ATTACHMENT 10
Property Value Studies

Power Lines and Land Value

*Peter F. Colwell**

***Abstract.* This study attempts to detect whether power lines, power line towers, or both have an impact on the selling price of proximate residential land and to measure the magnitude of these impacts if they exist. Secondly, it attempts to determine whether any impact which is found to exist is diminished through time possibly as the growth of trees obscures the view of towers and lines, as attitudes change, or as uncertainty about the effects diminishes. Finally, the extent to which the impact extends beyond lots with an easement is considered. Throughout, the focus is on the value of land even though the use of developed property sales would ordinarily preclude such a focus. The approach is that of a hedonic price index in which selling price is a Cobb-Douglas function of a number of property characteristics with land area being just one of the characteristics. By shifting the other property characteristic variables, it is possible to obtain predictions of land value alone.**

Introduction

There is some evidence that high voltage transmission lines and towers do not penalize proximate residential property in terms of selling price. Doubt is cast on the accuracy of this evidence because of the combination of two factors: (1) lot area is not held constant in these studies, and (2) developers tend to increase the area of lots that have an easement for a power line, while perceived lot area goes beyond the true lot line along a corridor right-of-way. Thus larger lot area, real or perceived, may compensate for proximity to the lines thereby disguising the penalty. What is needed for just compensation is knowledge of the impact on selling price while holding constant such things as lot area, real or perceived.

Literature

The issue of larger lots being associated with power lines thus offsetting detrimental effects was first mentioned by Kinnard [6] and later by Alleman [1]. A prime example of this kind of error is to be found in the survey results of Carll [3]. A more subtle error is found in the work of Bigras [2], and Derbes [5] (see also a recent working paper by Kinnard, Mitchell and Webb [7]). Derbes' sample includes lots that are almost exactly the same size and shape regardless of whether the lot is contiguous to the right-of-way or removed from

*Office of Real Estate Research, University of Illinois at Urbana-Champaign.1407 W. Gregory Dr., 304 DKH Urbana, Illinois 61801.
Date Revised—January 23, 1990; Accepted—March 30, 1990.

the right-of-way. While it may seem that Derbes has controlled for lot size, he has not done so in an important sense. Similarly, Bigras compares average unit prices of contiguous parcels to those of other parcels, ignoring the effect of the rights-of-way. Those lots that are contiguous with the right-of-way are larger in the sense that they have substantive use of the greenbelt that is the right-of-way. The open view is certainly available to them, and as a matter of practice, contiguous property owners have been known to extend their use of the right-of-way to swing sets, gardens, and other explicit use. Suppose that the greenbelt had not included power lines. One might expect that proximate properties would receive a premium. If we find that there is no premium or discount, it is natural to imagine that there are offsetting effects.

This paper avoids the Derbes/Bigras problem by using a sample of properties proximate to a power line located on easements rather than a fee right-of-way. In so doing, this paper raises new questions and provides results concerning whether the value decrement is simply associated with the easement and not with proximity to the line, ceteris paribus.

This paper is also differentiated from the previous literature in that it tests the hypothesis that the impacts of power lines diminish through time. Both Kinnard [6] and Reese [8] introduce the idea that the impact would be diminished if power lines and/or towers are screened from view. Kinnard also offers the opinion that the impact diminishes through time. While it is tempting to hypothesize that diminution of the effect is caused by the growth of trees that screen the lines and towers, there are a number of other reasonable hypotheses that are consistent with such a trend.

The Hypotheses and the Model

The first hypothesis is that residential selling prices are related to both proximity to the lines and proximity to the towers. Of course, the form that these relationships take is very important for measurement and for policy purposes. So, more specifically, it is very likely that lines and towers 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.

The second hypothesis is that any impact of the power lines and towers might be lessened through time. The following model was developed to represent these hypotheses:

$$SP_i = \beta_0 \prod_{j=1}^{5} x_{ij}^{\beta_j} \exp[\sum_{j=6}^{7} \beta_j x_{ij} + \beta_8(MOS_i) + \beta_9(1/DLN_i)$$
$$+ \beta_{10}(MOS_i/DLN_i) + \beta_{11}(1/DTWR_i) + \beta_{12}(MOS_i/DTWR_i)] \quad (1)$$

where

SP_i = the selling price of the i^{th} property,
x_{ij} = the j^{th} characteristic of the i^{th} property or sale,
DLN_i = the distance in feet from the center of the i^{th} property to the transmission line (i.e., the center of the easement),
MOS_i = the month of sale of the i^{th} property, and
$DTWR_i$ = the distance in feet from the center of the i^{th} property to the nearest tower.

According to the first hypothesis,

$$\beta_9, \beta_{11} < 0.$$

The second hypothesis suggests that

$$\beta_{10}, \beta_{12} > 0.$$

Also, the relative magnitudes of β_9 and β_{10} and of β_{11} and β_{12} should be such that the direction of the impact of lines or of towers is not reversed within the relevant range of *MOS*. That is,

$$\beta_9 + \beta_{10}(\max MOS) \leq 0, \text{ and}$$

$$\beta_{11} + \beta_{12}(\max MOS) \leq 0.$$

The Data and the Variables

The data are those that were used in Colwell and Foley [4] with the addition of variables for distance to a tower and the presence of an easement. Data were obtained from several sources. Large-scale plat maps furnished by the surveyors facilitated the accurate determination of lot areas and distance to the transmission line and towers. Data on property characteristics were obtained from property appraisal cards in the office of the supervisor of assessments.

Revenue stamps on each deed, verified by the transfer declaration, provided the selling price data. The transfer declaration discloses the full amount of consideration, the date and type of deed, certain characteristics of the property, and whether the transfer is between relatives or is a compulsory transaction. Since January 1, 1968, it has been necessary in Illinois for both parties to the transaction or their agents to attest to the accuracy of the transfer declaration by signing it. Willful falsification of the selling price on the transfer declaration constitutes a class B misdemeanor. Thus, it is felt that the price data are relatively accurate.

All properties in the sample are within 400 feet of the center of the electric transmission line in two subdivisions, Holiday Hills and Windsor Village, of Decatur, Illinois [4]. The sample consists of 200 sales from these study areas. The sample period is nearly eleven years, extending from January 1, 1968 to October 31, 1978. The beginning of the sample period is the day on which the Real Estate Transfer Act became effective.

Six variables describe the characteristics of the site and improvements. These are lot size, building size, number of bathrooms, basement, garage size, and the presence of a deck. *LTSF* is the area of the lot in square feet. Because of the tendency for lot areas adjacent to an electric transmission line to be larger, the only way to distinguish the partial effect of proximity of residential property to the line on selling price is to include a lot-area variable.

LVSF+1 refers to the living area of the house in thousands of square feet plus 1. *BATH*+1 represents the number of bathrooms plus 1. The basement variable, *BSMT*+1, is a linear transformation of a more conventional basement variable that takes on values of

0, 0.5, and 1. The conventional variable is multiplied by 2 before adding 1. So this variable equals 1 for a property with no basement; 2 for a property with a half basement; and 3 for a property with a full basement. *GRSF*+ 1 is the area of the garage in thousands of square feet plus 1.

The estimated elasticity coefficients for these five variables, *LTSF, LVSF*+ 1, *BATH*+ 1, *BSMT*+ 1, and *GRSF*+ 1, are expected to fall between 0 and 1, indicating diminishing marginal contributions from each of these five variables. The sum of the estimated coefficients on these five variables should be close to 1, indicating constant returns to scale in these variables. If so, doubling all these five variables results in doubling the selling price, other things remaining equal (i.e., two identical residential properties would be worth twice as much as one).

The four improvement variables (*LVSF*+ 1, *BATH*+ 1, *BSMT*+ 1, and *GRSF*+ 1), each have 1 added so that the property need not have some particular improvement such as a garage or a basement in order to have a positive selling price. Although this has practical consequences, because garages and basements do not exist throughout the sample, it may be viewed as just a conceptual nicety for the living area and bathroom variables. However, as a practical matter, it should be possible to predict vacant lot price using this model as a result of having shifted the improvement variables by adding 1 to each.

There are two dummy variables, *DECK* and *NBRHD*. *DECK* indicates whether or not the house sold has a deck or porch and *NBRHD* indicates whether the property is in Holiday Hills or Windsor Village. *NBRHD*= 1 for Holiday Hills. The antilog of the coefficient on a dummy variable such as a *DECK* or *NBRHD* is the ratio of the selling price of a house with the feature to that without.

All the seven variables described above were included in Model 1 so that the partial effects of the towers, transmission lines, and the impact of time on these effects may be detected. The variables 1/*DLN* and 1/*DTWR* measure proximity (i.e., the reciprocal of distance) of residential property to the electric transmission line and to the tower, respectively. Thus, as distance to the line or tower increases, the proximity variables decrease. If the coefficient on the proximity variable is negative, selling price rises and

Exhibit 1
Summary Statistics of Data

Variable	Maximum	Minimum	Std. Dev.	Mean
SP	53.9	15	8.191	27.977
LVSF	2.852	0.816	0.399	1.416
BATH	3.5	1	0.38	1.357
BSMT	3	0	0.831	0.835
GRSF	0.576	0	0.146	0.32
LTSF	30.75	5.416	4.201	9.863
DECK	1	0	0.434	0.25
NBRHD	1	0	0.385	0.18
MOS	128	0.733	35.612	59.744
DLN	400	10	122.028	199.624
DTWR	1443	60	181.779	307.288
ESMT	1	0	0.484	0.37

approaches an asymptote as distance increases. The function is, however, not remarkably well-behaved as distance gets very small.

The variables *MOS*(1/*DLN*) and *MOS*(1/*DTWR*) are constructed to detect the impact of time on the effects of the two proximity variables (*DLN*, *DTWR*) described above. The speculation is that any effects that do exist might be diminished through time. This diminution may be attributed to the growth of trees obscuring view of lines and towers, changing attitudes about lines and towers, or a reduction in the uncertainty of the effects of lines and towers.

Summary statistics for the raw data are provided in Exhibit 1. Note that *SP* is in thousands of dollars, *LVSF*, *GRSF* and *LTSF* are in thousands of square feet, and *DLN* and *DTWR* are in feet. All other variables are self-explanatory or explained above.

Estimation and Results

In order to make the model susceptible to linear estimation methods, equation (1) was transformed into natural logarithms as follows:

$$\begin{aligned} \ln SP_i = {} & \beta_0 + \beta_1(\ln LVSF + 1) + \beta_2(\ln BATH + 1) + \beta_3(\ln BSMT + 1) \\ & + \beta_4(\ln GRSF + 1) + \beta_5(\ln LTSF) + \beta_6(DECK) + \beta_7(NBRHD) \\ & + \beta_8(MOS) + \beta_9(1/DLN_i) + \beta_{10}(MOS_i/DLN_i) + \beta_{11}(1/DTWR_i) \\ & + \beta_{12}(MOS_i/DTWR_i) \end{aligned} \tag{2}$$

Two versions of the transformed model were estimated using Ordinary Least Squares with the results shown in Exhibit 2 (see Models 1 and 2). While Model 1 provides estimates for all the parameters in equation (2), Model 2 omits the last two variables, the ones relating to towers.

The explanatory power of these models is quite high. The adjusted coefficient of determination for Models 1 and 2 are both 0.771. Unadjusted, about 78.5% of the variation in the log of selling price is explained by these models. Every coefficient has the expected sign in both models.

All but four of the coefficients in Model 1 differ significantly from zero at the 90% level of confidence. The exceptions are the coefficients on *DECK*, 1/*DTWR*, *MOS*/*DLN*, and *MOS*/*DTWR*. The first two of these are only significant using a one-tail test at the 90% level of confidence. A case could be made for a one-tail test being the appropriate test. The *MOS*/*DTWR* is insignificant at any reasonable level of confidence. All but one of the coefficients in Model 2 differ significantly from zero at the 90% level of confidence. The exception is the coefficient on *DECK*. Model 2 differs from Model 1 in that it excludes the variables 1/*DTWR*, and *MOS*/*DTWR*.

As distance to the line approaches infinity, the rate of appreciation becomes simply β_8 in this model. Thus, the product of this coefficient when multiplied by 12 yields an annual rate of appreciation during the sample period for properties not impacted by the power line.

