CRITICAL AND EXTRAORDINARY ASSUMPTIONS

For every hypothetical condition, an Extraordinary Assumption is required. According to the *Canadian Uniform Standards of Professional Appraisal Practice* (CUSPAP 04/15/2008), an Extraordinary Assumption *"refers to a hypothesis – either supposed or unconfirmed – which, if not true, could alter the appraiser's opinions and conclusions."*

In order to achieve this objective, the following specific critical assumptions were made in the preparation of this study:

1. That comparable sale transactions negotiated at or after the issuance of building permits for tower and turbine installations would have reflected any and all concerns in the purchase price.

2. That none of the comparable sale transactions relied upon in this report are the subject of legal actions resulting from non-disclosure of information regarding the towers or turbines by any agents or vendors involved in the property sales.

3. That any and all adverse effects on market value as perceived by market participants would be reflected in the market evidence of nearby real estate transactions.

4. All estimates and projections are based upon circumstances and economic conditions prevailing as of the effective date, and that the critical assumptions above have been made.

SCOPE OF VALUATION AND REPORTING PROCESS:

The findings and conclusions outlined in this study are based on:

- Identification of wind farms wherein nearby residential property sales have taken place;
- Exterior inspection of properties sold in close proximity to wind farms, and those properties outside the viewshed;
- Research conducted for comparable property sales through MLS® records, GeoWarehouse®, MPAC (Municipal Property Assessment Corporation) and the records of the Land Registry Office. Photostatic copies of this data are available in the appraiser's file.
- Analysis and inspection of comparative data, confirmation of sale details and ownership/title transfer;
- Determination that the Highest and Best Use of target property and comparative sales properties are as categorized;
- A review of published statistical data as relating to economic indicators, and where necessary, a discussion in some detail;
- Research and selection of appropriate study references;
- Confirmation of data relied upon in the analytical process

VALUATION PROBLEM

The purpose of this study is to consider the effect on the market value of residential properties due to the presence of a wind farm. Based on the background research, it is evident that some members of the general public hold negative opinions with respect to the desirability of wind farms and perceptions of their effect on real estate value. This report considers a variety of perceived influences, and provides an estimate of their effect on local real estate values.

The most frequently identified factors perceived to have an adverse effect on the market value of residential real estate are:

- aesthetics;
- shadow flicker;
- vibration; and,
- audible sound (low frequency waves);

Measuring the extent of these perceptions and how they affect local real estate values requires the analysis of a wide range of variables associated with any given property.

The thesis is that when an identified study property is valued both with and without the identified impact, the difference represents the change in market value attributable to that impact. This study considers the impacts identified above on residential properties adjacent to an existing wind farm on a collective basis, not individually.

Real estate types considered in this study are rural residential properties.

During the course of conducting research and assembling the data for analysis, the following was undertaken:

- review of real estate effect studies prepared by others in Canada, USA, Great Britain, Australia and Europe (see Addendum C);
- review of fact sheets, guidelines and other relevant publications prepared by the Ministry of the Environment, Ontario (See Addendum D);
- attendance at a public meeting on the proposed regulations to implement the new Green Energy and Green Economy Act, 2009;

- discussions with a number of property owners in attendance;
- discussions with real estate developers, real estate brokers and other market participants; and
- discussions with several consultants involved in the development of wind farms.

During the course of research it was noted that although building permits are issued for construction of wind turbines, there could be a time delay of as much as 1 year from when the permits are issued to when work begins. These delays were attributed to a variety of reasons such as a shortage of cranes or ground conditions for preparing access routes tower sites.

While some of the nearby residential sale transactions may have been completed at or after the issuance of a building permits for the wind turbines, the towers may not have been in place or in operation. In such instances, due to a public information meeting regarding the approval process, combined with ongoing news media coverage of the projects, an assumption was made that purchasers of a particular property would have made a conscious decision as to whether or not the proximity of wind turbines influenced their purchase price. Only one owner, who purchased a vacant lot for a future house, expressed disappointment that he had not been aware of the nearby wind farm approval. He had not decided whether to build or not.

STUDY AREA SELECTION

Initially a number of areas containing wind farm developments were investigated to locate a suitable location for study. The criteria for selection included:

- A reasonable number of wind farm developments within a region, each having similar economic influences;
- Availability of MLS® data and registry office records for data confirmation;
- A base of residential properties that have potential for being influenced by exposure to wind farm developments;
- A sufficient volume of transactions of similar property transactions within that region that would provide an adequate base for analysis; and
- A reasonable travelling distance for conducting research since several property and area inspections would be required.

The Chatham-Kent area was ultimately selected as it met the above criteria. At present there are understood to be 64 operating wind turbines in the area. Chatham-Kent is attempting to position itself as a leader in Ontario's renewable energy sector. Wind turbines erected in the study area had rated capacities of 1.5 MW, and turbine blade lengths of 41m metres. According to the Chatham-Kent web site, February 2009, the Ontario Power Authority recently awarded three additional wind power projects. These approved wind farm development projects are expected result in the addition of a further 165 wind turbines for a total of 229 turbines within this region.

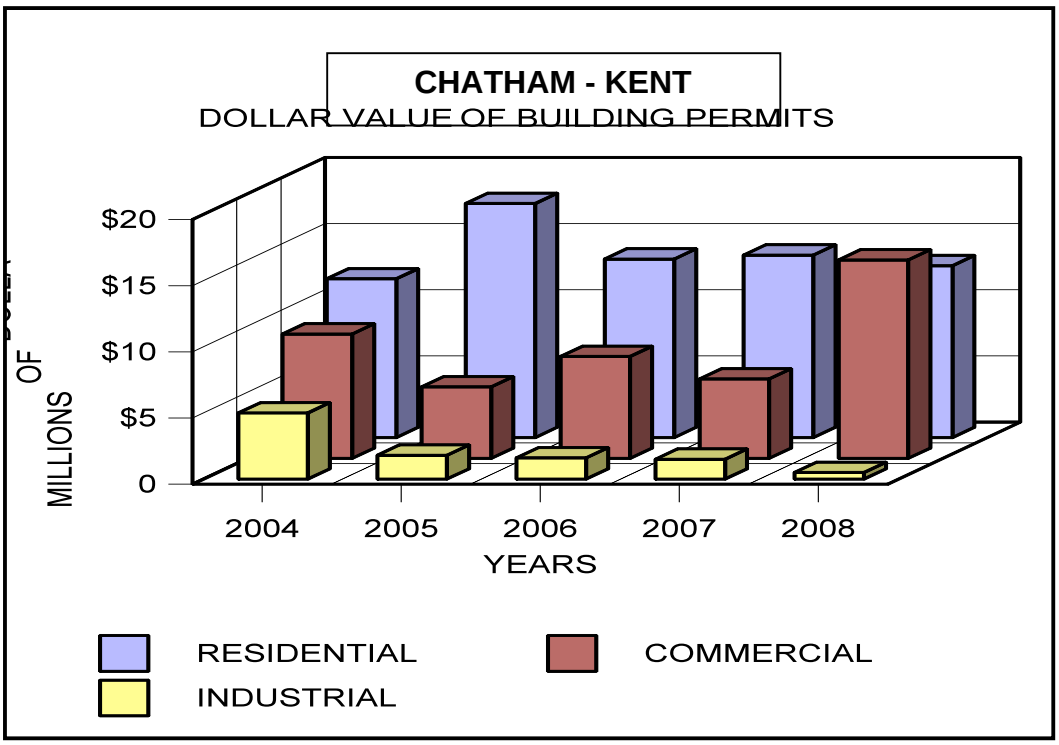
GENERAL OVERVIEW OF THE STUDY AREA

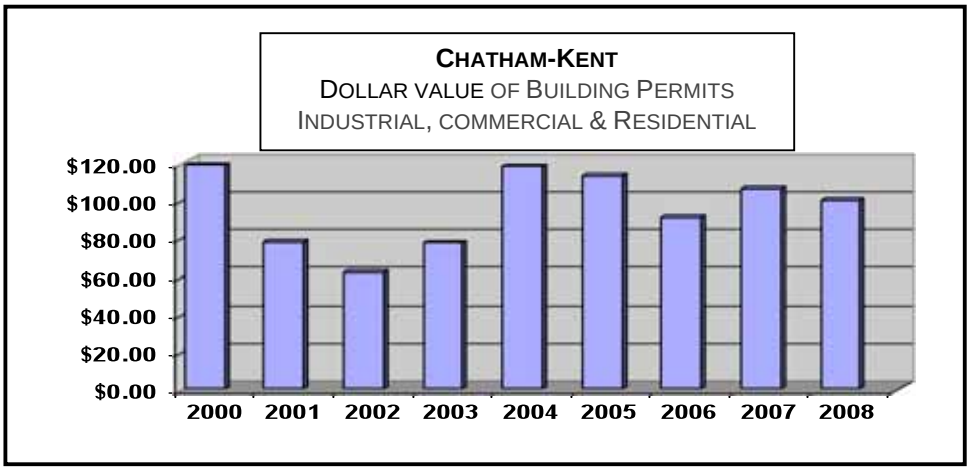
The study area in which the sale properties were located is known as the Municipality of Chatham-Kent. This Municipality is composed of 9 major communities and the surrounding rural areas that were amalgamated on January 1, 1998. The location of Chatham-Kent relative to major cities is shown below.

The population of Chatham-Kent as of 2006 was 108,177 compared to a population of 107,341 as of 2001(last census). .

The total workforce within Chatham-Kent is 58,860 persons. The occupation by industry that has the highest number of workers is Manufacturing and Construction, followed by Wholesale and Retail Trade, Business and Other Services. Agriculture and Other Resource based industries employ 10% of the labour force. If the work force was divided by Occupations, the highest percentage would go to Sales and Service Occupations followed by Trades, Transport and Equipment Operator and related Occupations. A strong tertiary occupation would be unique to processing, manufacturing and utilities.

International Truck and Engine Corp is the largest manufacturer in Chatham-Kent with 1,150 employees as of 2004. They are now down to 200 and there is a potential total plant layoff as of June 30th of this year. Union Gas Limited has 679 employees as of 2004 and this has not changed. Autolive Canada with 600 employees as of 2004 are now reduced to 50 employees, while YA Canada Fas Track Mail Processing Facility has 500 employees as of 2003 and are now reduced to 450 employees. Many of the smaller industries have between 200 to 300 employees. The following is a graph of the dollar value of building permits issued between 2000 and 2008 for the Chatham-Kent expressed in millions of dollars.

