A LITERATURE SURVEY AND ANALYSIS OF THE IMPACT OF HIGH-VOLTAGE OVERHEAD ELECTRIC TRANSMISSION LINES ON ADJOINING PROPERTY VALUES

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ABSTRACT

Research on the effects of overhead transmission lines on property values has expanded over the past fifteen years to include new methods of analysis and more detailed examination of the data. Conclusions as a result of these studies have varied widely, with some authors reporting no effects, others finding small effects, and still others reporting quite large effects. The purpose of this paper is to review and summarize the progress of research over the past fifteen years, to assess the knowledge gained from recent research, and to suggest directions for future studies. The study found that over the past several years, multiple regression analysis has become the dominant methodology applied to the question of transmission line impact on real estate values. Results from the literature survey further suggest that the market value of residential property can be affected by proximity to high voltage power lines. Majority of the findings of previous studies, from 1950s to 2013 conclude that property value effects due to high-voltage overhead transmission lines cannot be presumed and are generally infrequent. Further research is needed which would compare the growth in property prices of sales transactions both before and after the period of HVOTL provision. In addition previous studies had been limited to a specific case study region. Further case studies using hedonic price model techniques could measure differences in possible spatial or environmental effects of various neighbouring suburbs. Future research should equally seek to provide quantitative measures of the value impact as a function of the variable identified by survey participants

Keywords: *High-voltage Poles, Overhead Line, Power Plant, Property Value and Transmission Line*

INTRODUCTION

The effects of overhead transmission lines on property values has been of interest to utility companies for many years, to inform the company in planning the routing of rights-of-way and for determining compensation to property owners. Public planning agencies and property owners of affected parcels have also been concerned with understanding the possible magnitude of impacts and the factors leading to changes in property values.1 Research has been conducted on this issue since the 1950s, but over much of this period

the research approaches varied widely, research was based on case studies rather than a comprehensive testing of impacts under a range of circumstances, and findings have been ambiguous and sometimes contradictory (Kroll and Priestley, 1992).

It is very difficult to make general statements about the effect of transmission lines on property values. However, recent studies have indicated that transmission lines have either a small or no discernible impact on property values. Where an effect was found, the effect tended to diminish rapidly with distance from the line and over time. The impact of power transmission lines on property values remains insufficiently explored and inconclusively theorized (Elliott and Wadley, 2002). The bulk of research has been carried out in America and Canada with limited research in England and New Zealand. Some studies were undertaken to gain further understanding regarding the effect of high-voltage overhead transmission lines on abutting property values (Callanan, 2010).

Despite successive studies over the 1990s, the impact of high voltage overhead transmission lines (HVOTLs) on property values remains insufficiently explored and inconclusively theorised. Understanding the impact is important to electricity suppliers in planning routes and determining fair compensation in cases of full or partial resumption of private land. Those affected by the establishment or extension of transmission infrastructure also want greater certainty about the process and outcomes and how their economic or domestic operations are likely to be affected. Years of international practice in compensation raise the issue of the exact nature of the affliction created by power lines and equipment as a ma tter of fact (Elliott and Wadley, 2002).

Research has come from several different academic and professional fields. Appraisers have the longest history of examining transmission line impacts. Appraisal techniques compare sales prices for matched properties or use descriptive statistics comparing groups of sales, to examine whether properties crossed by or close to overhead transmission lines have lower (or higher) sales prices than unaffected properties. Attitudinal studies give a qualitative feel for effects of transmission lines, rather than a quantitative measure of degree of impact. These studies examine how property owners and others involved in property management or sales perceive the effects of transmission lines on sales price of property. Statistical analyses draw on data developed through appraisal techniques and other field study methodologies but measure impacts with more sophisticated statistical tools. Comparison of means and multiple regressions are the most common approaches used to look for statistically significant differences between sales of properties encumbered by or close to an overhead transmission line and sales of properties at other locations (Kroll and Priestley, 1992).

Attempts to correlate proximity to transmission lines with impacts to property values are complicated by the interaction of several relevant factors, including geographic region, land use, variability in perceptions over time, and limited sales data for similar properties before and after construction of transmission lines. Researchers have generally used survey-based

techniques and statistical analyses to make inferences and draw conclusions about the relationship between transmissions lines and property values. In general, surveys provide useful insights for estimating price effects based on public opinion, yielding what researchers refer to as "stated preferences." Statistical analyses, on the other hand, reflect the actual behavior of property buyers and sellers in terms of recorded sales prices, providing what researchers refer to as the "revealed preferences." In other words, there is often incongruity between what people think and how they actually behave. Measuring both perceptions and actual behaviors helps researchers understand the relationship between transmission lines and property values.

Power plant siting has become increasingly contentious, in part because power plants are a source of numerous negative local externalities including elevated levels of air pollution, haze, noise and traffic (Davis, 2008). It is hypothesized that there is no difference in the value conclusions of appraisers who have appraised residential properties proximate to high voltage power lines compared to appraisers who have not appraised such property (Vredenburgh, 1974). Alternatively, appraisers who have appraised such properties will differ in their conclusions regarding the value adjustment warranted when compared to appraisers who have not appraised such property. It is assumed that professionals having experience in appraising properties proximate to HVOETLs will report their conclusions based on other evidence, different from that used by experienced appraisers (Delaney and Timmons, 1992).

Since 1975, however, researchers at a variety of academic institutions, appraisal firms, and other consulting firms have begun to establish a more systematic body of research on the topic. The purpose of this literature review and analysis is to identify and describe the research that has been conducted between 1975 and 2013, to evaluate the strengths and weaknesses of the research, to assess the current state of knowledge on the topic, and to determine the type of research that could contribute to a better understanding of the issue in the future. The literature reviewed in this study has been identified from earlier review articles, through biographical reference sources, and through telephone interviews with academic researchers, appraisers, and utility company representatives (Kroll and Priestley, 1992).

STATEMENT OF THE RESEARCH PROBLEM

In the words of Delaney and Timmons (1992), there is a significant and varied body of literature focusing on the potential impact of high voltage overhead electric transmission lines on different property types. Almost all of the research reported in the literature to date has concluded that HVOETLs have little or no effect on property value. Kinnard (1988) reports on more than seventy five studies and articles (published and non-published) from the mid 1950s to 1988, that seek to determine what, if any, effect HVOETLs have on sale prices and market values of nearby real property. The studies cited examine improved

residential property, vacant land, including acreage and lots in subdivision, but excluding agricultural land that is actively farmed, and all other land uses, including actively farmed land (Delaney and Timmons, 1992).