Exhibit 2
Regression Results

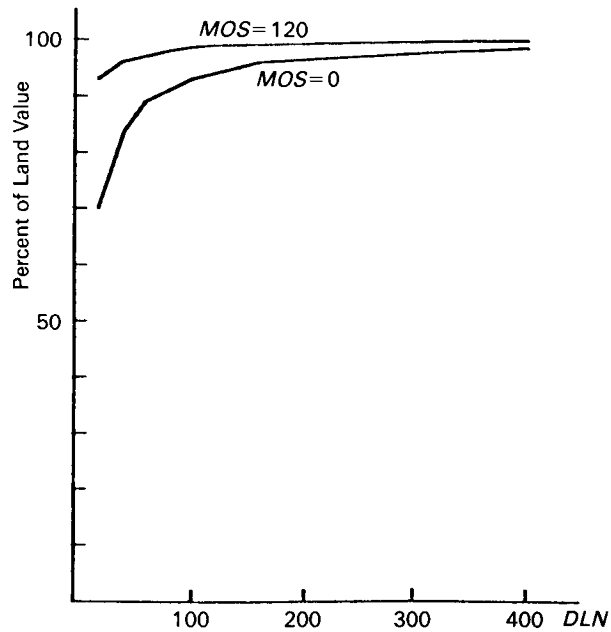
Explanatory Variable	Model 1 Coefficient (Std. Error)	Model 2 Coefficient (Std. Error)	Model 3 Coefficient (Std. Error)
Constant	2.111***	2.0995***	1.9974***
	(0.1297)	(0.1294)	(0.1271)
ln(*LVSF*+1)	0.4004**	0.3932***	0.3774***
	(0.0847)	(0.0846)	(0.0842)
ln(*BATH*+1)	0.2289**	0.2459*	0.3182**
	(0.0918)	(0.0903)	(0.0964)
ln(*BSMT*+1)	0.1214***	0.1195***	0.1332***
	(0.0256)	(0.0254)	(0.0257)
ln(*GRSF*+1)	0.2804**	0.2753**	0.3271**
	(0.0896)	(0.0896)	(0.0908)
ln(*LTSF*)	0.0850**	0.0731*	0.0801**
	(0.0409)	(0.0396)	(0.0389)
DECK	0.0342†	0.0310†	0.0106
	(0.0248)	(0.0240)	(0.0258)
NBRHD	0.0798**	0.0839**	0.0506*
	(0.0303)	(0.0301)	(0.0312)
MOS	0.0057***	0.0060***	0.0065***
	(0.0005)	(0.0004)	(0.0003)
$1/DLN_i$	−6.2276**	−6.9344***	—
	(2.0309)	(1.9723)	
MOS/DLN_i	0.0383†	0.0464**	—
	(0.0234)	(0.0227)	
$1/DTWR$	−8.7575†	—	—
	(6.0382)		
$MOS/DTWR$	0.0951	—	—
	(0.0802)		
ESMT	—	—	−0.0559**
			(0.0255)
$(1\text{-}ESMT/DLN_i)$	—	—	−5.1409***
			(1.2914)
R^2	0.771	0.771	0.772

***significant at the 99% level of confidence
**significant at the 95% level of confidence
*significant at the 90% level of confidence
†significant at the 90% level of confidence (one-tail)

The estimated annual rates for the two models are 6.8% and 7.2%, respectively. These rates are very realistic for the period and location.

The proximity variable $1/DLN_i$ is used in Models 1 and 2 as shown in Exhibit 2. The coefficient on this variable is significantly negative in both models. This means that selling price becomes higher as distance from the wires increases. The specific form of the function suggests that, over the relevant range, selling price increases at a decreasing rate and quickly approaches an asymptote. This intuitively appealing relationship is illustrated in Exhibit 3 based on Model 2 and on $MOS=0$.

Exhibit 3
Land Value as a Function of Distance to a Transmission Line



The proximity variable $1/DTWR$ worked less well than the corresponding power line variable in Model 1. As shown in Model 1, the coefficient on this variable is not significantly different from zero at the 90% level of confidence. Thus, this variable is excluded from Model 2.

The coefficients on the variable $MOS(1/DLN_i)$ are significantly positive in both Models 1 and 2. This means that the impact of the proximity variable $(1/DLN_i)$ diminished through time. The impact of time is illustrated in Exhibit 3 utilizing the parameters in Model 2 and $MOS = 120$. The value impact of distance to the power line disappears after 13.5 years according to Model 1 and 12.4 years according to Model 2. These periods date from the time of the first observations in this study and not from the time of the announcement or installation of the power lines. The $MOS/DTWR_i$ variable was included in Model 1. However, this variable proved to be insignificant, thus it is excluded from Model 2.

In both models, the coefficient on the neighborhood variable indicates that a Holiday Hills location is more expensive than a Windsor Village location. The premium is approximately 8.3% and 8.8%, for Models 1 and 2, respectively.

The coefficient on the variable *DECK* is significantly positive in both Models 1 and 2. The premium due to deck is approximately 3.5% and 3.1% for Models 1 and 2, respectively. Decks and porches are generally small in these neighborhoods, thus it is no wonder that their impact on selling price is small.

The coefficients on the five property characteristic variables ($\ln LTSF$, $\ln LVSF+1$, $\ln BATH+1$, $\ln BSMT+1$, $\ln GRSF+1$) are each significantly between 0 and 1, in both

Exhibit 4
Correlation Coefficients

	ln LVSF+1	ln BATH+1	ln BSMT+1	ln GRSF+1	ln LTSF	DECK	NBRHD	MOS	I/DLN$_i$	MOS/DLN$_i$	I/DTWR	ESMT
ln BATH+1	0.64											
ln BSMT+1	0.30	0.37										
ln GRSF+1	0.08	0.17	0.16									
ln LTSF	−0.16	−0.20	−0.17	0.13								
DECK	0.23	0.15	−0.03	0.21	0.01							
NBRHD	0.03	0.02	0.34	0.14	0.32	0.15						
MOS	−0.01	−0.05	−0.08	−0.03	0.02	−0.06	−0.06					
I/DLN$_i$	0.33	0.27	0.14	0.04	0.46	0.13	0.11	0.08				
MOS/DLN$_i$	0.25	0.26	0.13	0.08	0.35	0.05	0.05	0.39	0.85			
I/DTWR	0.02	−0.11	0.03	0.06	0.23	0.21	0.01	0.03	0.26	0.19		
MOS/DTWR	0.06	−0.09	0.01	0.02	0.14	0.12	−0.04	0.58	0.23	0.39	0.72	
ESMT	0.13	−0.12	0.01	−0.14	0.30	0.30	0.07	0.06	n.a.	n.a.	n.a.	
(I-ESMT)/DLN$_i$	0.26	0.44	0.18	0.16	0.18	−0.11	−0.07	0.05	n.a.	n.a.	n.a.	−0.26

models, indicating diminishing marginal contributions from lot size, living area, bathrooms, basement and garage. The sum of these coefficients is close to unity indicating approximately constant returns to scale in these five variables. These variables, of course, are highly related to excluded variables but, in general, are not themselves highly interrelated, as shown in the matrix of correlation in Exhibit 4. The exception is the relationship between living area and baths.

Eliminating Easement Impact

There may be the suspicion that the proximity variables in Models 1 and 2 work only because properties with easements are included in the sample and the impact of the line extends only to those properties. This suspicion implies that all the value effects of the transmission line derive from the presence of an easement and its concomitant restriction of rights. The following transformed model including easement variables was developed in order to separate the value effects due to an easement from those purely related to proximity.

$$\begin{aligned} \ln SP_i = {} & \alpha_0 + \alpha_1(\ln LVSF+1) + \alpha_2(\ln BATH+1) + \alpha_3(\ln BSMT+1) \\ & + \alpha_4(\ln GRSF+1) + \alpha_5(\ln LTSF) + \alpha_6(DECK) + \alpha_7(NBRHD) \\ & + \alpha_8(MOS) + \alpha_9(ESMT) + \alpha_{10}(\{1\text{-}ESMT\}/DLN_i) \end{aligned} \tag{3}$$

where

ESMT = a dummy variable with $ESMT=1$ for properties having an easement and $ESMT=0$ if they did not have an easement.

Model 3 above was estimated using Ordinary Least Squares and the results are shown in Exhibit 2. All the coefficents in Model 3 differ significantly from zero at the 90% level of confidence, except the coefficient on *DECK* which is insignificant. The adjusted coefficient of determination for Model 3 is 0.772.

The dummy variable for easement (*ESMT*) is significantly negative in Model 3 meaning that easements have negative impacts on property values. More importantly, the coefficient on the $[(1\text{-}ESMT)/DLN]$ variable is significantly negative meaning that value increases away from transmission lines on lots without easements. Thus, it is not just the easement but it is also purely proximity that has an impact on value.

Otherwise Model 3 is similar to the other models. The annual rate of appreciation for Model 3 is 7.8%. Like Models 1 and 2, the coefficient on the neighborhood variable indicates that a Holiday Hills location is more expensive than a Windsor Village location. The premium in Model 3 is 5.2%. The coefficient on *DECK*, however, is insignificant in Model 3.

All the coefficients on the five property characteristic variables (ln *LTSF*, ln *LVSF*+1, ln *BATH*+1, ln *BSMT*+1, ln *GRSF*+1) worked as expected for Model 3 also. Each of the coefficients is significantly between 0 and 1, indicating diminishing marginal contributions from lot size, living area, bathrooms, basement and garage. Again, the sum of these coefficients is close to unity indicating approximately constant returns to scale in these five variables.

Multicollinearity

Exhibit 4 gives the correlation coefficients for the correlations between all pairs of the explanatory variables that appear in the same equation. As far as the physical characteristics of the properties themselves, it appears that the only substantial collinearity is between the living area and bathroom variables. Yet the relative and absolute sizes of the coefficients on these variables are within the anticipated ranges, so there may be no problem here.

As is generally the case when developers plat a subdivision after a transmission line is in place, lot size is correlated with proximity to the line. Developers appear to compensate those located along the line with larger lot sizes. The existence of this relationship is the reason for the inclusion of a lot size variable. To omit the lot size variable would tend to lower the estimate of the impact of the transmission line.

The month of sale is highly correlated with the two variables in which it is found as the numerator (i.e., MOS/DLN_i and $MOS/DTWR$). The impact of this can be seen on the difference in the estimated coefficients on *MOS* in the two models. Model 2 which excludes the $MOS/DTWR$ variable has a higher coefficient on *MOS*. This suggests that it is not just the passage of time or general appreciation that is causing these properties to increase in value. Something is contributing to the appreciation close to the line.

Summary and Conclusions

The hypothesized relationships between the proximity variables ($1/DLN_i$, MOS_i/DLN_i) and land value are demonstrated for the sample in this study. Models 1 and 2 clearly establish that proximity to a power line is associated with diminished selling prices. Both models, however, show that this impact (i.e., reduced selling prices with greater proximity) is diminished through time perhaps as the growth of trees obscures the view of the electric transmission lines or perhaps for other reasons. As shown in Exhibit 2, the tower variable $1/DTWR$, however, did not work exceptionally well, although a case can be made that the negative impact of proximity to towers is significant. The variable $MOS/DTWR$ proved insignificant suggesting that the impact of towers does not diminish with time.

Model 3 establishes that easements have negative impacts on the values of property in the sample. The result for the variable $(1\text{-}ESMT)/DLN$ establishes that value increases away from transmission lines on lots without the easement. Therefore, this study establishes that there are value effects due to the easement as well as those that relate purely to the proximity of power lines.

In sum, this study establishes 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. Additionally, there may be a negative value impact of proximity to towers, but this impact showed no significant signs of diminishing through time. Finally, this paper demonstrates that the impact of transmission lines is not just related to the easement. Rather, there is a proximity effect even for those properties that do not have the easement.

References

[1] R. E. Allemann. On the Puzzle of the Power Line (letter). *The Appraisal Journal* (April 1968).
[2] R. Bigras. Real Estate Value Unaffected by High Tension Power Lines. *Right of Way* (April 1964), 11 16.
[3] C. D. Carll. Valuation of Power Line Right of Way. *The Appraisal Journal* (April 1956), 248 56.
[4] P. F. Colwell and K. W. Foley. Electric Transmission Lines and the Selling Price of Residential Property. *The Appraisal Journal* (October 1979), 490–99.
[5] M. J. Derbes, Jr. The Effect of An Electric Transmission Line Through a Subdivision. *Right of Way* (April 1968), 28–38.
[6] W. N. Kinnard, Jr. Tower Lines and Residential Property Values. *The Appraisal Journal* (April 1967), 269 84.
[7] ____, P. S. Mitchell and J. R Webb. The Impact of High-Voltage Overhead Transmission Lines on the Value of Real Property. Working paper, September 1989.
[8] L. Reese. The Puzzle of the Power Line. *The Appraisal Journal* (October 1967), 555–60.

High Voltage Power Lines: Do They Affect Residential Property Value?

*Charles J. Delaney**
*Douglas Timmons***

Abstract **A survey administered in 1990 suggests that proximity to high voltage power lines is being capitalized into lower values for residential properties. Respondents who had appraised such property report that power lines can affect residential property value to varying degrees under certain circumstances and that the market value of these properties is, on average, 10.01% lower than the market value for comparable properties not subject to the influence of high voltage power lines. Further, the results indicate that even appraisers who had not appraised such property believe that power lines contribute negatively to property value.**

Introduction

The popular press and recent articles in the academic literature [5], [6] underscore a dramatic shift in perception regarding the value of residential property located proximate to high voltage electric power lines. It is commonly believed that power lines impose a significant negative impact on the desirability, hence the value of, housing stock adjacent to or within a short distance of the lines. This perception is in stark contrast to the preponderance of research dating from the mid-1950s to the late 1980s which found no or negligible impact on property values from power lines [17]. The most commonly cited reason for this shift is the potential health hazards detailed in epidemiological studies claiming a positive correlation between long-term exposure to the electromagnetic fields produced by power lines and certain types of cancers in humans [12], [13], [19]. While no study to date has proved conclusively that a health hazard exists, the ongoing debate poses an interesting question for researchers in the field of valuation. Specifically, is the perception that residential property is negatively affected by proximity to power lines based on reality, i.e., changes in the market for such properties, or is it simply a belief unsubstantiated by market evidence. If appraisers are penalizing properties located near power lines, but this penalty is not substantiated by market evidence, then there is, indeed, cause for concern.

To address the question of whether high voltage overhead electric transmission lines (HVOETLs) result in a lower market value for residential property located adjacent to or within sight of (proximate to)[1] the lines, a survey of appraisers holding the RM designation was conducted in 1990. This survey questioned appraisers who have

*Hankamer School of Business, Baylor University, Waco, Texas 76798-8004.
**College of Business Administration, The University of Texas at San Antonio, San Antonio, Texas 78285-0633.
Date Revised—October 1992; Accepted—October 1992.

experience appraising residential property proximate to HVOETLs, as well as appraisers having no experience appraising such property.

One of the objectives of this study was to determine, based on the responses of experienced appraisers, whether the market value of affected properties was significantly lower than the market value of comparable properties not affected by HVOETLs. If this is indeed true, and given the sales comparison approach is used most often to value residential property, this would imply that the actual sale prices of dwellings proximate to HVOETLs are lower than for comparable properties not in proximity to HVOETLs.