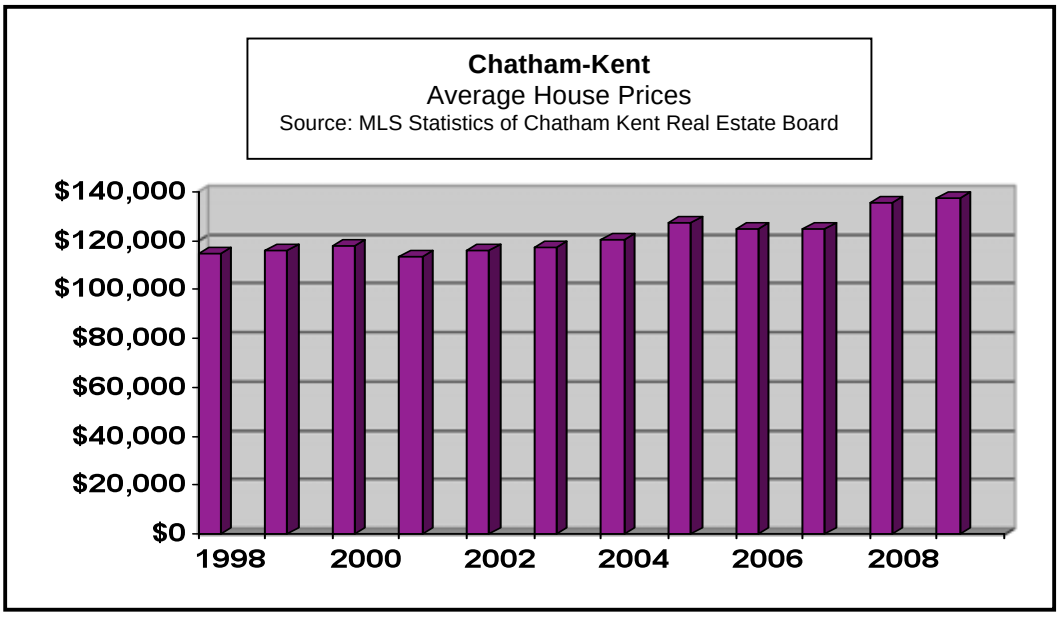




A surge in overall construction activity was seen at the turn of the millennium following the severe recessionary period during the early 1990's. Construction activity then slowed during a period of absorption followed by improvement during 2003. Since that time construction activity has been largely stable.

The impetus of growth in new residential construction resulted from low interest rates and the pent up demand for new housing following the recession in the early 1990's. The major focus of new residential construction has been within the urban areas of the City of Chatham.

A review of Multiple Listing Service (MLS®) statistics for Chatham-Kent show the average selling house prices for a given year. The following graph plots these average house prices between 1998 and 2008.



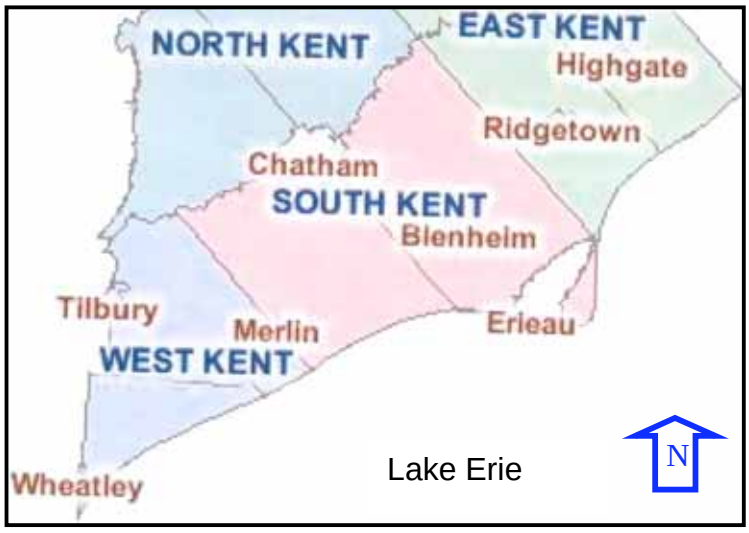
The previous chart of average house prices indicates a general increasing trend in average property sale price within Chatham-Kent. This graph shows prices that include a large volume of house prices from the urban area in the City of Chatham which are believed to have an impact on the overall annual average price. The MRA used in this study demonstrates that within the data set analysed, general price levels in the rural areas were not a significant factor in explaining the variances of sale prices.

STUDY AREA

The study area has a rural character, implying that the primary economic driver is agriculture or agriculture-related. In 2008, Chatham-Kent was the third highest producer in the entire Southwestern Ontario region for Winter Wheat, Grain Corn and Soybeans. In 2007(most recent) Chatham-Kent was the highest producer of tomatoes in Southwestern Ontario.

Transportation through Chatham-Kent is via Highway 401 which bisects Chatham-Kent traverses the full width of the municipality. Highway 401 extends from Windsor/Detroit to the easterly boundary of Ontario. Chatham-Kent is bounded to the south by Lake Erie. The study area is located between Lake Erie and Highway 401.

The rural housing type throughout Chatham-Kent is diverse and ranges from turn of the century homes (built between 1850 and 1900) to modern homes less than a year old. Typical structures include wood frame construction with brick veneer or wood siding, and 1 to 2 storey, including a single or double garage and an outbuilding that could serve as a workshop or as exterior storage. There are no single rural areas of Chatham-Kent that contain a higher concentration of rural properties. These property types are homogeneous throughout the Municipality of Chatham-Kent, and are commonly found throughout Southwestern Ontario. A general map of Chatham-Kent is provided below.



SUMMARY

Municipality of Chatham Kent

The Municipality of Chatham-Kent is dependant to a significant degree upon agriculture, manufacturing, and vehicle related industries. The City of Chatham has recently experienced an economic downturn of the auto and truck manufacturing sector due to its proximity to Windsor and Detroit, while the agricultural sector has been largely unaffected.

The Municipality comprises of the former City of Chatham with a population of approximately 44,000 people, with another eight communities within its borders with a total population between 1,000 and 12,000 people. Chatham-Kent has not grown substantially over the last five to ten years. It has remained fairly stable. Very little growth is expected within this region of South Western Ontario over the next decade. This is typical of other regions.

Study Area

The study area has been dominated by the agricultural industry for well over 100 years. Its success is due to fertile soils and fairly high heat units. Heat units in the Chatham-Kent region range from 3,340 and 3,560, in contrast to just north east in the London to Guelph area where the heat units range between 2,680 and 2,890. In other respects, the Chatham-Kent region is fairly typical to rural areas throughout other parts of South Western Ontario. Land uses within the study area are heavily dependent on cash crop farming. There is also a good mixture of rural housing that offers a wide range of amenities and locations.

ANALYSIS METHODOLOGY

The market for rural residential real estate consists of those individuals or families typically seeking property that provide a location, utility and area features consistent with their individual needs, and accordingly, are willing and prepared to pay a competitive price. In a competitive market, an informed purchaser will pay no more for a particular property than the cost of acquiring a satisfactory substitute that provides equal expected accommodations without undue delay. Those properties having undesirable features, either within the property itself, or nearby, often require a longer market exposure or tend to sell at lower prices. Wind farms are perceived by some to be such a nearby adverse external influence. Market value is typically estimated through the analysis of similar properties that have sold proximate to the date of valuation. If the market demonstrates that wind farms are indeed a negative influence, then an observable trend in lower selling prices should be apparent. The primary focus of this analysis is to assess the presence (or lack of) trend, and to quantify the extent of the price differential.

The identification and measurement process firstly requires the careful selection of properties that have sold proximate to a wind farm development. The properties must have been sold on the open market, with the vendor and purchaser being at arms length, both parties being fully aware of the neighbouring land uses, and neither being unduly motivated to complete the transaction. The selling prices of those properties are then compared to sales at or about the same time period that are distant from the wind farm project, yet are similar in nature and utility to the study properties.

There are basically two techniques for measuring the effect of a feature on the value of real estate, namely a “Paired Sales” analysis and by MRA.

A “Paired Sales” analysis has been used over the last few decades as the “default” solution for extracting variables that influence price. A “Paired Sale” would be a sale of a property that is identical to some other property under study with the exception that it is not subject to a specific variable (whatever that might be). In studying the two different index groups, the real estate analyst would extract a difference in price levels. The conclusion that would be reached is that the differences in the price levels of the comparable sales would be due to the influence of the variable in question.

Unfortunately, this “Paired Sales” methodology contains inherent limitations and is often considered to be flawed. Many academics and real estate practitioners have therefore stopped using this approach to evaluating effects from externalities on local real estate values. The difficulties and flaws with this procedure include:

(1) Insufficient quantities of “Paired Sales”. Ideal paired sales rarely, if ever, exist in the market place.

(2) Variations between the “Paired Sales” and the influencing factor under review require a substantial volume of “Paired Sales” to hold constant the other property differences or variables within the group.

The analysis is often undertaken by an application of a Direct Comparison Approach through a process of adjustment. The comparable sale properties, when adjusted for differences in the site size, building features, zoning, municipal services, financing etc, are thought to provide a basis or benchmark for indicating the market value of a study property absent the perceived influencing factor. A weakness in its application is that the adjustments are mostly unsupported and contain unconscious bias that can invalidate the results.

In this study a “Paired Sales” was prepared by using analytical tools such as CEM and Optimal which selects “Paired Sales” through a process of utility scores and bins. Since the selection process is not the sale price, these “Paired Sales” are drawn without bias.

The application of “Paired Sales” was enhanced by applying re-sales of properties within the main data set since a re-sale is closer in identity to what a “Paired Sale” should be.

Although considered in this study, it is recognised that it is an imperfect methodology applied to measure influences in an already imperfect market place.

MULTIPLE REGRESSION ANALYSIS (MRA)

The MRA technique has the ability to study large quantities of transacted sales data that are influenced by numerous variables over a specific time period. It is also known as a Multivariate Linear Regression Analysis.

Single Linear Regression analysis is a means for building models that describe how variation in one set of measurements affects variation in another set. The analyst forms a hypothesis that one variable is dependent on or responds to another variable (independent or predictor variable). In real estate value analysis, the dependent variable is often the sale price of a property in total or on a price per unit basis. The independent or predictor variable can be a characteristic of the property that is believed to have an influence on the dependent variable-sale price in this example. Aided by a computer with the ability to perform many calculations quickly, regression analysis provides a systematic method for building an equation that summarizes the relationship between the two variables. The resultant equation can then be used for the prediction of value.

Multiple Regression Analysis (MRA) extends the idea of a two variable linear regression model by allowing an analyst to include many explanatory factors to the regression equation. As in simple linear regression, a regression coefficient measures the impact of changes in each explanatory variable on the response variable. In MRA, the coefficient for each variable represents the effect of that variable on the dependent variable while holding the affect of all the other variables constant. In addition to its usefulness in prediction, this allows the use of MRA as an exploratory tool where the coefficients can be interpreted as a level of contribution of the predictor variable.

For this particular study, an MRA model can be specified that reduces the many characteristics of index properties into values for different variables. A regression run on a complete data base can then generate coefficients for the variables. The analyst's expertise in deciphering or interpreting these coefficients will lead to many conclusions of the market place.

Regression analysis is based on a number of assumptions as to the nature of the underlying data. The use of mathematical statistics allows the analyst to perform many diagnostic tests on the specified model to assess the level to which the assumptions are met. This allows the analyst to explicitly state the level of confidence that can be given to the results of

regression modeling. The recipients of the findings of such analysis can then make better informed decisions.

IMPLEMENTATION OF MRA

By using MRA, a "Model" of behaviour is developed that explains the variation in the prices of the comparables found in the market place. The comparables are sampled from a total potential number of sales within the array. The comparative data gathering process has the potential to gather a very high percentage of all possible sales. When using MRA, more sales data are better.

Once the data is placed into the MRA model, a "regression" run plots the results. MRA models are "smoothed" out to improve accuracy and functionality when deciphering the large quantities of data. Statistic tests are performed that assess the overall reliability of the model.

Once efficiency is established, the MRA produces a number of statistical reports. The ones of interest to this study are the coefficients. Graphics within the report demonstrate the possible relationships between variables.