As a matter of fact, in Delaney and Timmons's (1992) study, they reported that, during their time, there are four studies that used statistical models to determine if HVOETLs had a measurable impact on proximate to residential real estate. Three out of the four reported little or no discernible impact (Blinder, 1979; Brown, 1976; Kinnard, Geckler, Geckler, Kinnard and Mitchell, 1984) The long dissenting study reporting a significant negative impact on value is that of Colwell and Foley (1979). More recently, another study by Colwell (1990), not included in the Kinnard's (1988) bibliography, finds a negative impact on residential properties in close proximity to power lines, declining as distance increases. Further, the negative impact diminishes with time. Colwell (1990) also determines that properties not adjacent to but within sight of a utility easement suffer an impact as a result of proximity to power lines (Delaney and Timmons, 1992).

Two studies by Canadian Real Estate Research Corporation Ltd (1973) and Realty Research Group Ltd (1974) used paired sales analyses and direct comparison. Neither of the two studies detected any negative impact on residential property Value. Six case studies or mini appraisals were analyzed with none of the six finding any measurable impact on value (Lamprey, 1985 and Realty Research Group Ltd, 1974; Commonwealth Edison, 1978; Minnesota Power, 1983; Sherman, 1974 and Vredenburgh, 1974). Finally, of the ten studies classified as non-empirical or judgmental, only two (Ball, 1970 and Layton, 1962) appear to deal solely with the potential economic (value) effect pf HVOETLs on proximate improved residential real estate. The remainder addresses non-economic impacts. Neither the Ball (1970) study nor that of Layton (1962) concludes that proximity to HVOETLs adversely affects market value or sale price. The findings, regardless of study methodology overwhelmingly support the conclusion that little or no significant negative effect exists on property values attributable to HVOETL proximity (Delaney and Timmons, 1992).

A recent literature review (Reference G1) examined 17 studies on the relationship between transmission lines and property values to compare their results and to develop some general conclusions. The 17 studies, spanning the time period between 1956 and 2009, were compiled and reviewed by Real Property Analytics, Inc., a private firm specializing in the valuation of property potentially affected by external environmental factors. The studies evaluated impacts from transmission lines ranging from 69 kilovolts (kV) to 345 kV. Upon completion of their review of the studies, Jackson and Pitts (Reference G1) concluded the following: "The studies reviewed…generally pointed to small or no effects on sales prices due to the presence of electric transmission lines. Some studies found an effect but this effect generally dissipated with time and distance. The effects that were found ranged from approximately 2% to 9%. Most studies found no effect and in some cases a premium was observed."

Delaney and Timmons' (1992) survey results from 219 real estate appraisers found that 84 percent believed that transmission line proximity results in an average ten percent lower market value. Ten percent of respondents found no effect and six percent thought transmission lines increased property value due to larger lots for similar price. Prices of homes adjacent to the transmission line are similar to prices of other homes in the same neighborhood.

Brown (1976) conducted regression analysis on sales of farm land in Sakatchewan, Canada, between 1965 and 1970 and found that the relationship of land value to the number of power line structures was not statistically significant and that the lines did not negatively affect property value. Brown also found that the structures can be an impediment to farming operations. Colwell and Foley (1979) examined 200 property sales over a ten-year period in Decatur, Illinois and found that sales price increases as distance from a transmission line increases. Property values were approximately six percent lower within 50 to 200 feet of the transmission line, but there was no difference in property value beyond 200 feet.

Colwell (1990) followed up the study above and confirmed that the selling price of residential property increases as distance from the transmission line increases. The rate of increase slows with distance and eventually disappears. Rigdon (1991) evaluated 46 properties sold in Marquette County, Michigan over a five-year period and found no statistically significant relationship between sales price and proximity to a transmission line easement. Hamilton and Schwann (1995) reviewed previous literature and found that transmission lines can reduce adjacent property values, but that the reduction is generally less than five percent of property value and that the reduction diminishes at 600 feet.

Des Rosiers (1998) reviewed property values of 507 homes in the Montreal area and found an average drop in property value of 9.6 percent for homes immediately adjacent to the line. He also found an average increase of up to 9.2 percent in value for homes one to two lots away from the transmission line and no effect beyond 500 feet. Both the studies of Wolverton and Bottemiller (2003) and Cowger, Bottemiller and Cahill (1996) were conducted in Portland, Vancouver and Seattle. The 2003 work was set to repeat the 1996 study with more rigorous analytical methods. Both applied statistical methods to paired-sales analysis and found no price effect on residential property from proximity to transmission lines. The data also show no difference in appreciation rates between homes near a transmission line and homes further away.

Chalmers (2012) conducted a research on a study of 2000–2010 sales of properties located along 500 kV transmission lines that stretch across most of Montana. A combination of 49 individual transactions and an even larger number of lot sales in 7 subdivisions were studied using personal interviews, sales comparison, and paired sales techniques. The transactions are categorized into seven property types, representing a combination of agricultural, residential, and recreational uses. Results are summarized for each property

type, and the conditions that make properties vulnerable to transmission line impact are identified. At the most general level, the dominant considerations affecting any impact are use, property size, and the availability of substitutes.

Chalmers and Voorvaart (2009) studied residential properties sold in Connecticut and Massachusetts between 1999 and 2007 and found proximity to transmission lines to have an insignificant effect on sales prices. Carll (1956) compared property values and interviewed owners, buyers and brokers along a transmission line in Los Angeles and found that residences adjoining the righ of way (ROW) had not sold at a discount and that lenders did not adjust loan amounts for lots adjacent to the ROW. Bigras (1964) reviewed over 1,900 deeds of sale and mortgages in Quebec and found that prices for vacant land adjacent to transmission lines were generally higher than the average price of all transactions. Land adjacent to transmission lines was sold faster and was developed to a higher degree than land away from the lines.

Jackson and Pitts (2010) concluded from these studies that proximity to transmission lines results in little or no effect on property value. In studies where transmission lines were found to have impacts to property values, the decrease in values typically ranged from approximately two percent to ten percent. In some instances, increases in property value were found (Appendix G- Property Values Supplement, n.d.). Based on the aforementioned findings of previous studies, it could be seen that HVOTLs effect on property values has little or no significant effect. The gap left by previous research could be seen apparently as the past researchers concentrated on limited sales data. They mostly restricted their research on residential property value effect.

PREVIOUS EMPIRICAL STUDIES

High Voltage Electric Transmission Lines and Adjoining Land Use

In the words of Bond, Sims and Dent (2013), the provision of electricity, as with gas, water and telecoms, is an accepted and essential precondition of modern life. Almost every aspect of our lives, both at home and in the workplace, relies on the availability of instant electricity; few of us actually consider the infrastructure needed to make this possible, however. The distribution of electricity from one place to another relies on a network of cables, some sited underground and some suspended from large metal structures known as pylons. It is the more visible aspect of electricity distribution (Bond, Sims and Dent, 2013).