The second objective was to compare responses of appraisers having experience with this type of valuation assignment to the responses of appraisers without experience to determine if the value conclusions were significantly different. From this it could be determined whether the value conclusions regarding the consequences of proximity to HVOETLs (the estimated magnitude of the value impact) were different between the two groups.

Literature Review

There is a significant and varied body of literature focusing on the potential impact of HVOETLs 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 [17] 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 (the focus of this study), vacant land, including acreage and lots in subdivisions, but excluding agricultural land that is actively farmed, and all other land uses, including actively farmed land.

In addition to categorizing studies by type of property, Kinnard [17] further classifies the literature reviewed by date (pre-1970 or post-1970), topic (studies that focused on economic value versus non-monetary issues such as physical, health, and psychological effects of proximity to HVOETLs), and methodology used. These latter studies rely primarily on statistical models, direct comparisons of groups of sales, case studies and mini-appraisals, and judgmental and non-empirical studies, including those that rely on questionnaires.

Four studies used statistical models to determine if HVOETLs had a measurable impact on proximate residential real estate. Three out of the four reported little or no discernible impact (Blinder [2]; Brown [3]; Kinnard, Geckler, Geckler, Kinnard and Mitchell [8]).[2] The lone dissenting study reporting a significant negative impact on value is that of Colwell and Foley [5]. More recently, another study by Colwell [6], not included in the Kinnard bibliography [17], finds a negative impact on residential properties in close proximity to power lines, declining as distance increases.[3] Further, the negative impact diminishes with time. Colwell [6] 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.

Two studies used paired sales analyses and direct comparison. Neither study detected any negative impact on residential property value (Canadian Real Estate Research Corporation, Ltd. [4] and Realty Research Group, Ltd. [14]). Six case studies or mini-apprisals were analyzed with none of the six finding any measurable impact on value (Lamprey [9]; Realty Research Group, Ltd. [14]; Commonwealth Edison [7]; Minnesota Power [11]; Sherman [16]; and Vredenburgh [18]).[4] Finally, of the ten studies classified as non-empirical or judgmental, only two (Ball [1] and Layton [10]) appear to deal solely with the potential economic (value) affect of HVOETLs on proximate improved residential real estate. The remainder address noneconomic impacts. Neither the Ball [1] study nor that of Layton [10] conclude 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.

Study Justification

Although conventional wisdom indicates that HVOETLs negatively impact residential property values, the majority of related research indicates otherwise. The issue is of importance not only to property owners, but fee appraisers, tax assessors, mortgage underwriters, insurors, and others directly or indirectly involved with valuation. Specifically, is the valuation process being influenced by perception or is there hard evidence that the market is indeed valuing properties proximate to HVOETLs lower than comparable properties not so affected.

Study Hypothesis

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. 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 market evidence. Appraisers not having such experience are assumed to report their conclusions based on other evidence, different from that used by experienced appraisers.

Sample Group Profile

The survey was conducted in cooperation with personnel in the Research Department of the Appraisal Institute.[5] The Appraisal Institute was responsible for mailing out the questionnaire to a random sample of Appraisal Institute members holding the RM designation. The initial mailing was sent to 500 potential respondents. Based on previous survey research by the Appraisal Institute, a 50% response rate was anticipated from the initial mailing.[6] (The goal was to obtain a sample size sufficient to establish a 95% confidence level on the data analysis with a maximum bound on the error of 5%.) A cover letter encouraging each survey recipient to participate in the study also was included in the mailing. Of the 500 questionnaires mailed out, 53.6% (268) were returned. Of these, 49 were eliminated because of conflicting responses leaving a 43.8% usable response rate [(268–49)/500 = 43.8%]. Appraisers holding the RM designation from forty-seven states and Puerto Rico participated in this study. Sixty-four percent of those responding indicated they held the RM designation only, while the remaining 36% held two or more professional designations.[7]

Survey Design

The survey was designed to fit on both sides of one 8.5 by 14 inch page. (The Appendix presents the survey instrument.) Past research has shown a one-page survey to be preferable to a multi-page instrument in that potential respondents will be more likely to participate if they believe the time commitment to complete the survey is not excessive. This survey was designed to take no more than ten minutes to complete. A self-addressed and stamped envelope was included with the cover letter and questionnaire.

Results

Of the 219 usable responses to question 1, 84.0% of respondees indicated that the market value of residential property is negatively affected when located proximate to HVOETLs. In response to question 2, which asks, "How much, on average, is property value decreased?," the mean value decline was 10.2% with a standard error of .49.[8] Given the definition of proximate in the survey introduction, it is assumed that when a value range was noted by a respondent, the lower bound refers to the decline in the value of properties within sight of HVOETLs, while the upper bound refers to properties adjacent to HVOETLs. This would imply, as Colwell [6] found, that the negative impact due to HVOETLs declines with distance from the power lines. Alternatively, respondents could be indicating that proximity affects residential properties dissimilarly depending on such variables as: relative price of the subject; market supply and demand factors influencing the subject; quality of right-of-way maintenance; buffers; media exposure of potential health dangers; etc.

Depending on a respondee's answer to question 14, which asks, "In what state(s) do you do most of your appraisals?," and provided that individual had appraised property proximate to HVOETLs (from question 8), the responses to question 2 were grouped into eight geographic regions (Exhibit 1).

Exhibit 1 reveals that in seven of the eight regions, the mean decline in value ranges from 7.77% to 12.5%, with an average decline for all regions of 10.03% with a standard error of .51. The notable exception is New England, where the mean decline is 15.5% or almost twice that noted in the Midwest. While the number of responses from New England is insufficient to establish statistical significance, the considerable geographic variation in the estimated value decline is, indeed, of interest.

One possible explanation for this greater average decline could be higher public awareness of environmental issues. Another possible reason may be the population density in several of the New England states. In densely populated areas more properties are likely to be affected by HVOETLs than in states that are less densely populated. The

Exhibit 1
Regional Analysis of the Mean Percentage Decline and Range of Decline in Residential Property Value Due to HVOETL Proximity

Region	Mean Decline in Value	Range of Decline
Midwest	7.77 (41)	0–25
West Coast	9.79 (19)	2–25
S. Central	10.63 (27)	0–50
Rockey Mts.	10.94 (08)	0–25
Southeast	10.70 (34)	0–50
Mid-Atlantic	10.88 (21)	0–25
Plains	12.50 (03)	2–20
New England	15.50 (05)	5–20
All Regions	10.03 (158)*	0–50

where ( ) is the number of responses by region.

*The number of responses does not total 166 (219 usable responses less the 35 responses of those indicating that HVOETLs did not negatively affect residential property value less the 18 responses of those who thought a negative effect was warranted but had no experience) because eight respondees failed to indicate the state in which they did most of their appraisals.

Source: Authors

more people that are potentially affected, the greater the public voice demanding accountability from entities responsible for construction and maintenance of HVOETLs.

A further analysis of the responses given by participants who had appraised property proximate to HVOETLs and who believed that this proximity resulted in a negative effect was done using experience level as the means of categorizing responses. Of the 166 experienced respondees who concluded that value is negatively affected by HVOETLs, only 159 provided an estimate of the average percentage decline as well as indicating the number of years they had been in the appraisal business (from question 11). From Exhibit 2, it does not appear that the experience level of the respondent who had appraised property proximate to HVOETLs influences the estimate of the value decline.

Of the thirty-five respondees indicating HVOETLs had NO impact or POSITIVE

Exhibit 2
Mean Value Decline by Experience Level

No. of Years in Profession*	Mean Value Decline
5 to 10 years (41)	9.5%
11 to 15 years (57)	9.24%
More than 15 years (59)	10.59%

*less than five years omitted because only two respondents fell into this category

Source: Authors

impact on proximately located residential property, twenty-two individuals (10%) indicated that HVOETLs have no discernible impact on value. Thirteen respondents (6%), however, indicated HVOETLs impart a positive impact on value.

The reason most commonly given for a positive effect was the existence of larger yards which generated more privacy for owners. It was not possible to determine from the responses whether a dwelling proximate to HVOETLs and situated on a larger lot commanded a higher price than for a comparable dwelling situated on a standard size lot not subject to the influence of HVOETLs. If no price premium is paid for the dwelling with a larger lot then, indeed, a negative effect on value should be attributed to the electric transmission line as the larger lot is simply masking the effect of the power line.

What Contributes to the Decline in Value?

Survey participants who believed HVOETLs had a negative impact on property values were instructed to cite reasons for the value decline. Four specific choices were listed in the survey. Exhibit 3 clearly demonstrates that the most often cited factor is the visual unattractiveness of the power lines with concerns regarding potential health hazards second and disturbing sounds and safety concerns third and fourth, respectively.

Thirty respondents (13.7%) indicated there were other factors contributing to a decline in property value when situated near HVOETLs. Of these, thirteen persons felt that HVOETLs had a negative influence on value because of electrical interference with television and radio reception. Seven appraisers indicated that the power lines lessened

Exhibit 3
Reasons Cited for Decline in Value Due to HVOETL Proximity

Reason	Percent of Respondees Citing
Visually unattractive	93.9
Health problems	58.9
Disturbing sound	43.1
Unsafe	28.6
Other	14.0

Source: Authors

Exhibit 4
What Actions are Taken by Builders, Developers, or Sellers to Offset Negative Effects of HVOETLs?

Action	Percent of Respondees Citing
Lower price	68.5
Larger lot size	58.0
Buffers/landscaping	48.7
Other	8.0

Source: Authors

the utility of the property. This apparently was more of a concern when the HVOETLs ran along the boundary of the property. Other factors mentioned were that the rights-of-way allowed unauthorized entry to the property and the rights-of-way were not well maintained by the utility company.

Respondents who believed HVOETLs had a negative impact were instructed to indicate what actions they had observed implemented by builders, developers, or sellers designed to offset any such negative effects. From Exhibit 4 it can be seen that appraisers most often noted lower sale prices, larger lots, landscaping and buffering as remedies for proximity to the power lines.

There were seventeen responses (7.8%) to the Other category in Exhibit 4. Five respondees noted builders were simply avoiding the power lines and building further away from them. This would seem to indicate an additional cost in idle land that formerly would have been developed. Of course, builders and developers may be passing the cost back to the landowner in the form of lower bid prices. Another five participants said that the visual impact was mitigated by placing electrical power lines underground or by rerouting them away from developments.[9] Two respondees mentioned that builders were erecting fences along the right-of-way to partially block the view and as a safety measure to keep small children from wandering into the right-of-way. The remaining responses indicate that builders, developers, and sellers were offering financing concessions as an inducement to buyers to purchase residences proximate to HVOETLs.

The appraisers were asked how many residential properties they had appraised in the last five years. A little more than 4% (ten respondees) had appraised no residential properties in the last five years. These individuals were instructed to go directly to question 16 where they were asked if they had any other comments about how HVOETLs affect the valuation of residential property. As Exhibit 5 indicates, the vast majority of those responding to the survey are active residential appraisers.

Exhibit 5
Residential Appraisal Experience and HVOETL Appraisal Experience

No. of Residential Appraisals during Past 5 Years	Percent of Respondees Citing
None	4.0
<50	3.0
50–100	4.0
101–150	2.5
151–200	4.0
>200	82.5

HVOETL Appraisal	Percent of All Residential Appraisals
None	11.0
<10%	85.0
10–20%	2.5
>20%	1.0

Source: Authors

Slightly more than 11% of those appraisers who indicated they had appraised residential properties, had never appraised a property proximate to HVOETLs. Eighty-five percent of respondees indicated that less than 10% of the residential appraisals they conducted were of properties proximate to HVOETLs. Only 3.5% of those surveyed indicted that more than 10% of their work was conducted on HVOETL proximate property.

How Do Appraisers Measure the Impact of HVOETLs?

This question generated the widest range of responses of any question on the survey. The most frequently used method was matched pairs or paired sales analysis. This approach accounted for approximately 42% of all responses. Almost 27% of respondees indicted they compared properties proximate to HVOETLs with properties not proximate to HVOETLs. It is assumed that the comparison was of otherwise similar properties. Therefore, this method is really paired sales analysis, while not explicitly referenced as such. Thus, 69% of respondees used this method in determining the effect of HVOETLs on proximate residential real estate.[10]

Nine percent of respondees said they used public data, the market, or MLS to make comparisons. It is assumed that these respondents actually used these data to perform paired sales or matched sales analyses. Additionally, 7.5% of those surveyed felt that discussion with buyers, sellers, developers, or realtors was an effective way of arriving at the appropriate value adjustment for the presence of HVOETLs. Slightly less than 4% of appraisers said they used their own judgment to determine the effect of HVOETLs. The remaining responses were varied and in some cases unique. Examples of other techniques included: gross rent multiplier analysis, court awards, and the belief that adjustment was merited only when a property was experiencing an extended stay on the market.

Survey participants who had valued properties close to power lines were asked if there was anything further they would like to add that would help explain how HVOETLs affect appraisals of residential property. Thirty-nine appraisers provided additional insight. Twelve respondents felt that the size and placement of the structure carrying the power lines was extremely important in determining whether a property would ex-

Exhibit 6
How is the Impact of HVOETLs Measured?

Technique Used	Percent of Respondees Citing
Matched pairs (paired sales analysis)	69.0
Public data, the market, MLS information	9.0
Discussions with buyers, sellers, developers, realtors	7.5
Appraisers' own judgment	4.0
Other	10.0

Source: Authors

perience a value loss. They said that close proximity would naturally reduce the value more than if the HVOETLs were simply visible. These statements would appear to support the Colwell study [6] which found that the magnitude of the power line effect on property value is a function of the distance and relationship of the lines to the subject property.[11]

Five respondees thought that new or more expensive houses were affected more by proximity to HVOETLs, but one respondent disagreed, saying that it was the cheaper houses that experienced a decline in value. Two respondees mentioned that FHA financing might not be available for houses located close to high voltage power lines. Four individuals felt that property values were affected negatively only in soft markets.