The MRA indicates how much or how little wind farms have on real property, positive or negative. The MRA also provides a confidence interval. Statistically, the accepted confidence interval is established at the 95% to the 99% level. (The goal is to determine how statistically confident we are of the results and to demonstrate what the results mean.)

Like most types of analysis, MRA requires large quantities of data that particularly demonstrate the differences between properties. We are hopeful that there is a sufficient quantity of data that can be gathered for this type of study. MRA is the only known process that can effectively absorb and examine numerous interactive factors that influence real estate prices, all at the same time. It accomplishes this task by building all the factors of influence into the regression equation. As the model studies the influence of say, distance, it holds all the other factors (age, site size, building size, etc) constant. It continually repeats this individual process. That is why MRA is ideal for isolating the coefficients (expressed in dollars) to a given variable. Interpretation of the results is a key. It is not prudent to simply accept the results of the MRA blindly. The analyst must "step back" from the MRA outcomes to see if the results coincide with our appraisal knowledge of the problem at hand.

VALIDATION OF THE USE OF REGRESSION ANALYSIS

Regression analysis is a statistical modelling tool that has been employed very successfully in “Data Mining” and is used frequently at the corporate and government levels.

The Province of Ontario has adopted MRA in the assessment of residential properties for their new base of 1996. They also have test projects underway to extend MRA to other property sectors (vacant commercial land, industrial buildings, bank buildings and commercial plazas).

The Province of British Columbia has been using MRA in assessment for many years and has been a major consultant to the Province of Ontario on the implementation of their system.

Regression analysis is used by Statistics Canada in determining the Gross National Product for Canada and for the analysis of national data.

Regression Analysis was used in the USA by a large accounting firm to justify to the IRS the existence of “economic obsolescence” in large industrial buildings.

In this report a Regression Analysis was adopted as the preferred technique, however, due to the availability of several paired sales, these were analysis as a method of confirmation.

APPLICATION OF MULTIPLE REGRESSION ANALYSIS (MRA)

A total of 83 house sales within parts of Chatham-Kent that occurred over the last two years were analysed, proximate to wind farms, with the most recent sale in May 2009. This is a small sample relative to the size of data sets usually used in observational studies of this type. While a larger volume of sale would be preferred, this was a constraint attributable to the rural nature of the area where wind farms are placed. They are generally not developed in densely populated areas.

A ground qualitative view assessment technique was used to assign a sale property to either the viewshed group or the control group. For the purpose of this study, the viewshed is “a point within the study area whereby a sale property had a view of one or more wind turbines”. Any sale property found that did not have a view of a wind farm was deemed to be outside of the viewshed. Wind farms were not visible to all properties within the general area, as the view was sheltered either by bush lots or tree rows.

A simple difference in the means of sale prices between the viewshed group and the control group was employed to estimate the impact of a wind turbine(s). When these groups are different in characteristics relevant to the outcome of sale price, as they usually are in observational studies, the study is required to adjust for these differences. Regression modeling was the primary approach to make these adjustments. This approach was first used on the entire data sample and then on reduced data samples after the data was preprocessed through matching methods. These matching methods (Optimal and CEM) make the viewshed and control groups more comparable by pruning the least comparable sales from the full data set. Adjustments are then made on remaining differences in the reduced data sets by regression.

IDENTIFICATION OF COMPARABLE SALES

In assembling the comparative sales data, research was conducted with local Real Estate Board MLS® records, GeoWarehouse®, MPAC (Municipal Property Assessment Corporation) and at the Land Registry Office, with a view to finding properties within the viewshed and outside of the view shed.

The assembly of data did not focus on specific target residential property types, only residences on small acreages or lots that were within the viewshed or not in the viewshed. Sales of residences within small hamlets or communities were omitted from the data set since the selling prices of these properties were influenced by the convenience municipal services and amenities. Furthermore, wind farms are not typically situated in proximity to these locales. Sales of farm acreages with buildings were not included in this analysis as there was an insufficient volume of transactions for an effective analysis.

All of the comparable sales were inspected from the roadway. The sales were then cross referenced chronologically to identify any type of a buying pattern related to the sale dates of the transactions used in the study. The property variables or characteristics that were identified as having a potential influence on the study results are as follows.

Address: The address of the sale property.

Age of the House: The chronological age of the house at the time of the sale.

Basement: The sales were identified as either having a full basement or not at the time of the sale.

Basement Finishing: The sales were identified as either having some basement finishing or not at the time of the sale.

Condition of the House: Each house is classified as being in Fair, Good or Very Good condition.

Date of Sale: The date at which the sale property was determined to be the data whereby all conditions of the sale were met.

Elapsed Months: The difference in time between the oldest dated sale and the next occurring sale in months.

Garage: The sales were identified as having a garage or not.

House Size: The exterior square footage of the house above grade.

Lake Front: Signalling the difference between properties that were located on a river or lake front as opposed to not.

Location: Considers the possible difference of the sale property (within and beyond the viewshed) relative to important amenities such as major highways and goods and services.

Lot Size: The size of the lot of the sales expressed in square feet.

Number of Storeys: The number of storeys of the house on a given sale property.

Outbuildings: The sales were identified as having some type of a outbuildings such as a shed or barn.

Selling Price: The price which was agreed upon by the buyer and the seller.

Viewshed: Any sale that was located within a view of a wind turbine.

Viewshed Within: Any sale that was located in a viewshed was differentiated by a score that would separate the proximity of the wind farm to any sale within the view shed.

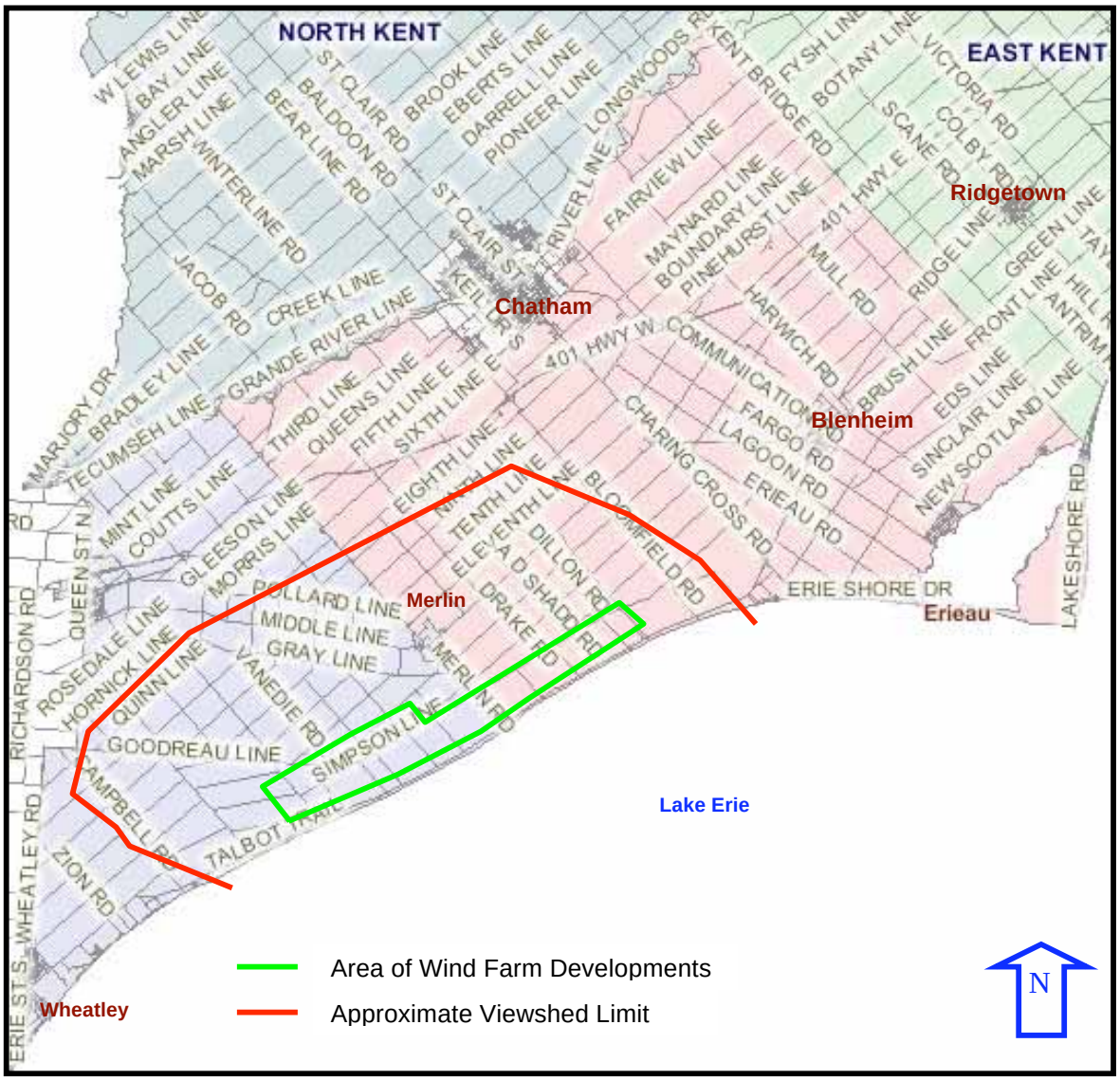
The specific Viewshed Within variable ultimately eliminated and said either the property had an average view or a no view. This is identified by Viewshed3. The number 3 does not have any reference other that this is the third name in the selection process of variables that tried to consider distance.

OVERVIEW OF THE PROBLEM AND THE TECHNICAL REPORTING ASPECTS OF THE STUDY

Introduction

Wind farms can be perceived by some nearby residential homeowners to be a source of nuisance, as a result of audible sound and aesthetics (visual appearance). Some claims have been made that suggest the presence of a wind turbine or wind farm could result in diminished real estate values for properties within the viewshed. Rural residential real estate is the principal target of this perceived association.

An analysis of sales of single family houses in south Chatham-Kent's rural area was undertaken to test this hypothesis. This study attempts to determine if residential properties located within a wind turbine's viewshed were or were not negatively influenced by reflecting lower sale prices in a statistically significant manner. By comparing properties that sold during the last several years, with a wind turbine(s) clearly visible and those farther way and outside the viewshed, but which are of similar age, lot size, and with similar amenities and economic influences, the differences in the selling prices of properties within the turbine's viewshed, on average, should be noticeably lower than the selling prices similar of similar properties outside a wind turbine's viewshed. The following is a map of the approximate area of the overall view shed. The red arc signifies the approximate location of the view shed. It should also be noted that some properties within this red arc were classified as being outside of the viewshed as the wind turbines were not visible due to tree lines or bush lots.



Study Design

This study focused on the inferred effects of Chatham Kent wind turbines on property prices. Specifically, it examined how the local market prices residential properties located within the viewshed of wind turbines compared to a control group of property sales outside the viewshed. As the wind turbines of this study are in a rural area of the County, obtaining a sample of sufficient size required the collection of house sales over a period of 2 years.

As part of this study's design, an examination of other previously executed studies, undertaken to measure the effect of wind turbine views on property pricing was completed. Although there is substantial literature on measuring effects of undesirable land uses on residential properties, research on the actual market effects of wind farms is lacking. Wind farms as a large scale energy source are relatively new to Ontario, which may explain the thin inventory of available studies. Schedule "A" outlines the research literature referenced at the outset of this study.