In cities and suburbs, most electricity lines are buried underground. As residential areas have expanded to meet increased housing demands, more homes have been built close to and even under electricity lines. The type of electricity distribution equipment now usually found within residential areas consists of: high-voltage overhead electricity lines (Bond, Sims and Dent, 2013).

High-voltage lines are normally sited *before* land is developed for residential use. When constructing a new line (underground or overhead) however, the electricity utility attempts to ensure that its equipment has a minimum impact on the surrounding environment. While the siting of new lines across private land will require permission from the land owner, the utility often has compulsory powers to purchase land, carry out operations and override personal interests where a land owner demands the removal of an existing line from their land (Bond, Sims and Dent, 2013).

In the US, Canada and Australia, HVOTLs are generally situated in a right-of-way (ROW), a corridor of land where building construction is prohibited. Homes abutting a ROW are likely to benefit from additional green space and increased privacy. Therefore, any negative impact on value from a proximate HVOTL may be diminished. In the UK and New Zealand (NZ) there is no requirement for a ROW and, as a consequence, the findings from studies undertaken in the US are not directly comparable to the results of UK or NZ studies (Bond, Sims and Dent, 2013).

More land near HVOTLs is being developed for residential use due to an increasing demand for new homes, ensuring that any relationship between HVOTLs and property prices gains the attention of the property profession and other stakeholders. The factors identified so far which may influence house prices near HVOTLs according to Bond, Sims and Dent (2013) include the following.

- Visual presence of the pylon and line: degree of visibility (height, style and appearance), orientation and proximity of a house to either lines or pylons (towers).
- The voltage of the lines.
- The extent and frequency of negative media reports of health risks or reductions in house price due to living near HVOTLs.
- Public and professional perceptions influencing attitudes towards amenity value and perceptions of risk.
- The 'safe' distance from the pylons and lines as perceived by residents.
- The type of health risk associated with living near HVOTLs and the level of risk perceived.
- The degree of noise coming from the HVOTLs.
- The socio-economic make-up of the resident population.
- Current market conditions, for example rising or falling housing prices. In a falling or weak market, purchasers have more choice of property and may choose to live away from HVOTLs; conversely, in a tight or rising market, there are generally fewer properties available for sale, so purchasers have less choice and may be more willing to live near a HVOTL.

Negative Effect of High Voltage Overhead Transmission Lines

According to Han and Elliott (n.d.), HVOTL infrastructure can create externalities and perceived threats to the immediate environment and adjoining residents. Their intensity will vary according to individual and community attitudes and expectations. Intertwined with these reactions is the fear of the homeowner's wealth and financial security being impacted with possible reductions in the value of their real estate.

HVOTLs are a familiar and readily-identifiable hazard for homeowners. Previous research (Elliott and Wadley, 2012; Cotton and Devine-Wright, 2011) suggests that they presented a symbolically negative image of the industrialised world. Elliott and Wadley (2012), through a

series of focus groups undertaken in Queensland, identified that health implications of Electric Magnetic Fields (EMFs) as the most likely HVOTL risk attribute to attract concern and the consequential risk of a possible reduction in property value often became evident in

discussions about EMF and, in fact, most other transmission effects (Han and Elliott, n.d.). All effects bear directly on the homeowner but EMF risk in particular has the potential to amplify indirectly (i.e. 'ripple') among the community and in the property market in a process known as 'consumption depreciation.' Residential real estate is both a consumption good and investment asset and is sensitive to social settings and planning regimes and practices (Han and Elliott, n.d.).

When HVOTLs are involved, purchase decisions factor in not only a resident's perceived loss of utility in foregone views and compatibility of adjacent land uses, but also in a reduction of investment value if prospective purchasers perceive a place as stigmatised. The environmental stigma arising from HVOTL is the perception of potential buyers and sellers of real estate in proximity to HVOTL who consider that the real estate is compromised in its utility by risk attributes and consequently diminished in value. Numerous factors affect market perceptions of utility (Han and Elliott, n.d.).

According to (Han and Elliott, n.d.), despite the fact that HVOTLs have existed for over 100 years, many people, and homeowners in particular, are still wary of them. Research into public reactions to the provision of lines has reinforced the finding of negative perceptions, albeit with substantial variation in intensity caused by measurement differences across studies, as well as disparities in socio-economic status and the choice of environmental variables (Priestly and Evans, 1996). Public perceptions of risk initially focused on aesthetic and engineering qualities. The year 1979 was a turning point, suggesting the first relation of EMF exposure to possible human health effects (Werthiemer and Leeper, 1979). Whilst such a link remains unproven, fears of transmission facilities have since been repeated (WHO, 2007).

Issues of safety and environmental damage, as well as interference with property rights, abet the negativity (Furby et al., 1988). Proposals of new lines can foster apprehension

about local residents' wealth and financial security, due to resumption procedures and associated compensation rights which could appear complex and threatening.

Statistical Analyses of Transmission Line Impacts

The first literature category includes eight statistical studies using multiple regression analysis or other closely related statistical techniques such as the analysis of covariance. Most of the studies reviewed use multivariate analysis whereby important determinants of pricing, such as the detailed physical characteristics of the properties, are held statistically constant in order to isolate the effects, if any, of the presence of transmission lines. Six of these studies focus on single family residential properties, and two address rural acreage and agricultural land (Jackson, Pitts and Norwood, 2012).

Early Statistical Studies

Brown (1976) published an article in 1976 that used paired sales analysis to look at sales of farm parcels from 136 acres to 350 acres in size in southeastern Saskatchewan. He found no negative influence of number of towers or the presence of HVTL relative to otherwise similar parcels without HVTL (Chalmers, 2012). Therefore one of the two rural land studies is provided by Brown (1976), who uses regression analysis to analyze sales of farm land in south-eastern Saskatchewan, Canada that occurred between 1965 and 1970. The study included sales of "quarter section" (136-199 acre) and "half section" (200-350 acre) parcels.

The relationship of land value to the number of power line structures was not found to be statistically significant. To further examine this relationship, very similar parcels, with the main difference being that one had a power line and one did not, were paired and analyzed (Jackson and Pitts, 2010). Overall, the sales with power lines sold for higher prices than their pairs without power lines. It is unreasonable to conclude that this higher price was due to the power lines and easements, but it appears that the lines did not negatively affect the market value of the farm land. However, Brown does note that the easement required by the power line does reduce the rights of the property owner, and that power line structures normally have an adverse impact on the efficiency of farming operations as a matter of fact (Jackson, Pitts and Norwood, 2012).

In the words of Elliott and Wadley (2002), unlike many studies prior to 1979, Colwell and Foley's work showed that the proximity to a line could be associated with diminished selling prices of some substance. "Although the transmission line appears to have little impact at distances beyond 200 feet, substantial differences in selling prices exist between 50 and 200 feet from the transmission line" (Colwell and Foley, 1979, as cited by Elliott and Wadley, 2002).