Perceptions Existing among Those Who Have Not Appraised Properties Proximate to HVOETLs

An interesting finding provided by the survey is that those appraisers who have not actually done a value estimation of a property proximate to a high voltage power line feel the negative impact will be greater than the decline observed by those appraisers who have done such work. Eighteen respondents who had not appraised any residential property proximate to HVOETLs indicated that the power lines would have a negative impact on residential property value. This group estimated an average decline in value of 11.94%, as compared to 10.01% for those who had actually appraised properties adjacent to or within sight of HVOETLs.[12]

Responses from appraisers who had not valued any residential properties proximate to HVOETLs included comments about perceived health hazards, particularly contraction of various cancers and health risks to young children. Further, these respondees indicated they thought developers had to lower lot prices to sell these properties and that HVOETLs impact more negatively when there is an oversupply of homes. One appraiser felt that lower priced homes were not particularly affected, and another respondent noted that homes near HVOETLs often were not well maintained. Additionally, two appraisers who felt there would be a negative impact noted that the value decline is not always substantial and that many home buyers considered the lines as only a minor adverse condition. Overall, it appears from the input of respondents who had no experience with appraising residential properties proximate to HVOETLs, that they had similar thoughts and views on the issue as their colleagues who had appraised such properties.

Conclusions

Results of this 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 appraisers 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. This finding is in contrast to much of the research conducted to date that finds little or no impact from high voltage power lines on residential property values. Eighty-four percent of the appraisers (Appraisal Institute members with the RM designation) surveyed believe that HVOETLs reduce the value of residential property located near the lines. Only 10% of respondees felt that proximity to the lines generated no value impact, while 6% said that proximity to the power lines increased property value.

Consequently, in most instances, appraisers are according a negative adjustment to properties bordering or within sight of HVOETLs. The range of value decline was estimated to be 0 to 50%. Based on market data, the majority of which was analyzed in the context of paired sales analysis, the mean decline in value noted by respondents who had appraised residential property subject to the influence of HVOETLs, and depending on geographic region, ranged from 7.77% to 15.5%, with the mean decline for all regions equalling 10.03%. Further, the results indicate that even appraisers who have not appraised such property believe that HVOETLs contribute negatively to property value. The estimated impact of power lines by this group of appraisers, however, was more than 19% greater than the estimate provided by appraisers who had experience with this type of appraisal (11.93% versus 10.01%).

As noted already, the results of this study conflict with the findings of the majority of studies conducted from the mid-1950s through the late '80s, 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 [5] and Colwell [6]) suggests that HVOETLs impart 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 purchasers and capitalized into lower property values. Survey respondees who have appraised property proximate to HVOETLs give support to this conclusion.

More often, however, appraisers noted it is the visual unattractiveness of power lines that accounts for the value decline. This is interesting in light of recent work by Colwell [6] which found a time dimension to the penalty associated with power line proximity. Specifically, the negative impact on value diminishes over time. Ostensibly, trees and other natural elements will be planted and grow which eventually will provide effective visual buffers thereby reducing or eliminating the visual unattractiveness. The logical implication is that residential property, new or existing and currently without adequate landscaping, may suffer a one-time penalty, but this penalty may not be permanent.

Given responses to several questions, specifically 4, 10 and 16, it would appear that owners of properties proximate to HVOETLs will face increasing difficulty in selling them in the future. It will be some time yet before research definitively can say whether or not HVOETLs impose a health hazard. Should that prove true, property values, no doubt, will continue to adjust in line with the perceived risks associated with this environmental hazard. The possibility exists that, in certain instances, residential properties may become virtually impossible to market; a situation similar to that facing property owners adjacent to sites where toxic or hazardous wastes have been discovered.

Implications for Future Research

Additional work is needed to clarify some of the issues revealed in this study, particularly with respect to the differential value effects noted by survey respondees.

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. 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—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 variables identified by survey participants.

Survey respondees who had not appraised residential property proximate to HVOETLs believe a greater negative value adjustment is warranted for this externality than appraisers who had appraised such property. While the authors believe experienced appraisers are reporting their estimates of the value impact based on market data, an important issue that is unresolved, however, is the basis by which non-experienced appraisers arrive at their estimates of the value impact. It may be that appraisers lacking experience are considering market data in estimating the impact of power lines, but not the same type of market data used by experienced appraisers. Alternatively, these estimates may be derived not through analysis of market data but through other means or may simply represent the perception of these appraiser respondents. To the extent perceptions, rather than market data, underpin the magnitude of any value adjustments, the valuation process may be suspect and open to criticism. Future research is needed to determine if the difference is statistically significant when larger samples are obtained and to determine the basis of this difference.

Appendix

Valuation of Property Proximate to High Voltage Overhead Electric Transmission Lines

The purpose of this survey is to determine if valuation of single-family residential real estate is affected when it is located *proximate* to high voltage overhead electric transmission lines (HVOETLs). HVOETLs are considered *proximate* if they

1. go through or touch the subject property in any way, or
2. are within sight of the subject property.

Instructions: Please answer the following questions and return this form in the enclosed post-paid, pre-addressed envelope. Thank you very much for your help.

1. Do you believe market value of residential property is *negatively* affected when it is located proximate to HVOETLs? (Circle number of answer.)

☐1 YES ☛ If yes, answer questions 2, 3 and 4, then go to 7.
☐2 NO ☛ If no, answer questions 5 and 6, then go to 7.

If yes:

2. How much, on the average, is property value decreased?
______%
3. What contributes to the decline in value? (Circle number(s) of answer(s) and make any additions.)
☐1 HVOETLs are visually unattractive
☐2 HVOETLs are unsafe
☐3 HVOETLs give off a disturbing sound
☐4 HVOETLs may cause health problems
☐5 Other: (please specify) ______________________________
____
____
4. What actions have you observed taken by builders, developers, or sellers of residential property to offset any negative effects associated with HVOETLs? (Circle number(s) and/or add actions.)
☐1 Proximate property had a larger lot
☐2 Proximate property had lower price
☐3 Proximate property had buffer added, e.g., landscaping to "hide" HVOETLs
☐4 Other: (please specify) ______________________________
____
____

If no:

5. Do you believe HVOETLs have *no* impact or a *positive* impact on proximately located residential property?
☐1 No impact
☐2 Positive impact
6. Please explain your answer to 5: ______________________________
____
____

7. How many residential properties have you appraised in the past 5 years? (Circle one number.)
   - ☐1 None ☛ ☛ *If you appraised no residential property within five years, go directly to question 16.*
   - ☐2 Less than 50
   - ☐3 50 to 100
   - ☐4 101 to 150
   - ☐5 151 to 200
   - ☐6 Over 200
8. What percentage of the residential properties that you appraised were located proximate to HVOETLs? (Circle one number.)
   - ☐1 None ☛ ☛ *If you appraised no residential property proximate to HVOETLs within five years, go directly to question 16.*
   - ☐2 Less than 10%
   - ☐3 10% to 20%
   - ☐4 21% to 30%
   - ☐5 31% to 50%
   - ☐6 Over 50%
9. How do you measure the effect of HVOETLs on residential property values? Specifically, what appraisal methods or data sources do you rely on to obtain an accurate measure of the value increase/decrease attributed to HVOETLs?

   ____
   ____
   ____
   ____
10. Is there anything you could add to your answers in questions 2–6 that would help explain further how HVOETLs affect your appraisals of residential property?
    - ☐1 Yes ☛ (please specify) ______________________________
    - ☐2 No ______________________________

    ____
    ____
11. How many years have you been in the appraisal business?
    - ☐1 Less than 5 years
    - ☐2 5 to 10 years
    - ☐3 11 to 15 years
    - ☐4 More than 15 years
12. What percentage of your billable time is spent on residential appraisals? ______%
13. Please list the professional appraisal designations that you presently hold.

    ____
14. In what state(s) do you do most of your appraisals?

    ____
15. Please list the major electric utility companies serving the area(s) where you do the majority of your appraisals.

    ____
16. Add any other comments about how HVOETLs affect the valuation of residential property.

    ____
    ____
    ____

Notes

[1]The definition of proximate property as being either adjacent to or within sight of power lines is consistent with the definition found in Kinnard [17] and the majority of studies cited in that work.
[2]From the title and annotation, the Brown study would appear to be misclassified.
[3]Colwell reports that the sales price of residential property increases at a decreasing rate up to about 200 feet from the power lines. Beyond this point no measurable impact is observed.
[4]Again, the Realty Research Group Ltd. study would appear to be misclassified in Kinnard's bibliography [17].
[5]The survey was conducted with members of the American Institute of Real Estate Appraisers. On January 1, 1991, the American Institute of Real Estate Appraisers and the Society of Real Estate Appraisers unified to form the Appraisal Institute.
[6]The sample size required to establish a 95% confidence level on the data with no more than a 5% error was determined using the sample size formula found in Zuwaylif [20]. The formula is: $n=\{(z)^2[(p)(1-p)]\}/e^2$, where n = the required sample size, z = the degree of confidence that the error in the estimate does not exceed the maximum allowable error, p = the estimate of population proportion, and e = the magnitude of the maximum allowable error. Letting $z=1.96$, $e=.05$, and $p=.133$, and solving for n yields a sample size of 177.
[7]Other designations held included the: SRA, SREA, SRPA, CRA, GRI, CAE, IFAS, and IFA.
[8]This estimate is based on the input of all survey respondents whether or not they had actually appraised property subject to the influence of HVOETLs.
[9]It is not clear to the authors that the respondents who mentioned burial of transmission lines were clear on what constitutes high voltage transmission lines. While residential electrical service is commonly underground, and in many areas is required by code or deed restrictions to be underground, high voltage lines, according to several major electric utilities, are almost always above ground, and they cite cost considerations as the major reason.
[10]The authors acknowledge the observation of an anonymous referee that question 9 in the Appendix, is worded in such a way that responses may be interpreted either as reporting what method appraisers did use in estimating the impact of HVOETLs or what method they would have preferred to use. Given the question was asked only of appraisers with experience appraising residential property subject to high voltage power lines, we believe they reported the methods they actually used to determine the value impact. We recognize, however, that this is our opinion and cannot be proved conclusively in the context of the survey.
[11]As noted by an anonymous referee, the survey questionnaire was not designed to elicit responses sufficient to yield interpretable estimates of the HVOETL effect on residential property value, i.e., specific estimates of the value impact as a function of distance or relationship of the lines to the subject property.
[12]Statistical tests were conducted to determine if the difference in the sample means was different from zero. While the statistics were such that the null hypothesis could not be rejected at any reasonable level of significance, further research may be warranted to ascertain if, in fact, a statistical difference exists when larger samples are obtained.

References

[1] T. Ball. The Economic Effects of Power Lines Adjacent to Residential Properties in Phoenix and Tempe, Arizona. Unpublished, 1970.
[2] C. Blinder. The Effect of High Voltage Overhead Transmission Lines on Residential Property Values, Laurel, Maryland. Paper presented to Second Symposium on Environmental Concerns in Rights-of-Way Management, Ann Arbor, Michigan, October 1979.

[3] D. Brown. The Effect of Power Line Structures and Easements on Farm Land Value. *Right of Way* (December 1975–January 1976), 33–38.
[4] Canadian Real Estate Research Corporation, Ltd. *High Voltage Electric Transmission Lines and Property Values.* Toronto, Canada: July 1973.
[5] P. Colwell and K. Foley. Electric Transmission Lines and the Selling Price of Residential Property. *Appraisal Journal* 47:4 (October 1979), 490–99.
[6] P. Colwell. Power Lines and Land Values. *Journal of Real Estate Research* 5:1 (Spring 1990), 117–27.
[7] Commonwealth Edison Company. The Effect of An Electrical Transmission Line Right of Way on Adjoining Property Values. Chicago, IL: January 1978.
[8] W. Kinnard, M. Geckler, J. Geckler, J. Kinnard and P. Mitchell. An Analysis of the Impact of High Voltage Electric Transmission Lines on Residential Property Values in Orange County, New York. Storrs, CT: Real Estate Counseling Group of Connecticut, Inc., May 1984.
[9] S. Lamprey. Economic Impact of Transmission Lines on Property Values in the State of New Hampshire, Vol. 2. Boston, MA: New England Hydro Transmission Corp., 1985.
[10] C. Layton. Subdivision Values Unaffected by Tower Lines Rosalie Subdivision No. 2. Maronb County. Detroit, MI: Detroit Edison Co., 1962.
[11] Minnesota Power. Affected Landowner Interviews. Duluth, MN: February 1983.
[12] *New York Times.* E.P.A. Draft Report Cites Studies Linking Cancer to Electricity. May 22, 1990, A22.
[13] ———. U.S. Sees Possible Cancer Tie to Electromagnetism. May 23, 1990, A10.
[14] Realty Research Group, Ltd. Impact of Hydro Transmission Lines on Residential Property Values. Toronto, Canada: 1974.
[15] ———. Impact of Hydro Transmission Lines on Agricultural Property Values. Toronto, Canada: 1974.
[16] R. Sherman. Impact of Power Line Easement on a Residential Subdivision. Columbus, OH: Ohio Electric Co., 1974.
[17] The Real Estate Counseling Group of Connecticut, Inc. The Effect of High-Voltage Overhead Transmission Lines on Sale Prices and Market Values: An Annotated Bibliography and Evaluative Analysis. Prepared by W. Kinnard for Central Maine Power Company, September 1988.
[18] M. Vredenburgh. Effects of Transmission Line Right of Way Upon Residential Property Values on West Chenango Road, County of Broome, State of New York. Albany, NY: New York State Electric and Gas Authority, June 1974.
[19] *Wall Street Journal.* How Electric Fields May Damage Human Cells. February 16, 1990, B1.
[20] F. Zuwaylif. *General Applied Statistics.* Reading, MA: Addison-Wesley, 1970.