In this study, the loss measured is the realized capitalized loss that occurs when a property is sold. This study does not look at the losses associated with a delayed sale or other issues that may affect the bundle of property rights infringed by the proximity of a wind turbine. It was noted that it was nearly impossible to determine the exact time when the wind farms were constructed. A considerable time lag was noted between the issuance date of the building permit to when the wind farm was actually physically constructed. The time lag was alleged to be due to weather, the availability of cranes to erect wind turbines, and road construction. However, it is known that considerable public awareness of the construction of wind farms was imminent since public meetings occurred and wind farm developers held barbeques and information meetings regarding the construction of wind farms in areas of Chatham-Kent.

This study presupposes the existence of two causal states, which are based on visual perception of a nearby wind turbine from a property or absence of such. For our purposes, they are labeled avg viz and no viz. They are not, however, well-defined states because of their qualitative nature and the observation made from one point on the ground. Although a wind turbine may be visible to an observer from an upper floor window of a house, it may not be visible to an observer on the ground. Any individual sale property in our data was assigned to one of two possible causal states and associated potential outcomes based on a view of a wind turbine(s) or not.

In this study, the effect of a wind turbine as the difference in the sample average of the observed sale price between the avg viz group and the no viz control group was estimated.

Excluding ID variables, these data were measured on 14 physical and location variables. Of these 14 predictor variables, only 8 variables were discovered to be important predictors of sale price based on initial regressions. These predictors and the binary variable viewshed3,

which is instrumental to measuring wind turbine visibility effect on price, were regressed on sale price in the final regression model on the full data sample. A random sample of 6 sales from the data set measured on these variables is in Table 1. Variable definitions are given in Table 2.

Figure 1 shows graphically the distribution of values for the variables in the data set employed for the final model of the regression analysis. As indicated by the plot for the binary viewshed3 variable of primary interest in this study, the control category has about 3 times the number of sales in the avg viz category. The distributions of sale price, house size and lot size are skewed to the higher values.

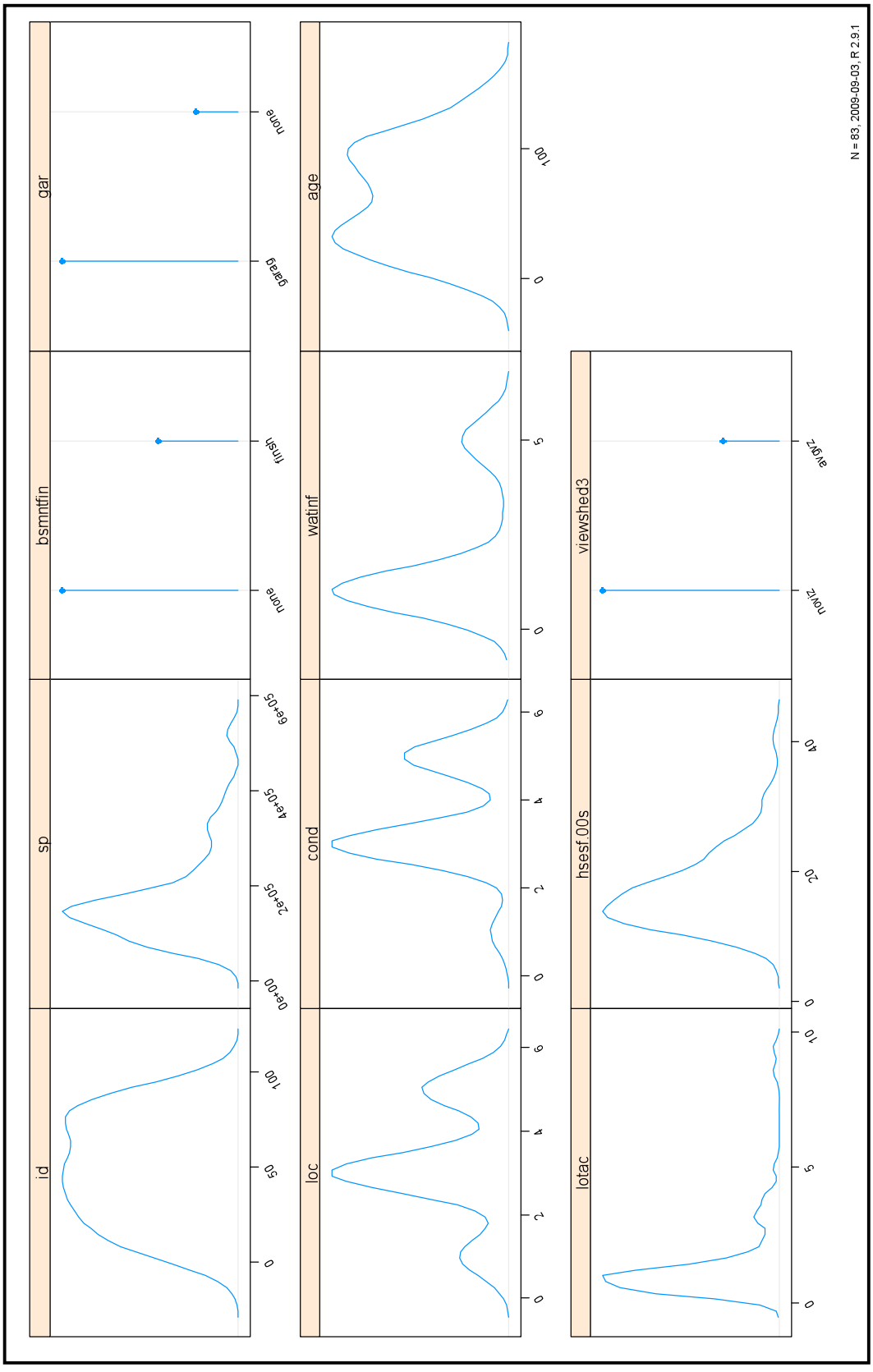
Table 1

id	sp	bsmntfin	gar	loc	cond	watinf	age	lotac	hsesf.00s	viewshed3
1	96000	none	garage	3	3	1	30	0.373	17.85	avg viz
3	124000	none	garage	1	3	1	49	0.744	10.73	avg viz
4	79000	none	garage	1	3	1	44	0.625	7.92	no viz
5	174000	none	garage	1	5	1	97	0.920	23.26	no viz
6	99500	none	garage	1	3	1	98	0.497	12.70	no viz
7	120000	none	none	1	3	1	82	1.311	15.14	no viz

Table 2: Variable Definitions

Id: property sale identification	**cond**: qualitative assessment of house condition - 1=fair, 3=average, 5=good
sp: continuous variable - sale price	**gar**: binary variable indicating if a property has a garage or otherwise
lotac: continuous variable - site area in acres.	**waterinf:** qualitative assessment of linkage to a body of water - 1=none, 3=water view, 5=water front
loc: qualitative assessment of location variable – 1=remote, 3=typical, 5=near town	**hsesf.00s**: continuous variable - size of living area excluding basement in hundreds of square feet
bsmntfin: binary variable designating if a house has basement finish or otherwise	**age**: continuous variable – age of the house in years
viewshed3: binary variable designating if one or more wind turbines are visible from a property	

Figure 1


N = 83, 2009-09-03, R 2.9.1
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sp
bsmntfin
gar
loc
cond
watinf
age
lotac
hsesf.00s
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0
50
100
0e+00
2e+05
4e+05
6e+05
none
fnish
gar3a
0
2
4
6
0
5
10
0
20
40
nov2
av2
0
50
100

Methodology

The primary objective of this study is to compare the house sales identified as located within the viewshed of one or more wind turbines with the sales of houses without this influence as a comparison (control) group. As this is an observational study, property sales self-assign to either the viewshed group or the control group based on the observations taken from site visits. Randomized assignment to either group, the gold standard of a causal inference study design, is clearly not possible with property sales data. Without random assignment, it could well be the case that these two groups, viewshed and control, are different from the onset. Those differences, not the impact of a visible wind turbine, may cause the measured difference in sale price between the groups, if any.

Several approaches were employed in this study to control for these differences. As a basic strategy, regression analysis was employed as an adjustment technique. Sale price was transformed to its natural log for the regressions as this allowed the interpretation of the estimates as a percentage. A second approach was to obtain smaller but more comparable samples by first preprocessing the data through matching of sales in the viewshed group with sales in the control group on their attributes. Two matching algorithms were employed for the matching exercise.

Exploratory Analysis

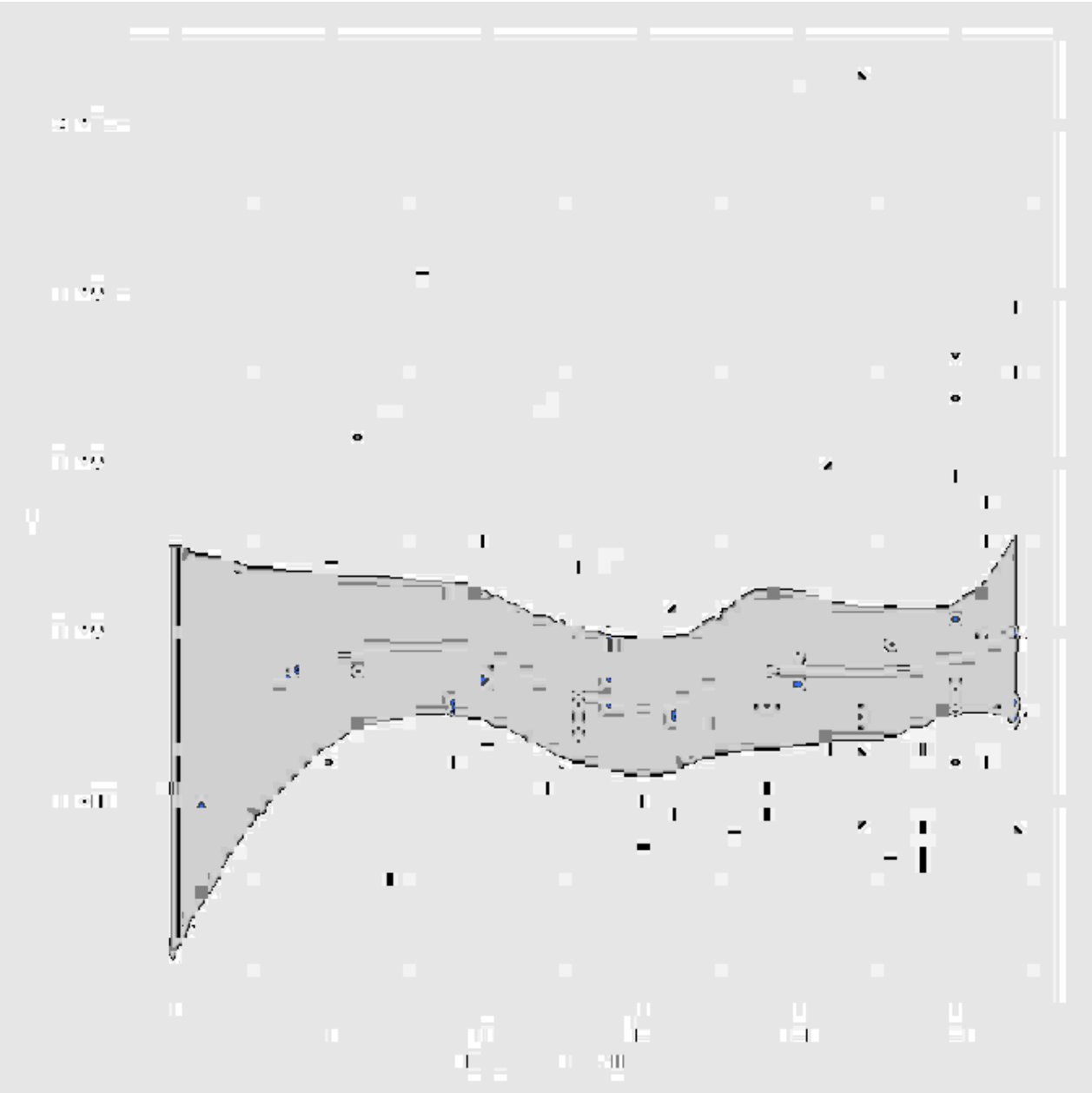
Figure 2 below is a graphic comparison of the distribution of sale prices before any adjustment by regression for differences between the viewshed group and control group. A comparison of the histograms of the two groups indicates the mean sale price of the viewshed group sale price distribution is less than that of the control group. The mean value of the viewshed group is approximately 7% lower than the mean value. Their distributions are similarly skewed to the right.

