmland in their jurisdictions, so they are unlikely to see

reducing the amount of developable land as something that would benefit the local agricultural enterprise. Even so, if development pressures increase in the future, these setbacks might play a role. Furthermore, in rural areas where development *is* a threat, these setbacks could have an impact. The next section uses the existing zoning ordinances to help quantify that impact.

7.2 Setback Distances

Of the nine jurisdictions with wind turbines in my study area, three have township-level zoning ordinances, five are zoned through a county-level ordinance, and one is unzoned. Though there are a number of similarities among these zoning ordinances—especially between two of the three in Huron County—they all have some slight differences. This section looks specifically at the impact of their regulations regarding setback distances from inhabited structures on the amount of potentially developable land.

It should be noted that when determining appropriate setback distances for wind turbines, local officials most commonly think about suitable distances to buffer existing infrastructure from any potentially adverse effects of the turbines. As a result, setbacks often apply not just to buildings, but also to a wide range of other types of infrastructure and land uses (see Table 7-1). When a wind developer is planning to site a project, all of these setbacks must be taken into consideration and applied to the existing landscape elements to identify the zoning constraints for the project. Because I am effectively reverse-engineering this process and treating the wind turbines as the existing landscape elements that constrain locations for habitable structures, this analysis ignores the other setback distances.

Table 7-1. Setback distances from various types of infrastructure in the case study windfarm communities

	Huron County	Chandler Township	Oliver Township	Highland Township
	Windfarms 1 & 3, part of 2	**Mixed-benefit (#2)**	**Mixed-benefit (#2)**	**High-growth (#4)**
Inhabited structures	1,000' for participating; 1,320' for non-participating	1,320'	1000' for participating; 1320 for non-participating	1.5 x total height
Property lines	None; easement if less than 1.5 x hub height	None; easement if less than 1.5 x hub height	1.5x total height	1.5 x total height
Border of overlay zone	2 x hub height	2 x hub height		
City or village	1,320'			
Public Road	(Greater of) 400' or 1.5xhub height	(Greater of) 400' or 1.1 x hub height	1.5 x total height; 1 x hub height when leased on both sides of roadway	1.5 x total height
Communication & electrical lines	(Greater of) 400' or 1.5xhub height	(Greater of) 400' or 1.1 x hub height		
Exceptions with written consent from property owner?	"Considered"	"Considered"	Considered, but must be at least greater of 1.5 x total height or 660'	"May be approved"

7.2.1 Availability of Land for Development

GIS analysis using the turbine locations for each of the case study windfarms and the existing zoning ordinance setback distances shows that there is great variation in terms of the number of acres rendered undevelopable as a result of the windfarm, ranging from 187 acres to 2,860 acres (see Table 7-2). Even after I account for the number of wind turbines in each wind

project, the amount of land per turbine rendered undevelopable by the presence of the turbines ranges from 6.9 acres per turbine to 84.7 acres per turbine.

Table 7-2. Land rendered undevelopable in windfarm case studies, based on existing zoning ordinance in each

	Developer-friendly (#1)	Mixed-benefit (#2)	Neighbor-friendly (#3)	High-growth (#4)
Total area of townships (acres)	46,082	58,224	45,864	46,693
Number of turbines	46	33	40	29
Setback	1,000' for participating; 1,320' for non-participating	1 township: 1,320' 2 townships: 1,000' participating / 1,320' non-participating	1,000' for participating; 1,320' for non-participating	1 township: none 1 township: 1.5 x total height
Total acres "undevelopable," with current zoning code*	2,729	2,794	2,860	187
Acres per turbine "undevelopable"	59.3	84.7	71.5	6.4
* Where zoning code differentiates between participating and non-participating landowners, I assume all landowners are participating.				

By far, the largest contributing factor in these differences is the specifics of the zoning ordinance. In High-growth (#4), only five of 29 turbines are in a township with zoning, and even then, the setback distance is only 720 feet, smaller than the setbacks in all other projects. By contrast, in Mixed-benefits (#2), the 1,320-foot setback applied to the 13 turbines in Chandler Township renders 1,433 acres undevelopable, which exceeds the 1,361 acres rendered undevelopable from the 20 turbines in neighboring McKinley and Oliver Townships, where the setbacks are 1,000 feet for participating landowners. To demonstrate the impact of setback distances on land potentially preserved from development, I also ran a GIS analysis for each of the windfarms using the setback distances specified in the zoning ordinances in this study (see Table 7-3).

Table 7-3. Impact of setback distance on the amount of land rendered undevelopable in windfarm case studies

	Developer-friendly (#1)		Mixed-benefit (#2)		Neighbor-friendly (#3)		High-growth (#4)	
	Acres	Acres/turbine	Acres	Acres/turbine	Acres	Acres/turbine	Acres	Acres/turbine
1.5 x total height*	1,104	24	1,272	39	1,570	39	922	32
1000 ft setback	2,729	59	2,262	69	2,860	71	1,907	66
1320 ft setback	4,080	89	3,594	109	4,796	120	3,113	107
* Total height varies based on turbines used in each project				Windfarm 1: 389'				
				Windfarm 2: 489'				
				Windfarm 3: 492'				
				Windfarm 4: 458.9' (weighted average of 3 different sizes of turbines)				

Through this second analysis—holding the setback distance constant across projects—it becomes evident that there is more at play than simply the setback distance. Notice, for example, that in Developer-friendly (#1), a 1,320-foot setback distance renders 88.7 acres per turbine undevelopable. By contrast, in Neighbor-friendly (#3), the same setback impacts 119.9 acres per turbine, effectively making 35% more land off limits to development (see Table 7-3). A key reason for this is turbine placement. In Developer-friendly (#1), turbines are placed closer together, with as many as seven turbines per township section,[26] making all but two of the 46 setback distance circles overlap (see Figure 7-1). In Neighbor-friendly (#3), though, turbines are much farther apart, with no more than five turbines per section and 14 of 40 turbines having non-overlapping setback distance circles (see Figure 7-2).

The reason for these differences is rooted in a policy change, but can be instructive in understanding how setback distances impact turbine density. Prior to the construction of Developer-friendly (#1), Huron County's zoning ordinance called for a 1,000-foot setback from all properties. Following complaints, primarily by neighbors of Developer-friendly (#1), the county changed its ordinance to require 1,320-foot setbacks from homes of non-participating

[26] This unit of measure comes from the Homestead Act of 1862, which standardized the surveying of western territories to create townships of 36 square miles divided into 36 sections of one square mile each. In many rural areas in states west of Pennsylvania—including Michigan—most roads still run along section lines, making the township section an easily distinguishable geographic feature.

landowners (that is, those not in the royalty pool) and 1,000-foot setbacks from homes of participating landowners. This ordinance change meant that any new turbines—including those in Neighbor-friendly (#3)—must be farther from homes of non-participating landowners, though turbines within Developer-friendly (#1) were able to continue as non-conforming structures (i.e., they were "grandfathered in"). By increasing the setback distances, the new ordinance expanded the footprint of the "no-turbine" zone around these homes, making the areas where turbines could be sited both smaller and less contiguous. While wind developers aim to maximize the density of turbines to take advantage of economies of scale within the development process, there are technical limits to how proximal turbines can be to each other without wind from one turbine disrupting airflow of another downwind. As a result, increased setback distances have the added effect of reducing the density of turbines.

Figure 7-1. Theoretically undevelopable area in Developer-friendly (#1), with a setback distance of 1,320 feet

Figure 7-2. Theoretically undevelopable area in Neighbor-friendly (#3), with a setback distance of 1,320 feet

I would be remiss if I did not note that all four of the zoning ordinances in the chosen windfarm case studies allow for exceptions (not variances, per say) to the setback distances with written consent from the affected property owner. Interviewees in each of the projects noted that, during the turbine siting process, these waivers allowed wind developers to site turbines where they might not otherwise have been able to do so. Conversely, though, someone wishing to build a new house closer to the turbine—in the area that I have considered "undevelopable"—

might also be able to do so. Tracking how often waivers are granted to build within the wind turbine setback zone would be a good follow-up to this part of the analysis.

7.2.2 Balancing Competing Needs and Property Rights

As with any land use regulation, local governments must balance a number of competing interests when setting regulations related to wind energy. On one hand, larger setbacks help buffer neighbors from some of the noise, flicker, and visual impacts of the turbines, and, as I just established, might help preserve more farmland. On the other hand, large setbacks make it more difficult for wind developers to site turbines. The turbine-siting process effectively involves drawing the inverse of the maps generated in Section 7.2.1, establishing "no-turbine" zones around the existing houses, property lines, and road right-of-ways to determine areas where turbines can be built. Thus, smaller setbacks give wind developers more flexibility in siting turbines and the opportunity to site more turbines within a given area. As a result, landowners who would financially benefit from having a turbine on their property are more likely to favor small setback distances, while those who will not directly benefit from wind turbines are more likely to favor larger setback distances—perhaps even distances large enough to preclude siting *any* turbines in the jurisdiction.

This idea of balancing community interests was frequently mentioned by local officials in the windfarm communities who were involved in adopting zoning ordinances regulating the turbines. When asked how they arrived at a setback distance that exceeded that of the county zoning at the time, an official in Mixed-benefit (#2) recalled:

> I guess always in the back of our minds we said, "Okay, the farmers that have the windmills, it's a benefit to them. But we do not want it to be a problem for a person that's not benefitting from the windmills." So that's why we, we put in some more restrictive setbacks and so forth.

Another official recounted that, in establishing the wind zoning ordinance, the planning commission's goal was to:

> Try to hit a happy medium that will work [for residents], [but one where] the developers will still say, "Yes, we can build."… It's impossible to write an ordinance that protects everybody in your county. You can't do it. Somebody's not going to be happy. Somebody got stepped on. Somebody didn't get what they wanted. But we wanted to try and do what we felt was in the best interest of most.

One of my interviewees acknowledged that this balancing act is a bit easier in an area with more homogenous land use. He recounted that, in a nearby township that has roughly even numbers of farmers and owners of lakeshore recreational homes, the decision to establish setbacks that effectively prohibit wind development led to threats of secession by the farmers. In contrast, he noted that his township's residents—who are predominantly farmers—largely agreed that the zoning ordinance should not "dictate to a farmer what they can and can't do with their property."

This local official was not the only interviewee to note that there was great reluctance within these communities to restrict landowners' ability to do what they want with their land, even if that includes hosting a wind turbine. In Developer-friendly (#1), where the zoning process was the most contentious of my case studies, one interviewee noted that nearly all of the people who came to hearings about the wind turbines were opposed to them. "But my feeling was what authority do I have to tell you what you can do with your land? ... If you want a windmill and they offer you one, take it. If you don't want it, you don't take it." Only one official overtly tied this issue to property rights, reasoning that if local zoning is too restrictive, it "treads on the rights" of large landowners. "At the same time, the person with two acres should have the same amount of rights." In this official's opinion, existing zoning was not adequately balancing these two interests.

7.2.3 Where There is no Zoning

Precisely because zoning ordinances are designed to balance the needs of competing interests in the community, one might expect that in the one windfarm jurisdiction with no zoning, the interests of one class of residents would benefit to the detriment of the others. When I recounted to local officials in Huron County that one of the jurisdictions in High-growth (#4) was unzoned, they reacted with astonishment, claiming that there must be lawsuits and many unhappy residents as a result.[27] Indeed, some might point to a recent court case in Windfarm 4, where a landowner sued the wind developer for siting a turbine too close to his property, as evidence that in the absence of zoning, landowners without turbines on their property are more likely to have their rights ignored.

In examining the battery of questions in the landowner survey about the perceived positive and negative impacts of wind energy as an indicator of the landowner's overall opinion of wind turbines (previously discussed in Section 4.3.4), I find quite the opposite. In Richland Township, where there is no zoning, both landowners with (see Table 7-4) and without (see Table 7-5) turbines on their property are more convinced of the positive impacts of wind energy and less convinced of the negative impacts than their counterparts in all other communities with wind turbines.

[27] To the best of my knowledge, this is the only unzoned Michigan jurisdiction with a utility-scale windfarm. However, there are a number of unzoned jurisdictions in Michigan, including all of the townships in Missaukee County, where Richland Township is located. In future research in my post-doctoral appointment managing the Michigan Public Policy Survey, I hope to include a question about zoning on this biannual survey of local officials across the state to better understand the prevalence and geography of zoning ordinances.

Table 7-4. Opinions on the possible impacts of wind energy (farmland owners in windfarm townships with turbines on their property)

	Richland Township "turbines"	All other windfarm "turbines"	Statistical significance
Create jobs	1.50	1.14	
Disrupt bird migration	-1.7	-1.27	*
Create noise pollution	-1.5	-0.59	***
Produce visual or aesthetic problems	-1.7	-0.77	***
Provide revenues for land owners	1.50	1.23	
Disrupt local weather patterns	-1.60	-1.30	
Cause human health problems	-1.70	-1.33	*
Preserve rural land	1.33	0.18	***
Help limit climate change	-0.75	-0.46	
Reduce nearby property values	-1.56	-0.87	**
Mean is calculated by assigning numbers to the response categories:		Strongly disagree = -2	
		Disagree = -1	
		Agree = 1	
		Strongly agree = 2	
p-values significant: *** <0.001 ; ** 0.001 - 0.01; * 0.01 - 0.05			

Table 7-5. Opinions on the possible impacts of wind energy (farmland owners in windfarm townships without turbines on their property)

	Richland Township "neighbors"	All other windfarm "neighbors"	Statistical significance
Create jobs	0.84	0.70	
Disrupt bird migration	-0.968	-0.455	*
Create noise pollution	-0.167	-0.048	
Produce visual or aesthetic problems	-0.133	0.0712	
Provide revenues for land owners	1.37	1.06	*
Disrupt local weather patterns	-1.00	-1.00	
Cause human health problems	-0.57	-0.73	
Preserve rural land	-0.30	-0.31	
Help limit climate change	-0.60	-0.56	
Reduce nearby property values	-0.19	0.04	
Mean is calculated by assigning numbers to the response categories:		Strongly disagree = -2	
		Disagree = -1	
		Agree = 1	
		Strongly agree = 2	
p-values significant: *** <0.001 ; ** 0.001 - 0.01; * 0.01 - 0.05			

The wind developer in High-growth (#4) believes that the very absence of zoning regulations led to more opportunity to discuss with landowners where turbines would be optimally placed:

> Landowners initially were always happy, because we were dealing directly with them…. [If a change needed to be made once construction started] we could do that on the fly with a couple of landowners' consent and boom, boom, boom, no problem. If it was an ordinance-regulated deal, we may have to go back through the whole site planning for 30 or 60 days.

However, given that in neighboring Highland Township, where there are zoning regulations, landowners are similarly enthusiastic about wind energy, the positive attitudes of landowners in Richland Township are more likely the result of the wind developer's practices in Windfarm 4 as opposed to the lack of zoning regulations. Even so, it does not appear that the absence of zoning regulations has resulted in an adverse distribution of property rights.

Such a finding might be at odds with conventional wisdom, but it is not unprecedented in the literature, especially in rural communities. In his 1991 book about cattle grazing in California, Robert Ellickson found that "members of tight social groups will informally encourage each other to engage in cooperative behavior" (1991, 167), turning to legal rules only "when the social distance between them increases, when the magnitude of what is at stake rises, and when the legal system provides an opportunity for the disputants to externalize costs to third parties" (283). Indeed, when asked to explain why there has been so little windfarm-related conflict between neighbors in Richland Township, one local official explained, "I think first of all they try to maintain that good neighbor policy. And the other: most of them are all related. Yeah. If you're related you let things—you accept it." Additional research is warranted to determine whether Richland Township is an anomaly—a peaceful unzoned jurisdiction with a windfarm—or not as rare as most would believe.

7.2.4 Township versus County versus State Control

Though this concern was not the focus of my research, four local officials expressed—unprompted—a fear that the state might decide to withdraw its delegation of zoning powers for wind energy and make all siting decisions at the state level as is done in 12 other states. While most (27 of the 50) states do delegate land use regulation and siting authority for renewable technologies to local governments, a move toward centralization would not be unprecedented, especially if the state decides to increase its Renewable Portfolio Standard and mandate that a higher percentage of electricity come from renewable sources. Where economically viable renewable energy projects sites are limited or local opposition is particularly strong, some states, including nearby Ohio and Wisconsin, have chosen to move siting authority to the state level to ensure that utilities are able to meet RPS targets (Rynne et al. 2011).

Michigan has not seriously considered removing local control over wind siting (at least, not to the extent that it has entered the public record). Even so, local officials in Huron County voiced concern that overly prohibitive wind zoning ordinances might eventually drive the state to make such a change. As a result, they have tried to ensure that wind developers could work within any proposed ordinance. One local official remarked, "We live in fear in this county that the state could take over wind ordinance development. So honestly, when we look at tweaking and working on an ordinance, we look at it from the standpoint of if the state got involved, what would they also say about what we did." Even the most skeptical interviewee, a local official who was not keen on additional wind development in his jurisdiction, thought it would be most prudent to change existing zoning incrementally to provide residents uncompensated by wind developers some additional buffer space. If local government zoned out wind energy entirely, it

would risk a situation where "the state would come in and just set the rules and we would have zero control."

Landowners in these windfarm jurisdictions, as well as landowners in the matched case studies, are largely of the same mindset as their elected officials. Though no respondents mentioned state takeover in the open-ended response, a battery of multiple-choice questions asked how much authority each level of government (and landowners) should have in deciding where turbines are sited. Overwhelmingly, respondents believe that such decisions should be made by landowners or local government, with a much smaller role for state government, and no role for the federal government. This holds true even when we compare the responses of landowners in the matched case communities with those of landowners in communities with windfarms (see Table 7-6). Furthermore, if we compare respondents in windfarms based on their current zoning arrangement (e.g., zoned by the local township or county, or not zoned at all), those in the only unzoned township in the study are most adamant that the state should stay out of wind siting decisions (see Table 7-7).

One might expect that wind developers would be in favor of state zoning, which would allow them to identify project sites where they can maximize energy output—and subsequently profits—rather than factoring in whether obstructionist local regulations will delay approval. My interviews with wind developers, though, point to the contrary: wind developers prefer to work with townships than with county or state regulatory bodies. In comparing his experiences in Michigan and Ohio, one developer noted that Ohio's state-level siting "is kind of a good news, bad news kind of thing. You only have one agency to deal with, but the requirements are pretty tight…. You basically have got to have a team of lawyers to help you get through the process.

It's more expensive." Another developer I interviewed, who worked mostly in Michigan, did not address state-level zoning but compared township and county zoning. He asserted:

> Right now local zoning is more effective, more efficient for us to work with the local townships than the county. The county has a broader area. They have broader agendas. And they have to look at a broader spectrum, which includes a lot of people that are not in favor of wind. That can drag a process down. And if we deal with local and we have large support and less small parcels you have a good momentum of pro wind building.

It is possible that these developers actually do advocate for state zoning but were censoring their opinions because we were speaking on the record. It appears, however, that they currently have enough communities with ample wind resources who are also willing to host turbines that they do not need the state to intervene. Should the state increase the RPS targets in the future, it would be important to see if and when the wind developers change their opinions.