Power Lines, Visual Encumbrance and House Values: A Microspatial Approach to Impact Measurement

Authors François Des Rosiers

Abstract

This research looks at the impact of high-voltage transmission lines (HVTL) on surrounding property values, using a microspatial approach. It is based on a sample of 507 single-family houses sold over the 1991–96 period in the City of Brossard, in the Greater Montreal area, Canada. Findings suggest that although severe visual encumbrance due to a direct view on a pylon or conductors does exert a significantly negative impact on property prices with depreciations ranging from 5% to well in excess of 20%, being adjacent to the easement will not *necessarily* cause a house to depreciate and may even increase its value in similar proportions where proximity advantages exceed drawbacks.

Introduction

Over the past two decades, environmental issues have drawn greater attention in the economic and real estate literature, particularly with respect to their impact on property prices. Despite its inherent weaknesses (Rosen, 1974), the hedonic approach remains the most reliable tool for measuring environmental negative externalities since it brings out buyers' disutility stemming from any perceived hazard through their actual pricing behavior. Using multiple regression analysis, it can indeed isolate the respective market value contribution of each attribute of the residential bundle, physical as well as neighborhood-related. For that reason, numerous environment-oriented hedonic analyses have been performed on the residential market since the early 1980s. The vast majority of them deals with issues such as air and sea water pollution (Diamond, 1980; Brookshire, Thayer, Schultze and D'Arge, 1982; Palmquist, 1984, 1988; Graves, Murdoch, Thayer and Waldman, 1988; Murdoch and Thayer, 1988; Kask and Maani, 1992; and Mendelsohn et al., 1992), the nearby presence of landfill, incinerator and nuclear plant sites (Nelson, 1981; Gamble and Downing, 1982; Smith and Desvousges, 1986; Cartee, 1989; Michaels and Smith, 1990; Zeiss, 1989, 1990; Mundy, 1992; Nelson, Genereux and Genereux, 1992; and Ketkar, 1992), as well as airport and highway proximity (Nelson, 1980; O'Byrne, Nelson and Seneca, 1985;

Pennington, Topham and Ward, 1990; and Uyeno, Hamilton and Biggs, 1993). The impact of chemical contamination (Ford and Gilligan, 1988), the proximity of a pipeline (Kask and Maani, 1992; and Simons, 1999), the presence of trees in the neighborhood (Orland, Vining and Ebreo, 1992) and the impact of earthquakes (Murdoch, Singh and Thayer, 1993) have also been investigated. Finally, Des Rosiers, Bolduc and Thériault (1999) analyze the impact of drinking water quality on house prices. A recent literature review by Boyle and Kiel (2001) provides a relatively comprehensive picture of the environmental hedonic price studies performed over the past decades.

Using hedonics, this analysis looks at the impact of high-voltage transmission lines (HVTL) on surrounding property values through a micro-spatial approach. The study is based on a sample of 507 single-family houses sold over recent years in the City of Brossard, a municipality located in the Greater Montreal area, Canada, on the south shore of the Saint-Lawrence River, and aims at sorting out both positive and negative effects resulting from immediate proximity to, as well as view on, a HVTL corridor. It also provides the possibility to test for the actual impact of the media coverage of the 1992 Floderus and Ahlborn and Feychting reports, two well-publicized Swedish epidemiological studies on electromagnetic fields (EMF)-induced health hazards.

Power Lines, Health Hazards and House Values

While the house price issue remains by itself a major research topic, it can hardly be isolated from the underlying EMF issue. Since the early 1970s, more than forty studies have investigated the EMF-induced risks of leukemia and brain cancer among both adult and child populations (Hydro-Quebec, 1996; and Saint-Laurent, 1996). In spite of some indications that children regularly exposed to transmission lines might be at risk, none of these studies can support any scientific evidence of a causal relationship between EMF exposure and cancer. Yet, as recently documented by Goeters (1997), the U.S. Government—via the Department of Energy and under the 1992 National EMF Research and Public Information Dissemination (RAPID) Program—openly encouraged states to adopt safety regulations with respect to the building and improvement of HVTLs in residential neighborhoods. Besides the status quo, three strategies were put forward, namely the ‘‘Prudent Avoidance’’ solution, the adoption of EMF intensity standards and a moratorium on any new installations. Similarly, the fear, though statistically unfounded, of any potential health hazard for nearby residents resulted over the past decade in a series of court cases whereby financial compensations were demanded for a hypothetical loss in value of affected properties, as a consequence of the ‘‘cancerphobia’’ syndrome. While no compensations had been granted until the early 1990s (McEvoy, 1994), two court decisions by the New York State’s Court of Appeal and the Court of Appeal of Kansas, Texas, have since stated that evidence of fear in the marketplace and ensuing economic damage to the property should be admissible as a ground for compensation, irrespective of the reasonableness of the fear (Rikon, 1996). This corroborates Mitchell's (2000) assumption as to the importance of a loss of marketability in the assessment of environmentally-induced economic damages. The issue, though, remains open as an accurate measurement of the economic damage to EMF-affected properties is still flawed by methodological bias (Bryant and Epley, 1998).

While several analytical approaches are currently being used to measure HVTL impacts on real estate values (Furby, Slovic, Fischhoff and Gregory, 1988; Furby, Gregory, Slovic and Fischhoff, 1988; Rhodeside and Harwell, 1988; Priestley and Evans, 1990; Delaney and Timmons, 1992; Kung and Seagle, 1992), it has understandably become a hot research area for hedonics as studies by Colwell and Foley (1979), Kinnard, Geckler, Geckler and Mitchell (1984), Colwell (1990), Kinnard (1990), Ignelzi and Priestley (1991), Kroll and Priestley (1991), Hamilton and Carruthers (1993), Hamilton and Schwann (1995), Kinnard and Dickey (1995), Callanan and Hargreaves (1995), Kinnard (1996) and Kinnard, Geckler and DeLottie (1996, 1997), among others, demonstrate. In short, most studies conclude that proximity to a HVTL per se does not necessarily lead to a drop in the value of surrounding properties and that other physical as well as neighborhood attributes prevail in the price determination process. Wherever negative impacts are at stake, these vary, by and large, between 1% and 6% of value at a 200 ft. distance, 9% in the case of improvements to existing lines (Ignelzi and Priestley, 1991) and between 6% and 9% of value at a distance of 50 ft. (Colwell and Foley, 1979; and Colwell, 1990). Moreover, detrimental effects tend to disappear beyond 400 ft. (650 ft. (Hamilton and Schwann, 1995). Similarly, where new lines are installed or existing lines modified, drops in value lessen over time and tend to fade away after four to ten years (Kroll, 1994: quoted by Kinnard, 1996). Kinnard (1988: quoted by Kinnard, Geckler and DeLottie, 1997) even identifies price increases for properties adjacent to a HVTL. In contrast, immediate proximity to, or direct view on, a pylon does cause house prices to drop, from 5% at a 50 m., or 160 ft., distance to more than 27% at 10 m., or 33 ft. (Callanan and Hargreaves, 1995; and Hamilton and Schwann, 1995). Finally, with respect to the media coverage of the 1992 the Swedish epidemiological studies, no significant price impacts were detected by authors.

To conclude, several factors must be considered when assessing the impact of HVTL structures on residential areas and the extent of visual encumbrance affecting homeowners: the distance and immediate proximity to, as well as the view on, both lines and pylons, the type and height of structures, the quality of easement landscaping and, finally, the surrounding topography, which may enhance or reduce negative externalities. According to Kinnard and Dickey (1995), several aspects of the phenomenon need to be clarified, namely the spatial delimitation of price effects, the very notion of proximity to HVTL structures and households' behavioral discrepancies between submarkets. Furthermore, considering the nonlinear, and possibly nonmonotonic, pattern of the price-distance hedonic relationship, the choice of a continuous functional form—sophisticated though it might be—remains problematic; hence the need for a microspatial investigation approach.

Study Area Description, Data Bank and Analytical Approach

This study is based on a sample of 507 single-family houses of which 257 town cottages sold in the City of Brossard between February 1991 and November 1996. Covering a territory of seventeen square miles, Brossard had a population of 69,000 by 1996. The study area, which is between 800 and 1,600 ft. wide, includes three distinct residential neighborhoods, which are referred to as sectors *R*, *S* and *T* after street denominations, and is bounded by three major highways, with a 315 Kv. transmission line running through its center. Mean house price stands at $225,924 (Can$), $160,209 and $115,260 in neighborhoods *R*, *S* and *T*, respectively, the overall average for the global sample reaching $169,600. The HVTL corridor itself is about two miles long and 200 ft. wide, with IVA (Improved Visual Appearance) conical steel pylons reaching, in most cases, between 155 and 175 ft. in height; within the study area, there are twenty-six pylons. The span between pylons varies from 650 to 1100 ft., minimal clearance between conductors and ground level standing from a low of 37 ft. to a high of 63 ft. While the neighborhood topography is flat with little tree planting around the HVTL structure, a cycling path is designed along its east side.

A major feature of this case study is the asymmetrical location of the line, which is within 150 ft. of the eastern boundary of the easement, as opposed to 50 ft. on the west side. Overall, 383 houses have a limited, moderate or pronounced rear, side or front view on the line, with thirty-four being directly adjacent to it. The average distance to the external boundary of the HVTL easement stands at 248 m., which is roughly 810 ft. As for the data bank, it includes some twenty-five property descriptors pertaining to physical, neighborhood, environmental, access, fiscal and sales time attributes as well as a series of HVTL-related descriptors: linear distance to the line and easement as well as dummy distance variables (50 and 100 m. increments); dummy variables to control for pylons' position relative to houses that are adjacent to the easement (house facing pylon, located one, two or three lots away from pylon, or mid-span located); and a series of interactive dummy descriptors to account for the combined extent of the view on the HVTL structures and the orientation of the property with respect to the easement. Finally, with two-thirds of the sample referring to post-1992 transactions—that is, 184 pre-1993 sales, 166 1993 and 1994 sales and 157 post-1994 sales—, interactive dummies are used to test whether properties adjacent to the HVTL easement have seen their market value affected as a result of the wide media coverage of the Swedish epidemiological studies. The operational definition of physical, fiscal, location and HVTL-related attributes are displayed in Exhibit 1.

Standard and stepwise regression procedures are successively used in the analysis. While both linear and log-linear functional forms are used, HVTL distance variables are also applied to several transformations including logarithmic, square root, inverse, quadratic and gamma. The analysis is first performed using the global sample. The market is then segmented and the east and west areas, the

Exhibit 1 | Operational Definition of Variables

Variable	Codification	Operational Definition
APPAGE	M	Apparent age of the property, in years.
LOTSIZE	M	Lot size, in square meters.
LIVAREA	M	Living area or the property, in square meters.
BASMTAREA	M	Finished basement area, in square meters.
OTHSIDING	D	Siding of the property, other than stone or brick.
LANDSCAPING	D	Presence of an above average landscaping.
LAMKITCAB	D	Presence of laminated kitchen cabinets.
HARDWOOD	D	Presence of hardwood floors.
AIRCONDND	D	The property is equipped with a central air conditioned system.
BUILT-IN	R	Number of built-in features in the kitchen.
EXCAVPOOL	D	Presence of an excavated swimming pool.
GARPLACES	M	Number of garage places.
ELECDOOR	D	The garage is equipped with an electric door.
BUNGALOW	D	The property is a one-story, single-family house.
SINGLATT	D	The property is an attached, single-family house.
ROW	D	The property is a row house.
SPLIT	D	The property is a split-level, single-family house.
SECTR2	D	The property is located in sector R2.
SECTR3	D	The property is located in sector R3.
SECTR4	D	The property is located in sector R4.
SECTR5	D	The property is located in sector R5.
SECTR6	D	The property is located in sector R6.
SECTS2	D	The property is located in sector S2.
SECTS3S4	D	The property is located in sector S3 or S4.
SECTT2	D	The property is located in sector T2.
EFFTXRATE	M	Effective tax rate of the property.
MONTHS	M	Number of months elapsed between January 1st 1991 and transaction date.
SERVICES	D	The property is located in a service area.
D_EASMT	M	Linear distance to HVTL easement.
D_LINE	M	Linear distance to line itself.
D(L)*	M	Optimal (value maximizing) distance from line.
D(E)*	M	Optimal (value maximizing) distance from easement.
LND_E	M	Natural logarithm of distance to HVTL easement.
LND_L	M	Natural logarithm of distance to line.
INVD_L	M	Inverse of distance to line.

Exhibit 1 | (continued)

Operational Definition of Variables

Variable	*Codification*	*Operational Definition*
SQRD_E	M	Square root of distance to HVTL easement.
SQRD_L	M	Square root of distance to line.
D0_EASMT	D	The property is adjacent to the HVTL easement.
D1_EASMT	D	The property is within 50 m. from the easement.
D2_EASMT	D	The property is between 51 and 100 m. away from the easement.
D3 EASMT	D	The property is between 101 and 150 m. away from the easement.
D4_EASMT	D	The property is between 151 and 200 m. away from the easement.
D5_EASMT	D	The property is between 201 and 300 m. away from the easement (reference).
D6_EASMT	D	The property is between 301 and 400 m. away from the easement.
D7_EASMT	D	The property is between 401 and 500 m. away from the easement.
D8_EASMT	D	The property is beyond 500 m. from the easement.
ADJPOST92	D	The property is adjacent to the HVTL easement and was sold after 1992.
ADJ9394	D	The property is adjacent to the easement and was sold in 1993 or 1994.
ADJPOST94	D	The property is adjacent to the easement and was sold after 1994.
FRONTVIEW	D	The property has a front view on the HVTL structures.
REARVIEW	D	The property has a rear view on the HVTL structures.
SIDEVIEW	D	The property has a side view on the HVTL structures.
LIMVIEW	D	The property has a limited view on the HVTL structures.
MODVIEW	D	The property has a moderate view on the HVTL structures.
PROVIEW	D	The property has a pronounced view on the HVTL structures.
FACNGPYL	D	The property is facing a pylon.
1LOTPYL	D	The property is one lot away from a pylon.
2LOTPYL	D	The property is two lots away from a pylon.
3LOTPYL	D	The property is three lots away from a pylon.
MIDSPAN	D	The property is located at mid-span.
12LOTPYL	D	The property is one or two lots away from a pylon.
3LOTMID	D	The property is three lots away from a pylon or located at mid-span.