As indicated by the scatterplot (Figure 3) of sale price on the number of months that have elapsed (emths) for each sale between the date of sale and the date of the oldest sale, changes in market conditions is not an important price influencing variable for this data. As the smoother line on the plot clearly shows, there is no clear sale price trend.

Figure 2


Sale Price Distribution of Control Group
Mean Sale Price ($179,403)
Frequency
0
5
10
15
20
1e+05
2e+05
3e+05
4e+05
5e+05
Sale Price
Sale Price Distribution of Viewshed Group
Mean Sale Price ($166,815)
Frequency
0
2
4
6
1e+05
2e+05
3e+05
4e+05
5e+05
Sale Price

Figure 3



The exploratory analysis revealed that sale properties in the control group differ from the viewshed group on some characteristics; in other words they are not closely comparable. This imbalance must be addressed before a comparison of mean prices between the two groups of properties can be inferred to measure the effect of a wind turbine on the values of nearby properties from which a wind turbine or turbines are visible. Two strategies were used in this study to balance the comparability between the two groups of properties. They are regression modeling and pre analysis matching.

Altogether, three approaches to estimate wind turbine effect were conducted in this study. Matching was combined with regression in two of these analyses.

Regression Analysis

The use of regression analysis to adjust the sale prices of individual properties in the sample for differences between them is common to studies of the type conducted here. After controlling for the differences in the measured characteristics of the sale properties, the difference in the sample means between the viewshed and Control groups is inferred to be the causal effect of wind turbines that are visible to the nearby properties.

As regression analysis is a statistical technique, it offers a measure of sampling error. It provides a measure of the confidence that can be placed in the estimate of turbine effect on price.

This study considered a sequence of regressions to arrive at the final model specification described here. All regression modeling was done with the log of sale price as the outcome variable, using various sets of predictor variables. The choice of variables selected for the final regression model depended on their predictive power for sale price.

The regression model results for the initial approach on the full data, presented in Table a.1, shows the adjustment variables are associated with sale price in an expected manner and with the correct signs. As none of these non-viewshed effect relationships is surprising, they are not discussed further in this report.

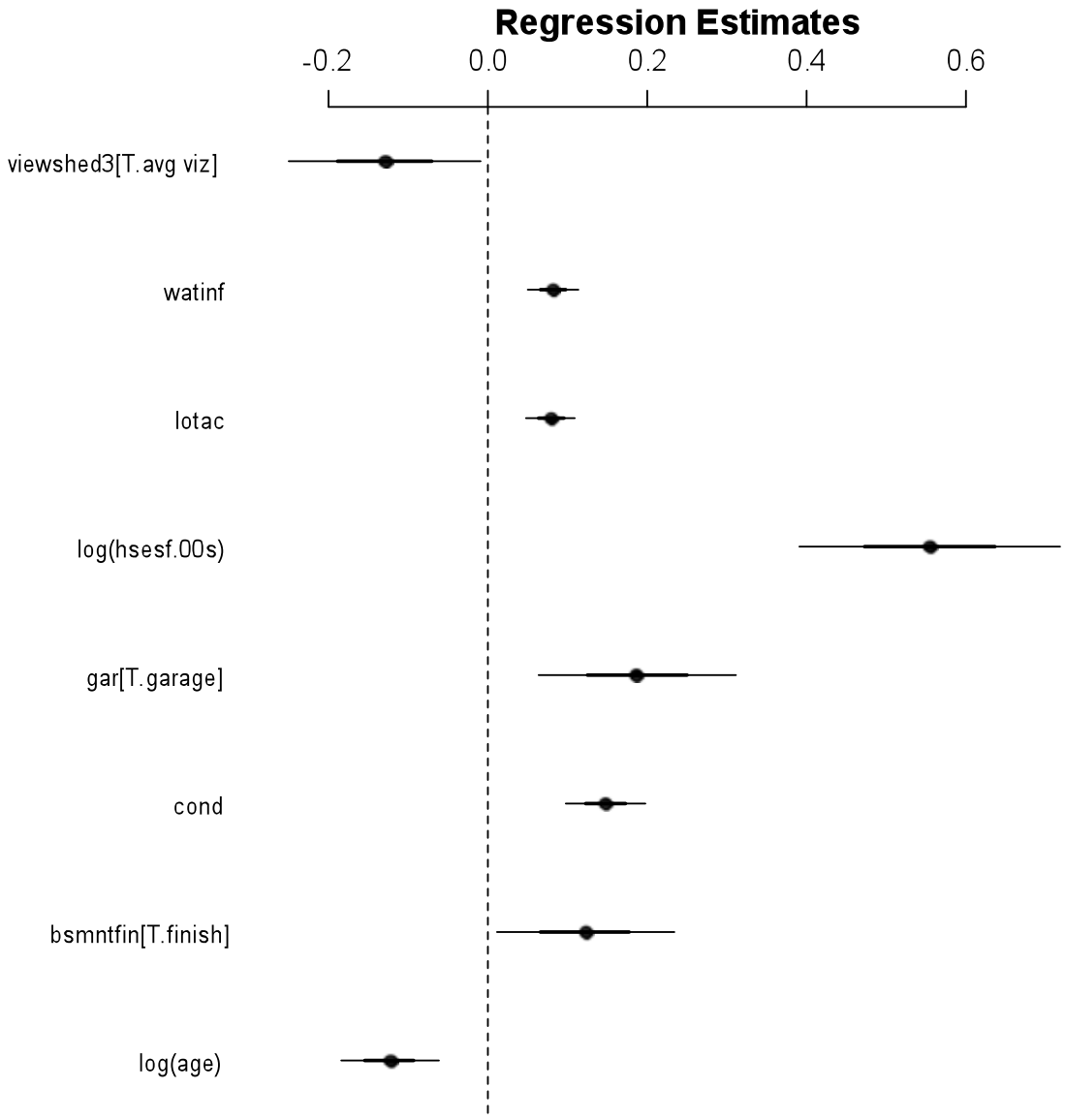
Table A.1: Summary of Final Regression Model

```
lm(formula = log(sp) ~ log(age) + bsmntfin + cond + gar +
log(hsesf.00s) +
lotac + watinf + viewshed3, data = wind.cln)


Residuals:
Min        1Q    Median        3Q       Max
-0.467791 -0.093272  0.002240  0.132561  0.405398

Coefficients:
Estimate Std. Error t value Pr(>|t|)
(Intercept)           9.92138    0.25967  38.208  < 2e-16 ***

log(age)             -0.12236    0.03080  -3.973 0.000163 ***

bsmntfin[T.finish]    0.12295    0.05537   2.220 0.029454 *

cond                  0.14775    0.02467   5.989 7.04e-08 ***

gar[T.garage]         0.18784    0.06200   3.030 0.003369 **

log(hsesf.00s)        0.55485    0.08158   6.801 2.30e-09 ***

lotac                 0.07977    0.01542   5.173 1.90e-06 ***

watinf                0.08210    0.01592   5.159 2.01e-06 ***

viewshed3[T.avg viz] -0.12879    0.05984  -2.152 0.034627 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.2054 on 74 degrees of freedom

Multiple R-squared: 0.8476,   Adjusted R-squared: 0.8312

F-statistic: 51.46 on 8 and 74 DF,  p-value: < 2.2e-16
```

The regression summarized in Table A.1 has an adjusted R-squared measure of 83%, which indicates a considerable proportion of the variation of the log of sale price is explained by the eight predictors included in the final model. Viewshed3 is the variable of interest for this study, and it is presented within the Table in bold type. Because the untransformed predictors are regressed on sale price expressed on the logarithmic scale, their coefficients can be interpreted as proportional differences. Thus, with all else held constant, houses with basement finish (bsmntfin) have sale prices, on average, approximately **12% greater** than houses without basement finish, houses on a water body like a lake or river have, on average, sale prices about **8% higher** than others, and so forth.

These patterns, however, are not comparable in the strength of their signal. The plot below relates the estimates and their associated level of certainty.

Figure A.1: Plot of Regression Estimates and Confidence Intervals - Final Model



The plot above outlines the coefficients presented in Table A.1 and ±1 standard error (thick line) and ±2 standard error (thin line) intervals estimated from the final regression. Strongest patterns are associated with the shortest lines relative to the size of coefficient; thus we have the greatest certainty with effect on sale price estimates for condition (cond), water influence (watinf), and house (log(hsesf.00s)) and lot size (lotac). Noticeably, the estimate for houses with wind turbine visibility (viewshed3) displays a wide confidence interval relative to its affect size. For the -13% impact on sale price from wind turbine visibility estimate, this translates to a margin of error between -3% and -23%.

Matched Samples

Overview

In observational studies, the use of regression modeling alone presents a risk of estimate bias (not human) because of dependency on model specification and the underlying assumptions that premise such a model. One approach often used to reduce the potential of bias in observational studies is to mimic a randomized experiment through data preprocessing by matching the treatment (in the viewshed) and control (out of the view shed) groups. By obtaining a sample of control sales that agrees as closely as possible with the viewshed group sales on an array of property characteristics that excludes their sale price, preprocessing the data by matching reduces dependence on the regression model and brings us closer to this goal. Matching the estimators for the two groups attempts to balance the characteristics between the groups so they are more alike than not, both in their distributions and coverage. The basis of this type of analysis is drawn from traditional appraisal methodology using “paired sales”. The differences are that specific programs are used to match the “Paired Sales” as opposed to human selection. It eliminates the problem of bias either conscious or unconscious and achieves better results. Two matching analyses were conducted.

OPTIMAL

The “MatchIt” package[3] of the R statistical software program was used to obtain a sample of sales in the Control Group matched to the 20 sales in the viewshed group as closely as possible on house characteristics that are independent of the wind turbines, before adjusting for remaining differences with regression. This automated matching process is summarized in Panel B below.

[3] Daniel Ho; Kosuke Imai; Gary King; and Elizabeth Stuart (2007), ``Matching as Nonparametric Preprocessing for Reducing Model Dependence in Parametric Causal Inference,'' Political Analysis 15(3): 199-236, http://gking.harvard.edu/files/abs/matchp-abs.shtml.
Full and optimal matching are implemented via the `optmatch` package (Hansen, 2004).