Table 7-6. Landowner opinions of how much authority government and landowners should have in deciding where wind turbines are sited

							Windfarm respondents	
	Response Options		All respondents	Matched case	All Windfarm		Neighbors	Turbines
Federal government	A great deal of authority		2%	2%	2%		2%	2%
	Some authority		29%	32%	27%		27%	29%
	No authority		69%	66%	71%		71%	69%
State government	A great deal of authority		5%	6%	3%		3%	3%
	Some authority		55%	56%	55%		55%	52%
	No authority		41%	38%	42%		41%	45%
Local governments	A great deal of authority		28%	23%	32%		34%	22%
	Some authority		55%	55%	55%		53%	63%
	No authority		17%	23%	13%		13%	15%
Landowners	A great deal of authority		85%	84%	86%		86%	87%
	Some authority		14%	15%	13%		14%	12%
	No authority		1%	1%	1%		1%	1%
Number of Respondents			1,159	470	689		552	137
p-values significant: *** <0.001 ; ** 0.001 - 0.01; * 0.01 - 0.05								

Table 7-7. Opinions of landowners in communities with windfarms, on how much authority government and landowners should have in deciding where wind turbines are sited, by current zoning arrangement

	Response Options		Local zoning	County zoning	No zoning		p-value
Federal government	A great deal of authority		2%	2%	0%		
	Some authority		27%	27%	23%		
	No authority		71%	71%	77%		
State government	A great deal of authority		5%	2%	0%		
	Some authority		58%	54%	39%		*
	No authority		37%	44%	61%		*
Local governments	A great deal of authority		34%	31%	23%		
	Some authority		52%	55%	62%		
	No authority		14%	13%	15%		
Landowners	A great deal of authority		82%	81%	90%		
	Some authority		17%	12%	10%		
	No authority		1%	7%	0%		
Number of Respondents			231	390	38		
p-values significant: *** <0.001 ; ** 0.001 - 0.01; * 0.01 - 0.05; · 0.05 - 0.10							

7.3 Conflicting Evidence: Recent Land Sales

The zoning mechanism hypothesis that I have tested so far in this chapter is based on the assumption that by rendering some land around wind turbines undevelopable, a community will experience less conversion of farmland. But as long as there is some land that can still be developed, it is possible that the presence of the turbines is simply transferring development from one area (e.g., in the vicinity of the turbines) to another (e.g., away from the turbines). This might happen at the local level, which would lead to increased development in a portion of a windfarm community without turbines; or at a more regional scale, which would shift development to similar countryside miles away. In some ways, this is not unlike what happens when suburban jurisdictions adopt low-density zoning to minimize additional population growth:

the demand for living in such communities does not disappear but rather just shifts to jurisdictions farther afield (thereby exacerbating urban sprawl).

While a full exploration of this issue is beyond the scope of this dissertation, the survey of landowners tested whether zoning was impacting farmland conversion at the township scale by asking whether the respondent had sold any farmland in the last five years and following up by asking about the purchaser. Overall, 106 respondents (8.9%) reported selling farmland since 2008, and all but one of these also gave some indication of how the land was being used. Of the respondents who sold land, most (77%) said that it was still being farmed, either by a family member or by someone who was not related to them. The remaining respondents (n=22) indicated that at least some of the land that they had recently sold was being used for some non-farming purpose.

Given the small number of transactions, there are no statistically significant differences between respondents in communities with windfarms and those in the matched case communities. However, if we set aside the lens of statistics (as I made a case for doing in Appendix B), the raw data show that there is actually a slightly higher rate of sales for non-farming purposes in windfarm communities than in non-windfarm jurisdictions (see Table 7-8). This finding is contrary to the zoning hypothesis. Ironically, it is driven largely by land sales by property owners who have turbines on their property, two of whom noted that they had sold land to a utility company for a substation. (More about the non-turbine land use impacts of wind energy follows in Section 7.4.) When I remove sales to electric utility companies (two in windfarm communities and one in a matched case community), there is less of difference in the rate of farmland sales for non-farming purposes between these two types of respondents. However, when we look at the number of acres sold for these non-farm purposes, we see that

respondents in windfarm communities sold significantly larger parcels (see Table 7-9). As a result, nearly five times more acres (650 compared to 110) were sold for non-farming purposes by landowners in the windfarm communities than by landowners in the matched case communities. This finding, then, seems to contradict the notion that zoning for wind turbines is reducing farmland conversion.

Table 7-8. The end use of farmland sold by respondents, since 2008

				Windfarm respondents	
Sold to	All respondents	Matched case respondents	Windfarm respondents	Neighbors	Turbines
A relative for farming	1.6%	0.6%	2.3%	2.5%	1.5%
A non-relative for farming	5.2%	5.0%	5.4%	5.6%	4.4%
Both a relative and non-relative for non-farming	0.2%	0.0%	0.3%	0.4%	0.0%
A relative for non-farming	0.5%	0.4%	0.6%	0.7%	0.0%
A non-relative for non-farming	0.8%	1.3%	0.6%	0.5%	0.7%
Someone for farming and non-farming	0.3%	0.0%	0.4%	0.4%	0.7%
Utility company	0.3%	0.2%	0.3%	0.0%	1.5%
Any farming	7.0%	5.6%	7.9%	8.4%	5.9%
Any non-farming	2.0%	1.9%	2.1%	1.9%	2.9%
Any non-farming (excluding utility company)	1.8%	1.7%	1.8%	1.9%	1.5%
Did not sell	91.1%	92.5%	90.2%	90.0%	91.2%
Total respondents	1,183	478	705	569	136

Table 7-9. Sales of parcels for non-farming purposes, since 2008

				Windfarm respondents	
	All respondents	Matched case respondents	Windfarm respondents	Neighbors	Turbines
0 - 20 acres	13	8	5	3	2
20 - 39 acres	3	1	2	1	1
40 - 79 acres	5	0	5	5	0
80 acres or more	3	0	3	2	1
Total number of transactions	24	9	15	11	4
Total acres*	760	110	650	520	130

* Calculated taking the mid-point for the range, and conservatively assuming 80 acres for those who selected the last category.

Because the landowner survey was not specifically designed to look at farmland conversion rates, I would hesitate to make that case without additional research. Since the sales data are not geo-located and the study included landowners across the entire township in which the windfarm is located, it is possible that the parcels sold were in parts of the township far from the turbines. If, upon further study, this proves to be the case, the turbines might simply be shifting farmland conversion from one area of the township (i.e., near the wind turbines) to another. Furthermore, my landowner survey did not distinguish between different non-farming uses (e.g., landowners who sold farmland for a residential development or for recreational use would have answered the same way), so there is no way to tell exactly how the land is currently being used. However, since any non-farm use of previously farmed land is, by definition, agricultural land conversion, it is counter to farmland preservation goals.

Finally, this argument has been based on a comparison of farmland conversion rates in the windfarm communities and the matched case communities, which is predicated on the assumption that these communities would have experienced similar development pressure in the absence of the windfarm. Determining the counterfactual—what the demand would have been if not for the windfarm—is difficult, if not impossible. It could be that the windfarms did dampen demand for farmland for non-farming purposes, and that farmland conversion would have been even higher if not for the windfarm. Needless to say, more research is warranted to better understand these recent incidents of farmland conversion in the windfarm communities and to determine how—if at all—farmland conversion is connected to wind development.

7.4 Countervailing Effects: Land Taken out of Production

While the GIS analysis to determine the impact of setback distances utilized single-pixel point features to represent wind turbines, in reality, utility-scale wind turbines do have non-

negligible land requirements. Though the land requirements of the turbine towers—which often exceed ten feet in diameter—are the most obvious, a wind turbine also needs an access road for maintenance and emergency personnel, as well as transmission lines and substations to feed the power generated into the electric grid. Thus, for all of their potential to prevent farmland conversion, as demonstrated in the last four chapters, the very act of erecting a wind turbine on farmland inevitably and immediately converts some land to a non-agricultural use.

One might argue—as did many of my interviewees and survey respondents—that the land taken out of production as a result of wind development is relatively small compared to the economic benefit provided by the turbines. Most commonly, wind developers and landowners with turbines on their property told me that each turbine and attendant access road required about two acres of land, which is not negligible but is significantly less than the 60+ acres per turbine rendered undevelopable as a result of the setback distance. However, I also consistently heard that some siting practices help to minimize agricultural land loss, while other siting practices are particularly disruptive to modern farming. While it was beyond the scope of this project to determine exactly how much land is being taken out of production as a result of wind development and how improved siting practices might reduce losses, in the next section, I recount anecdotal evidence that might be investigated with GIS analysis in the future.

7.4.1 Siting matters

When I asked wind developers whether they were doing anything to minimize the impact of turbines on farming operations, all three noted that they try to avoid siting the turbine in the center of a field. Instead, where possible, they have been siting the access road and occasionally the turbine itself on a property line. In many cases, the property line or fencerow is a sort of no-man's-land that was not being farmed anyway, so there is very little land taken out of production.

The wind developers noted, however, that there are additional benefits of siting on a property line:

> Rather than having a three- or four-, five-acre impact, now you're having less than half of an acre impact, and you get a nicer road, improves your ability to take your crops off of the field, and improves your ability to fertilize your crops, and improves your ability to plant your crops 'cause we're giving you better access into your field, and the actual piece of the turbine takes up about a tenth of an acre.

In addition, both developers and local officials noted that siting along fencerows prevents the placement of an additional obstacle—the turbine—in the field, so farmers can plant and harvest just as they always have. Because of these benefits, while none of the windfarm jurisdictions in my study require siting along fencerows, two of the zoning ordinances state that "the location of towers and access routes is encouraged along internal property lines."

There are, however, drawbacks to siting on fencerows. First, landowners on both sides must agree to have wind leases, or at minimum grant the wind developer an easement for the access road. In addition, wind contours or zoning regulations might make a strict policy of siting on property lines infeasible. Furthermore, removing these fencerows could have ecological consequences. As one landowner noted, "Now there aren't any windbreaks to buffer the blowing topsoil, blowing snow, or the wind. Removing fence lines, the brush and trees have taken away cover for deer runs and other wildlife."

Developers noted that the second-best solution is often to site the turbine and access road in the middle of the field, but parallel to crop rows. If the access road does not cut across the field at an odd angle, the farmer can plant right up to the road without disrupting the planting pattern, minimizing "wedges of unproductive land here and there." Furthermore, this approach provides farmers with another access road into their farm—a benefit mentioned in the survey by 21% of landowners with turbines on their property.

7.4.2 Transmission Lines and Eminent Domain

While the nuisance of farming around the turbines and access roads was the primary concern across all windfarms, mentioned by 39% of landowners with turbines on their property, landowners in Mixed-benefits (#2) were also concerned about how the placement of transmission line poles were impacting their ability to farm. While in the other case study communities the local transmission lines had enough capacity to accept the power generated by the wind turbines, a new high-voltage transmission line is being constructed in the vicinity of Mixed-benefits (#2) to allow more wind development in the area. Both landowners and local officials in Mixed-benefits (#2) noted that, though the transmission line poles take up very little land, there are many more transmission line poles than wind turbines, and they are still obstacles that must be farmed around, disrupting planting patterns. Furthermore, because transmission utilities are granted the power of eminent domain, landowners have very little say in where the poles are placed. Again, while this is not an issue where wind energy is feeding into a grid where there is excess capacity, any calculations of how much land is taken out of production by wind turbines should also consider the transmission lines and grid infrastructure needed to move the power from the windfarm to electrical consumers.

7.5 Beyond Setbacks: Other Regulations

Though this chapter has so far dealt exclusively with setback distances, there are other regulations within a zoning ordinance that, while not having a direct impact on farmland preservation, could have indirect effects. For example, zoning restrictions may influence whether a wind project is economically viable from a wind developer's perspective, or whether it is socially acceptable to neighboring landowners.

The wind turbine zoning codes in my study area all include at least some regulations beyond setbacks (see Table 7-10), and these regulations often reflect some of the common concerns voiced by residents in the landowner survey. All five address the visual appearance of the turbine, requiring it to be a non-reflective color and prohibiting it from displaying advertisements, addressing the aesthetic concerns which served as the most common complaint of survey respondents. In addition, the zoning ordinances all require some sort of decommissioning plan and financial assurance (sometimes in the form of a bond) that the wind developer will cover the costs of deconstructing the turbines, addressing residents' concern over what will someday happen to the turbines when they reach the end of their usable life. Only four of the five zoning ordinances set noise limits, either at a residence or property line, though this was residents' second most common concern. Also, a good number of residents (n=14) as well as interviewees expressed concern over the red lights atop the turbine, which are required by the Federal Aviation Administration (FAA). Notably, three of the five ordinances prohibit the turbine from being "artificially lighted, except to the extent required by the FAA."

Table 7-10. Regulations present within the wind zoning ordinances of windfarm case communities

		Chandler Township	Huron County New	Huron County Old	Oliver Township	Highland Township	Comments in landowner survey
	Visual appearance	✓	✓	✓	✓	✓	47
Noise	At residence, school	✓	✓	✓			31
	At property line				✓		
	Decommissioning	✓	✓	✓	✓	✓	17
	Lighting	✓	✓	✓			14
	Tower separation	✓	✓	✓	✓		0
	Total height	✓	✓	✓			0
	Ground clearance	✓	✓	✓			0
	Complaint resolution plan	✓	✓		✓		0

7.6 Answering Research Questions and Testing Hypotheses

This chapter examined the treatment of wind turbines in the zoning ordinances of each windfarm township in the study, as a way to better understand what impact these regulations have on the availability of developable land—the focus of my zoning mechanism research question. I found that, though farmland preservation considerations are rarely at the top of officials' minds as they establish setback distances for wind turbines, the amount of land rendered undevelopable by the presence of the turbines can be substantial. As I had hypothesized (H5), I found that while the size of the windfarm does have some bearing on the amount of land theoretically preserved, the specific setback distances may have an even greater impact. Furthermore, I found that turbine spacing is also a determinant: the more space between turbines, the less overlap there is in the setback distance circles between them, which thereby preserves more land per turbine than siting regimes where the turbines are closer to each other. While turbine separation can be included in the zoning ordinance, larger setback distances reduce turbine density, serving as a two-pronged mechanism for rendering additional lands undevelopable.

Local officials, however, should not take this as a carte-blanche recommendation to maximize setback distances. Though land preservation benefits increase with larger setback distances, large setbacks also make it more difficult for wind developers to site projects within communities; they may effectively "zone out" wind turbines, negating all possible farmland preservation benefits. Instead, I would recommend that local officials have frank conversations with the wind developer, seeking to maximize the setback distance without jeopardizing the project—a practice that seems to have occurred at least to some extent in all four case studies.

In addition, jurisdictions that wish to utilize wind development as a farmland preservation tool should exercise their right to amend the wind zoning ordinance over time. I would suggest adopting a zoning ordinance prior to windfarm construction that allows for some flexibility in turbine placement. For example, the zoning ordinance could specify smaller setback distances or grant exceptions to the required setbacks to allow landowners with turbines on their property to voluntarily agree to have turbines placed closer to their own homes (a feature in many of the zoning ordinances I reviewed). Following construction, once there is no longer interest in or capacity for additional wind energy development, local officials could amend the ordinance to increase the preservation benefits. Increasing setback distances and disallowing setback exceptions would effectively close the loopholes that allow a new home to be constructed where it would otherwise be prohibited due to its proximity to a turbine. In effect, this would make many existing homes non-conforming with the code and require any future construction to be built farther from the turbines.

In this chapter I also noted, however, that these land preservation benefits are only theoretical. Each of the zoning codes within my study allows for waivers to the required setbacks with the written consent of affected landowners. In addition, even if the setbacks are upheld, since they apply only to land in the immediate vicinity of the turbines, there is little reason to believe that a landowner intent on building a new home in the windfarm community would not simply find a building site somewhere else in that township. The survey of landowners seems to indicate that this might, in fact, be happening. Specifically, I found that there is no reduction in the sale of land for non-farming purposes in communities with windfarms than in matched case communities, and that the parcels sold for non-farming purposes in these windfarm communities are significantly larger than in the matched cases—meaning that

more land might actually have been lost. Because of the limitations of this survey question—and the startling implications if this finding holds true—more research in the form of geospatial analysis is warranted.

Finally, I note that the very act of erecting a wind turbine on farmland immediately converts some land to a non-agricultural use. While it was beyond the scope of this project to quantify that impact, both the landowner survey and interviews with local officials and wind developers indicated that some turbine siting practices lead to more loss of productive land than others. Geospatial analysis could quantify the land requirements of turbines and their accompanying infrastructure and confirm whether alternate siting practices do indeed keep more land in production. This information would assist local officials in deciding whether additional zoning requirements would make wind development more compatible with farmland preservation goals.

Chapter 8. Conclusion, Recommendations, and Future Research

The overall aim of this research was to investigate practitioner claims that windfarms help to preserve farmland. I endeavored not only to determine whether windfarms have actually impacted rates of farmland conversion, but also to begin to understand *why* they might be having such an impact. Specifically, I tested three different mechanisms, derived from both the rural planning and wind energy literatures, by which wind turbines might be altering the farmland conversion process. Notably, all three of these mechanisms came up, unprompted, in at least one of my interviews with local officials and wind developers. Most commonly, local officials talked about the additional revenues that wind energy development provides, especially in direct payments to landowners who host turbines on their property. They noted that high crop prices in recent years mean that this revenue is not necessarily required to balance farm budgets, but given the long-term instability of crop prices and the ever-present threat of a poor yield, wind development income is a good hedge against bad times.

It is important to note, however, that my research questions and hypotheses were all based on wind energy as a possible farmland preservation tool for the "growing" rural America, where the primary threat to agricultural land is urbanization. Instead, the primary concern of local officials in all of my selected case studies—even those with recent double-digit housing unit gains—was youth flight, a concern typically associated with rural areas in decline, where

population numbers are precipitously dropping. The language of *farmland* preservation still resonated with these interviewees, but their primary concern was with *family farm* preservation. These two issues are certainly related: a declining proportion of residents connected to agriculture makes farmland much more susceptible to non-farm conversion (Healy and Short 1979). However, my hypotheses and the theory behind my research questions drew from a farmland preservation literature that assumes development pressure is present, whereas the interviewees reported near-zero demand for new home construction on farmland even before the turbines were built.

However, not all was lost through the selection of these cases. In fact, in some ways, it may have been a fortunate coincidence that some of my hypotheses intended for communities facing urbanization might also translate to those facing decline. I hypothesized, for example, that the additional wind-related income would reduce financial pressure to sell land to a developer. My respondents, however, pointed out that the added income reassured young people that farming could be profitable, making them more interested in taking over the family farm. Just as I hypothesized, landowners are investing this new wind-related income in the farm. While the Impermanence Syndrome of the farmland preservation literature would predict that such actions are a strong indication that these landowners *themselves* expect to be farming longer (Adelaja, Sullivan, and Hailu 2011), such investments on behalf of their successors are no less powerful indicators of a renewed sense of agriculture's permanence within the community. While additional research needs to be done in communities where local officials identify urbanization as the primary concern, I have every reason to believe that some of this work is transferable to such a context. As a result, wind energy development might actually further the planning goals of both rural Americas, making it unique among rural planning strategies that

have traditionally focused either on land use regulation (to address urbanization) or on economic development (to address depopulation). After two or more decades with few breakthroughs in the field of rural planning, this research might help prompt rural planning scholars to take a fresh look at whether other types of rural development (e.g., agricultural processing plants or, perhaps controversially, gas or oil wells) might have ramifications for both land use and economic development.

Case study selection aside, through a closer look at the effect of wind energy development on investment and land use expectations (Chapter 4), local economic development and property tax spending (Chapter 5), new home building (Chapter 6), and the possibility of future development (Chapter 7), this research provides a number of valuable insights into the social and economic impact of wind energy in rural communities. In the following sections, I summarize the study's contributions to scholarship, both in rural land use planning and wind energy policy, and I discuss the implications for practitioners and policymakers in both of these areas. In keeping with my interest (and research fellowships) in sustainability, I also discuss the social, economic, and environmental trade-offs suggested by my research findings. Like any research project, this study also uncovered a host of related issues that warrant further investigation, so in the final section I outline what could be a career's worth of follow-up research.

8.1 Scholarly Contributions

Taken as a whole, this research constitutes the first contribution to scholarly literature on the connection between wind energy development and farmland preservation. Specifically, I found that the connection is twofold: windfarms provide economic benefit to landowners as well as reducing the amount of developable land in communities that include wind turbines in their zoning ordinance. The economic benefits are highest for the landowners who host turbines on

their property, who are also the landowners most likely to have their land rendered undevelopable as a result of zoning ordinance setback distances between turbines and inhabited structures. Accordingly, wind development provides a unique opportunity to prevent development on large swaths of land without compensating landowners directly (as in PDR or TDR) or incurring their wrath for "downzoning" (Coughlin 1991). This is a particularly relevant contribution for the rural planning literature, which has been relatively inactive in the last decade and has struggled to find solutions that are attractive to owners of large tracts of farmland (Adelaja and Gottlieb 2009; Schnidman, Smiley, and Woodbury 1990).