Colwell and Foley's (1979) Study and Colwell (1990) Follow Up Study

Since 1979 other studies have been conducted. Colwell published a further paper in 1990 based on the foregoing study area and data set. One particular criticism of previous studies was that no account was taken of a possible enhancement in value arising from lots which are contiguous to the easement and therefore have "use" of the greenbelt as in an open view, gardens, swing sets etc (Elliott and Wadley, 2002).. Colwell (1990) accordingly formulated the following hypotheses:

1. H1. Residential selling prices are related both to proximity to the lines and to the pylons. It was argued that lines and pylons have a large negative impact in close proximity but that any impact declines at a decreasing rate as distance increases. Additional distance beyond a few hundred feet might make very little difference.
2. H2. Any impact of the power line and pylons might be lessened through time.

In summary, the second study again established that the negative impact of power lines is large in close proximity, but declines as distance increases. Furthermore, the impact of the lines diminishes with time. There may be an additional negative value impact of proximity to pylons but this impact showed no significant signs of diminishing through time (Elliott and Wadley, 2002).

Colwell and Foley (1979) and Colwell (1990) analyzed 200 home sales located in Decatur, Illinois. The Colwell and Foley study found that proximity to an HVTL reduced sale price and that lots encumbered by a power line easement tended to be larger than unencumbered lots. Colwell's later study looked at the same data as the earlier study, finding that the HVTL price effect diminished over time. This finding is rationalized by observed tree growth (screening), changing attitudes, and reduced uncertainty regarding the effects of an HVTL. Both analyses relied on multiple regression equations relating the natural log of sale price to elements of comparison, capturing the effects of home and site characteristics, changing market conditions, varying neighborhoods, and proximity to an HVTL (Bottemiller and Wolverton, 2013).

Colwell and Foley (1979) hypothesize that there are costs imposed on residential property stemming from close proximity to electric transmission lines. Two neighborhoods in Decatur, Illinois, were chosen for this research. The sample consisted of 200 sales during the ten-year study period from January 1968 to October 1978. Within 400 feet of all properties in the sample is an electric transmission line of double-circuit 137-thousand-volt conductors. The model consists of an equation that relates selling price, the dependent variable, to ten independent or explanatory variables, including lot size. Lot size is particularly important in this study because residential lots abutting an electric transmission line tend to be larger than other lots in the subdivision. The results of this study show that selling price becomes higher as distance from the transmission line increases. The selling price increases at a decreasing rate and quickly approaches an asymptote. The most substantial impacts are observed between 50 and 200 feet from the

line, but the lines seem to have little or no effect at distances beyond 200 feet (Jackson, Pitts and Norwood, 2012).

In a follow up study, Colwell (1990) measures the impacts of power lines and towers on the selling price of residential land with a hedonic price index in which the selling price is a Cobb Douglas function of a number of property characteristics. The data used in this study is identical to the data used in Colwell and Foley (1979), with additional variables for distance to a tower and the presence of an easement. Like the previous study, these models show that the selling price of residential property increases as distance from a power line increases. The selling price increases at a decreasing rate and quickly approaches an asymptote. The negative impacts tend to diminish or disappear over time (Jackson, Pitts and Norwood, 2012).

Rigdon's (1991) Analysis

Rigdon (1991) analyzes the impact of a 138 kV transmission line on vacant recreational land in Marquette County, Michigan using multiple regression techniques. Forty six sold properties ranging from 10 to 160 acres were selected in two large "neighborhoods" during the study period of January 31, 1986 to January 30, 1991. Results indicated no statistically significant relationship between sales price and proximity to a power line easement. In other words, Rigdon (1991) published a study in 1991 in which he used multiple regression analysis to analyze the effect of a 136 kV line on recreational parcels ranging from 10 to 160 acres in size in Marquette County, Michigan. Based on 46 sales in the period from 1986 to 1991, he concluded that there were no land value effects associated with proximity to the HVTL (Chalmers, 2012).

Hamilton and Schwann (1995) Study

In 1995, two academics named Stanley Hamilton and Gregory Schwann published a highly empirical study of residential home prices in Vancouver, British Columbia. The study contrasted sales in four separate Vancouver neighborhoods of residences adjacent to power lines of 60kV or greater from 1985 to 1991. The sample size was impressive, containing 12,907 transactions in the four study areas. The percentage decreases in property values were not as great as those originally measured in the Houston area in this author's 1993 study. Hamilton/Schwann nevertheless concluded to an undeniable drop in value: "We find that properties adjacent to a line lose 6.3 percent of their value due to proximity and the visual impact."6 The well-supported findings presented in this article lead one to conclude that the depressing effect power lines have on property values is not merely an American phenomenon (Bolton and Sick, 1998).

Among post-1979 studies, that of Hamilton and Schwann (1995) has been cited as one of the most reliable. It examined the effect of proximity to transmission lines in sale prices of 12,907 single detached dwellings in four Vancouver neighbourhoods over the period 1985-

1991. The regression results showed that proximity to high voltage electric pylons was significant with respect to depreciation in property prices (Gregory and von Winterfeldt, 1996). A particular aspect to note in their study was that the HVOTLs effects varied among the four neighbourhoods. The rights of way in two areas were 140 metres in width with two 500kV and one 230kV power lines on steel pylons; one with two transmission lines on steel pylons; and one area with a 60kV line on wooden poles. Distances were measured from the centre of the transmission line right of way (Elliott and Wadley, 2002)..

Hamilton and Schwann (1995) analyzed 12,907 transactions from four neighborhoods in Vancouver, Canada, occurring over the 1985-1991 period. The study found a 6.3% diminution in value for homes in close proximity to power lines and towers. An important aspect of this study is the rich (large and detailed) sample, which enabled the authors to investigate the effects of numerous elements of comparison and to examine many functional forms for the regression equation. Price equations were found to be heteroskedastic, and estimation methods were used to account for this and derive credible estimates of statistical significance. The article is silent, however, concerning whether the power lines are on easements or fee title land, the prevailing topography, prevalence or lack of tree screening, and the like (Bottemiller and Wolverton, 2013).

Hamilton and Schwann (1995) present a study of 12,907 arms-length sales of single-family detached homes in four neighborhoods in the Vancouver area between 1985 and 1991. The neighborhoods are in close proximity to existing transmission lines. The authors find that properties adjacent to a line lose6.3% of value due to proximity and visual impact. Properties more distant from a line lose on average only 1% of their value (Jackson, Pitts and Norwood, 2012).