Using the Optimal Matching Sequence

Panel B: Regression Model on Data Matched by MatchIt Package Using Optimal Method

```
Call:
matchit(formula = viewshed ~ hsesf.00s + cond + loc + lotac +
age + watinf, data = mwind, method = "optimal")
```

Table B1: Summary Of Balance For All Data

Means Treated	Means Control	SD Control	Mean Diff	eQQ Med	eQQ Mean	eQQ Max
distance	0.390	0.194	0.169	0.197	0.168	0.193	0.366
hsesf.00s	16.727	17.352	6.038	-0.625	0.885	1.337	9.460
cond	3.000	3.762	1.160	-0.762	0.000	0.700	2.000
loc	3.500	3.159	1.208	0.341	0.000	0.600	2.000
lotac	1.627	1.379	1.388	0.247	0.100	0.230	0.851
age	63.600	64.905	36.474	-1.305	8.000	8.600	30.000
watinf	2.700	1.603	1.420	1.097	0.000	1.100	4.000

Table B2: Summary Of Balance For Matched Data

Means Treated	Means Control	SD Control	Mean Diff	eQQ Med	eQQ Mean	eQQ Max
distance	0.390	0.362	0.181	0.029	0.008	0.029	0.102
hsesf.00s	16.726	17.630	5.572	-0.903	0.920	1.123	3.600
cond	3.000	3.000	1.124	0.000	0.000	0.200	2.000
loc	3.500	3.400	1.392	0.100	0.000	0.300	2.000
lotac	1.627	1.401	1.855	0.226	0.146	0.257	0.851
age	63.600	62.300	40.901	1.300	5.000	6.800	29.000
watinf	2.700	2.400	1.957	0.300	0.000	0.300	4.000

Table B3: Percent Balance Improvement

Mean Diff.	eQQ Med	eQQ Mean	eQQ Max
distance	85.457	95.384	84.98	72.119
hsesf.00s	-44.423	-3.955	16.04	61.945
cond	100.000	0.000	71.43	0.000
loc	70.698	0.000	50.00	0.000
lotac	8.684	-45.662	-11.76	0.000
age	0.365	37.500	20.93	3.333
watinf	72.648	0.000	72.73	0.000

Table B4: Matched Sample Size

	Control	Treated
All	63	20
Matched	**20**	**20**
Unmatched	43	0
Discarded	0	0

Tables B1 to B4 are output from the matching process. Tables B1 and B2 outline the comparability of the two groups before and after matching, respectively. A summary of the improvement in comparability of the groups achieved by matching is in Table B3. Table B4 shows that matching has reduced the original sample of 83 sales to a smaller sample of 40 sales, consisting of 20 sales in the viewshed group (inside the view shed-Treated) and 20 sales in the control group(outside of the viewshed).

Figure B.1 is a visual display of the imbalance in the attributes between the two groups before matching (raw) and the improvement in the comparability of these attributes caused by the matching process (matched).

The comparison is made on the calculated propensity score for each sale. A propensity score of a property is its conditional probability of falling into the viewshed group given its attributes. It is a single value measure that summarizes all the attributes of any one property. Matching occurs on these propensity scores. It can be said that the propensity score is an overall utility score of the property similarly used in Qualitative and Quantitative analysis within the Direct Comparison Approach used by appraisers using Quality Point.

A comparison of the distributions of the propensity scores between the viewshed and control groups for both the raw and the matched data sets is offered by the histogram plots of Figure B.1. As the plots in the left column show, the distributions of the scores before matching are quite different. This difference disappears after matching, with the viewshed and control groups having similar propensity score distributions in the matched sample.

Figure B.2 below is a dot plot of these propensity scores. In addition to plotting the scores of the matched data set, it also shows the propensity scores of the discarded sales.

Figure B.1: Histogram Plots Comparing Propensity Scores between Raw and Matched Data by Viewshed and Control Groups

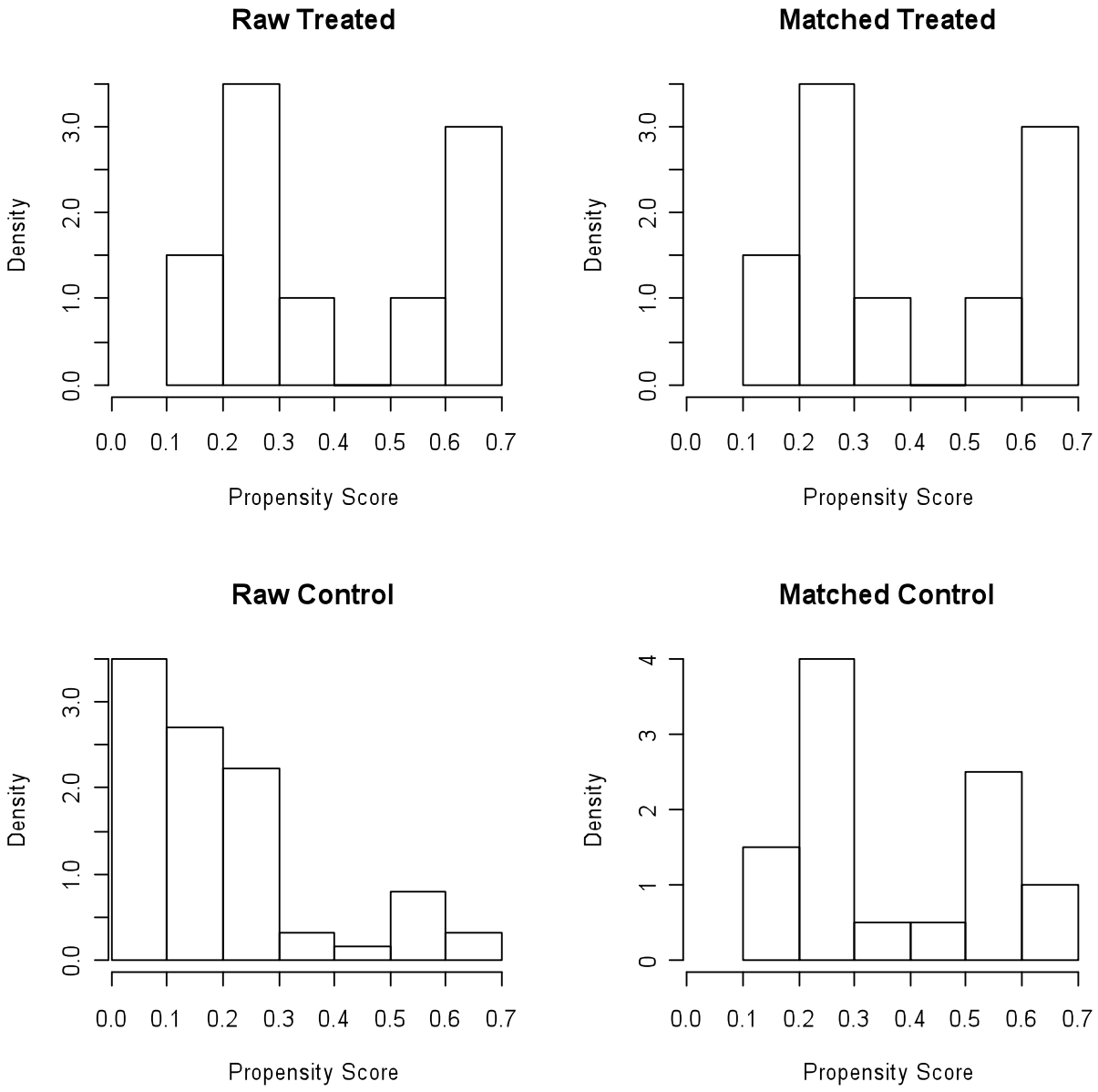
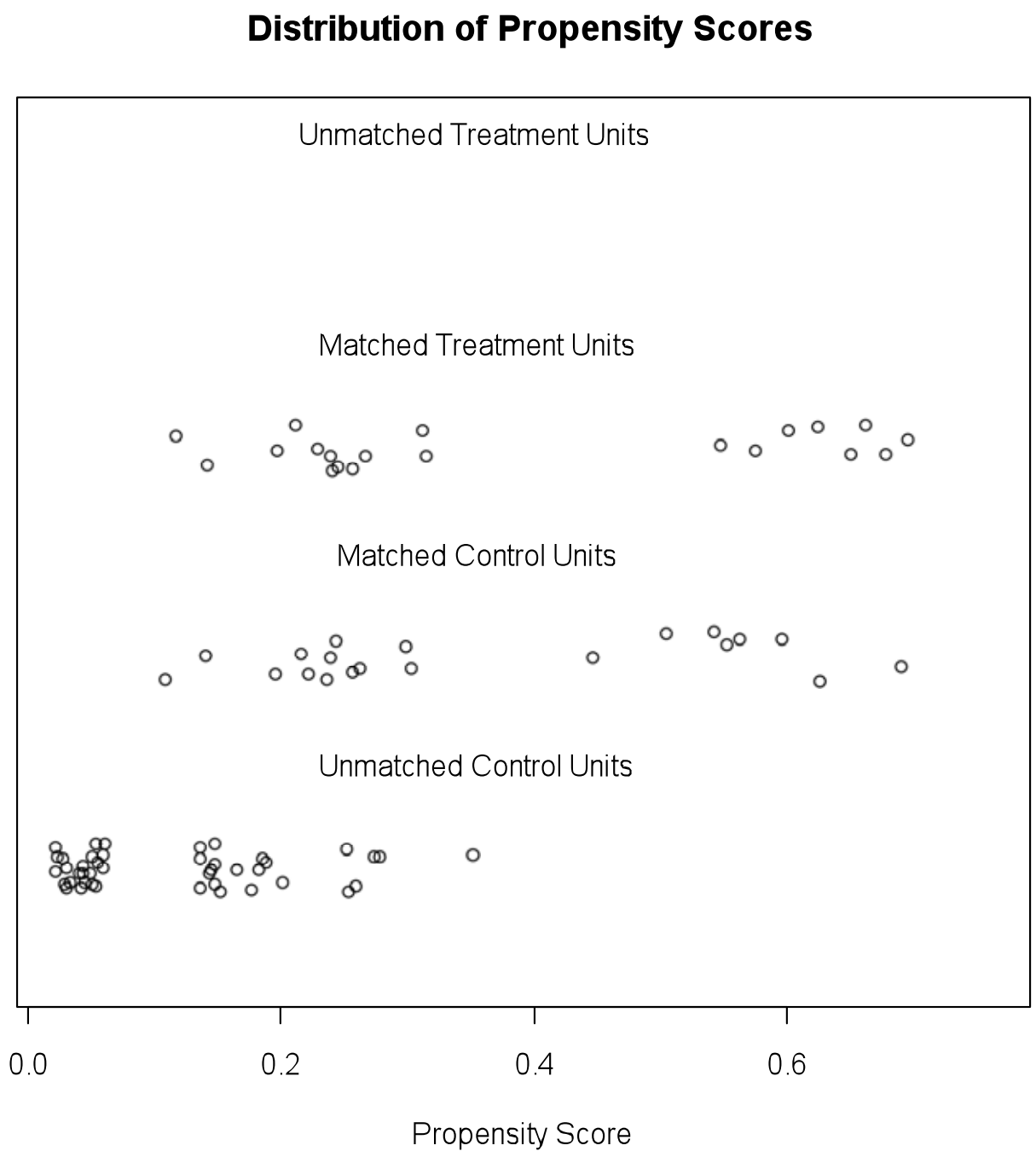


Figure B.2: Plot Comparing Propensity Scores between Raw and Matched Data by Viewshed (Treatment) and Control Groups



After matching, comparability between the groups has improved in the smaller matched data set (mdata). Overall, matching has made the two groups more alike than not.