In addition, this research connects to existing scholarship in both rural land use planning and wind energy policy. Planning scholars might be particularly interested in High-growth (#4), where there is no zoning ordinance and wind siting is a private agreement between the wind developer and landowner. While land use scholars tend to assume that zoning is the most effective way to mediate competing community interests, my research finds that all landowners in this community—those with and without turbines on their property—are more convinced of the positive impacts of wind energy and less convinced of the negative impacts than their counterparts in all other communities with wind turbines. They also reported very few landowner disputes during windfarm planning and construction. This finding is consistent with Ellickson's (1991) work suggesting that among close-knit communities, personal relationships often lead to cooperative behavior, even in the absence of regulation compelling fair play, and it warrants more investigation.

This research also makes a significant addition to scholarship on the social and economic impacts of wind energy development. It supports and expands the small body of evidence drawn from U.S. windfarm communities about the impact of wind development on local jobs (Slattery,

Lantz, and Johnson 2011), property taxes (M. E. Kahn 2013), and rural landowners' attitudes towards wind energy (Brannstrom, Jepson, and Persons 2011); it also provides an American counterpart to Canadian research on "appropriate" setback distances (Watson, Betts, and Rapaport 2012). Perhaps most notably, this is the first study to look in depth at alternate royalty-sharing arrangements. While much of the research from Europe looks at the effect of community ownership on local attitudes toward wind energy (Warren and McFadyen 2010; Phimister and Roberts 2012), this is the first study to look at differences that derive from the distribution of royalty payments in windfarms owned by a wind developer. While I find that pooling royalties leads to less noticeable impacts on farm budgets for landowners who host turbines on their property, it also leads to neighbors who are more likely to believe in the positive impacts of wind energy and less likely to believe in the negative impacts than are neighbors in communities where royalties are not pooled and those in the matched (no-turbine) communities. Furthermore, landowners in communities where there is less pooling also report more community conflict, as there is more of a divide between the "haves" and "have nots." Pooling, therefore, can help gain community acceptance for wind—which in turn might ultimately make more communities willing to accept windfarms with their knock-on farmland preservation benefits—and help keep the peace among neighbors.

8.2 Recommendations for Policy and Practice

8.2.1 Rural Planners and Local Officials

This research is perhaps most directly applicable to rural communities and landowners grappling with the question of whether to welcome wind development. As my research has shown, welcoming wind turbines would almost certainly result in an influx of revenue at both the individual and community level, which helps to make farming more profitable and decreases the

likelihood that the farm will either be abandoned or sold to a developer in the future. However, wind energy also brings with it landscape changes to both the daytime and nighttime sky, disturbances to crops and soil during construction, and the potential for community conflict between those who favor local wind development and those who oppose it. Consequently, rural communities need to consider whether wind development and its attendant effects fit within the overall goals of the community, and if so, to adopt zoning ordinances that support those goals.

When considering the specifics of wind turbine zoning regulations, local officials in all of the jurisdictions in my case study deliberately tried to strike a balance between competing community interests as they set guidelines for where the turbines could be placed. I found very little evidence that local officials were considering what impact the zoning ordinance might have on local land use after construction of the windfarm. While my research suggests that the chosen setback distance has a large impact on the farmland preservation benefits of the windfarm after construction, many of the decisions made early on might undercut these longer-term benefits. Most of the zoning ordinances that I analyzed, for example, allow for written exceptions to the setback distances between turbines and inhabited structures. While these were intended to allow landowners with turbines on their property to voluntarily agree to have turbines placed closer to their own homes, these same exceptions might also be used in the future to allow for construction of a new home where it might otherwise be prohibited due to its proximity to a turbine.

One way around this is for local officials to bear in mind that the zoning ordinance is not set in stone but is an evolving tool intended to implement a community's current and future land use plans. Jurisdictions that wish to utilize wind development as a farmland preservation tool might consider establishing a zoning ordinance prior to windfarm construction that allows for

more flexibility in turbine placement—i.e., by specifying smaller setback distances or granting exceptions to the required setbacks. Following construction, once there is no further interest in or capacity for additional wind energy development, these setback distances might be increased or special exceptions might be disallowed. In effect, this would make many existing structures non-conforming with the code and require any future construction to be built farther from the turbines.

Local officials in jurisdictions with windfarms should also consider how their use of the added property tax revenues paid by wind developers impacts their community's long-term goals. If urbanization is seen as a threat, using the revenue to provide urban services—such as providing trash collection, paving gravel roads, or increasing access to high-speed internet—might run counter to goal of minimizing new residential development. If, in contrast, the primary concern is youth flight, putting tax revenues towards such ends might be a good use of funds—but probably only if there is money to maintain these services into the future.

8.2.2 Wind Developers

The findings on the consequences of alternative leasing and siting policies will also be useful to wind developers, who can draw on this research to supplement their own knowledge gained from experience in the field. Wind developers realize, for example, that pooling royalties helps to minimize community conflict during the leasing and siting process. My research also provides survey-based evidence that pooling royalties significantly improves neighboring landowners' attitudes towards wind energy, but does little to change their farm budgets or investment behaviors. This study also helps to quantify which siting and construction practices landowners see as most disruptive to the farming operation, information wind developers can use to tailor their practices so as to minimize crop disturbance. Of course, their interactions with

landowners have made wind developers well aware of these concerns. My survey findings, though, can help identify how prevalent these concerns really are amongst landowners with turbines on their property, and wind developers can also use them to better inform potential farmland leasers about the kinds of impacts to expect.

This study also underscores that it would behoove wind developers to be as frank as possible with landowners and community members when they are trying to site a new project. My research finds evidence to support wind developers' claims that landowners who are part of the royalty pool in communities with wind turbines are, overall, more convinced of the positive impacts of wind energy and less convinced of the negative impacts than similar landowners in a community without a windfarm. However, overselling the benefits can backfire, as I found with the local job creation issue. In places where wind developers make claims of direct job creation, once the project has been built, landowners are actually *less* convinced of such benefits than landowners in areas without windfarms, presumably disappointed that so much of the construction work is done by outside contractors. In contrast, when the developer portrays job creation as an indirect benefit that results from leaseholders spending wind income on farm improvements, landowners in these communities have an even higher opinion of the job creation benefits of wind energy. Rural landowners, perhaps even more than the general public, really want the "straight story" when they are contemplating making a change. Wind developers would be well advised to give it to them.

8.2.3 State Policymakers

State policymakers—especially those in Michigan—should take away three key lessons from this research. The first is that the uncertainty in property tax treatment of wind turbines is delaying local decision-making on how to use additional revenues. While farmland owners who

host turbines benefit from direct payments by wind developers, these tax revenues are the primary economic benefit to the other residents in these windfarm communities. As a result of tax treatment uncertainty, the community as a whole is not yet seeing tangible benefits of the windfarm. This has caused some souring of opinion among those who don't directly benefit, which in turn may discourage other communities from welcoming wind energy. To remedy this, state policymakers and the State Tax Commission need to assure local governments that the tax valuation of wind equipment will not change in the future.

The second and third takeaway messages for state policymakers are especially relevant as legislators consider increasing the state's renewable portfolio standard (RPS). Currently, debate at the state level is being framed within the context of a report commissioned by Governor Snyder that found that the key hindrances to increasing the state's renewable portfolio standard are local land use regulations that block wind projects and public opposition in rural communities where the turbines would be sited (Quackenbush and Bakkal 2013). This may have policymakers wondering if higher RPS targets could be achieved without state takeover of land use regulation for wind turbines, or without upsetting a large number of rural constituents. My research provides insights on both questions. First, I found that both rural residents and wind developers prefer regulation at the local level. While wind developers acknowledged that this might allow some local governments to zone out wind development, it also affords communities that want wind development the flexibility to establish more wind-friendly ordinances than what would likely be set at the state level.

Second, with respect to public opposition of rural residents, my research found that wind development is like many other land use issues in that those opposed to it tend to be the most vocal at public meetings, but they are also in the minority. Though their vocal opposition may

derail some proposals, the local leaders I interviewed appeared to be able to look more broadly to gauge public opinion in their jurisdiction and act accordingly. Furthermore, I found that once a windfarm is constructed, residents' opinions of wind energy tend to improve, likely due to the direct economic benefits of the windfarm (and perhaps also as a result of familiarity with the turbines, which might not seem so bad once they're in place). Thus state legislators should not be deterred by such vocal opposition but rather should allow local governments to determine whether wind development matches local land use goals.

8.3 Sustainability Trade-offs

Because it finds evidence for a connection between wind energy and farmland preservation, this research on its face suggests that wind energy is a sustainability win-win: Those concerned with climate change can feel better knowing that wind turbines are not having adverse social impacts on the rural communities in which they are sited and instead are providing economic benefits and helping to sustain a tradition of family farming. In addition, from an ecological perspective, farmland is a good place to site turbines because it typically has lower biodiversity as a result of monoculture cultivation. Most inland farming communities don't pose as much threat for birds as potential windfarm sites closer to water bodies, and open fields are not a primary habitat for bats, the animal most threatened by wind turbines (Erickson et al. 2002). From a social perspective, farmland also seems to be a better fit for wind development than ridge-top or off-shore siting in places that are valued more for their scenic beauty than for their utility as a working landscape.

Even so, my research highlights that there are trade-offs. Though the land requirements for siting a wind turbine are relatively small—and may be minimized through better siting practices—placing a windfarm in an agricultural area will certainly take some land out of

production. In light of increasing food needs from a growing population, any loss in tillable acreage might have adverse downstream sustainability effects on a global scale, from increasing global malnutrition to the destruction of tropical rainforests (Foley et al. 2011; Scharlemann and Laurance 2008). If providing food security is the primary concern, directing wind development away from agricultural communities—off-shore or to scenic ridge-tops—might be the more sustainable solution.

In light of research that shows the energy-efficiency benefits of dense urban development (Ewing and Rong 2008; Wilson 2013), one might also ask if it is sustainable to revitalize rural areas in decline, or if it might rather be better to let these areas depopulate and their residents move to higher-density urban communities. I would argue, however, that much as our bodies require good cholesterol to keep the bad cholesterol in check, low-density *rural* communities are needed to help keep low-density *suburbs and exurbs* in check, thereby containing the footprint of cities. Providing opportunities for young people to stay in more remote rural communities means less out-migration to urban areas, which, in turn, drives fewer urban residents to the urban fringe. Furthermore, if farming were both more lucrative in rural communities at the urban fringe, landowners in these communities would have less financial need to sell their land off for development, which would help prevent cities from expanding outward. As I argued in my recommendations to rural planners and local officials, however, communities that decide to welcome wind development must take care to ensure that their land use policies and use of additional property tax revenues support sustainable community goals.

8.4 Areas for Additional Research

This dissertation was both explanatory and exploratory in nature, aiming to find early evidence for a phenomenon suggested by practitioners but one completely absent from the

scholarly literature. As a result, it uncovered a host of additional questions that should be further explored to better understand the impact of wind energy development on farmland, farmland owners, and agricultural communities more broadly. Within the selected cases, it did not consider all possible social, economic, and environmental impacts, or even the opinions of residents in the vicinity of the windfarm who do not own farmland, but rather honed in on those issues directly tied to farmland preservation. Furthermore, because of its case study design, the generalizability of these research findings may be limited. While selecting cases from a single state allowed me to hold constant a number of contextual factors so that I could better understand how royalty pooling and property tax policies affect farmland preservation outcomes, this research does directly address whether and how state-level policies might alter these results. Consequently, I propose future research that spans three broad areas: following up on unanswered questions with the four windfarm communities studied in this dissertation, expanding the scope of this research to windfarms in other policy contexts, and extending this research to look beyond wind energy to other policy issues impacting rural communities.

8.4.1 Follow-on Research

A number of remaining questions about the four windfarms that I studied would make for promising follow-on projects. The first is to better understand how much land the wind turbine, access roads, electric substation and new transmission line poles associated with wind development actually take out of production, and further to quantify the impact that alternate siting practices have on land use. This could be achieved through a relatively straightforward geospatial analysis comparing pre- and post-windfarm satellite/aerial imagery of my case study communities. It would, however, require high-resolution imagery to measure relatively small features (e.g., a 10-foot-wide access road), and this imagery would have to be taken during the

growing season to identify whether any previously farmed land was left fallow due to poor infrastructure placement.

Geospatial analysis of aerial imagery could also help to better answer one of the questions related to the demand-side mechanism. Specifically, it could identify whether new homes built since the construction of the windfarm replaced older farmsteads, as interviewees suggested, or whether they were built on farmland. It would also allow me to better visualize where this new construction is taking place relative to the wind turbines. In addition, a more in-depth analysis of building permit data, perhaps supplemented by interviews or surveys of owners of these new homes, would better uncover the motivations of these landowners to build in the windfarm community.

In addition, when I conducted my research, all four of the windfarms studied were relatively new additions to the landscape, having been built within the last five years. It would be instructive to return to these communities in perhaps a decade to see how the social, economic, and land use effects of the wind development will have changed. Expanding the research timeframe would allow for more farmland to change hands (e.g., be bought, sold, or passed down to the next generation), for wind-related property tax revenues to be invested (or not), and for the national housing market to recover, all of which might enable better comparisons between windfarm and matched case (non-windfarm) communities. Finally, such a longitudinal study would determine whether, as some suggest, the wind turbines become part of the landscape with time (Devine-Wright 2005).

8.4.2 Expansion to non-Michigan Windfarms

Though selecting cases within a single state allowed me to look at the impact of royalty pooling and partial tax abatements, it also limited my ability to generalize to windfarms beyond

Michigan. Expanding this research to other contexts would be a natural next step. Replicating this in one of the 12 U.S. states with state-level wind siting regulation, for example, might challenge my conclusion that the optimal setback distance for maximizing farmland preservation benefits is one developed in collaboration between the wind developer and local officials. Conducting this study in a state like Indiana, which fully exempts wind turbine equipment from property taxes, would better test whether these indirect benefits (or lack thereof) change the attitudes, investment behaviors, and land use expectations of neighbors who do not benefit directly from the wind development; I expect they might. Furthermore, as previously mentioned in Chapter 7, I hope to find another case of a windfarm sited in an unzoned community to see whether Richland Township (in High-growth #4) is an anomaly, or whether it is not unusual to have a relatively non-controversial wind project in the absence of land use regulation.

Replicating this research internationally would provide an endless array of research possibilities. As mentioned in Chapter 2, most of the existing wind energy scholarship comes from Europe, which has a longer and more extensive history of windfarm development; and more recently from Canada, which has set aggressive targets for increasing its share of renewable energy. Even so, none of this literature has specifically connected wind development to farmland (or even farming community) preservation, perhaps as a result of more stringent controls on exurban development and less expectation that farmland can be developed. These countries, though, also have wide variation in the structure of their electric power sectors, funding sources for renewable energy, level of public participation in land use regulation, and—perhaps most critically—social and economic structures in rural communities (Ellis et al. 2009; Alterman 1997). An international comparison could examine how each of these factors affects

landowners' and local officials' opinions of the farmland preservation potential of wind development.

8.4.3 Extensions beyond Wind Energy

This research also provides a springboard to extend my research beyond wind energy development to other issues of importance to rural communities. For example, it would be a valuable contribution to energy policy research to explore how the impacts of oil and gas development, which has recently been expanding as a result of enhanced extraction techniques such as hydraulic fracturing ("fracking"), compare to those of wind energy development. Though they have some commonalities including similar land leasing and royalty pooling arrangements, their differences (e.g., real and perceived negative impacts, amount of local tax revenues, locus of regulatory control) might well have very different social, economic, and land use implications for the communities in which they are sited.

Finally, this research has provided me with a solid methodological foundation for conducting research in rural communities. Though my methods derived from the best available practices (e.g., Dillman, Smyth, and Christian 2009), by most measures my response and cooperation rates far exceeded expectations. While I have attributed this to the inclusion of a prepaid incentive of a $2 bill, it is impossible to know how much was a function of my research topic, target population (Groves and Couper 1998), timing of the survey (Pennings, Irwin, and Good 2002) or mode of contact (Smyth et al. 2010). Further research that systematically varies these elements would not only contribute to the survey methodology literature, but also be of great utility to social scientists aiming to study a wide range of topics that affect rural populations.

Appendix A – Details on Case Study Selection

Discussion of criteria for selecting case studies using the diverse case approach

Early discussions with local officials in areas with wind energy, as well as the rural planning and wind energy literatures, were influential in helping me identify criteria with which to select these diverse cases. Perhaps most obviously, one likely determinant of new residential development is the amount of development pressure in an area. Residents in areas that are urbanizing often feel as if the change has occurred overnight. In reality, though, most farmland conversion is a slow, almost imperceptible process: first one field is converted and then another, until, seemingly suddenly, urban uses outnumber agricultural uses and people start to become concerned about loss of farmland (Eberhart 1976). As a result, in rural areas that are urbanizing, past residential development is often a good indicator of future residential development. This can be measured directly though the decennial U.S. Census, which includes data on the number of occupied housing units within each jurisdiction. Including cases in areas that are experiencing high growth as well as those that are experiencing low growth fits the diverse case approach.

In my early discussions with wind developers and local officials in communities with wind farms, one key distinction between wind projects is in how direct payments (royalties) to landowners are shared within the host community. At one extreme, only landowners with turbines on their property are paid for hosting turbines. At the other, all property owners in the vicinity of the windfarm receive royalties from the wind developer. In the former case, fewer people are each getting paid more money; in the latter, roughly the same amount of money is

shared by many more households. This distinction is particularly important for understanding the supply-side mechanism, which deals with the impact that additional revenues have on farm investment and subsequently on commitment to farming. Observing projects that span this spectrum allows me to see whether farmland retention is robust to royalty arrangement.

Finally, differences in how revenues are shared are also a function of state and local tax policy. In many states, wind turbines are considered industrial equipment and are therefore subject to property tax, usually assessed by the local government, with revenues going to the municipality, county, and state, as well as the local school district. In other states, wind equipment is exempt from property taxes, and municipalities that host turbines receive no additional tax revenues. As a result, including cases where the municipality does and does not receive tax revenues from the wind project allows for a wider view of possible scenarios.