Delaney and Timmons's (1992) and Des Rosiers;s (1998) Studies

Delaney and Timmons (1992), surveyed a random sample of residential appraisers holding the Appraisal Institute's RM designation, obtaining 219 usable responses. In summary, appraiser opinions reported by them were (1) proximity to power lines reduces home value by about 10% and (2) reasons for the value diminution are unattractiveness, health concerns, and sound. Surveyed appraisers also noted that developers attempt to mitigate power line effects on sales activity through price reductions, larger lot sizes near the lines, and creation of buffer zones. Delaney and Timmons make a tacit assumption that the opinions of the responding appraisers on the effects of HVTLs are an accurate reflection of market response, which may or may not be true (see Kinnard). However, use of random sampling methods does support the validity of their results in so far as they represented the opinions of RM designated appraisers at that time (Bottemiller and Wolverton, 2013).

Des Rosiers (1998) used a micro-spatial approach involving 50 multiple linear regression models, which found disparate power line effects, ranging from negative 23% to positive 22%. However, the primary result was a 9.6% reduction in value for a home adjacent to a

power line and facing a pylon. The regression models used included both nominal price and natural log of price as dependent variables. The data consisted of 257 sales transactions located in three neighborhoods of Brossard, Quebec, differentiated by mean price, that is, CN$225,924, CN$160,209, and CN$115,260. The HVTL pylons were described as being of "enhanced visual appearance" conical steel; however, the pylons and power lines were highly visible and mostly unscreened by vegetation (Bottemiller and Wolverton, 2013).

Des Rosiers (1998) looks at the impact of high-voltage transmission lines (HVTLs) on surrounding properties using a micro spatial approach. The study area includes three distinct neighborhoods in the city of Brossard, in the greater Montreal area, with a 315 kV transmission line running through the center. 257 residential properties in these neighborhoods sold during the study period between February 1991 and November 1996. The data bank includes 25 property descriptors pertaining to physical, environmental, neighborhood, access, fiscal and sales time attributes as well as a series of HVTL-related descriptors. Standard and stepwise regression procedures are successively used in the analysis. This model shows that a residential property both adjacent to an HVTL easement and facing a pylon experiences a drop in value due to the visual encumbrance (on average the decrease was 9.6% of the mean house price) (Jackson, Pitts and Norwood, 2012).

Des Rosiers (1998) discovered that properties located one to two lots away from a pylon usually benefit from a market premium (on average 7.4% to 9.2% of the mean house price) due to increased visual clearance and privacy. A property at mid-span will experience a decrease in value (on average 4.7% of the mean house price) because the low minimal clearance of the lines causes a visual obstruction. Properties with a moderate or limited, rear or side view on an HVTL structure but not adjacent to the easement usually experience a market premium of 2.8% to 3.8% due to the improved visual clearance these properties enjoy. The net visual encumbrance (difference between proximity drawbacks and advantages) reaches a maximum between 50 and 100 meters from the easement external boundary, and diminishes quickly thereafter to fade away entirely beyond 150 meters. Luxury home prices are more sensitive to the visual encumbrance of HVTL structures (Jackson, Pitts and Norwood, 2012).

Wolverton and Bottemiller's (2003) Study

Wolverton and Bottemiller (2003) offer a confirmatory study of an earlier article by Cowger, Bottemiller and Cahill (1996). This more recent study investigates whether the results of the original study hold using more rigorous analytical methods. The original study used a paired sales analysis to determine any difference in sales price between properties abutting transmission line right-of-ways in Portland, Vancouver and Seattle, and properties located in the same cities but away from a transmission line. However, the original study did not control for differences between the subject properties and the comparables. Wolverton and Bottemiller's (2003) study attempted to overcome this

problem using regression analysis. Analysis of covariance (ANCOVA) was used to test for an "abutting transmission line" effect on sales price. The data from these models does not support any price effect on residential property from being located adjacent to an HVTL. This confirms the results of the original study. The data also shows no difference in appreciation rates between homes along an HVTL right-of-way and homes located further away from the HVTL (Jackson, Pitts and Norwood, 2012).

Chalmers and Voorvardt (2009) Statistical Analysis

Chalmers and Voorvardt (2009) also addressed the issue of impacts on residential property values and prices using a multiple regression framework. Based on a study of residential properties in Connecticut and Massachusetts sold from 1999 to 2007 and located in proximity to 345 kV transmission lines, the authors analyzed the effects of proximity (distance to the lines) and encumbrance (area on a property encumbered by the easement) and found proximity to have an insignificant effect on sales price. They concluded that "the only variable that appears to have any kind of systemic effect is the encumbrance variable," although its statistical significance varied and the effect was "generally small." The authors also addressed potential effects due to the visibility of the transmission line and found a lack of any significant impacts on sales prices (Jackson, Pitts and Norwood, 2012).

Chalmers and Voorvaart (2009) analyzed 1,286 single-family residential transactions located in four study areas in the northeastern United States. They regressed the natural log of sale price on housing characteristics, year of sale, and neighborhood subareas. Their study found no significant price effect from proximity to, or visibility of, HVTLs. They did investigate whether or not higher-valued properties were affected, operationalizing "higher valued" as prices in excess of the median price (Bottemiller and Wolverton, 2013). In late 1994, Gimmy (1994) presented a seminar before the EMF Regulation and Litigation Institute.11 In part, the seminar presented a matched-sales analysis of California residential property that indicated diminutions in lot values from properties abutting power line easements of 18% to a whopping 53.8%.12 While the methodology employed in this study does not seem as rigorously empirical as that used by Hamilton/Schwann, it may demonstrate that California landowners are more sensitive to the EMF property devaluation issue than those in British Columbia (Bolton and Sick, 1998).

Jackson (2010) examined rural agricultural and recreational land located in Wisconsin. He used regression modeling to compare online (HVTL power line proximate) sales to offline sales (more than one-quarter mile from an HVTL power line). Although the models indicated online sale prices 1.1% to 2.4% lower than offlne sale prices, the differences were not statistically significant, meaning one cannot reject the null hypothesis of no power line price effect. The article also provides guidance for identifying variations in types of power line intersections (such as edge position, clipping, middle position, and diagonal position)

that could be useful for appraisal report-writing purposes (Bottemiller and Wolverton, 2013).

These statistical studies point to a mix of conclusions regarding the effects of transmission lines on sales prices and property values. Many of the studies found no statistically significant impacts (Brown, Rigdon, Wolverton and Bottemiller, Chalmers and Voorvardt) while others found impacts or lack of impacts under certain conditions. For example, researchers that found effects also generally found that impacts diminish with distance from the lines (Colwell and Foley, Colwell, Hamilton and Schwann, Des Rosiers). The statistical studies are summarized in Exhibit 1.