Tables B.5 is the summary of the regression model built on the matched data set. Besides the viewshed variable, only three predictors were included in this model. These three predictors are helpful in explaining the variation in the log of sale price. The reason why only three predictors were used is because these were significant in explaining variation in the data set. Using too many variables against too small a sample would undermine the basic principles of regression analysis.

Table B:5 indicates that, contrary to the expectation of a statistically important negative coefficient for viewshed obtained from the regression on the full data set (outlined in Panel A), the regression on the smaller matched data sample of 40 sales shows viewshed has no clearly identifiable relationship with sale price. Although the viewshed coefficient has a value of -9%, the standard error is almost 12%. The output shows a probability of 45% of obtaining the coefficient value returned, even if the statement of a zero effect between sale price and viewshed were true. It can reasonably be concluded, therefore, that the model indicates there is no relationship between price and viewshed.

Table B.5 Summary of Regression Model - Data Matched Optimal Method

```
Call:
zelig(formula = log(sp) ~ viewshed + age + hsesf.00s + lotac,
model = "ls", data = mdata, weights = "weights")

Residuals:
Min      1Q  Median      3Q     Max
-0.6559 -0.2388  0.0293  0.2247  0.6321

Coefficients:
Estimate Std. Error t value Pr(>|t|)
(Intercept) 11.27470    0.22463   50.19  < 2e-16 ***
viewshed    -0.08945    0.11594   -0.77  0.44558
age         -0.00626    0.00136   -4.61  5.1e-05 ***
hsesf.00s    0.05082    0.01097    4.63  4.9e-05 ***
lotac        0.11917    0.03048    3.91  0.00040 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.364 on 35 degrees of freedom
Multiple R-squared: 0.634,    Adjusted R-squared: 0.593
F-statistic: 15.2 on 4 and 35 DF,  p-value: 2.72e-07
```

USING THE CEM MATCHING SEQUENCE

As a second matching approach, the CEM package[4] was employed in the R library of analytic functions. The CEM function was chosen from the available matching functions because of its similarity to the matching process traditionally used by property appraisers for variables with continuous values. The basic idea with CEM is to temporarily coarsen continuous variables such as house size so that substantively indistinguishable values are grouped and assigned the same numerical value. It is on these assigned values that matching occurs. Panel C of shows the matching analysis by CEM and final adjustment by regression.

Panel C: Regression Model on Data Matched by MatchIt Package Using Coarsened Exact Matching (cem) Method

```
Cem Matching Call:

library(cem)
todrop <- c("sp", "bsmnt", "outbldgs", "gar", "bsmntfin", "id")

matcem <- cem(treatment = "viewshed", data = wind,
drop = todrop, cutpoints = list(age = 4, hsesf.00s = 3, lotac = 3))

est <- att(matcem, log(sp) ~ viewshed + age, data = wind)
summary(est)
```

Table C.1: Matched Sample Size

```
summary(est)


G0 G1
All       63 20
Matched   11  9
Unmatched 52 11
```

[4] The program implements the Coarsened Exact Matching (CEM) algorithm described in Stefano M. Iacus, Gary King, and Giuseppe Porro, "Matching for Causal Inference Without Balance Checking"