Figure A-1. List of utility-scale windfarms in the Great Lakes states

	Wind Farm Name	County	Capacity (MW)	% cropland	County population change 1990 - 2010
Illinois	Crescent Ridge Wind Farm	Bureau	54.45	79%	3%
As of	Providence Heights Wind Farm	Bureau	72	79%	3%
May 2012	Big Sky Wind Farm	**Bureau**	239.4	79%	3%
	Big Sky Wind Farm	**Lee**	239.4	73%	10%
	Lee-Dekalb Wind Energy Center	**Dekalb**	217.5	88%	46%
	Lee-Dekalb Wind Energy Center	**Lee**	217.5	73%	10%
	Top Crop Wind Farm Phase II	Grundy	198	77%	55%
	Grand Ridge Energy Center Phase II, III, and IV	LaSalle	111	85%	10%
	Grand Ridge Wind Farm Phase I	LaSalle	99	85%	10%
	Top Crop Wind Farm Phase I	LaSalle	102	85%	10%
	Mendota Hills Wind Farm	Lee	51.66	73%	10%
	GSG Wind Farm	**Lee**	80	73%	10%
	GSG Wind Farm	**LaSalle**	80	85%	10%
	Streator Cayuga Ridge South Wind Farm	Livingston	300	90%	6%
	Rail Splitter Wind Farm	**Logan**	100.5	77%	0%
	Rail Splitter Wind Farm	**Tazewell**	100.5	74%	15%
	Camp Grove Wind Farm	**Marshall**	150	74%	5%
	Camp Grove Wind Farm	**Stark**	150	87%	-3%
	Twin Groves Wind Farm Phase I	McLean	198	85%	39%
	Twin Groves Wind Farm Phase II	McLean	198	85%	39%
	White Oak Wind Farm	McLean	150	85%	39%
	EcoGrove Wind Farm Phase I	Stephenson	100.5	85%	5%
Indiana	Benton County Wind Farm	Benton	131	101%	-1%
As of	Fowler Ridge Wind Farm	Benton	600	101%	-1%
1/2/2013	Hoosier Wind Project	Benton	106	101%	-1%
	Wildcat Wind Farm	**Madison**	200	71%	4%
	Wildcat Wind Farm	**Tipton**	200	96%	6%
	Meadow Lake Wind Farm	White	501.2	93%	9%
Michigan	Garden I	Delta	20	5%	10%
As of	Beebe	Gratiot	81	70%	9%
1/1/2013	Gratiot County	Gratiot	212.8	70%	9%
	Echo	Huron	110	74%	8%
	Harvest	Huron	52.8	74%	8%
	Harvest II	Huron	59.4	74%	8%
	Michigan Wind I	Huron	69	74%	8%
	Sigel	Huron	64	74%	8%
	Lake Winds	Mason	100.8	18%	20%
	Stoney Corners	Missaukee	60	17%	33%
	Stoney Corners	Osceola	60	20%	26%
	Michigan Wind II	Sanilac	90	60%	17%
	Tuscola Bay Wind	Tuscola	120	59%	11%
	Tuscola Bay Wind	Bay	120	59%	6%
	Tuscola Bay Wind	Saginaw	120	56%	1%
Ohio	Buckeye Wind Project	Champaign	135	65%	16%
As of	Hog Creek Wind Farm I & II	Hardin	67	77%	5%
May 2012	Hardin Wind Farm	Hardin	300	77%	5%
	Timber Road I, II, & III	Paulding	199	89%	7%
	Blue Creek Wind Farm Project	Paulding	350	89%	7%
	Blue Creek Wind Farm Project	Van Wert	350	90%	2%
Wisconsin	We Energies/Glacier Hills	Columbia	162	49%	35%
As of	Butler Ridge	Dodge	54	61%	26%
May 2012	Forward	Dodge	129	61%	26%
	Forward	Fond du Lac	129	61%	25%
	Cedar Ridge	Fond du Lac	68	61%	25%
	Blue Sky Green Field	Fond du Lac	145	61%	25%

Selecting Matched Cases

In order to understand how the presence of the windfarm is impacting landowners, it would be useful to know how landowners in my chosen case studies would have responded in the absence of the windfarm. This, of course, is not possible, so I have chosen to utilize matched cases for each of the wind case studies. To be clear, these are not "control cases" as typically understood in experimental research. Because the presence of a windfarm is not randomly assigned to a community, and, indeed, was determined prior to my research, I do not have a true control case. However, I select communities that are as similar as possible to my wind cases, except for the absence of a wind project; these matched sites are intended to model what might have happened in my wind cases if the wind turbines had not been built.

Because the matched cases will be included only in the landowner survey portion of my research project, it was important to find municipalities that were as similar as possible on the variables that may impact the dependent variables associated with that portion of my research: long-term expectations for the farm and on-farm investments.[28] The first is strongly connected to the level of development pressure in the area, which, as I explained in the previous section, is related to the recent rate of housing unit growth. The second variable—on-farm investment—is tied both to household income (e.g., wealthier landowners have more money to invest in their land) and to the type of farming operation (e.g., dairy farming is more capital intensive than grain farming).

Because each of these factors—housing unit growth rate, household income, and type of farming operation—is spatially correlated, the best matched cases are likely to be proximal to the selected case studies. My research topic, however, complicates selecting nearby cases. The

[28] Though these are highly correlated to farm characteristics, the USDA's Census of Agriculture reports only at the county level. As a result, I needed to find correlates available at the sub-county level reported by US Census data.

wind turbines in my case studies are over 450 feet tall, and as a result, can be viewed from miles away. Because rural jurisdictions in Michigan have a relatively small footprint,[29] this means that a single windfarm can be seen from two or three townships away. Furthermore, three of my case studies are located in Huron County, where there is literally no township entirely out of the viewshed of one of the six existing windfarms.[30]

To select the matched cases, I first used US Census data to identify the 2000-2010 housing unit growth rates and average household income of all townships within the counties adjacent to my wind case studies. I identified several municipalities that had similar characteristics to my selected wind cases. I then used Google Earth to compare land use characteristics (e.g., size of parcels, type of ground cover) in the candidate communities to those in the wind cases. I also took a reconnaissance trip to these locations to confirm that the agricultural operations were similar in appearance to those in the wind cases, and to confirm that no windfarm was visible from any part of the candidate municipality.

This process was much more art than science, in part because each windfarm crosses municipal boundaries: three of the cases span two townships, while the fourth is in three townships. Often, the housing unit growth and average household income in the jurisdictions hosting the same windfarm were quite different (see Table A-1). When that happened, I tried to find a matched case that was somewhere in between. Finding a matched case for Windfarm 4 was particularly challenging because, although the windfarm is sited in an agricultural community, the surrounding townships are predominantly forested. There was no single best match with both a similar average household income and a growing housing unit rate. As a result, I chose two townships to use as the matched community for this case.

[29] The prototypical township is six miles by six miles.
[30] I confirmed this on a drive in December 2013, when I was trying, in vain, to find a matched case site within Huron County.

Table A-1. Jurisdiction-level variables used in matched case selection

Case Study	Jurisdiction	Housing Unit Change: 2000 - 2010	Median Household Income	% Farming Occupation
Developer-friendly (#1)	Bingham Township	2%	43,333	1.8%
	Sheridan Township	4%	48,125	2.9%
Matched Case #1	Elk Township	4%	46,417	3.5%
Mixed-benefit (#2)	Chandler Township	3%	47,917	7.4%
	McKinley Township	-1%	48,500	4.3%
	Oliver Township	-4%	44,784	4.8%
Matched Case #2	Marlette Township	-5%	46,400	4.2%
Neighbor-friendly (#3)	Bloomfield Township	-2%	36,103	8.8%
	Sigel Township	-4%	54,306	6.1%
Matched Case #3	Moore Township	0%	37,292	7.9%
High-growth (#4)	Richland Township	11%	49,792	5.9%
	Highland Township	2%	46,397	7.3%
Matched Case #4	Hersey Township	7%	40,357	0%*
	Richmond Township	-3%	49,091	3.0%

Source: American Community Survey 2008-2012

*I think that there might be an error in this number, perhaps because of too few respondents. Given my survey results, there are definitely a handful of full-time farmers in this township.

The survey respondents' answers to demographic questions suggest that not all of my choices for the matched case communities were wise (see Table A-2). In High-growth (#4) in particular, landowners in the windfarm community owned and farmed more acres of land, were nearly twice as likely to report being full-time farmers, and derived over three times as much income from farming as landowners in the matched case community. As I discuss in more detail in Chapter 4, since acres farmed is strongly correlated to on-farm investment, this led to surprising results in comparing on-farm investment in High-growth (#4). To a lesser extent, this also posed a problem in Neighbor-friendly (#3), where landowners in the windfarm community were more likely to be full-time farmers and reported higher farm-related income.

Table A-2. Comparison of means/proportions for a range of demographic variables to determine fitness of the chosen matched case community

	Developer-friendly (#1)		Mixed-benefits (#2)		Neighbor-friendly (#3)		High-growth (#4)	
	Windfarm	Matched case	Windfarm	Matched case	Windfarm	Matched case	Windfarm	Matched case
Acres farmed	187	216	239	196	249	242	235	155
Acres owned	192	201	229	192	235	223	210**	151**
Percent farm income	31%	27%	41%*	29%*	51%***	34%***	37%***	13%***
Full-time farmers	31%	29%	37%	30%	47%	37%	38%**	19%**

p-values where there is a significant difference of means: *** <0.001 ; ** 0.001 - 0.01; * 0.01 - 0.05.

Appendix B – Details on Landowner Survey Design and Implementation

Unit of Analysis

Articulating the unit of analysis for this part of my research was a complex process. I am ultimately interested in the investment (and divestment) decisions of agricultural landowners in my case study communities. While some properties are owned by a single person, most are jointly owned—by spouses, siblings, parent and child, or business partners. As a result, it is better to think of my unit of analysis—the agricultural landowner—as an entity that more closely resembles a business than an individual. This distinction has an important implication for sample design, which is described in the next section.

Sample Design and Construction

A number of address-based frames are available for researchers conducting mail surveys. One popular service is based on address lists from the US Postal Service. In addition, a number of commercial sample frame lists are also available. While some of these lists provide demographic information about the address-holder, none of these lists include how many acres are associated with each address, or whether that land is agricultural. As a result, these sample frames would contain an unknown number of addresses that would be out of my target population (i.e., addresses for rural residents who do not own agricultural land). The list would also exclude people who own farmland in my study area but live outside of the area.

As a result, I decided to create my own sample frame from tax rolls. The benefit of using tax rolls is that there are far fewer instances of missing data—all property within the

municipality is included on the roll, even if it is exempt from taxes. Furthermore, the tax rolls include the mailing address of the taxpayer, not just the physical address of the parcel, so that landowners who live outside the study area can be included in the sample frame. Unique to my target population, farmland—actually agricultural land—is one of six property classes within the Michigan tax code (Feldman, Courant, and Drake 2003). As a result, there are rules governing which land may be classified as "agricultural" (Michigan State Tax Commission 2013).[31]

To build my sample frame, I contacted the office responsible for property tax records for each of my case study communities—in most cases, the county Tax Equalization office—and asked for a list of all taxpayers of agricultural parcels within that jurisdiction. In most cases I was given the information free of charge, but only in hardcopy, so I needed to transcribe the lists. These lists also included many duplicates—sometimes the same people owned many different agricultural parcels in a jurisdiction, and sometimes the same residential mailing address was associated with different taxpayer names (e.g., Joe Smith, Joe and Jane Smith, Smith Dairy Farms). After purging these duplicates, I compiled a list of unique taxpayers in each jurisdiction in my study area. As Table B-1 demonstrates, a significant proportion (18%) of land owners lived outside the township. Though it was time-consuming to create my sample frame, I believe it is much more effective than any frame I could have purchased at identifying all owners of agricultural land in my study area.

[31] As I later discovered, however, this system wasn't necessarily foolproof. Specifically, "tree farms" are included in the agricultural land classification, though they don't fit the aim of my research particularly well. Furthermore, local tax assessors have quite a bit of discretion in determining whether a wooded lot in a predominantly agricultural area should be considered agricultural or residential (partially wooded lots are highly sought after for rural estates).

Table B-1. Number of agricultural landowners in study area, by jurisdiction

Case Study	Jurisdiction	Agricultural landowners	Out-of-township addresses
Developer-friendly (#1)	Bingham Township	160	23
	Sheridan Township	136	30
Matched Case #1	Elk Township	162	29
Mixed-benefit (#2)	Chandler Township	148	33
	McKinley Township	59	11
	Oliver Township	134	25
Matched Case #2	Marlette Township	194	43
Neighbor-friendly (#3)	Bloomfield Township	135	18
	Sigel Township	104	11
Matched Case #3	Moore Township	190	34
High-growth (#4)	Richland Township	73	8
	Highland Township	86	24
Matched Case #4	Hersey Township	62	18
	Richmond Township	87	13
Total		1,730	320

Once a sample frame is created, there are a number of considerations at play in selecting a sample. The first is about the size of the sample. Often, practical constraints such as available budget drive this consideration. I was fortunate that, as a result of fellowship funding, my budget was not a constraining factor; I had enough money to survey everyone in the sample frame (i.e., to conduct a census) rather than draw a sample. This turned out to be doubly lucky because sampling from small populations can lead to greater error than sampling from larger populations (Isaac and Michael 1981). Because my study relies on comparing respondents not just between jurisdiction (e.g., those with wind turbines and those without) but also between subpopulations within jurisdictions (e.g., those in windfarm jurisdictions with turbines on their property and those without), my population sizes are very small. Even sending the survey to 90% of the people in my sample frame could have introduced error bars of greater than ±5%. As

a result, I decided not to sample from my frame, but rather to send the survey to all agricultural landowners in each jurisdiction.

One of the key risks in most mail surveys is that the researcher has no way to ensure that the questionnaire gets into the hands of the person selected to complete it. In most household surveys, the unit of analysis is an individual. Because the researcher does not know how many eligible people reside in the household, the researcher selects a method to randomize which member of the household should take the survey (e.g., the member with the next birthday, rather than, by default, the person who opened the mail). When these instructions are not followed, responses can be skewed (Gaziano 2005). My survey, however, does not aim for randomization within the household. Much like a researcher conducting an establishment/business survey, I am interested in reaching the person or people with the information most pertinent to my research—those who make decisions about the farmland. Thus, my survey cover letter specified that "the survey should be answered by the person (or people) that makes decisions about your farmland." (See Appendix C for the full text of the survey cover letter.) While I have no way to ensure that householders who owned the land were the ones taking the survey, the level of detail and completeness of survey responses on landowner-specific questions seem to suggest that the surveys reached their intended recipients.

Questionnaire Design

Most of the questions in my survey were drafted specifically for my particular area of study. (See the complete questionnaire in Appendix C.) The process of developing these questions began with an initial sketch of the issues that I wanted to cover in the survey (i.e., my dependent and independent variables). I then conducted cognitive interviews with farmland owners in my hometown (Maybee, Michigan) to better understand what sort of investments they

make in their farms; their sensitivity to being asked about land purchases, financial investments, or other delicate issues; and what approach I should take in presenting myself to farmers who would not know me personally. Notably, they convinced me that I should offer to thank the respondents by sending them my research results (84% of respondents did request these results), and that sending a single $2 bill would be more impactful as a novelty than sending $5.

Following the cognitive interviews, I produced a first draft of survey questions that I vetted with my committee and subsequently revised. I then pre-tested my survey, in hard copy, with a different set of agricultural landowners from my hometown. This pre-test also asked them to keep track of the total time it took to take the questionnaire so that I could provide potential respondents with an accurate estimate. In this pre-test, I looked to see if respondents were correctly following skip-patterns, and I asked for verbal feedback following the pre-test for questions that were unclear. While members of my pre-test pool helped me perfect the general landowner questions, they had very little familiarity with wind energy and therefore were less helpful in identifying aspects related to wind leases or windfarm impacts that I had missed. Pre-testing with some landowners in areas with wind turbines would have made my survey much stronger.

Following the pre-tests, I made additional tweaks to my questions and formatted the survey. Following Dillman and colleagues (2009), I included a full-color cover and spaced out my questions to provide lots of white space. While I could have saved money by reducing the font size, I used 12-point font, since many of the landowners in my study area might not have the best eyesight. I also decided to print an ID number on the back of the form that would allow me to track participation so I could target follow-up mailings (explained in more detail in the next section). I originally thought that this would also allow me to geocode responses, but because of

the high percentage of absentee landowners and the fact that many people own multiple non-contiguous parcels, I decided to rely on the respondents' own reporting of their proximity to wind turbines in my analysis. In the end, my questionnaire included 10 pages (plus a front cover and instruction page), and six sections.

Survey Implementation

A common problem with mail surveys is low response rates, which can lead to non-response error if the respondents are different from the non-respondents. My final response rate of 71.9% (AAPOR RR2) is exceptionally high for mail surveys, and I largely attribute it to my survey implementation decisions, including multiple contacts, personalized communications, a pre-paid incentive, and strategic timing based on the schedules of my target population. I relied heavily on Dillman, Smyth, and Christian's Tailored Design Method to increase response rates through carefully timed, frequent communication with sampled households (Dillman, Smyth, and Christian 2009). For this project, each potential respondent was contacted up to four times over the course of six weeks (see Table B-2). Each potential respondent was sent a pre-notification letter on full-color letterhead, warming them up to the idea of my survey and indicating that the survey would soon follow (see Appendix C). Letters to the selected households in the matched case communities included a special line saying:

> Even though your township does not have any large windfarms, your participation is important so that we can compare your answers to people like you in areas where there are windfarms. **Please do not take this survey as any indication that wind energy is being considered for your township.**

This was an attempt to pre-empt objections that the survey was irrelevant to them, as well as to allay fears that wind development was imminent since these communities were near areas that already had wind energy.

Table B-2. Survey contact schedule

Date	Mailing	To Whom?
February 5, 2014	Pre-notification letter	All selected households
February 18, 2014	First questionnaire (+ cover letter, IRB sheet, return envelope)	All selected households (less any for which the first mailing came back as undeliverable)
February 26, 2014	Follow-up postcard	All selected households in Missaukee, Osceola, and Sanilac Counties
February 26, 2014	Follow-up letter from Huron County Board of Commissioners	All selected households in Huron County
April 7, 2014	Replacement questionnaire (+ cover letter, return envelope)	All selected households who had not responded by the mailing date

Two weeks later,[32] all selected households were sent a catalog envelope containing a cover letter, the IRB disclosure sheet, survey, and a stamped return envelope (see Appendix C). Again, the cover letter had a special message for the households in the matched case communities. Attached to the cover letter was a $2 bill affixed with a sticker upon which "Thank you" was hand-written. Previous research has shown that including a small pre-paid cash incentive is more effective at boosting response rates than post-paid incentives because it evokes in potential respondents a sense of reciprocation (Groves and Couper 1998). My decision to use $2 bills as opposed to two $1 bills was a bit eccentric, but it did not go unnoticed—there were 11 unsolicited comments on the survey about the $2 bill.[33] I also paid extra to have actual stamps affixed to the return envelopes, as research has shown that these personal touches can improve response rates (Dillman and Parsons 2008).

A week later, I sent the selected households in Missaukee, Osceola, and Sanilac Counties a postcard, thanking those who had responded and encouraging the rest to respond soon (see

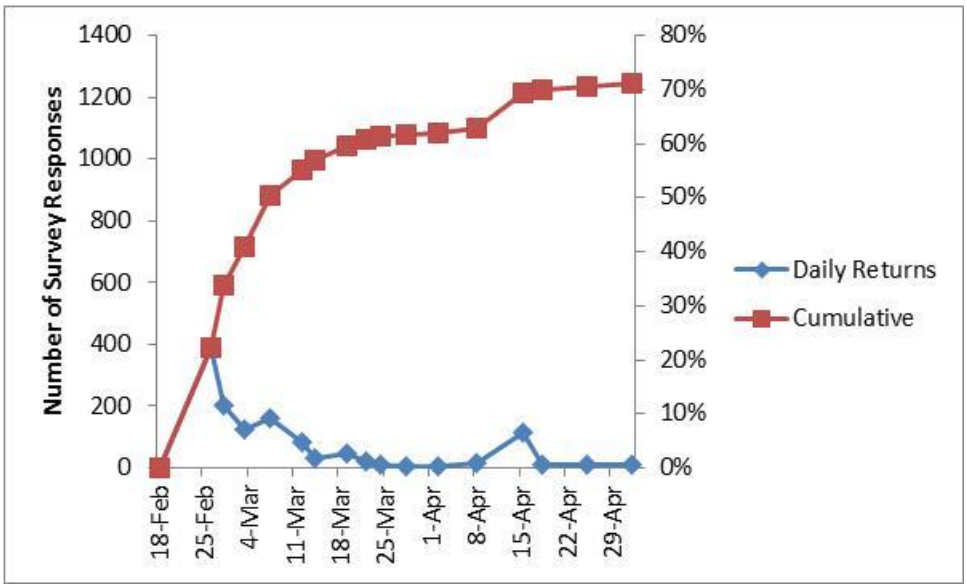
[32] Dillman et al. (2009) recommend sending the survey one week after the pre-notice letter. That was my intention. However, a printing error (the survey envelopes were sealed before I could insert the $2 pre-paid incentive) and a bank holiday (President's Day) delayed the mailing by one week.