Exhibit 1 | (continued)
Operational Definition of Variables

Variable	*Codification*	*Operational Definition*
LV_FRONT	D	The property has a limited front view on the HVTL structures.
LV_SIDE	D	The property has a limited side view on the HVTL structures.
LV_RRSIDE	D	The property has a limited rear or side view on the HVTL structures.
MV_FRONT	D	The property has a moderate front view on the HVTL structures.
MV_REAR	D	The property has a moderate rear view on the HVTL structures.
PV_FRONT	D	The property has a pronounced front view on the HVTL structures.
PV_REAR	D	The property has a pronounced rear view on the HVTL structures.
PV_SIDE	D	The property has a pronounced side view on the HVTL structures.

Notes:
M = Metric variable;
R = Rank variable; and
D = Dummy variable.

three distinct residential neighborhoods as well as the lower and upper-price submarkets are considered alternately.

Major Findings

Overall Models' Performances

Detailed regression results for the linear and log-linear forms applied to the global sample using subsectors and HVTL dummies (Models 1 and 4) are reported in Exhibit 2. As can be seen, both explanatory and predictive performances are excellent thanks to highly detailed geographic descriptors, with an adjusted R^2 of .951 (linear) and .968 (log-linear) and relative prediction errors of 9.3% and 7.2%, respectively. F-values are in excess of 400 in either case. While all regression coefficients are significant at the 0.05 level, most of them display significance levels that fall well below the 0.01 threshold and their sign and magnitude are in

Exhibit 2 | Full Regression Result for the Global Sample—Linear and Log-linear Forms

	Linear Form (Model 1)				Log-linear Form (Model 4)			
Variable	Parameter Estimate ($)	*t*-Value	Prob.	VIF	Parameter Estimate	*t*-Value	Prob.	VIF
Intercept	139,261	18.91	0.0001	0.00	12.0257	298.92	0.0001	0.00
APPAGE	−1,177	−6.39	0.0001	2.12	−0.0121	−10.24	0.0001	4.48
LOTSIZE	61	7.54	0.0001	3.18	0.0003	8.26	0.0001	3.32
LIVAREA	574	26.77	0.0001	3.61	0.0022	19.32	0.0001	5.06
BASMTAREA	91	5.14	0.0001	1.19	0.0006	7.44	0.0001	1.25
OTHSIDING	5,999	2.35	0.0194	1.32	—	—	—	—
LANDSCAPING	9,933	3.67	0.0003	1.57	0.0305	2.51	0.0124	1.61
LAMKITCAB	—	—	—	—	−0.0204	−2.34	0.0199	1.87
HARDWOOD	12,293	4.54	0.0001	1.58	—	—	—	—
AIRCONDND	—	—	—	—	0.0263	2.78	0.0057	2.10
BUILT-IN	4,225	4.09	0.0001	1.46	0.0177	3.95	0.0001	1.40
EXCAVPOOL	7,597	3.24	0.0013	1.23	0.0615	5.75	0.0001	1.31
GARPLACES	—	—	—	—	0.0266	3.53	0.0005	2.74
ELECDOOR	4,469	2.21	0.0274	1.31	—	—	—	—
BUNGALOW	—	—	—	—	−0.0752	−5.44	0.0001	2.24
SINGLATT	−20,621	−8.17	0.0001	2.06	−0.2394	−18.85	0.0001	2.66
ROW	−30,950	−8.25	0.0001	2.00	−0.3355	−14.43	0.0001	3.93
SPLIT	−28,336	−3.18	0.0016	1.21	−0.0429	−3.44	0.0006	1.40
SECTR2	—	—	—	—	0.0966	2.88	0.0041	5.94

Exhibit 2 | (continued)

Full Regression Result for the Global Sample—Linear and Log-linear Forms

	Linear	Form (Model 1)			Log-linear	Form (Model 4)		
Variable	Parameter Estimate ($)	*t*-Value	Prob.	VIF	Parameter Estimate	*t*-Value	Prob.	VIF
SECTR3	−28,029	−7.96	0.0001	1.46	−0.1413	−7.18	0.0001	2.33
SECTR4	11,621	4.10	0.0001	2.07	0.1024	5.85	0.0001	4.05
SECTR5	26,075	6.44	0.0001	1.76	0.1582	7.25	0.0001	2.60
SECTR6	32,675	8.23	0.0001	1.52	0.1533	7.16	0.0001	2.25
SECTS2	—	—	—	—	0.0621	4.69	0.0001	2.64
SECTS3S4	—	—	—	—	0.0785	6.31	0.0001	1.87
SECTT2	8,534	2.96	0.0032	1.29	0.0543	3.70	0.0002	1.71
EFFTXRATE	−57,075	−18.32	0.0001	1.50	−0.2847	−18.68	0.0001	1.83
MONTHS	—	—	—	—	−0.0007	−4.19	0.0001	1.25
SERVICES	—	—	—	—	0.0335	2.57	0.0104	1.89
FACNGPYL	−16,559	−2.44	0.015	1.10	−0.0954	−3.15	0.0017	1.12
12LOTPYL	15,332	2.72	0.0067	1.04	0.0711	2.79	0.0055	1.06
LV_SIDE	5,646	2.78	0.0056	1.48	—	—	—	—
LV_RRSIDE	—	—	—	—	0.0279	3.37	0.0008	1.52
MV_REAR	6,499	2.25	0.0248	1.10	0.0356	2.76	0.0060	1.12
K:		23				29		
Adj. R^2		0.9508				0.9678		
F-Value:		426.34				525.07		
SEE%:		9.27				7.20		

line with theoretical expectations. In either functional form of the global model, the particularly high stability of the hedonic prices pertaining to living area, property type (Model 4) and effective tax rate are noteworthy. Finally, no excessive multicollinearity is detected via the VIF indicators, although the log-linear form brings out two sets of highly correlated variables—namely *APPAGE* with *SECTR4* on the one hand and *LIVAREA* with *SECTR2* on the other hand. By and large, and in spite of differences in the variable selection among models, the performances achieved with the global sample are quite representative of those arrived at overall.

Turning to HVTL-related descriptors, it should first be kept in mind that positive or negative contributions to property values, as reflected in the coefficients of dummy variables, should always be interpreted in the light of omitted dummies. For instance, the impact of a limited or moderate view on HVTL structures as measured from Models 1 and 4 is only positive in relation to the impact exerted by a pronounced view, which in this case is used as the default attribute and, therefore, commands no price adjustment. The findings leave little doubt as to the main conclusion of this study: the position of a property along a HVTL structure highly influences its marketability and, therefore, exerts a significant impact on its value. The statistical evidence that emerges simply reproduces the market behavior of homeowners as to their trade-off between, on the one hand, perception of HVTL health hazards and, on the other hand, positive as opposed to negative externalities linked to the presence of a nearby transmission line. As will now be analyzed in detail, studies that essentially focus on the distance to a HVTL structure fail to consider such behavioral patterns, which can only be captured through a microspatial approach.

The following analysis summarizes the full regression results of the study with respect to HVTL-related attributes, although Exhibit 3 only reports partial results for a selection of all fifty models developed. While other non-HVTL coefficients are not shown, overall model performance indicators (adjusted R^2 as well as relative Root MSE, or *SEE%*) are displayed for each model, together with the number of independent variables (K) used in the analysis. Specific comments relative to the functional form resorted to, the use of spatial sectors or sub-sectors and the type of HVTL descriptors included in the equation are also reported. Furthermore, for each submarket, mean house price, number of cases, as well as number of adjacent properties are indicated. Both explanatory and predictive performances are quite good in all cases, with adjusted R^2 fluctuating from a low of 85.7% (Upper Third Segment, Model 48) to a high of 97.3% (East Area, Model 10) and reaching, on average, 92.1%. As for the *SEE%*, it stands at around 6% to 8% of the mean price, with upper and lower limits at 11% (East Area, Model 12) and 5.1% (Lower Third Segment, Model 42) respectively. Finally, all models have been tested for multicollinearity through variance inflation factors (VIFs), a reliable diagnosis. Except for a few descriptors, no severe collinearity was detected, which translates into highly stable and consistent parameters in terms of both signs and magnitudes. Thus, for the vast majority of regression coefficients

Exhibit 3 | Impact of HVTL Attributes on Property Values—Summary of Regression Results

Model Number & Market Segment	Comments	# Cases / # Adj.	# Ind. Var. (*K*)	Adj. R^2	SEE%	HVTL Attributes: Variable	Coeff.	Prob.	% of Mean Price
Global Sample	Mean house price = $169,600	507 / 34							
1	Linear / subsectors / HTLV dummies		23	0.9508	9.27	*FACNGPYL*	−16,559	0.0150	−9.8
						12LOTPYL	15,532	0.0067	9.2
						LV_SIDE	5,646	0.0056	3.3
						MV_REAR	6,499	0.0248	3.8
2	Linear / subsectors / HTLV dummies		24	0.9507		*FACNGPYL*	−16,551	0.0151	−9.8
						1LOTPYL	16,771	0.0703	9.9
						2LOTPYL	14,790	0.0400	8.7
						LV_SIDE	5,642	0.0057	3.3
						MV_REAR	6,490	0.0252	3.8
3	Linear / sectors / HTLV dummies		24	0.9555	8.52	*FACNGPYL*	−0,083	0.0192	−8.0
						1LOTPYL	0,119	0.0142	12.6
						LV_RRSIDE	0,039	0.0001	4.0
4	Linear / subsectors / HTLV dummies		29	0.9678	7.2	*FACNGPYL*	−0,095	0.0017	−9.1
						1LOTPYL	0,071	0.0055	7.4
						LV_RRSIDE	0,028	0.0008	2.8
						MV_REAR	0,036	0.0060	3.6
5	Linear / sectors / HTLV dummies		30	0.9678	7.2	*FACNGPYL*	−0,095	0.0018	−9.1
						1LOTPYL	0,100	0.0160	10.5
						2LOTPYL	0,054	0.0929	5.5
						LV_RRSIDE	0,028	0.0009	2.8
						MV_REAR	0,035	0.0064	3.6

Exhibit 3 | (continued)

Impact of HVTL Attributes on Property Values—Summary of Regression Results

Model Number & Market Segment	Comments	# Cases / # Adj.	# Ind. Var. (*K*)	Adj. R^2	SEE%	HVTL Attributes: Variable	Coeff.	Prob.	% of Mean Price
6	Linear / sectors / HTLV dummies		26	0.9418	10.08	*FACNGPYL*	−20,388	0.0060	−12.0
	Dummy distance (easement)					*3LOTMID*	−7,939	0.0501	−4.7
						LV_SIDE	4,866	0.0269	2.9
						D2_EASMT	−8,992	0.0004	−5.3
						D3_EASMT	−6,872	0.0083	−4.1
7	Linear / sectors / metric distance (line)		20	0.9369	10.49	*LND_L*	2,323	0.0245	—
East Area	Mean house price = $167,704	257 / 19							
8	Linear / subsectors / HVTL dummies		17	0.9594	9.64	*1LOTPYL*	27,263	0.0207	16.3
						LV_SIDE	11,065	0.0002	6.6
10	Log-linear / subsectors / HTVL dummies		20	0.9734	7.26	*1LOTPYL*	0,123	0.0164	13.1
						LV_RRSIDE	0,026	0.0160	2.7
11	Linear / sectors / HTVL dummies		22	0.9552	10.13	*3LOTMID*	−12,857	0.0188	−7.7
	Dummy distance (easement)					*LV_SIDE*	8,673	0.0097	5.2
						D1_EASMT	−14,029	0.0028	−8.4
						D2_EASMT	−20,464	0.0001	−12.2
						D3_EASMT	−7,853	0.0756	−4.7

Exhibit 3 | (continued)

Impact of HVTL Attributes on Property Values—Summary of Regression Results

Model Number & Market Segment	Comments	# Cases / # Adj.	# Ind. Var. (*K*)	Adj. R^2	SEE%	HVTL Attributes: Variable	Coeff.	Prob.	% of Mean Price
13	Linear / sectors / HVTL dummies		17	0.9522	10.46	*1LOTPYL*	32,446	0.0117	19.3
	Metric distance (line)					*LV_SIDE*	15,287	0.0001	9.1
						D_LINE	22,154	0.0003	
West Area	Mean House price = $171,550	250 / 15							
14	Linear / sectors / HVTL dummies		21	0.9417	8.43	*FACNGPYL*	−36,158	0.0001	−21.1
						MIDSPAN	12,682	0.0711	−7.4
						LIMVIEW	12,090	0.0001	7.0
						MODVIEW	10,637	0.0014	6.2
						PROVIEW	11,344	0.0089	6.6
17	Log-linear / sectors / gamma (line)		16	0.9455	8.17	*LND_L*	0,051	0.0005	—
						D_LINE	−0,416	0.0001	—
						D(L)*	0,123	MAX	—
18	Log-linear / sectors / gamma (easement)		16	0.9450	8.22	*LND_E*	0,019	0.0017	
						D_EASMT	−0,273	0.0001	
						D(E)*	0,070	MAX	
Neighborhood *R*	Mean house price = $225,924	186 / 10							
20	Log-linear / subsectors / HVTL dummies		20	0.9535	7.69	*FACNGPYL*	−0,080	0.1009	−7.7
						LV_RRSIDE	0,044	0.0011	4.4
						MV_REAR	0,108	0.0001	11.4
						PV_REAR	0,061	0.0292	6.2