Exhibit 1. Summary of Statistical Analyses of Transmission Line Impacts

Author(s)	Year(s) of Study	Location of Study	Property Type	Power Line Type	Effects Found
Brown	1965 to 1970	Saskatchewan, Canada	Farm Land	Transmission lines varying in voltage	No Effect
Colwell & Foley	1968 to 1978	Decatur, IL	Residential	138 kV transmission line	Diminished property values are associated with proximity to a transmission line. Substantial differences in selling price exist between 50 and 200 feet from the line, but disappear beyond 200 feet.
Colwell	1968 to 1978	Decatur, IL	Residential	138 kV transmission line	Selling price increases at a decreasing rate as distance to a power line increases. These negative impacts typically diminish with time.
Rigdon	1986 to 1991	Marquette County, Michigan	Unimproved Recreational	138 kV transmission line	No Effect
Hamilton & Schwann	1985 to 1991	Metropolitan Vancouver	Residential	Transmission lines varying in voltage from 60 kV to 500 kV	Properties adjacent to a line lose 6.3% of value due to proximity and visual impact. More distant properties are scarcely affected, losing on average only 1% of value.
Des Rosiers	1991 to 1996	City of Brossard, Canada (Greater Montreal Area)	Residential	315 kV transmission line	Effects ranging from a negative impact of 9.6% of mean home price to a 9.2% premium, depending on the visual encumbrance, proximity to the line, and other factors.
Wolverton & Bottemiller	1989 to 1992	Washington & Clackamas Counties (Portland, OR), King County (Seattle, WA) & Clark County (Vancouver, WA)	Residential	6 BPA transmission lines varying in voltage from 115 kV to 500 kV	No Effect
Chalmers & Voorvardt	1999 to 2007	Connecticut and Massachusetts	Residential	345 kV transmission lines	A small effect attributable to the encumbrance of a power line easement. No effect attributable to proximity or visibility of the lines.

Source: Jackson, Pitts and Norwood (2012)

The distance at which the effects dissipate varied from 150 meters, or approximately 450 feet (DesRosiers), to 200 feet (Colwell and Foley). In some cases, visual encumbrance (the placement of a power line structure in relation to the house) was found to have an impact, and a premium was even noted by one researcher due to increased visual clearance and privacy (Des Rosiers). Some studies suggest a lessening of effects over time (Colwell, Des Rosiers). Where negative effects were found, these impacts were generally small (less than 10% of unimpaired value). The two researchers that addressed rural properties with generally large tracts of land did not find any effects on price and value (Rigdon, Brown).

In 1995, a group of real estate consultants in Missouri conducted a survey of residential brokers and salespersons, some 167 professionals, all in the St. Louis area. The results were published in a study concluding that 54% of those surveyed believed high voltage overhead

electric transmission lines ("HVOETLs") "very negatively affected" residential property values; another 23.8% considered HVOETLs to "somewhat negatively" affect property values (Bolton and Sick, 1998).

Survey Studies on the Effect of HVOTLs on Property Values

Kinnard's (1967) Survey Study

In 1967, Kinnard reported on a survey of owners of residential properties located in subdivisions either abutting power line right of way easements or encumbered by them. His fidings were based on 36 responses from residents of 15 subdivisions located in Hartford, Connecticut. He also surveyed appraisers, builders, real estate sales professionals, and lenders. Kinnard's main findings were (1) the value of most residential properties is unaffected by overhead electric transmission lines, (2) overhead electric lines do affect land development by reducing density due to larger lots being typical of abutting and encumbered properties, and (3) real estate sales professionals and appraisers expressed more negativity toward power line proximity than actual market participants. Reese9 put a public voice to appraiser negativity toward power lines in his response to the Kinnard article while also posing two important questions: (1) are survey responses valid, and (2) are survey methods powerful enough to measure and control for all of the factors affecting market value? (Bottemiller and Wolverton, 2013)

In Kinnard's (1967) study, questionnaires were sent to property owners intersected by or abutting transmission line right-of-way (ROW) in 17 Connecticut subdivisions. Over 85 percent indicated they would purchase again in the same location. Kinnard concluded that property value is not significantly affected by proximity to transmission lines. In his seminal study of these issues, Kinnard (1967) analyzed over 1,200 sales and re-sales of residential properties in 17 subdivisions located in nine suburban towns in Metropolitan Hartford, Connecticut. All of these subdivisions, developed between 1954 and 1964, were either intersected by or abutted a tower line right of way. Kinnard found that sales prices did not vary significantly based on proximity to a tower line right of way as a matter of fact.

However, the lots closest to the right of way were generally larger, which means that more land area can be obtained closer to a power line for the same price as a smaller, more distant lot. The rate of absorption and financing terms of properties close to a power line were not significantly different from those of more distant properties. Over time, negative impacts decreased substantially (Kinnard and Dickey, 1995). Overall, Kinnard concluded that the value of residential property is not significantly affected by proximity to a tower line. Although Kinnard's surveys of market participants revealed that negative attitudes toward these lines do exist, market evidence shows that properties near tower lines are readily salable on competitive market terms ((Jackson, Pitts and Norwood, 2012).

Kung and Seagle's (1992) Study

In 1992, Kung and Seagle analyzed 47 responses to a survey of homeowners living near power lines. They also analyzed a small sample of four home sales near the same power lines and seven home sales located in the same neighborhood but not near the power lines. They did not control for differences in elements of comparison prior to computing and comparing price per square foot differences which is a troubling issue foreseen by Reese in 1967 extending here to Kung and Seagle's small sample empirical analysis. In addition, their survey questionnaire included strong language linking power line proximity to cancer, resulting in a predictable response.
(Bottemiller and Wolverton, 2013)
In addition to survey research concerning power transmission lines and property values, Kung and Seagle (1992) also analyzed sales data of properties in Memphis and Shelby Counties, Tennessee. They used this sales data to formulate a computerized map and database using a GIS system. The average price per square foot for properties adjacent to a transmission line was compared to similar measures for homes further away. The prices of homes adjacent to the power transmission lines are very similar to prices of other homes in the same neighborhood. Any slight differences in price are attributable to the differences in property condition, style, buyer preference and seller motivation. There was no evidence to indicate that the power transmission lines had any significant impact on the sales prices of the residential properties (Jackson, Pitts and Norwood, 2012).