[33] In the future, I would like to do a test to see if using a single $2 bill as opposed to two $1 bills has any impact on response rate. I have no way of knowing how much it helped my response rate but have a gut feeling that at least among this particular population, it provided some boost.

Appendix C). Huron County households received a follow-up letter with similar text on Huron County Board of Commissioners letterhead, with the return address of the Huron County office in Bad Axe (see Appendix C). I initially tried to have a letter of support sent out in all of the case study areas, but only Huron County was responsive to my requests. Dillman and colleagues (2009) suggest sending the letter of support before the first survey, but I was unable to make that deadline due to printing lead times.

While Dillman and colleagues recommend sending a replacement survey four weeks after mailing the first survey, at that point I was still receiving a couple of dozen surveys each day (see Figure B-1). I decided to wait until the responses dwindled to only ten surveys a day. I had originally budgeted sending a single replacement survey by regular first class mail to all who had not responded in some way (either through a returned survey or through a request not to be further contacted), as I had done with my previous mailings. By the time my response rate had dwindled, however, I had achieved a higher-than-anticipated response rate (61%), which meant that I had more money than planned for follow-up. As a result, I decided to incorporate a tangential survey methodology experiment into my dissertation. I randomly selected half of the non-responders to receive a complete replacement survey via first class mail, while the remainder received the same packet via priority mail. While a full discussion of the implications of this experiment is beyond the scope of this dissertation, 26.4% of potential respondents who received the replacement survey via first class mail responded, compared to 28.5% of those who received it via priority mail.

Figure B-1. Survey responses, by postmark date



As a result of these steps, I achieved a response rate of 71.9% (AAPOR RR2). While this is an exceptional response rate for most urban planning mail surveys, it is only slightly above average for my particular population of interest. According to Groves and Couper, "residents of small towns are found to cooperate at a higher level than those in large cities, while those in rural areas respond at an even higher rate" (1998, 176). Furthermore, I was careful to follow the advice of Pennings and colleagues (2002) and send the survey during the winter when respondents who farm would be snowbound. Though I did not keep track of exact numbers, I did find that a number of respondents with Michigan addresses returned their surveys from Florida or were delayed in responding because they had been on vacation. In February and March, it may be difficult to reach retirees who seek sunnier weather at the end of winter.

Data Coding

One of the downsides of a mail survey, especially in comparison to a web survey, is that rather than having respondents key in their data directly, the researcher is left with the task of data coding. Because of the higher-than-expected response rate, I decided that it would be

impractical for me to do all of the data entry myself, and I hired three undergraduate research assistants (RAs) to help me. As a result, I had to devise a data-entry system that would allow multiple people to work simultaneously and that would not require special software beyond that available in the University computing labs. I also wanted to make sure that the system allowed the RAs to work independently but did not require them to use their discretion on any out-of-the-ordinary responses, which I wanted them to pass them along to me.

I decided to create a bare-bones web-based version of the survey using the Google Form functionality. This allowed me to share the link to the data-entry form exclusively with my RAs, who could access it on any computer with an internet connection. All of the entered data was saved to an Excel sheet that I could easy access at any time. For multiple-choice questions, I assigned a number to each response option, a dummy '0' if the question was left blank but should have been answered (i.e., missing item), and '9' for inapt responses (e.g., two checked boxes instead of just one, something written in when that wasn't an option, etc.). Whenever the RAs coded 9, they flagged the item with a sticky note. When they finished entering data, they gave any flagged surveys directly to me for manual review (I explain that process in more detail below).

As a way to validate the data entry, each surveys was keyed in twice by two different RAs. While the primary goal was to identify any errant keystrokes, I also used this procedure to see if any of the RAs were not flagging items for my review as instructed. I used Microsoft Excel's "find duplicate" functionality to identify those surveys where the entered data did not exactly match. I reviewed those surveys myself to determine why there was a discrepancy between the two records, corrected the errors, and provided the RAs with feedback to improve their accuracy.

In examining surveys that RAs had flagged, I looked at about 50 of them together to see if there were recurring issues I could address by creating a new code. For example, Question 3.3 asked how the respondents expected most of their land to be used when sold. A number of respondents were using the 'other' option to write sentiments to the effect of "my land is not for sale," so I created code '98—no plans to sell' to accommodate such responses. Similarly, other respondents checked both of the first two responses—'farmed by a family member' and 'farmed by a non-family member'—so I created code '96—farmed (not sure by whom).' Throughout the form, respondents commonly wrote "not sure" or "?" next to the question, so I added 'code 99—not sure' to all questions.

Before analyzing the data, I also cleaned it, flagging and removing from analysis survey responses where an error might have occurred. For example, I removed the following respondents:

- Those who reported hosting wind turbines whose location I could not confirm. Because owners of farmland may own additional acreage outside of my study area, this might not be an error so much as a complication my analysis cannot account for.
- Respondents in matched case communities who reported leasing land to a wind developer or seeing turbines from their home. Again, these might not be in error—they might own land, including a residence, in an area with wind turbines—but I excluded them because they do not satisfy a criterion for the matched cases: being out of sight of a windfarm.

All told, 21 responses (1.7% of the total) were flagged and excluded from the quantitative analysis of survey responses.

In addition to the multiple-choice questions, the survey also included four short open-ended response questions and a large blank space on the back cover in which respondents could provide any additional responses. Nearly a quarter (23.7%) of respondents included comments on this last page, and some even included additional attached pages with more comments. All of these comments were transcribed by the RAs so that I would have a digital record of them.

Coding for the open-ended questions was facilitated with the NVivo software package. To code the four short open-ended questions, I first read through all responses for a given question, taking note of recurrent themes, and generated a set of codes for that question only. To code the open-ended question on the back page, I started by importing some of the codes used in coding the interviews (described in the next section), and adding to them as new and potentially relevant points were made. The final page of open-ended responses often veered off-topic (e.g., into commentaries on politics, farming, or family history); I did not create codes for any of the themes that strayed far from my research interest. The final list of survey codes appears in Appendix D.

Data Analysis

Most of the closed-ended responses in the survey were analyzed using statistical methods: linear regression models for continuous/ordinal values and Chi-squared contingency tables for categorical variables. Though very few questions investigated a truly continuous dependent variable, some of the multiple-choice questions clearly indicated a continuum that could be treated as continuous. For questions about investment, for example, I treated the midpoint of the range as a continuous rather than categorical response. I also treated responses to a 5-point Likert scale as continuous for the purposes of analysis. Most often, my null hypothesis was testing whether the mean of the dependent variable remained constant across three types of respondents: those with turbines on their property, landowners in windfarm communities who did not have turbines on their property, and landowners in the matched case community. These independent variables appeared as factors within the linear model. In addition, I frequently included other independent variables to increase the fit of the linear model:

number of acres the respondent owned, number of acres the respondent farmed, whether anyone within the respondent's household was a full-time farmer.

Where the dependent variable of interest was more categorical (e.g., responses of "farmed," "developed," or "idle" to the question of how the land would be used in the future), I constructed a contingency table and tested the null hypothesis that each of the respondent groups (turbines, neighbors, and control) would respond to the question with the same distribution. When some of the cells in the contingency table had frequencies fewer than five, I used Fisher's Exact Test rather than a Chi-squared (χ^2) statistic to determine statistical significance. Where Fisher's Exact Test indicated statistically significant differences in the observed data from the expected counts ($p<0.05$), I used a test of proportions of the observed and expected percentages in each cell to determine which cells were contributing to the difference.

Early in the analysis, the data seemed to defy the rules of parametric statistics. Even after trying every sort of data transformation—taking the log, square root, or reciprocal, or turning the data into a rate (e.g., investment per acre owned)—I was unable to achieve normality of errors or homoscedasticity. After multiple consultations with statistics instructors, I realized that the rules of parametric statistics are particularly important in constructing confidence intervals. Because I had conducted a census, I did not actually need confidence intervals (or perhaps even statistics).

In analyzing survey data, researchers commonly use statistics to make assertions about the entire population based on the sample collected. Statistics are especially useful in accounting for sampling error—the likelihood that the (small) number of people who were randomly selected to take the survey are in some way different from the population as a whole. In a census, however, where the entire population is asked to take the survey, the sampling error

approaches zero. Of course, there may be non-response error if the respondents are different from the non-respondents, which is always difficult to assess.

Common approaches to measure non-response error are to track down non-respondents and get them to take the survey, to compare late responders to early responders, or to use other publicly available information about the entire sample to see if non-responders are demographically different from responders. While the first technique is very difficult, I was able to use the latter two to determine whether non-response error might be a problem in my survey. Because I tracked when completed surveys were returned, I could compare late responders to those who replied earlier. Specifically, 2.6% of respondents returned a completed survey only after they received a second survey in the mail—eight weeks after the first survey was sent. On survey statistics that I expect to impact my analysis, there are very minimal changes in the mean values of these two groups, and nothing that rises to the level of statistical significance (see Table B-3). Furthermore, though I know very little demographically about the households in my sample frame aside from their mailing addresses, in the wind case study communities, I do know which households host wind turbines on their property and which do not. Comparing the response rates of those landowners with and without turbines on their property, I found very little difference in the response rates of these groups (see Table B-3). This gave me additional confidence that my non-response errors would be relatively low.

Table B-3. Comparison of early and late responders to determine non-response bias

	Mean of early responders	Mean of late responders (n=32)	p-value
Acres Farmed	218	186	.58
Acres Owned	208	188	.54
Total Investment	216	196	.76

Table B-4. Comparison of response rates by type of landowner, to determine non-response bias

	Turbines	Neighbors	Matched cases
Total in population	283	741	690
Returned surveys	203	527	501
Response rate	71.7%	71.1%	72.6%

Appendix C – Landowner Survey Materials

- Pre-notification letter
- Survey cover letter
- Questionnaire
- IRB information sheet
- Reminder postcard (Missaukee, Osceola, and Sanilac County respondents only)
- Reminder letter from Huron County Board of Commissioners
- Replacement questionnaire cover letter

WIND ENERGY & FARMING PROJECT
URBAN & REGIONAL PLANNING PROGRAM

SARAH MILLS, DOCTORAL CANDIDATE

February 5, 2014

«Envelope_Name»
«Address_1»
«City», «State» «Zip»

Dear «Salutation_Name»,

I am writing to ask for your help with an important study I am conducting to understand the relationship between wind turbines and farming. In the next few days you will receive a request in the mail to participate in this project by answering questions about the farmland that you own in «Township» Township.

You are probably wondering "why me?". Your address was randomly selected from among the owners of farmland in «County» County. I am writing to you in advance because many people like to know ahead of time that they will be asked to fill out a questionnaire. This research can only be successful with the generous help of people like you.

To say thanks, you will receive a small token of appreciation with the request to participate. I hope you will take 10-15 minutes of your time to help me. Most of all, I hope that you enjoy the opportunity to voice your thoughts and opinions about wind energy and the impact that it has on farmland and rural communities more broadly.

Best wishes,

Sarah Mills

2000 BONISTEEL BLVD.
ANN ARBOR, MI 48109-2069

(734)735-3194
sbmills@umich.edu

WIND ENERGY & FARMING PROJECT
URBAN & REGIONAL PLANNING PROGRAM

SARAH MILLS, DOCTORAL CANDIDATE

February 12, 2014

«Envelope_Name»
«Address_1»
«City», «State» «Zip»

Dear «Salutation_Name»,

I am writing to ask for your help in understanding the impact that wind turbines and windfarms have on farming communities. The best way to learn about this issue is by asking owners of farmland themselves to share their thoughts and experiences. Your address is one of only a small number of owners of farmland in «County» County that have been randomly selected to help in this study. «Matched_case_2»

Because some of these questions ask about your future plans for your land and recent improvements to your property, the survey should be answered by the person (or people) that makes decisions about your farmland.

The questions should take less than 15 minutes to complete. Your responses are voluntary and will be kept confidential. Your answers will never be associated with your name or address. If you have any questions about this survey, please call me at (734)735-3194 or email me at *sbmills@umich.edu*. You should also feel free to contact Dr. Richard Norton, Department Chair and my advisor, by telephone at (734)764-1300 or by email at *rknorton@umich.edu*. An information sheet outlining more details about this research is enclosed.

By taking a few minutes to share your thoughts and opinions about wind energy and telling us more about your farmland you will be helping us out a great deal, and a small token of appreciation is attached as a way of saying thank you. I would also be happy to share my research results with you. One of the last questions asks you how you would like to be informed of the results from this survey.

I hope that you enjoy the opportunity to voice your thoughts and opinions about wind energy.

Many thanks,

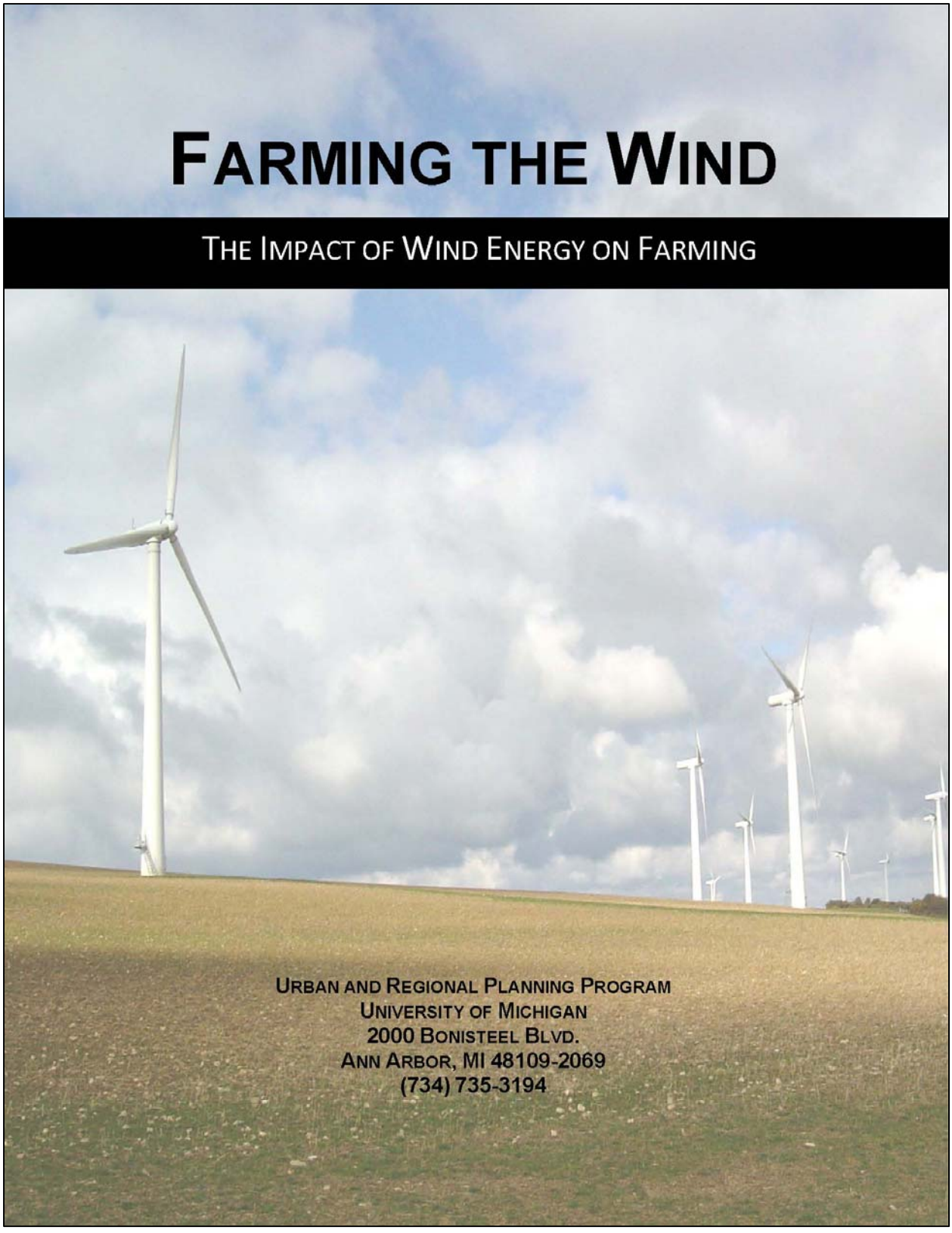
Sarah Mills

Sarah Mills
Doctoral Candidate

«ID»

2000 BONISTEEL BLVD.
ANN ARBOR, MI 48109-2069

(734)735-3194
sbmills@umich.edu


FARMING THE WIND
THE IMPACT OF WIND ENERGY ON FARMING
URBAN AND REGIONAL PLANNING PROGRAM
UNIVERSITY OF MICHIGAN
2000 BONISTEEL BLVD.
ANN ARBOR, MI 48109-2069
(734) 735-3194

Instructions

- This survey is intended for all owners of agricultural land, not just farmers. Even if you don't farm yourself, please complete the survey. We need to hear from you.

- The person or people at this address who typically make decisions about your agricultural land should fill out this survey.

- You can use a pen or a pencil to mark your answers.

WIND ENERGY

These questions ask about your attitudes toward and experience with wind energy.

1.1 How strongly do you agree or disagree with each statement about wind turbines?

Wind turbines…	Strongly Agree	Agree	Disagree	Strongly Disagree
…create jobs.	☐	☐	☐	☐
…disrupt bird migration.	☐	☐	☐	☐
…create noise pollution.	☐	☐	☐	☐
…produce visual or aesthetic problems.	☐	☐	☐	☐
…provide revenues for land owners.	☐	☐	☐	☐
…disrupt local weather patterns.	☐	☐	☐	☐
…cause human health problems.	☐	☐	☐	☐
… preserve rural land.	☐	☐	☐	☐
… help limit climate change.	☐	☐	☐	☐
… reduce nearby property values.	☐	☐	☐	☐

1.2 How much authority should each of these groups have for deciding where wind turbines are sited?

	A Great Deal of Authority	Some Authority	No Authority
Federal government	☐	☐	☐
State governments	☐	☐	☐
Local governments	☐	☐	☐
Land-owners	☐	☐	☐

1.3 Can you see any wind turbines from your property in Huron County?

☐ Yes ☐ No (GO TO Question 1.5)

1.4 About how many turbines can you see from your property?

_____ TURBINES

1.5 Can you hear any wind turbine(s) from your property?

☐ Yes ☐ No

1.6 Do you lease any land to a wind developer?

☐ Yes ☐ No

1.7 Did you receive any royalties from a wind energy project in 2013?

☐ Yes ☐ No (GO TO PAGE 5, "YOUR COMMUNITY")

1.8 About how much did you receive in wind energy royalties in 2013?

☐ $ 0 - 99
☐ $ 100 - 499
☐ $ 500 – 999
☐ $ 1,000 – 1,999
☐ $ 2,000 – 2,999
☐ $ 3,000 or more

1.9 How does this royalty income affect your farm business?

1.10 Are any wind turbines sited on your property?

☐ Yes ☐ No (GO TO PAGE 5, "YOUR COMMUNITY")

1.11 Are fields with turbines easier or more difficult to farm?

☐ Easier to farm
☐ More difficult to farm
☐ Both easier AND more difficult to farm
☐ No difference (GO TO PAGE 5, "YOUR COMMUNITY")

1.12 How is it easier or more difficult to farm?

YOUR COMMUNITY

These questions ask about how you feel about population growth in Huron County, and how it affects you.

2.1 How strongly do you agree or disagree with each statement?

	Strongly Agree	Agree	Disagree	Strongly Disagree
Development is happening too quickly in Huron County.	☐	☐	☐	☐
Huron County is losing its rural character.	☐	☐	☐	☐
Huron County's most productive farmland should be preserved for agriculture.	☐	☐	☐	☐
Development in Huron County is making life better.	☐	☐	☐	☐
There should be limits on where development can occur in Huron County to protect local farmland.	☐	☐	☐	☐
I am satisfied with Huron County as a place to live.	☐	☐	☐	☐

2.2 Did you personally grow crops or raise livestock in Huron County in 2013?

☐ Yes

☐ No (GO TO PAGE 7, "FUTURE PLANS")

2.3 How strongly do you agree or disagree with each of this statement?

	Strongly Agree	Agree	Disagree	Strongly Disagree
I am satisfied with Huron County as a place to have an agricultural operation.	☐	☐	☐	☐

2.4 Have you experienced any of the following in the last five years?

	Yes	No	Not Applicable
Difficulty in purchasing farmland because of escalating land prices.	☐	☐	☐
Difficulty in obtaining new rental land in this area.	☐	☐	☐
Difficulty in retaining existing rental land.	☐	☐	☐

FUTURE PLANS

These questions are about what you think might happen to your farmland in the future.