Table C.2 Summary of Regression Model - Data Matched cem Method

```
Treatment effect estimation for data:
(Linear regression model estimated on matched data only)

Coefficients:
Estimate Std. Error t value   p-value
(Intercept) 12.3485988  0.2324106 53.1327 < 2.2e-16 ***
viewshed    -0.0702465  0.2142539 -0.3279  0.747017
age         -0.0082206  0.0028356 -2.8991  0.009982 **
---
 Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

After matching by the CEM method, comparability between the groups has improved (output not shown) in the smaller matched data set of 20 sales. Overall, matching has made the two groups (G0=no viz, G1=avg viz) more alike than not.

Table C.2 is the summary of the regression model built on the matched data set. Besides the viewshed variable, only one predictor (age) is included in this model to explain remaining variation because of the small sample size of the matched data.

Similar to the regression estimate obtained on the matched data by the optimal method (outlined in Panel B), Table C:2 shows the regression on the smaller matched data sample of 20 sales has brought back a strong indication that viewshed has no clearly identifiable relationship with sale price. The viewshed coefficient has a value of -7%, with a very large standard error of 21%. With this large sampling error, it can reasonably be concluded that the matched data does not refute the hypothesis of no relationship between price and viewshed.

PAIRED SALES ANALYSIS

A common method of analysis by real estate valuers and consultants is the “Paired Sales” or “re-sales”.

The “Paired Sales” method involves the pairing of IDENTICAL sales in every respect with the exception of characteristic under review. “Paired Sales” do not exist in the market place. The confusion by real estate analysts is the difference between the words “identical” and “similar”. Many consultants believe because they have similar sales that they are identical. Unfortunately that is not the case. How consultants analyze similar sales is to make ad hoc adjustments (based upon no evidence) to the data with respect to differences between the paired similar sales to the property characteristic in question. This is a common strategy when trying to group sales that are near or adjacent to wind farms and those that are not. The difficulty with this strategy is that it is subjective in nature, and often very difficult to reproduce.

A closer data match would be “re-sales” that have occurred over a period of time. Thus to measure the effect of wind turbines on real estate values, one should be able to decipher from the “re-sales” the difference in sale prices and the “re-sale” price.

Some “re-sales” of the same property were noted in the data compiled for this analysis. 14 examples of “re-sale” sales were identified for an independent analysis, as shown below. With a view to respecting the rights to privacy of the property owners, and to maintain the confidentiality of purchase price information, the specific property addresses have not been identified. Full details have been retained in the author’s files as required by the Appraisal Institute of Canada, and should they be required for court testimony.

ADDRESS	DATE OF SALE	SALE PRICE	IN THE VIEWSHED	PRICE DIFFERENTIAL
Property A	2008/05	96000	Yes	+$7,000
Property A1	2003/08	89000		
Property B	2009/02	124000	Yes	+$41,500
Property B1	2003/05	82500		
Property C	2008/08	79000	Yes	-$6,000
Property C1	2006/10	85000		
Property D	2007/08	174000	Yes	+29,000

Property D1	2005/03	145000		
Property E	2008/05	99500	Yes	+$9,500
Property E1	2004/05	90000		
Property F	2007/12	131000	Yes	-$4,000
Property F1	2005/06	135000		
Property G	2008/04	152500	Yes	+$12,500
Property G1	2007/11	140000		
Property H	2009/05	79900	Yes	-$5,100
Property H1	2003/09	85000		
Property I	2009/05	70500	Yes	+$6,500
Property I1	2007/01	64000		
Property J	2009/01	65000	Yes	-$52,000
Property J1	2004/12	117000		
Property K	2007/03	95000	No	-$15,000
Property K1	2005/04	110000		
Property L	2007/09	325000	Yes	+$177,000
Property L1	2005/10	148000		
Property M	2007/05	200000	Yes	-$95,000
Property M1	2005/04	295000		
Property N	2008/09	105000	Yes	+$30,000
Property N1	2006/07	75000		

14 pairs of identical properties were found to have sold over the last 5 years. These were in fact re-sale of the same properties. Out of the 14 re-sales, 13 were re-sales that were in the viewshed and 1 re-sale outside of the viewshed. If the “re-sales” are taken at face value, there are 8 re-sales in which their values have increased over time and 6 that have shown a decrease in value. It is interesting to note that the sale that is not in the viewshed showed a decrease in value. Since the element of time is constant and had no effect on sale price, there had to be a reason for the differences in the sale prices within the “re-sales”. The interpretation of the “re-sales” has identified some of the reasons for the differences in the sale prices.

Property A sold in 2008 on the MLS®. At that time the home was in good condition and had some updates. There was no MLS® listing on the property when it sold in 2003. However, we did find a 2002 MLS® listing that indicated that the property had received some renovations. In other words, the change in the sale price levels between 2003 and 2005 was not due to a difference in the condition of the home. Everything else seemed identical. So what was the real cause of the increase in value?

Property B sold on the MLS® in 2003. It required updating and it was not in the same condition when it sold in 2009. This might explain the +$41,500 increase between the sale dates 2003 and 2009.

Property C, when it sold in 2006 appeared to be in better condition then when it sold in 2008 at a loss. This could explain the price difference between the sale dates.

Property D revealed no MLS® listing when it sold in 2003. The 2008 MLS® sale indicated that the house was in good repair at the time of the sale. It is not known if there was any difference in the property between the two sale dates.

Property E sold in 2006 and 2008. On both MLS® listings of the property, it indicated that the property had not changed and was in good condition when sold each time. The cause for the property to increase in value by $9,500 is not known.

Property F sold in 2005 and 2007. In both instances the home was in good repair yet it sold for a loss. The rationale for the loss is unknown.

Property G sold in 2007 and 2008. The 2007 sale indicated that the home needed some work. The 2008 sale reflected the improvements made to the property that is why it sold for a profit.

Property H sold in 2003 and in then in 2009 for a loss. Each of the MLS® listings indicated the home was in average condition and no changes had been made to the home. The rationale for loss in value is not known.

Property I sold in 2007 and again in 2009 for an increase of $6,500. When the property sold in 2007 it had some updates and was in a good state of repair. When it sold in 2009, it sold in “as is” condition which suggests some type of a problem. However, it sold at an increased price in 2009.

Property J sold with a loss of $53,000 between 2004 and 2009. There was no 2004 MLS® listing for this property, but there was an expired 2006 listing. According to the 2006 MLS® listing the home appeared to be in average condition. However, when it sold in 2009 the MLS® listing reports the house being sold “as Is” condition which suggests some type of a issue. This could explain a large portion of the loss.

Property K, which was just outside of the viewshed, sold in 2005 and in 2007 for a loss of $15,000. A review of both MLS® listings at the time of these sales, disclosed no evidence of any changes to the property. There is no rationale as to why the property sold for less in 2007.

Property L sold in 2005 and 2007 for an increase of $177,000. The MLS® indicates that the home had been substantially updated at the time of the 2007.

Property M sold in April 2005 for $295,000 and resold in May 2007 for $200,000. This appears to indicate a loss of $95,000. When this property sold in April 2005 it sold under a power of sale and in "as is" condition. When it sold in May 2007 it had a new septic system and was in average condition. The difference in the selling prices between the dates was the result that a lot had been severed off the property after the purchase in 2005. The original lot size of the property in April 2005 was larger than when it sold in May 2007. Thus the price differential was the result of the lot size difference and is not related to the wind turbines.

Property N sold in 2006 and in 2008 for a profit of $30,000. There was no MLS® listing found when it sold in 2006 and the 2008 listing basically showed that it was in average condition. There is no rationale as to why this property sold at an increased price.

Even using “re-sales” as a point of entry in determining the impact of wind farms on property values does not show any casual relationship. With the “re-sales” that were found in the data set, there was more evidence on the outset that property values have increased despite the existence of wind farms. Yet in many instances there was no explanation of why these “re-sales” increased or decreased in value.

The problem of using “Paired Sales” or even “re-sales” as a model for determining the effect on real estate of a given property characteristic is very simple. These types of analysis cannot hold these physical differences between properties constant. In order to understand what groups of data are telling us we need to code the data. The “re-sales” “Paired Sales” methods do not allow for any coding nor do they allow for any levels of measurement.

Discussions with the realtors, buyers and sellers involve tend to be bias and skews results. A tool is required that is capable of holding constant all the variables, is capable of categorizing the variables, and finally, is capable of labeling the characteristics that impede on value.

The only real estate model that can actually hold constant all the variables that interact on price in a given real estate market place is Multiple Regression Analysis. This is the basis of this analysis and the authors have made every attempt to draw any inference, negative or positive, from the data procured from the marketplace as to the relationship of wind turbines and the sale price of nearby rural residential properties.

SUMMARY AND CONCLUSION

Sales prices of property in a given area provide the best source of evidence to establish market value. In attempting to establish the extent of a specific influence on the value of real estate, the available data must be divided and analysed into two groups; those exposed to the influence and those not. In the case of wind farms, it is appropriate to group the available sales data into those within the viewshed of the wind farms and those not.

When residential properties within a viewshed (viewshed group) are compared to those not in a viewshed (control group), there will be differences in selling prices between the two groups that are not related to the wind farms. The authors adopted a basic regression modeling in attempting to rationalize these differences as it allows for the introduction of multiple variables.

An initial exploratory analysis helps to demonstrate that point. On page 41 there is a visual presentation of the average sale prices of data within the “control group” and the “viewshed” group. This graph shows a 7.5% decrease between the average sale prices of each group. On the initial examination it would appear that sales located in the “viewshed” sold “on average” 7.5% lower. It would be wrong to assume that the -7.5% is the result of the wind turbines because the average sale price from each group represents the unexplained functions of all the variables.

Through a review of the MLS® data sheets and other records, as well as ground proofing inspections, the variables were identified and placed into the spreadsheet for regression modeling. These variables include such features as lot size, location, garage, basement finish, house condition, age etc. These variables can help to explain the differences in the selling prices of the dataset to allow for a more probative focus on the influence of the wind farms on those property sales within the viewshed.

The initial regression run showed that the variable “viewshed” returned a negative coefficient of 13%. In regression analysis, a coefficient or value will always be returned in the results. The quantum of the result indicates whether or not the coefficient is statistically significant. In this application, the “viewshed” variable returned, what is commonly referred to as a “Standard Error”, that could be inferred to be fairly wide. The word “Error” may be misleading to some, in that it is not really an error. The error in the sampling is the

difference between the data drawn and the total data population. In this case the total population of data is really hypothetical since the "Error" is the calculation of the fact that one is working with a sample not the entire population. There will always be some difference. In the case of the Standard Error in this analysis, it was .059 or 6.0%. Thus the 13% negative coefficient could have returned a value between -19% and -7% which is a very wide spread. It was also noted that the "T" value which measures statistical strength was a -2 which really signifies the weakness of the returned coefficient of -13%. In our opinion, this suggests that there was no consistency in this -13% coefficient being generated by the regression model.

Our exploratory data analysis was not limited to regression modeling on the whole data set. Since we know there are differences between the rural residential sales of each group we were able to segregate the data into closely matched datasets taken from each group. Once they were separated into like datasets, regression analysis could be re-applied to these smaller but more like sales to determine the effect of wind turbines on property values. On page 49 of the report there are four graphs. On the left side of the page are graphs (lower and upper) showing the Raw Treated and Raw Control groupings of data. By matching these sales from the data set as shown on the right side of the page (matched Treated and Control groups) we were able to create a fairly close match or analysis.

The output of the regression modeling on page 47 of the matched data sets using the "optimal" method returned a -9.0% coefficient for the variable "viewshed" with a high standard of error and a very low T value. This suggests that the coefficient returned by this regression run is not statistically significant.

We then extended the matching analysis to include the "CEM" method. The "CEM" method segregates data from two groups using a different technique then the "optimal" method. It must be remembered that both the "CEM" and the "Optimal" method does not consider sale price as a matching variable. The regression run using the "CEM" method is shown on page 52. Once again, a -7% coefficient is found for the variable "viewshed" returned by this model. The "Error" was very wide and the T value was extremely low. The conclusion is that the coefficient that "viewshed" returned is not deemed to be statistically significant.

The last considered approach was to take raw data in the form of paired sales. These paired sales were taken from the data inputs. This data set is located on page 54 of the report. Our examination of this data set was simply to determine the price differences of the same properties regardless of whether or not the residual price was negative or positive. By simply viewing the raw data without any formal analysis, no relationship could be

determined between the presence of wind turbines and rural residential properties.

It is of paramount importance to note that any diminution in market value may be as a result of influences other than wind turbines. For example, a vendor may be motivated to accept a price lower that expected or even lower than their own earlier purchase price. Such motivations may be due to job loss, corporate transfer with employer compensation for price loss, ill health, old age or death.

The three regression models in this study returned a similar negative coefficient for the variable “viewshed” supported by a wide Standard Error and low T scores that clearly show that those coefficient results could not be relied upon as being statistically significant. It could not be said that rural residential houses located in a viewshed sold for lower prices.

RECOMMENDATIONS FOR FUTURE STUDIES

The study of wind farms and their effect on property values is, and will likely continue to be a subject of debate for many years. Central to any future studies will be the methodology chosen for such a task. As pointed out earlier, the analytical options are limited. Furthermore, the real estate market is not perfect. It is comprised of individuals who hold differing ideals and objectives.

The motivations for buying and selling can vary significantly and can be influenced by numerous factors including, but not limited to financial capabilities, family criteria influences including physical and health limitations, employment etc. It can also be influenced by external factors such as the number of competing listings of properties available for sale, the price of gasoline vis-à-vis travelling distances, and prevailing economic conditions. As a result the data available for analysis will be imperfect, resulting in unpredictable differences and conclusions. Seeking perfection in analytical results can be an elusive and perhaps unattainable objective.

Most competent analysts will acknowledge that a large volume of well researched data, when properly analysed, is more likely to produce a more reliable result than a small selection of data. The commonly used “paired sales” analysis relies on only a few observations and frequently adopts “ad hoc” methods of rationalizing variances. This technique has been used since the 1930’s in real estate appraisal practice and can often be proven to be unreliable by rendering biased results due to flawed adjustments and insufficient support. It is for this reason that a “paired sales” analysis, using only a few sales transactions, that are unlikely to be ideally comparable, is a statistically inferior

approach.

Some studies on wind farm influences to date have relied exclusively on interviews of area residents. Such interview formats as a basis by reaching a conclusion can be misleading for several reasons. Bias can be built in by the way the questions to be asked are framed. The questions asked are rarely if ever presented with the results for review. The answers given by the respondents may not be truthful for a variety of reasons. Interview format studies are not evidence, they are unsubstantiated opinions, and as such are not empirical or reliable.

The authors believe that the Multiple Regression Analysis technique is the preferred choice in the analysis of data for several reasons. It utilizes a large volume of market derived observational data, and is capable of minimizing the element of bias. MRA can extract a detailed view of the primary influencing variables on price and examined them on a micro level (assuming the data is available).

In future studies of the overall impact of wind farms on nearby property values, the many variables having independent influences must be carefully grouped for analysis. In addition to the usual adjustment for property differences, the following areas are suggested for possible groupings for analysis:

- the distance to a wind turbine;
- the number of visible turbines;
- angle/direction of visibility;
- the influence of visibility of a hilly terrain or bush cover;
- noise measurements at different times of the day;
- noise measurements under different wind conditions;
- the influence of vibrations;
- volume of competing listings of properties available for sale;
- length of exposure time prior to consummation of a sale; and
- the time of year.

Although distance is an important element that needs to be incorporated in any future design program, it must be carefully related to the other influences. If a negative effect becomes evident, then it may be necessary to study the distance at which the impact is no longer measurable. An attempt was made in this study modeling by incorporation this variable into the MRA equation. There was an insufficient volume of sales in order to provide any concrete evidence as to the distance of influence on property prices.

The mandatory minimum noise set back distance, based on the new Ontario guideline from wind turbines to the closest Point of Reception (neighbouring house), is 550 meters. This new set back distance may differ with set backs in other locales. The present suggested setback distance was arbitrarily determined. Absent concrete data gleaned from the market place in terms of the minimal distance of influence (if there is one) it seems unreasonable to some developers that increased boundary lines be set.

A more detailed scoring system to encompass the subtle differences may be required. The site inspection of the sale properties disclosed varying degrees of influence. For example; some had visible views of wind turbines from the driveway and others only from the rear yard. Some had views of wind turbines only when approaching or leaving a property. Some properties were proximate to wind turbines but they were not visible or audible as they were separated by trees. These subtle differences may play a role in analyzing the effect of wind farms on property values. Close proximity to a wind farm development may be a factor, but in future studies the criterion used for scoring the degree of influence requires careful consideration.

If turbine noise is deemed to be a factor to be scored, the relationship of the prevailing winds to the nearby properties may also have to be taken into account. The relationship of wind speed to turbine noise may also need study. Future studies may require mapping the sound measurement results within the viewshed of the wind farms located within the area under study. Wind turbine attributes may also need to be considered in the future.

At a public hearing attended by the authors, a neighbouring complainant suggested that vibrations from the turbines were bothersome. If vibrations are found to be a factor to be analysed, the nature of the subsoil conditions may have to be considered for their influence on the transmission of the vibrations. A clayey subsoil material may have a different influence on the transmission of vibrations than say bedrock.

The proximity of a wind farm development to a property sale may show improvement by using a more comprehensive scoring system, but its reliability is ultimately base in the volume of supporting market driven data.

When a sale property near a wind farm is consummated, an important question in future studies may be the volume of available of competing listings of a similar nature, and their influence on the buyer's decision. Were there a number of listings available to the buyer at the time of the sale within the area of the viewshed, and what influence might they have had on the sale price?

In future wind farm studies specific attention to the influence on the price paid by a buyer of the length of time the property was exposed for sale on the market may be required. The exposure/listing times of the sale properties may need to be examined in the sales groupings, both in and out of the viewshed. As noted earlier in this report, there are many factors that can influence the length of marketing exposure. It may be necessary to consider these factors and determine, if possible, if a lower selling price was related to any specific factor or simply if the property became "stale" on the market. Extended listing times can lead buyers to perceptions of problems that may not exist.

The sale date of the property within the viewshed relative to the time of the year may be worthy of further study. During the summer months property owners and buyers are more mobile or spend more time out of doors. During winter months there can be less tree foliage making the turbines more visible, yet there may be less emphasis on surroundings and a greater focus on other amenities that a given property offers. An analysis to consider if buyers are more sensitive to wind farms during different periods in a given year may be worthy of consideration.

APPLICABILITY OF STUDY RESULTS TO OTHER REGIONS

This study focused only on the influence of wind farm development along the north shore of Lake Erie in the Chatham-Kent area of Ontario. The study results derived from market evidence in this area may not be relevant to other regions of Ontario or Canada. Differences may arise due to variations in:

- socio-economic influences
- Wind directions
- subsoil conditions
- tower heights
- turbine models
- turbine age

- volume of competing listing of properties available for sale
- jurisdictional set back requirements from property lines or neighbouring properties
- area topography
- tree lines and bush lots

As a result of differences in some of these variables there may well be dissimilar study results. Caution should be used before suggesting that similar results would be found in other areas.