Cowger, Bottemiller and Cahill's (1996) Study

Cowger, Bottemiller and Cahill (1996), these three real estate professionals employed by the Bonneville Power Administration in Portland, Oregon, published another study in Right of Way magazine in 1996. This study again concluded that overhead transmission lines negatively influence value: "Overhead transmission lines can reduce the value of residential and agricultural property. The impact is usually small (0-10%) for single-family residential properties. The greatest impacts have been measured in intensively managed agricultural property (irrigators, etc., and in rural, second (vacation) home developments" (Bolton and Sick, 1998).
Cowger, Bottemiller, and Cahill (1996) used matched pairs to test for significant HVTL proximity effects. They examined 296 matched pairs consisting of a home sale abutting an HVTL right of way paired with a sale of a highly similar, nearby home unaffected by an HVTL. They used *t*-tests to examine differences between pairs in mean price per square foot, finding that HVTL proximity had no impact on home price. The study did not analyze or control for the impact of lot size differences between affected and unaffected properties, nor did it control for minor differences in other elements of comparison. These potential weaknesses were addressed in a follow-up study by Wolverton and Bottemiller (2003), where multiple regression modeling was used to control for element of comparison

disparities. The follow-up study confirmed the "no-effect" conclusion of the earlier matched pairs analysis (Bottemiller and Wolverton, 2013).

Cowger, Bottemiller and Cahill (1996) analyze a market-based study that was conducted by the Bonneville Power Administration (BPA). Utilizing a paired sales analysis technique, this study compares the prices of improved residential properties bordering overhead high voltage power lines to similar properties away from the lines. Residential properties in four counties were chosen for this study, including Washington and Clackamas Counties (Portland, OR); Clark County (Vancouver, WA) and King County (Seattle, WA). All 1990 and 1991 home sales that abutted BPA high-voltage transmission lines in these counties were identified and paired with comparable home sales further away from the lines. On average, homes adjoining a power line in Portland sold for a 0.95% premium, in Vancouver a 1.03% discount, and in Seattle a 1.82% discount. None of these price differences were statistically significant from zero at the 95% probability level. Therefore, it is assumed that proximity to a transmission line has no substantial effect on the prices of these homes. The sales data for this study was subsequently analyzed with the use of multivariate statistical techniques with similar findings (see Wolverton and Bottemiller, 2003, reviewed above as cited by Jackson, Pitts and Norwood, 2012).

None of the above studies employing other sales analysis techniques found any effect on sales price due to proximity to a transmission line. These studies are summarized in Exhibit 2.

Exhibit 2. Summary Table of Sales Studies Using Other Techniques

Author(s)	Year(s) of Study	Location of Study	Property Type	Power Line Type	Effects Found
Bigras	1948 to 1961	Ste. Foy (Quebec), Three Rivers & Montreal, Canada	Residential	230 kV, 69 kV & 180 kV transmission lines	No Effect
Kinnard	1954 to 1964	Metropolitan Hartford, Connecticut	Residential	Transmission lines varying in voltage	Larger lots near ROW sold for the same price as smaller lots more distant from the ROW
Kung & Seagle	1989 to 1990	Memphis and Shelby Counties, Tennessee	Residential	Unknown	No Effect
Cowger, Bottemiller & Cahill	1990 to 1991	Washington & Clackamas Counties (Portland, OR), King County (Seattle, WA) & Clark County (Vancouver, WA)	Residential	6 BPA transmission lines varying in voltage from 115 kV to 500 kV	No Effect

Source: Jackson, Pitts and Norwood (2012)

While these analyses are less detailed and do not in most cases control for the range of variables the regression based studies account for, the conclusions and findings are

generally similar to the findings of the statistical sales price analyses. Some of the statistical studies found small effects under certain conditions, but effects generally dissipated with time and distance. Overall, any negative impacts that were found tobe attributable to the presence of high voltage transmission lines were less than 10%. Most studies found no effect, and in several cases a premium was observed which was attributable to the additional open area provided by the transmission line easement (Jackson, Pitts and Norwood, 2012).

Regression Analysis Results on the Effect of High-voltage Transmission Lines on Property Values

In the words of Chalmers (2012), beginning in the late 1960s, there has been in excess of 100 studies that in one way or another address the effect of HVTL on real estate values, and several recent publications review the literature in detail. The interested reader is referred to a 2009 article by Chalmers and Voorvaart, a recently published review by Jackson and Pitts,3 and a review prepared by Thomas Priestly for the Montana Department of Environmental Quality. The conclusions reached in these reviews indicate that multiple regression analysis is increasingly recognized as the most reliable technique to investigate whether HVTL systematically impact property values and, if so, to what extent. According to Chalmers (2012), the results of these studies can be generally summarized as follows:

- Over time, there is a consistent pattern, with about half of the studies finding negative property value effects and half finding none.
- When effects on value have been found, they tend to be small; almost always less than 10% and usually in the range of 3% to 6%.
- Where effects on value are found, they decline rapidly as distance from the lines increases and usually disappear at about 200 to 300 feet.
- Two of the studies investigated behavior of the effect over time and found that, if there were effects, they tended to dissipate over time as well.

The relatively small effects on property value attributed to the proximity of HVTL in the published literature do not mean that the direction of the effect of transmission lines on property values is not negative. The general interpretation is that, even though transmission line issues have been a prominent concern in most of the communities studied, and even though the direction of effect on real estate value is generally negative, their presence is apparently not given sufficient weight by buyers and sellers of real estate to have had any consistent, material effect on market value (Chalmers, 2012).

Finally, Jackson (2010) recently published an analysis of sales of rural land parcels in Wisconsin.8 He studied the sale of 88 properties in Wisconsin, occurring over the period 2002–2008, that were encumbered by a transmission line easement. The properties averaged 50 acres in size. Local appraisers then selected unaffected property sales that

were otherwise similar to the affected properties. The analysis controlled for time, location, mix of land classification (agricultural, wooded, open, wetland), whether the purchaser was a government agency, and whether the property was transitioning to a higher use. His results indicate a small (1.1% to 2.4%), but statistically insignificant, effect for the sale of properties crossed by HVTL relative to uncrossed properties. When the sales were grouped by location of the line on the property, properties with edge locations showed no effect, while properties crossed by the line showed a small price effect of −2.1% to −3.4% (Chalmers, 2012).

MAJOR FINDINGS AND LESSON LEARNT FROM PREVIOUS STUDIES

Using descriptive statistics to determine the impact of HVOTL hazard on selling price at various distances from the line, the results indicate a gradual increase in mean selling price with increasing distance from the HVOTL until a distance of 200 metres or more when there

is little or no impact on property price. More specifically, sale prices within 50m distance from

the HVOTL (marked by a single red line in Figure 1) show a 20% reduction price when compared to the mean house price within Eight Mile Plains. Prices within the 50 to 100m band show approximately 15% lower than the mean price and approximately 7% within the

100 and 200m distances (Han and Elliott, n.d.).

These findings reflect those of the most recent overseas studies using hedonic regression techniques. More particularly Sims and Dent (2005) in their UK based case study demonstrated the value of property within 100 metres of the HVOTL is reduced by 6–17 per cent (an average of 11.5 per cent). The presence of a pylon was found to have a more significant impact on value than the HVOTL and could reduce value by up to 20.7 per cent compared with similar property sited 250 metres away. Rosiers (2002) found that overall the price reduction was approximately 10% of mean house value of the global sample and 15%-20% for upper price properties (Han and Elliott, n.d.)