3.1 For how much longer do you think you will own any farmland in Huron County?

- ☐ 1 to 10 years
- ☐ 11 to 20 years
- ☐ 21 to 30 years
- ☐ More than 30 years

3.2 Do you have a succession plan in place for your land?

- ☐ Yes
- ☐ No

3.3 How do you think ***most*** of your land in Huron County will be used when you sell it?

- ☐ Farmed by a family member
- ☐ Farmed by a non-family member
- ☐ Converted to a housing development / subdivision
- ☐ Convert to an industrial, commercial, or retail use
- ☐ Idle—neither farmed nor developed
- ☐ Other (please explain): _____

3.4 If you had been asked question 3.3 five years ago, do you think you would have answered the same way?

- ☐ Yes (GO TO PAGE 8, "ON-FARM INVESTMENT")
- ☐ No

Why not?

ON-FARM INVESTMENT

These questions ask about the investments that you might be making on your farm.

4.1 Since 2008, have you purchased any additional farmland?

☐ Yes ☐ No (GO TO Question 4.3)

4.2 How many acres did you buy?

☐ 0 – 19 acres
☐ 20 – 39 acres
☐ 40 – 79 acres
☐ 80 acres or more

4.3 Since 2008, have you sold any farmland?

☐ Yes ☐ No (GO TO PAGE 9, Question 4.7)

4.4 How many acres did you sell?

☐ 0 – 20 acres
☐ 20 – 39 acres
☐ 40 – 79 acres
☐ 80 acres or more

4.5 To whom did you sell the land? (CHOOSE ALL THAT APPLY)

☐ A relative for farming
☐ A relative for non-farming
☐ A non-relative for farming
☐ A non-relative for non-farming.
☐ Other (PLEASE EXPLAIN) _____

4.6 Why did you sell this land?

4.7 Since 2008, about how much money have you spent on improvements to your **home** (even if that home is not in Huron County)?

- ☐ Less than $ 10,000
- ☐ $ 10,000 – 49,999
- ☐ $ 50,000 – 99,999
- ☐ $ 100,000 – 149,999
- ☐ $ 150,000 – 199,999
- ☐ $ 200,000 – 249,999
- ☐ $ 250,000 – 299,999
- ☐ More than $300,000

4.8 Since 2008, about how much money have you spent on improvements to your **outbuildings, including grain storage**?

- ☐ Less than $ 10,000
- ☐ $ 10,000 – 49,999
- ☐ $ 50,000 – 99,999
- ☐ $ 100,000 – 149,999
- ☐ $ 150,000 – 199,999
- ☐ $ 200,000 – 249,999
- ☐ $ 250,000 – 299,999
- ☐ More than $300,000

4.9 Since 2008, about how much money have you spent on improvements to your **field drainage and irrigation**?

- ☐ Less than $ 10,000
- ☐ $ 10,000 – 49,999
- ☐ $ 50,000 – 99,999
- ☐ $ 100,000 – 149,999
- ☐ $ 150,000 – 199,999
- ☐ $ 200,000 – 249,999
- ☐ $ 250,000 – 299,999
- ☐ More than $300,000

4.10 Since 2008, about how much money have you spent on purchasing **new or used farm equipment** including trucks, tractors or other farm machinery?

- ☐ Less than $ 10,000
- ☐ $ 10,000 – 99,999
- ☐ $ 100,000 – 199,999
- ☐ $ 200,000 – 299,999
- ☐ $ 300,000 – 399,999
- ☐ $ 400,000 – 499,999
- ☐ $ 500,000 – 599,999
- ☐ $ 600,000 – 699,999
- ☐ $ 700,000 – 799,999
- ☐ More than $800,000

YOUR HOUSEHOLD

These questions ask about your household—that is, the people that live with you.

5.1 Is farming the primary occupation for anyone in your household?

☐ Yes ☐ No

5.2 About how much of your household income comes from farming?

☐ 0 – 24%
☐ 25 – 50%
☐ 51 – 75%
☐ 76 – 100%

5.3 About how many total acres of farmland do you currently own? Include all land that is tillable or suitable for livestock, regardless of whether or not it was planted in 2013.

☐ 0 – 19 acres
☐ 20 – 59 acres
☐ 60 – 249 acres
☐ 250 – 499 acres
☐ 500+ acres

5.4 How much of your land did **someone else** farm in 2013 [either through a lease or sharecropping]?

☐ None
☐ 1 – 19 acres
☐ 20 – 59 acres
☐ 60 – 249 acres
☐ 250+ acres

5.5 How much land did you lease or sharecrop **from** someone else in 2013?

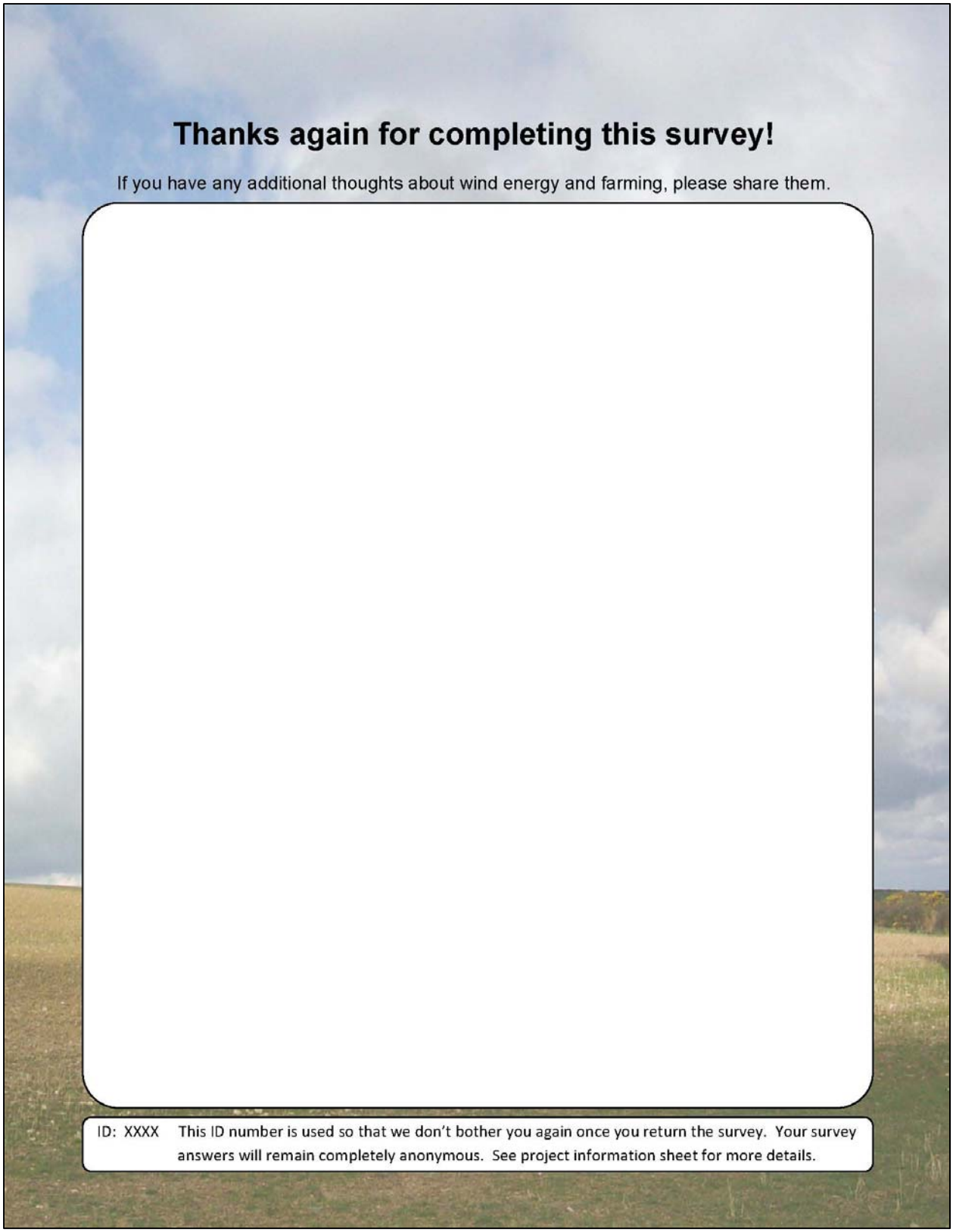
☐ None
☐ 1 – 19 acres
☐ 20 – 59 acres
☐ 60 – 249 acres
☐ 250 – 499 acres
☐ 500+ acres

RESEARCH RESULTS

As a small token of thanks, we'd be happy to send you the results of our study.

6.1 How would you like to receive the research results from this survey?

☐ U.S. Mail
☐ Email. My email address is: _____
☐ Neither. No need to send me the results.


Thanks again for completing this survey!
If you have any additional thoughts about wind energy and farming, please share them.
ID: XXXX This ID number is used so that we don't bother you again once you return the survey. Your survey answers will remain completely anonymous. See project information sheet for more details.

FARMING THE WIND: THE IMPACT OF WIND ENERGY ON FARMING

Research Topic
This research looks at the impact that windfarms have on farmland owners and rural communities more broadly.

Your Role
If you agree to be part of the research study, you simply need to complete the enclosed survey that asks your opinion about wind energy, your opinion of development projects in your community, as well as provide details about your farmland: investments that you've made recently, and your future plans.

Benefits of the research
This research will help inform rural communities who are considering allowing wind energy development about the potential impacts—both positive and negative—on their community as a whole as well as on individual landowners. It is unlikely that you will directly benefit from this research.

Risks and discomforts
There is little risk associated with this study. Participating in this study is no more risky than other everyday activities.

Confidentiality
Your survey is marked with an ID number to be able to track your participation in the study—so that we won't bother you again once you've completed the survey. The key matching your survey ID to your address is saved in a password-protected computer, accessible only to the researchers, and will be destroyed at the end of the study. Your answers will never be associated with your name or mailing address in any research report.

Compensation
As a small token of appreciation, you are being given $2 whether your complete the survey or not. Further, you may elect to receive the research findings from this study when they are available in November 2014.

Important notes
Participating in this study is completely voluntary. Even if you decide to participate now, you may change your mind and stop at any time. You may choose not to answer any survey question for any reason.

Returning a completed survey in the enclosed envelope is implicit consent to these terms.

If you have questions about this research study, you may contact Sarah Mills at (734)735-3194 or sbmills@umich.edu; or her advisor Professor Richard Norton at (734)764-1300 and rknorton@umich.edu.

The University of Michigan Institutional Review Board Health Sciences and Behavioral Sciences has determined that this study is exempt from IRB oversight.

THIS SHEET IS YOURS TO KEEP.

February 26, 2014

Last week a survey was mailed to you because your household was randomly selected to help in a study about wind turbines and farming. If someone at your address has already completed and returned the questionnaire, please accept our sincere thanks. If not, please have the person (or people) that make decisions about your farmland do so right away—even if you do not live in an area with wind turbines, it is important we hear from you. I am very grateful for your help with this important study.

If you did not receive a survey, or if it was misplaced, please call me at (734)735-3194 or email me at *sbmills@umich.edu* and I will get another one in the mail for you today.

Sincerely,

Sarah Mills, Doctoral Candidate

February 26, 2014

Last week a survey was mailed to you because your household was randomly selected to help in a study about wind turbines and farming. If someone at your address has already completed and returned the questionnaire, please accept our sincere thanks. If not, please have the person (or people) that make decisions about your farmland do so right away—even if you do not live in an area with wind turbines, it is important we hear from you. I am very grateful for your help with this important study.

If you did not receive a survey, or if it was misplaced, please call me at (734)735-3194 or email me at *sbmills@umich.edu* and I will get another one in the mail for you today.

Sincerely,

Sarah Mills, Doctoral Candidate

February 26, 2014

Last week a survey was mailed to you because your household was randomly selected to help in a study about wind turbines and farming. If someone at your address has already completed and returned the questionnaire, please accept our sincere thanks. If not, please have the person (or people) that make decisions about your farmland do so right away—even if you do not live in an area with wind turbines, it is important we hear from you. I am very grateful for your help with this important study.

If you did not receive a survey, or if it was misplaced, please call me at (734)735-3194 or email me at *sbmills@umich.edu* and I will get another one in the mail for you today.

Sincerely,

Sarah Mills, Doctoral Candidate

February 26, 2014

Last week a survey was mailed to you because your household was randomly selected to help in a study about wind turbines and farming. If someone at your address has already completed and returned the questionnaire, please accept our sincere thanks. If not, please have the person (or people) that make decisions about your farmland do so right away—even if you do not live in an area with wind turbines, it is important we hear from you. I am very grateful for your help with this important study.

If you did not receive a survey, or if it was misplaced, please call me at (734)735-3194 or email me at *sbmills@umich.edu* and I will get another one in the mail for you today.

Sincerely,

Sarah Mills, Doctoral Candidate

HURON COUNTY BOARD OF COMMISSIONERS

250 East Huron Avenue, Room 305, Bad Axe, Michigan 48413-1398
Phone: (989) 269-8242 • Fax: (989) 269-6152 • Email: boc@co.huron.mi.us
Website: www.co.huron.mi.us

February 12, 2014

Dear Huron County Land Owner:

I am writing to encourage you to take part in a survey about wind energy and farming that you should have received last week. This survey is part of a research project that will help the Board of Commissioners and other local officials better understand the impact that wind projects are having on landowners like you. Sarah Mills at the University of Michigan is studying four different wind projects to figure out which projects lead to the most benefits for the community. When her research is done, Sarah has promised to share the results with us so that we can use them in making future decisions about wind project siting. To be clear, your survey responses will remain completely anonymous. Sarah will only share with us a **summary** of the responses, not the actual surveys themselves.

Your response is very important in order to accurately reflect the opinions of landowners in your township. If you have already returned your survey to Sarah, thank you! If you have not, please consider doing so right away. If you did not receive a survey, or if it was somehow misplaced, you should contact Sarah directly at (734) 735-3194 or email her at *sbmills@umich.edu*.

Thank you for considering this request. The Board of Commissioners is really looking forward to hearing your opinions about how the windfarms are affecting you.

Sincerely,

Clark E. Elftman

Clark Elftman
Chairman

WIND ENERGY & FARMING PROJECT
URBAN & REGIONAL PLANNING PROGRAM

SARAH MILLS, DOCTORAL CANDIDATE

March 31, 2014

The Bensinger Family
4405 Pike Street
Ubly, MI 48475

Dear Bensinger Family,

In mid-February I sent a letter to your address that asked for a member of your household to complete a questionnaire about issues related to wind turbines and farming. To the best of my knowledge, it has not yet been returned. [If you returned it in the last 3 or 4 days, our letters probably crossed in the mail; you can ignore this letter, and thank you!]

I am writing again because of the importance that your household's questionnaire has for helping to get accurate results. It is only by hearing from nearly everyone in the randomly-selected sample that I can be sure that the results truly represent farmland owners in Huron County.

I understand that this might be a busy time for you, and as I mentioned before, the questions should take no more than 15 minutes to complete. Your responses are voluntary and will be kept confidential. Your answers will never be associated with your name or address. If you have any questions about this survey, please call me at (734)735-3194 or email me at sbmills@umich.edu. You should also feel free to contact Dr. Richard Norton, Department Chair and my advisor, by telephone at (734)764-1300 or by email at rknorton@umich.edu.

I'd like to thank you in advance for your help in my research project, and do hope that you'll return the survey with the enclosed envelope as soon as you can.

Many thanks,

Sarah Mills

Sarah Mills
Doctoral Candidate

2001

2000 BONISTEEL BLVD.
ANN ARBOR, MI 48109-2069

(734)735-3194
sbmills@umich.edu

Appendix D – Survey Code Book

Nodes

Name	Sources	References
About farmers	1	1
Broken turbine	1	3
Construction	1	5
Cranes	1	1
Developer-specific	2	9
DTE	2	4
Exelon	1	1
Geronimo	1	1
Heritage	1	1
ITC	1	2
Subcontractor	1	6
Impacts	0	0
As part of modernizing	1	4
Birds bats wildlife	3	15
Climate change	2	3
Compared to other energy	2	25
Conflict of interest	1	1
Decommissioning	2	17
Energy independence	1	4
Enough already	1	7
Farm income	2	8
spent in local community	1	3
Farming (as Q1.12)	1	3
Access Roads	1	3
Compaction	1	3
Construction Debris	0	0
Construction Disruption	0	0
Crop damage	1	3
Crop dusting	1	2
Irrigation	1	2
Land out of production	3	16
Lie down areas	0	0
More paperwork	0	0
Obstacles	1	7
Odd angles or paths	1	2
Payments not enough for inconvenience	0	0
Payments outweigh inconvenience	0	0
Size of equipment	0	0
Tile	2	9
Topography	1	5

Nodes

Name	Sources	References
Vague damage	2	2
Farmland preservation	3	9
Flicker	2	6
For those who aren't paid	3	23
Good use of wind resource	1	3
Health	2	9
In history	1	2
Jealousy or Greed	2	8
Local jobs	3	18
Losing blade	1	1
Misinformation	2	5
Need for alternative energy	1	9
Noise	3	31
On electricity rates	1	16
Power going elsewhere	1	6
Property Taxes	1	9
Depreciation Table or STC	2	6
Property Values	2	10
Red Lights	1	14
Road damage or traffic	2	3
RPS	1	4
Subsidization	2	27
Tension in community	3	9
Traffic	1	2
Transmission lines	2	10
Eminent Domain	1	4
TV reception	1	3
View or Tourism	3	47
Weather	0	0
Lawsuit	2	3
Leases	1	1
Pooling	1	1
Cons	1	2
Pros	0	0
Too low	2	8
Won't renew	1	2
On my property	0	0
I'd like one	1	29

Nodes

Name	Sources	References
I'm glad I don't have one	1	7
Regret having done it	2	6
Property Rights	1	3
Of farmland owners who want turbines	1	1
Of neighbors	1	2
Q1.12 ONLY Impact on Farming	0	0
Access Roads	1	30
Compaction	1	7
Construction Debris	1	2
Construction Disruption	1	1
Crop damage	1	2
Crop dusting	1	1
Land out of production	1	4
Lie down areas	1	1
More paperwork	1	1
Obstacles	1	55
Odd angles or paths	1	4
Payments not enough for inconvenience	0	0
Payments outweigh inconvenience	1	2
Size of equipment	1	5
Tile	1	11
Topography	1	6
Vague damage	1	2
Q1.9 Royalty affect	0	0
Easier to pass on	1	1
Guaranteed or certain	1	5
Just another crop	1	3
Little	1	43
Negative	1	4
None	1	68
Positive Impact	1	86
Extra income	1	26
Helps - vague	1	29
Large	1	5
More than crops	1	3
Spent on	1	23
Covers property taxes	1	12
Improvements or purchases	1	3
Local economy	1	2

Nodes

Name	Sources	References
Retirement	1	6
Too soon to tell	1	5
Q3.5 Change in Future Expectations	0	0
Change in farming	1	3
Change in health or family plans	1	28
Farmland prices	1	6
Wind turbines	1	2
Hurting farming	1	1
Hurting residential use	1	4
Q4.6 Why sold land	0	0
For development	1	3
High land prices	1	7
Needed money	1	31
Other personal reasons	1	39
Retired	1	12
Taxes too high	1	2
Wind Turbines	1	2
Research Critique	0	0
Bad or confusing question	1	8
Comment on $2 bill	2	10
Needed or thanks	1	10
Siting	1	8
Disagreement	1	6
In less-populated areas	1	1
Off-shore	1	2
On government land	1	4
On less-productive land	1	10
Smaller turbines	1	5
Zoning	2	4

Appendix E – Details on Interview Design and Implementation

Interview Guide Design

Semi-structured interviews strike a nice balance between soliciting the same information from all interviewees (as in fully scripted interviews), and allowing the conversation to evolve and focus on topics specific to a particular interviewee (as in a free-form interview). As a result, semi-structured interviews generally begin with a common set of open-ended questions that set the stage for the topics of interest to the researcher but encourage the interviewee to enter into a conversation. A skilled interviewer can ask probing follow-up questions to solicit additional details or clarifications and keep the conversation moving. Some of these follow-up probes might be scripted, while others can be developed on the fly. Having an "interview guide"—a list of possible questions—is considered a best practice to ensure that all topics of interest are covered within the interview so that follow-up is not necessary, as well as to ensure that question wording isn't unduly biased.