Exhibit 3 | (continued)

Impact of HVTL Attributes on Property Values—Summary of Regression Results

						HVTL Attributes			
Model Number & Market Segment	Comments	# Cases / # Adj.	# Ind. Var. (*K*)	Adj. R^2	SEE%	Variable	Coeff.	Prob.	% of Mean Price
21	Linear / metric distance (L)		11	0.9117	9.95	*SQRD_L*	27,776	0.0092	—
Neighborhood *S*	Mean house price = $160,209	155 / 9							
22	Linear / subsectors / HVTL dummies		20	0.9343	6.54	*FACNGPYL*	−37,540	0.0021	−23.4
						1LOTPYL	25,323	0.0211	15.8
						2LOTPYL	17,890	0.0286	11.2
						3LOTPYL	−25,116	0.0265	15.7
						MIDSPAN	−13,595	0.0217	8.5
						LV_RRSIDE	5,153	0.0328	3.2
24	Log-linear / subsectors / HTLV dummies		20	0.9461	5.85	*FACNGPYL*	−0,186	0.0055	−17.0
						1LOTPYL	0,197	0.0016	21.8
						3LOTPYL	−0,123	0.0455	−11.6
						MIDSPAN	−0,063	0.0447	−6.1
						LV_RRSIDE	0,034	0.0108	3.3
26	Linear / metric distance (line)		15	0.9249	6.99	*1NVD_L*	−2,89	0.0040	—
Neighborhood *T*	Mean house price = $115,260	166 / 15							
27	Linear / subsectors / HVTL dummies		18	0.9411	5.98	*FACNGPYL*	−18,484	0.0012	−16.0
						MODVIEW	2,403	0.0565	2.1
29	Log-linear / subsectors / HVTL dummies		18	0.9432	5.57	*FACNGPYL*	−0,126	0.0032	−11.9
						REARV	0,024	0.0443	2.4
						MV_FRONT	0,052	0.0108	5.3
						D1_EASMT	0,041	0.0341	4.2

Exhibit 3 | (continued)

Impact of HVTL Attributes on Property Values—Summary of Regression Results

Model Number & Market Segment	Comments	# Cases / # Adj.	# Ind. Var. (*K*)	Adj. R^2	SEE%	HVTL Attributes: Variable	Coeff.	Prob.	% of Mean Price
30	Linear / metric distance (line)								
Lower Half Segment	Mean house price = $116,692	257 / 18	20	0.9403	6.02	*INVD_L*	−8,900	0.0900	—
32	Log-linear / sectors / HVTL dummies		20	0.8778	6.74	*FACNGPYL*	−0,137	0.0012	−12.8
						LIMVIEW	0,032	0.0137	3.3
						MODVIEW	0,024	0.0346	2.5
						PROVIEW	0,055	0.0002	5.7
	Log-linear / sectors / HVTL dummies Metric distance (easement)		19	0.8810	6.65	*FACNGPYL*	−0,140	0.0006	−13.0
						D_EASMT	−0,107	0.0001	
Upper Half Segment	Mean house price = $223,990	250 / 16							
36	Linear / sectors / HVTL dummies		15	0.8858	9.43	*1LOTPYL*	52,039	0.0163	23.2
						LV_SIDE	9,216	0.0019	4.1
39	Log-linear / subsectors / HVTL dummies		21	0.9258	7.13	*1LOTPYL*	0,148	0.0358	16.0
						2LOTPYL	0,088	0.0357	9.2
						LV_RRSIDE	0,039	0.0001	4.0
						MV_REAR	0,033	0.0683	3.3
40	Linear / sectors / metric distance (easement)		13	0.8845	9.48	*SQRD_E*	17,745	0.0130	—

Exhibit 3 | (continued)

Impact of HVTL Attributes on Property Values—Summary of Regression Results

						HVTL Attributes			
Model Number & Market Segment	Comments	# Cases / # Adj.	# Ind. Var. (K)	Adj. R^2	SEE%	Variable	Coeff.	Prob.	% of Mean Price
Lower Third Segment	Mean house price = $104,643	168 / 12							
43	Log-linear / sectors / HVTL dummies		19	0.8699	5.45	*FACNGPYL*	−0,139	0.0009	−13.0
						REARV	0,038	0.0031	3.8
						SIDEV	0,040	0.0003	4.1
						LV_FRONT	0,048	0.0034	4.9
45	Linear / sectors / metric distance (easement)		17	0.8598	5.36	*D_EASMT*	−9,808	0.0008	—
Upper Third Segment	Mean house price = $250,597	171 / 13							
47	Log-linear / subsectors / HVTL dummies		15	0.8889	7.27	*LV_SIDE*	0,041	0.0006	4.2
						PV_SIDE	−0,056	0.0978	−5.4
48	Linear / sectors / dummy distance (easement)		15	0.8574	8.81	*D0_EASMT*	−15,778	0.0211	−6.3
						D1_EASMT	−17,115	0.0172	−6.8
						D2_EASMT	−18,979	0.0012	−7.6
						D3_EASMT	−13,404	0.0180	−5.3
50	Log-linear / sectors / metric distance (line)		15	0.8759	7.69	*LND_L*	0,030	0.0001	—

pertaining to physical, neighborhood or environmental attributes, statistical significance stands well below the 0.01 threshold.

Impact of Immediate Proximity to a HVTL Easement

In most market segments considered, the residential property that is both adjacent to a HVTL easement and facing a pylon (*FACNGPYL*) experiences a significant drop in value due to the visual encumbrance. This drop, which averages 9.6% (that is, between −8.0% and −12%) of mean house price in the global sample (Models 1–7), reaches 21% (most significant estimate) in the west area (Models 14–18) where a 50 ft. setback with respect to the HVTL easement is found. In the east area, however (Models 8–13), characterized by a 150 ft. setback, a direct view of a pylon had no significant impact on prices. The negative impact of facing a pylon strongly varies among sectors: whereas it stands at 7.7% (not significant at 0.05) of mean sale price in neighborhood *R* (Models 19–21), it amounts to between 12% (log-linear form) and 16% (linear) in neighborhood *T* (Models 27–30) and exceeds 23% in neighborhood S (Models 22–26). A direct view on a pylon is also detrimental to properties belonging to the lower end of the market (Models 31–35 and 41–45), whose value drops by roughly 10% to 15% (most significant estimates) depending on the market segment and functional form used. While impacts are seemingly more difficult to capture for upper-price properties (Models 36–40 and 46–50), findings nevertheless suggest price drops in the 15%–20% range after one sale (case # 436), located in the east area, is removed from analysis (not presented here).

In contrast, a property located one or two lots away from a pylon (*12LOTPYL*) usually benefits from a market premium, which mirrors the improved visual clearance and increased intimacy thus generated. Results obtained with the global sample show price increases between 7.4% and 9.2% of mean house value. However, the rise proves substantially higher for properties located one lot away from a pylon (*1LOTPYL*, between 10.5% and 12.6%) than for those located two lots away (*2LOTPYL*, 8.7%). For adjacent properties belonging to the east area, being one lot from a pylon translates into a premium in the 13%–19% range whereas no significant price impact is detected in the west area: due to a reduced setback, the pronounced visual encumbrance tends to cancel out proximity advantages. In turn, the premium is significant at a two-lot distance (10.3%). Similarly, a 13% price rise is generated in neighborhood *S* for adjacent houses located one or two lots away from a pylon; again, the impact is substantially higher (16%–22%) at a one lot distance. The same pattern emerges in the upper-half segment where the premium stands between 16% and 23% of mean house price at a one lot distance, as opposed to roughly 9% two lots away.

Finally, a property located three lots from a pylon or at mid-span (*3LOTMID*) will, by and large, experience a significant price drop as a consequence of the visual encumbrance caused by conductors in the HVTL corridor section with low minimal clearance relative to ground level. Results obtained with the global sample suggest a 4.7% depreciation, as opposed to 7.7% in the east area. In the west area, a mid-span location (*MIDSPAN*) results in a 7.4% price drop. Similarly, in neighborhood *S*, a property located three lots away from a pylon or at mid-span will loose somewhere between 6% and 16% of its market value.

In order to test for the net effect of immediate HVTL proximity on house values, model results derived from the global sample as well as from east and west areas were applied to the 34 adjacent cases in the study. Overall, proximity advantages and negative impacts tend to cancel each other out (+0.2% of mean house value), with an average 3.4% gain for the nineteen east area units against a 4.0% loss for the fifteen properties located on the west side of the easement. Exhibit 4 provides a convenient visualization of the impacts of HVTL structures on the market value of adjacent properties.

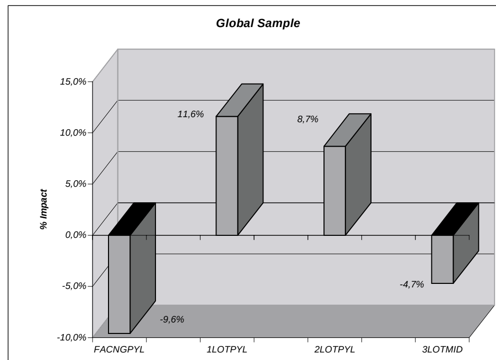
Impact Linked to the Visibility of HVTL Structures and the Orientation of the Property

Findings suggest that far from being a drawback, a view on the HVTL structures translates in most cases into higher values, due to the improved visual clearance it implies. Thus, in the global sample, houses with a limited or moderate, rear or side view on the corridor benefit from a market premium of around 2.8%–3.8% of mean price. A similar pattern is obtained for both east and west areas where a positive impact emerges for a limited, side view (east area, 5.2%–9.1%) and for a limited, rear or side view (east and west areas, 2.7%–4.3%). In the west area, the premium reaches 5.1% of mean price for a rear, moderate view on the HVTL corridor while even a pronounced, front view results in a 7.2% price rise. By and large, a view on the west corridor, be it limited, moderate or pronounced and irrespective of the orientation of the house, translates into a market premium in the 6%–7% range.

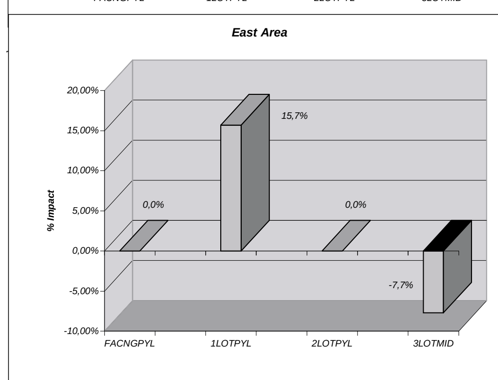
An analysis by neighborhood generates similar findings, with a limited, rear or side view on the HVTL corridor resulting in value rises of between 3.2% and 4.4%, depending on neighborhood and functional form used. In neighborhood *R*, the positive impact of a rear exposure even reaches 11.4% of mean price for a moderate view, as opposed to 6.2% for a pronounced one. In neighborhood *T*, a moderate, front view also generates a premium of roughly 5%. Results derived from the price segmentation, finally, corroborate the findings. For the lower price segments of the sample, a market premium of between 2.1% and 5.8% of mean price, depending on extent of exposure and building orientation, is associated with a rear, side or front view on the corridor. In contrast, while properties belonging to the upper-price segments of the market also seem to benefit from a limited or moderate visual exposure on the lines, a pronounced, side view on HVTL structures depreciates values by some 8.7% (upper-third segment). This suggests that owners of luxury houses tend to be more sensitive than others to the potential visual encumbrance resulting from the nearby presence of a HVTL.

Exhibit 4 | Impact of HVTL Structures on the Market Value of Adjacent Properties

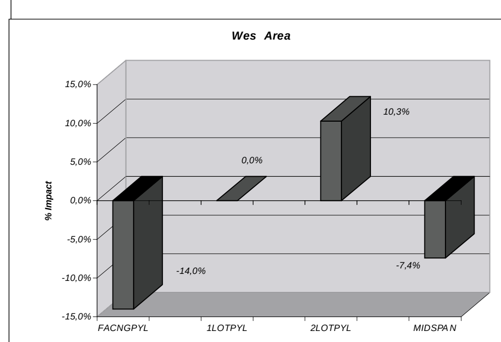
	HVTL Attribute	% Impact
Global Sample		
House facing pylon:	*FACNGPYL*	*-9,6%*
One lot away from pylon:	*1LOTPYL*	*11,6%*
Two lots away from pylon:	*2LOTPYL*	*8,7%*
Three lots away from pylon or mid-span location:	*3LOTMID*	*-4,7%*



East Area (150 ft. setback to HVTL)		
House facing pylon:	*FACNGPYL*	*n.s.*
One lot away from pylon:	*1LOTPYL*	*15,7%*
Two lots away from pylon:	*2LOTPYL*	*n.s.*
Three lots away from pylon or mid-span location:	*3LOTMID*	*-7,7%*



West Area (50 ft. setback to HVTL)		
House facing pylon:	*FACNGPYL*	*-14,0%*
One lot away from pylon:	*1LOTPYL*	*n.s.*
Two lots away from pylon:	*2LOTPYL*	*10,3%*
Mid-span location:	*MIDSPAN (sig. 0.07)*	*-7,4%*



N.B.:
Percentage price impacts reported here are an average of all significant coefficients derived from various functional forms and should herefore be viewed as indicators only. Besides, they reflect "gross" location impacts due to a view on pylons and conductors alone.