The MSTI Review Project (2012) discovered that most property value impact studies use market response to evaluate impact. From a market response perspective, transmission lines affect property values adversely when they sell at price lower or more slowly than comparable properties without transmission lines. This approach tends to find less evidence of negative impact than what might be expected based on surveys and interviews that ask people about their feelings about transmission lines. The majority of responses to such queries reveal negative associations with transmission lines, although not without variation and some exceptions.

Over the past several years, multiple regression analysis has become the dominant methodology applied to the question of transmission line impact on real estate values. And

indeed, if the objective is to determine whether there is a generalizable, statistically significant relationship between transmission lines and real estate value, multiple regression over a large number of observations is unquestionably the definitive methodology. But, it must be recognized that the result is essentially an average. It addresses the question of whether there is a consistent effect between the variables in question. The absence of an effect in this context can be misinterpreted to mean that transmission line impact is a nonissue. On the contrary, transmission lines may be a big problem under certain specific circumstances, but those circumstances are sufficiently rare that they do not show up in the statistical analysis. Further, the statistical analysis does not help identify those circumstances where transmission lines may have an impact (Chalmers, 2012).

Results from the Portland Study Area represent a refinement to the earlier work by Wolverton and Bottemiller (2003) by provision of a more precise model, principally due to the current study's data set allowing for better statistical control of the pricing influence of the city's market areas (neighborhoods) and school districts. The resulting improved precision, in terms of smaller regression error, uncovers the significance of the HVTL price effect, which was not evident in the prior study. In addition, Bottemiller and Wolverton's (2013) study confirms the earlier Portland area finding of no appreciable difference in the price response to changing market conditions for HVTL-abutting and non-abutting homes (Bottemiller and Wolverton, 2013).

Chalmers (2012) discovered that when trying to generalize about the considerations that stand out when considering the potential effect of transmission lines on these properties, three issues are dominant. Firstly, the more heavily oriented the property is toward residential use, the more vulnerable it is to transmission line impact. Properties oriented more toward purely recreational use are much less vulnerable to HVTL impact, and properties with pure agricultural use show no price effects of transmission lines whatsoever. Secondly, the larger the property, the less vulnerable it is to transmission line impact.

Larger properties have a greater likelihood that the location of the lines will not interfere with the use of the property; or, if they do interfere, that there are siting alternatives for dwelling or recreational improvements, which can mitigate the impacts. Thirdly, the availability of otherwise comparable substitutes is a third factor affecting the vulnerability of a property to transmission line effects. If there are alternative properties very similar to the subject except for the transmission line, there can be significant price and absorption effects. On the other hand, if a property is relatively unique and the transmission lines are but one of several differentiating factors, the property is less vulnerable to price and absorption effects (Chalmers, 2012).

CONCLUSION

Results of Delaney and Timmons' (1992) survey strongly suggest that the market value of residential property can be affected by proximity to high voltage power lines. It is clear from the responses of appraiser experienced in this type of appraisal assignment that affected properties are selling at a discount to comparable properties not subject to the influence of HVOETLs. Delaney and Timmons' findings is in contrast to much of the research conducted to date that finds little or not impact from high voltage power lines on residential property values. Eighty four percent (84%) of the appraisers surveyed believe that HVOETLs reduce the value of residential property located near the line. Only 10% of the respondents felt that proximity to the lines generated no value impact, while 6% said that proximity to the power lines increased property value (Delaney and Timmons, 1992).

As noted already, the results of Delaney and Timmons' (1992) study conflict with the findings of the majority of studies conducted from the mid 1950s through the late 1980s which generally support the conclusion that HVOETLs have little or no impact on property value. The question begs, why is it that only the more recent research (the notable exception being Colwell and Foley (1979) and Colwell (1990) suggests that HVOETLs impact a significant negative effect on residential properties? One logically would have to credit increased public awareness from recent media coverage of the potential adverse health consequences from long-term exposure to the electromagnetic fields generated by such facilities. As the public has become more aware of the possible link between power line proximity and health, this concern is being incorporated into the pricing calculus of residential home purchase and capitalized into lower property values. Survey respondents who have appraised property proximate to HVOETLs give support to this conclusion (Delaney and Timmons, 1992).

RESEARCH CONTRIBUTION TO EXISTING LITERATURE

Considerable research has been conducted regarding the price effects of HVTL proximity. This study adds to an understanding of this complex phenomenon in a number of ways: it takes a second look at Portland and Seattle during a different market period; it focuses on a seller's market segment of the market cycle; it offers a fist-ever empirical HVTL study of the Seattle upper-priced housing market; and it confirms findings of a previous study regarding how abutting and non-abutting homes react to changing market conditions. The study also confirms that all markets do not react in the same way to HVTL proximity. Portland appears to differ from Seattle, and higher-priced homes in Seattle differ from more typically priced Seattle homes (Bottemiller and Wolverton, 2013).

The research conducted by Chalmers (2012 is certainly consistent with the findings in the published literature that property value effects cannot be presumed and are generally infrequent. On the other hand, the current research reminds us that transmission lines can create significant price and absorption effects and provides guidance in identifying circumstances where these effects are most likely to occur.

SUGGESTIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH

Further research is needed which would compare the growth in property prices of sales transactions both before and after the period of HVOTL provision. In addition previous studies had been limited to a specific case study region. Further case studies using hedonic price model techniques could measure differences in possible spatial or environmental effects of various neighbouring suburbs (Han and Elliott, n.d.).

Additional work is needed to clarify some of the issues revealed in Delaney and Timmons (1992) study particularly with respect to the differential value effects noted by survey respondents. Results strongly suggest that high voltage power lines can affect residential property value to varying degrees in certain circumstances. There remains, however, a question as to what the appropriate value measurement is for residential property due to HVOETL proximity. For example, appraisers indicated that HVOETLs may affect some residential properties and not others, the effect being a function of the relative price of the property being appraised (Delaney and Timmons, 1992).

Whereas some appraisers claim it is only lower priced properties that suffer from proximity to high voltage power lines, other appraisers claim just the opposite, that is, it is higher priced properties that suffer. Related issues are whether or not the value effect is proportional over all price ranges, whether or not the effects vary depending on geographic region, and the magnitude of any effect as a function of distance and relationship of the subject property to the power lines. Future research should seek to provide quantitative measures of the value impact as a function of the variable identified by survey participants (Delaney and Timmons, 1992).

Given this finding, it would be beneficial if a future study were to compare higher-priced custom homes with typically priced homes in other locations to determine if this result can be confirmed elsewhere (Bottemiller and Wolverton, 2013)

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