Because my interviews aimed at soliciting specialized information from three distinct groups of people—realtors/auctioneers/appraisers, local officials, and wind developers—I developed three different interview guides. I first asked questions that were relatively easy for interviewees to answer to make them feel more comfortable with me. Only later, after building trust, did I move to topics that were more controversial or speculative. In my interviews with

realtors, for example, I first asked about the historic market for farmland in the area. Only later did I inquire about the possible impact of windfarms or ask for anecdotes about recent sales.

While I did solicit feedback from my committee on the guides, I did not conduct a formal pre-test. Instead, I arranged my early interview schedule so that I could tweak the guide after my first couple of interviews. The guides posted in Appendix F are the final iteration of each version.

As the transcripts show, my interviews rarely followed the interview guide. Most often, we talked about the same questions but in a different order, and I sometimes introduced previously unasked questions. Even so, I found these guides very useful, especially with less-talkative interviewees. The list of questions also served as a useful prop during interviews when I wanted to pause briefly to decide where to take the interview, when I needed to act distracted while my interviewee attended to other business, or when I wanted to give my interviewee additional time to formulate an answer.

Unit of Analysis

The unit of analysis for this portion of my research varies. For the realtor/auctioneer/appraiser interviews, the unit of analysis is the region. This is because the geographic reach of most of these real estate professionals is quite large—often multiple counties. As a result, the three case studies in Huron County (Cases 1, 2, and 3) are all served by the same realtors. While I have multiple observation points (i.e., individual realtors) within a particular county, I aggregate my data to compare interviews in the Huron County "Thumb" Region with those in the McBain Region.

Because my interviews with local officials and wind developers are not directly tied to a specific research question but rather provide context and background information about the wind

projects, the unit of analysis varies. The local officials spoke largely in terms of their jurisdiction: a township or the entire county. The township as a unit of analysis is sub-case-study level (i.e., there are multiple townships within a case study). Interviews with Huron County officials cross three case studies, while the interviews with Missaukee and Osceola County officials all pertain to the same High-growth (#4) case study. The discussions with wind developers provide data that corresponds to a specific case study.

Interview List Construction

In order to identify realtors to interview, I used online real estate listings to look for realtors with active listings of vacant farmland parcels. I contacted them, explained that I was interested in better understanding the market for farmland in their area, and asked if they or a colleague would be best able to answer my questions. Sometimes the realtors would say that they themselves were a good fit. More often, though, they would refer me to another realtor or an auctioneer who usually was a much better fit. I continued to look for additional realtor interviewees in each region until I had reached the point of saturation or redundancy (Kuzel 1999), when I began to hear the same responses over and over again and/or I had run out of suggestions for knowledgeable interviewees. In total, I interviewed six realtors/auctioneers: four in the Thumb region, and two near McBain.

Identifying the remainder of interviewees—local officials and wind developers—was a largely formulaic process. I used publicly available listings of local officials to contact the township supervisor in each of the case study townships and tried to be as persistent and accommodating as possible in order to get an interview. Where the jurisdiction was locally zoned, I asked the supervisor for contact information for the planning commission chairperson. I also used local listings to contact the chair of the county Board of Commissioners and the chair

of the county Board of Commissioners finance (or tax) committee, unless they were the same person. In the end, only two people in this list refused to be interviewed, both of them township supervisors. This resulted in 14 interviews with local officials, including one group interview of a supervisor and both the current and past chair of the township planning commission.

I also tried to interview the wind developers involved in each of the case study projects. I used local newspaper articles about the projects to identify the project manager for the wind farm of interest at each wind developer and was often able to find direct contact information through additional online searching. Though they were initially reluctant, I succeeded in talking to developers in two of the four projects.[34] In place of the developer who refused, I spoke to an environmental consultant who works for a variety of developers and did much of the feasibility analysis and community outreach on Mixed-benefits (#2).

Finally, I interviewed the Program Manager for the Michigan Department of Agriculture and Rural Development's Farmland Preservation Office.

Interview Procedures

After identifying potential interviewees, I usually contacted them via telephone to try to schedule an interview; for the wind developers, I initially had only email addresses. When possible, I arranged to meet the interviewees in person at their home or office, though I did conduct six of the 24 interviews by telephone.

I began each interview by introducing my topic in very general terms via the interview consent form (see Appendix F). Following each interview, I thanked the interviewee in person and then followed up with a hand-written note. I also asked each of my interviewees if they

[34] The Developer-friendly (#1) and Mixed-benefits (#2) cases were done by the same developer, who refused to be interviewed, citing legal concerns.

would like to be informed of my research findings (all said they would) and solicited an address so that I could forward the findings when they became available.

Data Coding

To aid in the analysis of the interview data, I coded the transcripts from each of the interviews using NVivo. I began by developing a rubric based on the interview guides for each of the questions, on some of the common themes that emerged as I conducted the interviews, and on the identifying characteristics of the interview (i.e., the position of the interviewee and the case stud(ies) with which the interview was associated). As I conducted the coding, if I felt that a theme was not properly captured by the existing rubric, I would add another code (or set of codes) and return to the interviews that I had already transcribed to recode them as necessary. The final list of interview codes appears in Appendix G.

Data Analysis

Most of the analysis of the interviews focuses on the words of the interviewees themselves. In some situations, I compare the opinions of interviewees within the same case, while in others I contrast opinions across different cases. While I rarely look for an actual count of the number of times a given word came up within an interview or the amount of time spent talking about a specific topic, in some situations I do quantify the number of interviewees who discussed a particular topic, especially if it was in response to a question posed to all interviewees.

Appendix F – Semi-structured Interview Materials

- Interview guide for realtors
- Interview guide for wind developers
- Interview guide for public officials
- Consent form

Interview Guide for Realtors

1. How would you describe real estate market for farmland in [XXX] county/township?
    a. Who is buying the land?
    b. For what purpose?
    c. What size parcels are usually changing hands?
    d. How has the market for farmland changed in the last decade?

2. What kind of demand is there for new construction in the county/township?
    a. Is it out-of-towners or locals looking to build new houses?
        i. If locals, do they buy / receive property from someone in their family, or buy it through a realtor?
    b. What are the primary characteristics they are looking for as they find a piece of property?
    c. Can you give me some examples of recently built homes?

3. How has the presence of the windfarm impacted the market for farmland?
    a. Are there examples of new homes built or major remodels in area of windfarm?
    b. What are potential buyers worried about?
    c. How far does the impact extend?
        i. Where are new houses getting built?
        ii. Can they still see the turbines?
    d. Do farmers with turbines seem any more or less interested in selling their property?
    e. Are you aware of any land with wind leases changing hands?
        i. Was there anything unique about that transaction?

Interview Guide for Wind Developers

1. Can you walk me through the wind planning process as it unfolded for [this] project?
    a. Were there any differences in the process in different municipalities?
2. What role did you play in the planning commission and township board's discussion of the wind zoning ordinance?
    a. Were you present at meetings?
    b. Did you provide any suggested language?
    c. Did you suggest other windfarms they should visit?
3. What sort of reception did you receive from the community?
4. Do you have any figures on the economic benefits that this particular windfarm has on the community?
    a. How much are you contributing in property taxes?
    b. Did you pay for any other municipal-level services?
    c. How does the amount you pay in royalties and other direct payments for [this] wind project compare to what you pay in property taxes?
5. How do you decide what terms to offer in a lease agreement?
6. How do you decide how to handle the royalty payments?
    a. What is the rationale behind deciding [not] to pool royalties?
    b. What is the rationale behind deciding [not] to offer friendly neighbor agreements?

Thinking not just about this project but about all of your projects:

7. What is the biggest hindrance to wind development?
8. What makes a project easy?
9. When you are considering proposing a wind farm in particular place, where does receptivity of the community fit into your calculus?
    a. What difference does it make if some of the large landowners are also skeptical?
    b. How does this compare to the specifics of the zoning code in terms of being an impediment, or do they go hand-in-hand?
10. How much "educating the public" do you do in proposed windfarm sites?
    a. If a municipality was really against the idea of wind, do you try to change their mind?
    b. At what point in the process do you start this education campaign?
11. How do you deal with misinformation?
12. What are the key benefits that you use in educating the public?
    a. Are the public benefits different than landowner benefits?
    b. Does farmland preservation come up?
        i. If so, how do you explain it?
13. Do you take any measures to minimize impact of wind turbines on farming operations?
    a. During construction?
    b. During siting?

Interview Guide for Township Supervisors and Planning Officials

1. What are the major issues on the minds of large landowners in the township/county?
    a. Are they worried about:
        i. Too much (or not enough) development?
            1. Census shows loss/gain; where? Is it a concern?
        ii. Crop prices?
        iii. Soil issues like drainage / irrigation?
        iv. Property taxes?
        v. Land fragmentation?
        vi. Succession plans?
    b. How have these issues changed in the last decade?
    c. How do landowners feel about the windfarm?
        i. Impact on the economics of their farm?
        ii. Impact on the easy of farming?
        iii. Impact on possibility for development?
2. How has this been translated in your master plan and/or zoning ordinance?
    a. What specific policies address these concerns?
3. Can you walk me through the wind planning process as it unfolded in this township?
    a. How does wind energy development fit in with other township goals?
    b. With farmland preservation, specifically?
4. What were the major concerns voiced by township residents related to wind energy?
    a. Where there clear divisions among different groups of residents?
5. How were specifics of the wind zoning regulations determined?
    a. Was there discussion on setback distances?
        i. What were the options?
        ii. Who supported each?
    b. What role did the wind developer play in informing the wind zoning regulations?
        i. Were they present at public meetings?
        ii. Did they provide sample language?
        iii. Did they suggest other windfarms to visit?
    c. How did knowledge of the wind developer's compensation scheme factor into the zoning ordinance?
    d. Are you doing anything to minimize impact of wind turbines on farming?
    e. If you could go back and rewrite your wind ordinance, is there anything you would change? Why?
6. How has the presence of the wind farm impacted this township?
7. What relationship do you see, if any, between wind energy and farmland preservation?
8. [for Supervisors only] How have property tax revenues from the wind farm been used?
    a. Do you have additional plans in the future?
    b. Have you reduced property tax rates?
9. Do you have any advice for other municipalities considering whether or not to welcome windfarms?

FARMING THE WIND: THE IMPACT OF WIND ENERGY ON FARMING

Research Topic
This research looks at the impact that windfarms have on farmland owners and rural communities more broadly.

Your Role
If you agree to be part of the research study, you will be asked to participate in one face-to-face interview at the location of your choice. The interview should take about one hour. I would like to audio record the interview to make sure that our conversation is recorded accurately. You may still participate in the research even if you decide not to be recorded. The discussion topics include recounting the process of siting one specific windfarm as well as more general topics related to public outreach and the siting process.

Benefits of the research
This research will help inform rural communities who are considering allowing wind energy development about the potential impacts—both positive and negative—on their community as a whole as well as on individual landowners. It might also help wind developers understand what aspects of a project are most beneficial or disruptive to a community, allowing them to accentuate the positives in approaching a community and mitigate against the negatives. It is unlikely that you will directly benefit from this research.

Risks and discomforts
There is little risk associated with this study. Participating in this study is no more risky than other everyday activities.

Confidentiality
We plan to publish the results of this study, but will not identify you by name, though your official title may be used. To keep your information safe, the audio file of your interview will be stored on a password-protected computer, until a written word-for-word copy of the discussion has been created. As soon as this process is complete, the audio file will be deleted. The researchers will enter study data on a computer that is password-protected and uses special coding of the data to protect the information. The researchers plan to keep this study data indefinitely for future research about wind energy and farmland.

Compensation
You will not be paid for your participation, though you may receive a copy of the research results of this study.

Important notes
If you have questions about this research study, you may contact Sarah Mills at (734)735-3194 or sbmills@umich.edu; or her advisor Richard Norton at (734)764-1300 and rknorton@umich.edu.

The University of Michigan Institutional Review Board Health Sciences and Behavioral Sciences has determined that this study is exempt from IRB oversight.

By signing this document, you are agreeing to be part of the study. Participating in this research is completely voluntary. Even if you decide to participate now, you may change your mind and stop at any time. You will be given a copy of this document for your records and one copy will be kept with the study records. Be sure that questions you have about the study have been answered and that you understand what you are being asked to do. You may contact the researcher if you think of a question later.

I agree to participate in the study.

_____ _____
Signature Date

I agree to be audio recorded as part of the study.

_____ _____
Signature Date

Appendix G – Interview Code Book

Nodes

Name	Sources	References
Advice to Others	12	17
Cases	0	0
1 Ubly	9	9
Comparison to Ubly	5	8
Control Community	3	4
Harvest	12	12
Harvest-area comparison	5	10
Sigel	10	10
Stoney Corners	6	6
Thumb-Cadillac comparison	1	3
Community Priorities	10	21
Decommissioning	8	10
Farming	1	1
Profitability	5	9
Size of farms	8	9
Type of crops	6	7
Farmland Market	3	6
Buyers	7	15
Competition with Hunting Ground	4	6
Prices	8	11
Recent changes	3	5
Size Parcels	3	4
Farmland Preservation	15	33
Construction practices	1	1
H1 Farm incomes	8	11
H2. Residential demand	4	6
H3 Zoning setbacks	2	2
Lost land	9	10
Siting practices	1	2
Impacts (as in survey)	3	3
Birds and bats	8	13
Flicker	7	12
For those who aren't paid	8	10
Health	5	7
Jealousy-related conflict	4	6
Local Jobs	6	14
Losing blade	2	2
Need for alternative energy	5	6
Noise	10	14

Nodes

Name	Sources	References
Red Lights	6	7
Road damage	1	1
Transmission lines	4	6
TV reception	2	2
View	8	8
Weather	2	2
Interviewee	0	0
County BoC	4	4
Developer	3	3
PC	3	3
Realtor	6	6
Supervisor	7	7
Lawsuit	7	7
New Construction	0	0
By whom	10	13
Demand	11	17
Where	5	6
Planning Process	4	9
Goals	9	20
Involvement of Developer	11	19
Public Hearings	10	16
Referendum	1	1
Site visits	7	8
Who initiated	6	6
Population Growth	5	8
Property right	1	5
Property Taxes	0	0
Abatement	8	13
Change tax rate	4	7
Depreciation Table	12	24
Existing Taxbase	6	6
Impact	13	27
Impact beyond landowners	4	5
Other payments	1	1
Use of new revenue	8	17
Public Opinion	13	19
Enough already	4	4
Non-farmers	5	6
Tension in Community	4	4

Nodes

Name	Sources	References
Siting	0	0
Density of Turbines	6	8
Landowner meetings	11	21
Property Lines	11	23
Setback distances	9	14
Wind developer requirements	4	22
Turbines on Existing Home Market	6	11
Turbines on Farming	1	1
Compaction	4	4
Crane Walks	5	5
Crop damage	4	4
Extra income	8	11
Field Tile	9	14
Irrigation	3	3
Obstacle	7	11
Roads	7	9
Ruts	2	2
Turbines on Farmland Market	3	5
For development	3	6
For farming	5	8
On sales agreements	6	7
Wind Leases	5	9
Anecdotal Lease Numbers	7	15
On farmer investments	6	11
On local economy	6	7
Pooling	4	9
Public Officials	1	1
Steady income	2	3
Zoning Code	8	16
No zoning	1	1
Self-zoned	8	13
State Take-over	5	9

Selected Bibliography

Adelaja, Adesoji, and Keith Friedman. 1999. “Political Economy of Right-to-Farm.” *Journal of Agricultural and Applied Economics* 31 (3): 565–79.

Adelaja, Adesoji, and Paul D Gottlieb. 2009. “The Political Economy of Downzoning.” *Agricultural and Resource Economics Review* 38 (2): 181–99.

Adelaja, Adesoji, Kevin Sullivan, and Yohannes G. Hailu. 2011. “Endogenizing the Planning Horizon in Urban Fringe Agriculture.” *Land Use Policy* 28 (1). Elsevier Ltd: 66–75. doi:10.1016/j.landusepol.2010.05.002.

Alterman, Rachelle. 1997. “The Challenge of Farmland Preservation: Lessons from a Six-Nation Comparison.” *Journal of the American Planning Association* 63 (2): 220–43.

American Wind Energy Association. 2014. “State Wind Energy Statistics: Michigan.” *Michigan Wind Energy*. http://www.awea.org/Resources/state.aspx?ItemNumber=5216.

Andriano, Jennifer R. 2009. “The Power of Wind: Current Legal Issues in Siting for Wind Power.” *Planning & Environmental Law* 61 (5): 3–13.

Bidwell, David Charles. 2011. “The Structure and Strength of Public Attitudes Towards Wind Farm Development.”

Black, Geoffrey, Donald Holley, David Solan, and Michael Bergloff. 2014. “Fiscal and Economic Impacts of State Incentives for Wind Energy Development in the Western United States.” *Renewable and Sustainable Energy Reviews* 34 (June). Elsevier: 136–44. doi:10.1016/j.rser.2014.03.015.

Brannstrom, Christian, Wendy Jepson, and Nicole Persons. 2011. “Social Persectives on Wind-Power Development in West Texas.” *Annals of the Association of American Geographers* 101 (4): 839–51.

Brookings Institution. 2010. *State of Metropolitan America: On the Front Lines of Demographic Change*. Washington, DC.

Bryan, Frank. 1986. “Defining Rural: Returning to Our Roots.” In *Rural Public Administration*, edited by Jim Seroka, 9–20. New York: Greenwood Press.

Carlson, J. Lon, David G. Loomis, and James Payne. 2010. “An Assessment of the Economic Impact of the Wind Turbine Supply Chain in Illinois.” *The Electricity Journal* 23 (7): 75–93. doi:10.1016/j.tej.2010.07.006.

Coughlin, Robert E. 1991. “Formulating and Evaluating Agricultural Zoning Programs.” *Journal of the American Planning Association* 57 (2): 183–92.

Cudd, Stacia. 2011. “Saving Farmland One Wind Energy Project at a Time.” National Association of Farm Broadcasting News Service. http://apps2.eere.energy.gov/wind/windexchange/filter_detail.asp?itemid=3368.

D’Souza, Gerard E., and Tesfa G. Gebremedhin. 1998. *Sustainability in Agricultural and Rural Development*. Edited by Gerard E. D’Souza and Tesfa G. Gebremedhin. Brookfield, VT: Ashgate.

Daniels, Thomas L. 1997. “Where Does Cluster Zoning Fit in Farmland Protection?” *Journal of the American Planning Association* 63 (1): 129–37.

Daniels, Thomas L, and Mark B Lapping. 1996. “The Two Rural Americas Need More, Not Less Planning.” *Journal of the American Planning Association* 62 (3): 285–88.

Daniels, Thomas L. 1989. “Small Town Economic Development: Growth or Survival?” *Journal of Planning Literature* 4 (4): 413–29. doi:10.1177/088541228900400404.

———. 1990. “Policies to Preserve Prime Farmland in the U.S.A.: A Comment.” *Journal of Rural Studies* 6 (3): 331–36. doi:10.1016/0743-0167(90)90087-O.

———. 1999. *When City and Country Collide: Managing Growth in the Metropolitan Fringe*. Washington, DC: Island Press.

Davis, Judy S, Arthur C Nelson, and Kenneth J Dueker. 1994. “The New ’ Burbs: The Exurbs and Their Implications for Planning Policy.” *Journal of the American Planning Association* 60 (1): 45–59.

Deaton, B James, John P Hoehn, and Patricia E Norris. 2007. “Net Buyers, Net Sellers, and Agricultural Landowner Support for Agricultural Zoning.” *Land Economics* 83 (2): 153–65.

Devine-Wright, Patrick. 2005. “Beyond NIMBYism: Towards an Integrated Framework for Understanding Public Perceptions of Wind Energy.” *Wind Energy* 8 (2): 125–39. doi:10.1002/we.124.

Diaz, Daniel, and Gary Paul Green. 2001. “Growth Management and Agriculture : An Examination of Local Efforts to Manage Growth and Preserve Farmland in Wisconsin Cities , Villages , and Towns.” *Rural Sociology* 66 (3): 317–41.

Dillman, Donald A., and N. Parsons. 2008. “Self-Administered Paper Questionnaires.” In *Handbook for Public Opinion Research*, edited by W. Donsbach and M.W. Traugott, 262–70. London: Sage.

Dillman, Donald A., J. D. Smyth, and L. M. Christian. 2009. *Internet, Mail, and Mixed-Mode Surveys: The Tailored Design Method*. 3rd ed. New York: Wiley.

Duke, Joshua M, and Lori Lynch. 2006. “Farmland Retention Techniques: Property Rights Implications and Comparative Evaluation.” *Land Economics* 82 (2): 189–213.

Eberhart, Dee. 1976. “Toward an Awareness of Special Needs: Planners and Small Towns.” *Small Town* 6 (October): 4.

Ellickson, Robert C. 1991. *Order Without Law*. Cambridge: Harvard University Press.

Ellis, Geraint, Richard Cowell, Charles Warren, Joseph Szarka, Richard Hadwin, Paul Miner, Maarten Wolsink, and Alain Nadaï. 2009. “Wind Power: Is There A ‘Planning Problem’? Expanding Wind Power: A Problem of Planning, or of Perception? The Problems Of Planning—A Developer’s Perspective Wind Farms: More Respectful and Open Debate Needed, Not Less Planning: Problem ‘Carrier’ or Proble.” *Planning Theory & Practice* 10 (4): 521–47.

Erickson, Wally, Greg Johnson, David Young, Dale Strickland, Rhett Good, Michelle Bourassa, Kim Bay, and Karyn Sernka. 2002. *Synthesis and Comparison of Baseline Avian and Bat Use , Raptor Nesting and Mortality Information from Proposed and Existing Wind Developments*. Portland, OR. http://www.bpa.gov/Power/pgc/wind/Avian_and_Bat_Study_12-2002.pdf.

Esseks, Dick, Lydia Oberholtzer, Kate Clancy, Mark B Lapping, and Anita Zurbrugg. 2009. *Sustaining Agriculture in Urbanizing Counties: Insights from 15 Coordinated Case Studies*.

Ewing, Reid, and Fang Rong. 2008. “The Impact of Urban Form on U.S. Residential Energy Use.” *Housing Policy Debate* 19 (1): 1–30.

Feldman, Naomi E., Paul N. Courant, and Douglas C. Drake. 2003. “The Property Tax in Michigan.” In *Michigan at the Millennium*, edited by Charles L. Ballard, Paul N. Courant, Douglas C. Drake, Ronald C. Fisher, and Elisabeth R. Gerber, 577–602. East Lansing: Michigan State University Press.

Foley, Jonathan A, Navin Ramankutty, Kate A Brauman, Emily S Cassidy, James S Gerber, Matt Johnston, Nathaniel D Mueller, et al. 2011. “Solutions for a Cultivated Planet.” *Nature* 478 (7369). Nature Publishing Group, a division of Macmillan Publishers Limited. All Rights Reserved.: 337–42. http://dx.doi.org/10.1038/nature10452.

Ford, Kristina, James Lopach, and Dennis O’Donnell. 1990. *Planning Small Town America: Observations, Sketches and a Reform Proposal*.

Found, William C., and C.D. Morley. 1973. “A Behavioural Typology of Land Uses for Metropolitan Rural Space: The Case of Toronto.” In *Agricultural Typology and Land Use*, edited by L.G. Reeds, 295–313. Hamilton, Ontario: International Geographical Union Commission for Agricultural Typology.

Gaziano, Cecilie. 2005. “Comparative Analysis of Within-Household Respondent Selection Techniques.” *Public Opinion Quarterly* 69 (1): 124–57.

Getzels, Judith, and Charles Thurow. 1979. *Rural and Small Town Planning*. Chicago: American Planning Association.

Godschalk, David R. 2006. *Buildout Analysis: A Valuable Planning and Hazard Mitigation Tool*. Chicago.

Groves, Robert M, and Mick P. Couper. 1998. *Nonresponse in Household Interview Surveys*. New York: Wiley.

Hammon, Jay. 2012. “Diapering the Devil: How Alaska Helped Staunch Befouling by Mismanaged Oil Wealth: A Lesson for Other Oil Rich Nations.” In *The Governor’s Solution: How Alaska's Oil Dividend Could Work in Iraq and Other Oil-Rich Countries*, edited by Todd Moss, 5–54. Washington, DC: Center for Global Development.

Hart, John Fraser. 1995. “‘Rural’ and ‘Farm’ No Longer Mean the Same Thing.” In *The Changing American Countryside: Rural People and Places*, edited by Emery N Castle, 63–76. Lawrence, Kansas: University Press of Kansas.

Healy, Robert G, and James L Short. 1979. “Rural Land : Market Trends and Planning Implications.” *Journal of the American Planning Association* 45 (3): 305–17.

Heimlich, Ralph E. 1989. “Metropolitan Agriculture: Farming in the City’s Shadow.” *Journal of the American Planning Association* 55 (4): 457–66.

Hoen, Ben, Ryan Wiser, Peter Cappers, Mark Thayer, and Gautam Sethi. 2011. “Wind Energy Facilities and Residential Properties: The Effect of Proximity and View on Sales Prices.” *Journal of Real Estate Research* 33 (3): 279–316.

Ilg, Randy E. 1995. “The Changing Face of Farm Employment.” *Monthly Labor Review*, no. April: 3–12.

Irwin, E. G., A. M. Isserman, M. Kilkenny, and M. D. Partridge. 2010. “A Century of Research on Rural Development and Regional Issues.” *American Journal of Agricultural Economics* 92 (2): 522–53. doi:10.1093/ajae/aaq008.

Isaac, S., and W.B. Michael. 1981. *Handbook in Research and Evaluation*. San Diego: EdITS Publishers.

Kahn, Matthew E. 2013. “Local Non-Market Quality of Life Dynamics in New Wind Farms Communities.” *Energy Policy* 59 (August). Elsevier: 800–807. doi:10.1016/j.enpol.2013.04.037.

Kahn, Robert D. 2000. “Siting Struggles : The Unique Challenge of Permitting Renewable Energy Power Plants.” *Electricity Journal*, no. March: 21–33.

Kline, Jeffrey, and Dennis Wichelns. 1994. “Using Referendum Data to Characterize Public Support for Purchasing Developme ...” *Land Economics* 70 (2): 223–33.

———. 1996. “Measuring Public Preferences for the Environmental Amenities Provided by Farmland.” *European Review of Agricultural Economics* 23: 421–36.

Kuzel, Anton. 1999. “Sampling in Qualitative Inquiry.” In *Doing Qualitative Research*, edited by B. Crabtree and W. Miller, 2nd ed., 33–45. New York: Sage.

Lantz, E, and S Tegen. 2008. “Variables Affecting Economic Development of Wind Energy.” In *WINDPOWER 2008*. Houston, TX.

Lapping, Mark B. 2006. “Rural Policy and Planning.” In *Handbook of Rural Studies*, edited by Paul Cloke, Terry Marsden, and Patrick Mooney, 104–22. Sage.

Lapping, Mark B, Thomas L. Daniels, and John Keller. 1989. *Rural Planning and Development in the United States*. New York: Guilford Press.

Liu, Xiangping, and Lori Lynch. 2011. “Do Agricultural Land Preservation Programs Reduce Farmland Loss? Evidence from a Propensity Score Matching Estimator.” *Land Economics* 87 (2): 183–201.

Lockeretz, William. 1986. “Trends in Farming near Cities.” *Journal of Soil and Water Conservation* 41 (2): 256–62.

Logan, J.L., and Harvey Molotch. 1986. *Urban Fortunes: The Political Economy of Place*. Berkeley, CA: University of California Press.

Lopez, Rigoberto A, Adesoji O. Adelaja, and Margaret S Andrews. 1988. “The Effects of Suburbanization on Agriculture.” *American Journal of Agricultural Economics* 70 (2): 346–58. doi:10.2307/1242075.

Lundberg, Russell R. *Harvesting the Wind: Huron County, Michigan*. Bad Axe, MI. http://www.planningmi.org/downloads/harvesting_the_wind_huron_county_michigan_ppt.pdf.

Magliocca, Nicholas, Virginia McConnell, Margaret Walls, and Elena Safirova. 2012. “Zoning on the Urban Fringe: Results from a New Approach to Modeling Land and Housing Markets.” *Regional Science and Urban Economics* 42 (1-2). Elsevier B.V.: 198–210. doi:10.1016/j.regsciurbeco.2011.08.012.

Marcouiller, D. W., J. G. Clendenning, and R. Kedzior. 2002. “Natural Amenity-Led Development and Rural Planning.” *Journal of Planning Literature* 16 (4): 515–42. doi:10.1177/088541202400903572.

Marini, Matteo B., and Patrick Mooney. 2006. “Rural Economies.” In *Handbook of Rural Studies*, edited by Paul Cloke, Terry Marsden, and Patrick Mooney, 91–103. Sage.

Mason, Jennifer. 2006. “Mixing Methods in a Qualitatively Driven Way.” *Qualitative Research* 6 (1): 9–25.

Maxwell, Joseph A. 2005. *Qualitative Research Design: An Interactive Approach*. Thousand Oaks, CA: Sage.

McGowan, G, and Stephen R Connors. 2000. “Windpower: A Turn of the Century Review.” *Annual Review of Energy and the Environment* 25: 147–97.

Michigan State Tax Commission. 2013. *Property Classification*. https://michigan.gov/documents/treasury/ClassificationRealProperty_195107_7.pdf.

Morgan, D.L. 2007. “Paradigms Lost and Pragmatism Regained: Methodological Implications of Combining Qualitative and Quantitative Methods.” *Journal of Mixed Methods Research2* 1 (1): 48–76.

Munday, Max, Gill Bristow, and Richard Cowell. 2011. “Wind Farms in Rural Areas: How Far Do Community Benefits from Wind Farms Represent a Local Economic Development Opportunity?” *Journal of Rural Studies* 27 (1). Elsevier Ltd: 1–12. doi:10.1016/j.jrurstud.2010.08.003.

Murray, Michael, and Larry Dunn. 1995. “Capacity Building for Rural Development in the United States.” *Journal of Rural Studies* 11 (1): 89–97.

Nelson, Arthur C. 1986. “Programs Using Land Markets to Evaluate Urban Containment Programs.” *Journal of the American Planning Association* 52 (2): 156–71.

———. 1992a. “Preserving Prime Farmland in the Face of Urbanization: Lessons from Oregon.” *Journal of the American Planning Association* 58 (4): 467–88.

Nelson, Arthur C. 1992b. “Characterizing Exurbia.” *Journal of Planning Literature* 6 (4): 350–68. doi:10.1177/088541229200600402.

Newburn, David A, and Peter Berck. 2006. “Modeling Suburban and Rural-Residential Development Beyond the Urban Fringe.” *Land Economics* 82 (4): 481–99.

Norris, Patricia E, Lynn R Harvey, B James Deaton, and Melissa A. Savard. 2002. *Can Use Value Assessment for Property Taxation of Agricultural Land Protect Environmental Amenities?*.

Park, Jung Jin, and Paul Selman. 2011. “Attitudes Toward Rural Landscape Change in England.” *Environment and Behavior* 43 (2): 182–206. doi:10.1177/0013916509355123.

Pennings, Joost M E, Scott H Irwin, and Darrel L Good. 2002. “Surveying Farmers: A Case Study.” *Review of Agricultural Economics* 24 (1): 266–77.

Phimister, Euan, and Deborah Roberts. 2012. “The Role of Ownership in Determining the Rural Economic Benefits of On-Shore Wind Farms.” *Journal of Agricultural Economics* 63 (2): 331–60. doi:10.1111/j.1477-9552.2012.00336.x.

Plantinga, Andrew J, and Douglas J Miller. 2001. “Agricultural Land Values and the Value of Rights to Future Land Development.” *Land Economics* 77 (1): 56–67.

Poor, P. Joan, and Rina Brule. 2007. “An Investigation of the Socio-Economic Aspects of Open Space and Agricultural Land Preservation.” *Journal of Sustainable Agriculture* 30 (3): 165–76.

Pruetz, Rick. 2012. *Lasting Value: Open Space Planning and Preservation Successes*. Chicago: American Planning Association.

Pyle, Lizabeth A. 1986. “Sellers and Nonsellers of Land for New Rural Housing.” *Professional Geographer* 38 (4): 343–49.

———. 1989. “Persistent Landownership at the Rural-Urban Fringe.” *Urban Geography* 10 (2): 157–71.

Quackenbush, J.D., and S. Bakkal. 2013. *Readying Michigan to Make Good Energy Decisions: Renewable Energy*. Lansing, MI. http://www.michigan.gov/documents/energy/renewable_final_438952_7.pdf.

Rabe. 2006. *Race to the Top: The Expanding Role of U.S. State Renewable Portfolio Standards*. Arlington, VA.

Raup, Phil M. 1975. “Urban Threats to Rural Lands : Background and Beginnings Urban.” *Journal of the American Institute of Planners* 41 (6): 371–78.

Rynne, Suzanne, Larry Flowers, Eric Lantz, and Erica Heller. 2011. *Planning for Wind Energy*. Chicago: American Planning Association.

Salamon, Sonya. 1992. *Prarie Patrimony: Family, Farming, and Community in the Midwest*. Chapel Hill: University of North Carolina Press.

Scharlemann, Jörn P W, and William F Laurance. 2008. "How Green Are Biofuels?" *Science* 319 (5859): 43–44. doi:10.1126/science.1153103.

Schnidman, Frank, Michael Smiley, and Eric G. Woodbury. 1990. *Retention of Land for Agriculture: Policy, Practice, and Potential in New England*. Cambridge: Lincoln Institute of Land Policy.

Sears, David W, and Norman J. Reid. 1995. *Rural Development Strategies*. Chicago: Nelson-Hal.

Seawright, Jason, and John Gerring. 2008. "Case Selection Techniques Case Study Research: A Menu of Qualitative and Quantitative Options." *Political Research Quarterly* 61 (2): 294–308.

Sharp, Jeff S, and Jill K Clark. 2008. "Between the Country and the Concrete: Rediscovering the Rural-Urban Fringe." *City & Community* 7 (1): 61–79.

Slattery, Michael C., Eric Lantz, and Becky L. Johnson. 2011. "State and Local Economic Impacts from Wind Energy Projects: Texas Case Study." *Energy Policy* 39 (12). Elsevier: 7930–40. doi:10.1016/j.enpol.2011.09.047.

Smithers, John, Alun E. Joseph, and Matthew Armstrong. 2005. "Across the Divide (?): Reconciling Farm and Town Views of Agriculture–community Linkages." *Journal of Rural Studies* 21 (3): 281–95. doi:10.1016/j.jrurstud.2005.03.003.

Smyth, J. D., D. a. Dillman, L. M. Christian, and a. C. O'Neill. 2010. "Using the Internet to Survey Small Towns and Communities: Limitations and Possibilities in the Early 21st Century." *American Behavioral Scientist* 53 (9): 1423–48. doi:10.1177/0002764210361695.

SNL Energy. 2011. *Renewable Electricity: Tracking Projects and Progress in U.S. Renewable Portfolio Standards March 2011*. Charlottesville, VA. http://ww1.prweb.com/prfiles/2011/04/18/8320252/RPS SNL Energy white paper 032011.pdf.

Sokolow, Alvin D. 2006. *A National View of Agricutlural Easement Programs: Easements and Local Planning*. *Agriculture*.

Teddlie, C., and F. Yu. 2007. "Mixed Methods Sampling: A Typology With Examples." *Journal of Mixed Methods Research* 1 (1): 77–100. doi:10.1177/2345678906292430.

Theobald, David M. 2001. "Land-Use Dynamics Beyond the American Urban Fringe." *Geographical Review* 91 (3): 544–64.

Toke, Dave. 2005. “Explaining Wind Power Planning Outcomes: Some Findings from a Study in England and Wales.” *Energy Policy* 33 (12): 1527–39. doi:10.1016/j.enpol.2004.01.009.

Towe, Charles A., Cynthia J. Nickerson, and Nancy Bockstael. 2008. “An Empirical Examination of the Timing of Land Conversions in the Presence of Farmland Preservation Programs.” *American Journal of Agricultural Economics* 90 (3): 613–26. doi:10.1111/j.1467-8276.2007.01131.x.

Union of Concerned Scientists. 2003. *Farming the Wind : Wind Power and Agriculture*.

US Department of Agriculture. 2012. *2012 Census of Agriculture County Profile*. Washington, DC.

———. 2014. *U.S. Farms and Farmers*. Washington, DC. http://www.agcensus.usda.gov/Publications/2012/Preliminary_Report/Highlights.pdf.

US Department of Energy. 2014. “WindExchange.” *Office of Energy Efficiency and Renewable Energy*. http://apps2.eere.energy.gov/wind/windexchange/schools/.

Van der Horst, Dan. 2007. “NIMBY or Not? Exploring the Relevance of Location and the Politics of Voiced Opinions in Renewable Energy Siting Controversies.” *Energy Policy* 35 (5): 2705–14. doi:10.1016/j.enpol.2006.12.012.

Vogt, Christine a., and Robert W. Marans. 2004. “Natural Resources and Open Space in the Residential Decision Process: A Study of Recent Movers to Fringe Counties in Southeast Michigan.” *Landscape and Urban Planning* 69 (2-3): 255–69. doi:10.1016/j.landurbplan.2003.07.006.

Warren, Charles R., Carolyn Lumsden, Simone O’Dowd, and Richard V. Birnie. 2005. “‘Green on Green’: Public Perceptions of Wind Power in Scotland and Ireland.” *Journal of Environmental Planning and Management* 48 (6): 853–75.

Warren, Charles R., and Malcolm McFadyen. 2010. “Does Community Ownership Affect Public Attitudes to Wind Energy? A Case Study from South-West Scotland.” *Land Use Policy* 27 (2): 204–13. doi:10.1016/j.landusepol.2008.12.010.

Watson, Ian, Stephen Betts, and Eric Rapaport. 2012. “Determining Appropriate Wind Turbine Setback Distances: Perspectives from Municipal Planners in the Canadian Provinces of Nova Scotia, Ontario, and Quebec.” *Energy Policy* 41 (February). Elsevier: 782–89. doi:10.1016/j.enpol.2011.11.046.

Wilson, Bev. 2013. “Urban Form and Residential Electricity Consumption: Evidence from Illinois, USA.” *Landscape and Urban Planning* 115 (July). Elsevier B.V.: 62–71. doi:10.1016/j.landurbplan.2013.03.011.

Zollinger, Brett, and Richard S. Krannich. 2009. “Factors Influencing Farmers’ Expectations to Sell Agricultural Land for Non-Agricultural Uses.” *Rural Sociology* 67 (3): 442–63. doi:10.1111/j.1549-0831.2002.tb00112.x.