Impact of Distance to Line or Easement

While resorting to a continuous distance-to-line or distance-to-easement function yields highly significant coefficients, it only provides an overview of the behavioral pattern relative to the nearby presence of a HVTL and does not allow for the microspatial, and relatively complex, aspects of the phenomenon under investigation to be adequately considered. In contrast, the use of dummy distance variables does. With respect to the global sample, findings indicate that properties located within 50–150 m. (roughly 165–500 ft.) of the HVTL easement, which face some degree of visual encumbrance without benefiting from the advantages of an immediate proximity, experience drops in value in the 4.1% (325–500 ft.) to 5.3% (165–325 ft.) range. A similar pattern is found in the east area where locating within 50 m., or 165 ft., of the easement results in a 8.4% depreciation, which rises to over 12% for properties located further away (50–100 m., or 165–325 ft.). This negative impact is substantially reduced (−4.7%), while not statistically significant, for houses located within the 100–150 m. (325–500 ft.) buffer and fades away beyond that limit. However, results derived from neighborhood *T* suggest that cheaper properties located nearby the easement without being adjacent to it (that is, within 50 m., or 165 ft.) still enjoy increased visual clearance, which translates into a market premium of roughly 4.2%. Finally, luxury properties (upper-third segment) seem, yet again, to be more sensitive to visual encumbrance. The proximity impact proves negative for both adjacent properties (−6.3%) and non-adjacent ones located within 150 m. (500 ft.) of the HVTL easement. As with other market segments, the maximum negative impact (−7.6%) is reached between 50 m. and 100 m. (165–325 ft.) and lessens thereafter to disappear beyond 150 m. (500 ft.).

To summarize, coefficients derived from distance attributes suggest that net visual encumbrance, defined as the difference between, on the one hand, drawbacks resulting from visual encumbrance and, on the other hand, proximity advantages, reaches a maximum between 50 and 100 m. (165–325 ft.) from the easement external boundary, and diminishes quickly thereafter to fade away beyond 150 m. (500 ft.).

Impact of the Media Coverage of Swedish Epidemiological Studies

Following Kinnard, Geckler and DeLottie's (1997) study, it proved interesting to assess the impact of the 1992 Swedish epidemiological studies on EMF-induced health hazards. Thus, three interactive, dummy control variables were added to the global model, in addition to the trend descriptor. In so doing, it becomes possible to bring out any difference in households' market behavior characterizing the 1993–94 period as well as post-1994 sales of HVTL-adjacent properties. While findings from the linear model suggest that a negative impact might actually apply for the 1993–94 period, the log-linear form, in turn, produces positive coefficients,

Exhibit 5 | Synopsis of HVTL Attributes' Impact on Surrounding Property Vales

Variable	Global Sample	East Area	West Area	Neighborhood *R*	Neighborhood *S*	Neighborhood *T*	Lower Half Segment	Upper Half Segment	Lower Third Segment	Upper Third Segment
FACNGPYL	−(***)		−(***)	−(*)	−(***)	−(***)	−(***)	−(***)[a]	−(***)	−(***)[a]
1LOTPYL	+(**)	+(**)			+(***)			+(**)		
2LOTPYL	+(**)		+(**)		+(**)			+(**)		
3LOTPYL					−(**)					
MIDSPAN			−(*)		−(**)					
12LOTPYL	+(***)				+(***)					
3LOTPYL	−(**)	−(**)			−(***)					
FRONTV									+(**)	
REARV						+(**)			+(***)	
SIDEV									+(***)	
LIMVIEW			+(***)				+(**)			
MODVIEW		−(**)	+(***)			+(*)	+(**)			
PROVIEW			+(***)				+(***)			
LV_FRONT									+(***)	
LV_SIDE	+(***)	+(***)						+(***)		+(***)
LV_RRSIDE	+(***)	+(***)	+(***)	+(***)	+(**)			+(***)		
MV_FRONT						+(**)				
MV_REAR	+(**)		+(***)	+(***)				+(*)		
PV_FRONT			+(**)							

Exhibit 5 | (continued)

Synopsis of HVTL Attributes' Impact on Surrounding Property Vales

Variable	Global Sample	East Area	West Area	Neighborhood *R*	Neighborhood *S*	Neighborhood *T*	Lower Half Segment	Upper Half Segment	Lower Third Segment	Upper Third Segment
PV_REAR				+(**)			+(**)			
PV_SIDE										−(**)
D0_EASMT										−(**)
D1_EASMT		−(***)				+(**)				−(**)
D2_EASMT	−(***)	−(***)								−(***)
D3_EASMT	-(***)	-(*)								−(**)
D_LINE	+(**)	+(***)	+(***)	+(***)	+(***)	+(*)				+(***)
D_EASMT			+(***)				−(***)	+(**)		

Note: (*)Regression coefficient significant at the 10% level.
(**)Regression coefficient significant at the 5% level.
(***)Regression coefficient significant at the 1% level.
[a]Sale #436 (East Area) removed from calculations.

with a magnitude that increases over time. Since none of the resulting parameter estimates emerge as being statistically significant at the 0.05 level, it can be concluded that the Swedish studies had virtually no measurable impact on house prices, which corroborates previous findings.

Conclusion

This research looks at the impact of HVTL on surrounding property values, using a microspatial approach. In accordance with Hamilton and Schwann (1995), Callanan and Hargreaves (1995) and Kinnard, Geckler and DeLottie (1997) studies, the findings suggest that severe visual encumbrance due to a direct view on a pylon does exert a significantly negative impact on property prices. Overall, the price reduction stands at roughly 10% of mean house value (global sample), but it averages 14% in the study area where the setback between the power line and the lot boundary is only 50 ft. (west area). While properties belonging to the lower end of the market experience price reductions in the 10%–15% range, findings also suggest price drops of around 15%–20% for upper-price properties. In one neighborhood (*S*), the depreciation even reaches 23%. Similarly, a direct view on the conductors will usually reduce property values by 5%–10%; in some cases though, the market discount exceeds 15%.

However, being adjacent to the easement will not *necessarily* cause a house to depreciate. It may even increase its value in similar proportions—that is, between 7% and 22%—where proximity advantages (enlarged visual field, increased intimacy) exceed drawbacks. Such findings are in line with those of a perception study by Saint-Laurent (1996) suggesting, on the one hand, that HVTL-induced risks are ranked by households far behind other known health hazards and, on the other hand, that proximity advantages for adjacent residents largely outweigh inconveniences. In this study, proximity advantages and negative impacts for adjacent properties tend to cancel each other out (+0.2%), as shown by a simulation performed on the thirty-four adjacent cases in the study.

Turning to non-adjacent, but visually exposed, properties, findings suggest that far from being a drawback, a view on the HVTL structures translates in most cases into higher values, due to the improved visual clearance it implies. Thus, in the global sample, houses with a limited or moderate, rear or side view on the corridor benefit from a market premium of roughly 3% to 4% of mean price. As for negative visual impacts, where applicable, they tend to decrease rapidly with distance, and are no more significant beyond 150 m. (500 ft.). Findings also suggest that net visual encumbrance reaches a maximum for houses located between 50 and 100 m. (165 and 325 ft.) from the easement boundary—with values dropping by some 5%–12% of mean price—and tends to disappear beyond 150 m. (500 ft.).

Finally, as found by Kinnard, Geckler and DeLottie (1997), no significant price change can be detected for adjacent properties following the media coverage of the 1992 Swedish epidemiological studies on EMF-induced health hazards.

References

Boyle, M. A. and K. A. Kiel, A Survey of House Price Hedonic Studies of the Impact of Environmental Externalities, *Journal of Real Estate Literature*, 2001, 9:2, 117–44.

Bryant, J. A. and D. R. Epley, Cancerphobia: Electromagnetic Fields and Their Impact on Residential Loan Values, *Journal of Real Estate Research*, 1998, 15:1/2, 115–29.

Brookshire, D. S., M.A. Thayer, W.D. Schulze and R.C. D'Arge, Valuing Public Goods: A Comparison of Survey and Hedonic Approaches, *The American Economics Review*, 1982, 72, 165–77.

Callanan, J. and R. V. Hargreaves, The Effect of Transmission Lines on Property Values: A Statistical Analysis, *New Zealand Valuers Journal*, June, 1995.

Cartee, C. P., A Review of Sanitary Landfill Impacts on Property Values, *The Real Estate Appraiser and Analyst*, Spring 1989, 43–6.

Colwell, P. F., Power Lines and Land Values, *Journal of Real Estate Research*, 1990, 5:1, 117–27.

Colwell, P. F. and K. W. Foley, Electric Transmission Lines and the Selling Price of Residential Property, *The Appraisal Journal*, October 1979, 490–99.

Delaney, C. J. and D. Timmons, High Voltage Power Lines: Do They Affect Residential Property Value?, *Journal of Real Estate Research*, 1992, 7:3, 315–29.

Des Rosiers, F., A. Bolduc and M. Thériault, Environment and Value: Does Drinking Water Quality Affect House Prices?, *Journal of Property Investment & Finance*, 1999, 17:5, 444–63.

Diamond, D. B. Jr., The Relationship Between Amenities and Urban Land Prices, *Land Economics*, 1980, 56:1, 21–32.

Ford, D. A. and M. Gilligan, The Effect of Lead Paint Abatement Laws on Rental Property Values, *Journal of the American Real Estate and Urban Economics Association*, 1988, 16: 1, 35–46.

Furby, L., P. Slovic, B. Fischhoff and R. Gregory, Public Perception of Electric Power Transmission Lines, *Journal of Environmental Psychology*, 1988, 27, 69–83.

Furby, L., R. Gregory, P. Slovic and B. Fischhoff, Electric Power Transmission Lines, Property Values and Compensation, *Journal of Environmental Management*, 1988, 8, 19–43.

Gamble, B. H. and H. R. Downing, Effects of Nuclear Power Plants on Residential Property Values, *Journal of Regional Science*, 1982, 22:4, 457–78.

Goeters, J. E., *Environmental Issues in Real Estate*, Upper Saddle River, NJ: Prentice Hall, 1997.

Graves, P., J. C. Murdoch, M. A. Thayer and D. Waldman, The Robustness of Hedonic Price Estimation: Urban Air Quality, *Land Economics*, 1988, 64:3, 220–33.

Hamilton, S. W. and C. Carruthers, *The Effects of Transmission Lines on Property Values in Residential Areas*, Vancouver, BC: University of British Columbia, 1993.

Hamilton, S. W. and G. M. Schwann, Do High Voltage Electric Transmission Lines Affect Property Value?, *Land Economics*, 1995, 71:4, 436–44.

Hydro-Québec, *Les champs électriques et magnétiques et la santé*, Environnement et Collectivités, 2ème éd., February 1996.

Ignelzi. P. C and T. Priestley, *A Statistical Analysis of Transmission Line Impacts in Six Neighborhoods*, Volumes I & II, Albany, CA: Pacific Consulting Services, 1991.

Kask, S. B. and S. A. Maani, Uncertainty, Information and Hedonic Pricing, *Land Economics*, 1992, 68:2, 170–84.

Ketkar, K., Hazardous Waste Sites and Property Values in the State of New-Jersey, *Applied Economics*, 1992, 24, 647–59.

Kinnard, W. N. Jr., The Impact of High-Voltage Transmission Lines on Real Estate Values, *Journal of Property Tax Management*, 1990, 1:4, 324–46.

——., *EMF and the Eighth Deadly Sin: The Literature on Property Value Impacts from Proximity to High-Voltage Transmission Lines Since 1994*, Paper presented at the EMF Regulation and Litigation Institute, Washington, DC, April 15-16, 1996.

Kinnard, W. N. Jr. and S. A. Dickey, A Primer on Proximity Impact Research: Residential Property Values Near High-Voltage Transmission Lines, *Real Estate Issues*, 1995, 20:1, 23–29.

Kinnard, W. N. Jr., M.B. Geckler, J. K. Geckler and P.S. Mitchell, *An Analysis of the Impact of High Voltage Overhead Electric Transmission Lines on Residential Property Values in Orange County, New York*, Storrs, CT: Real Estate Counseling Group of Connecticut, May 1984.

Kinnard, W. N. Jr., M. B. Geckler and J. W. DeLottie, *Effects of Proximity to High-Voltage Transmission Lines on Nearby Residential Property Values: An International Perspective*, Real Estate Counseling Group of Connecticut, Inc., August 1996.

——., *Post-1992 Evidence of EMF Impacts on Nearby Residential Property Values*, Paper presented at the 1997 Annual Conference of the American Real Estate Society, Sarasota, FL, April 16–19, 1997.

Kroll, C. A. and T. Priestley, *The Effects of Overhead Transmission Lines on Property Values: A Review and Analysis of the Literature*, Washington, DC: Edison Electric Institute, 1991.

Kung, H-T. and C. Seagle, Impact of Power Transmission Lines on Property Values: A Case Study, *The Appraisal Journal*, July 1992, 413–18.

McEvoy, S. A., Double-Edge Sword of Damocles: Utility Companies' Liability for Diminution of Property Values Due to Electromagnetic Fields, *Real Estate Law Journal*, 1994, 23, 109–22.

Mendelsohn, R., D. Hellerstein, M. Hughenin, R. Unseworth and R. Brazee, Measuring Hazardous Waste Damages with Panel Models, *Journal of Environmental Economics and Management*, 1992, 22, 259–71.

Michaels, R. G. and V. K. Smith, Market Segmentation and Valuing Amenities with Hedonic Models: The Case of Hazardous Waste Site, *Journal of Urban Economics*, 1990, 28, 223–42.

Mitchell, P. S., Estimating Economic Damages to Real Property Due to Loss of Marketability, Rentability and Stigma, *The Appraisal Journal*, 2000, 68:2, 162–70.

Mundy, B., The Impact of Hazardous Materials on Property Values, *The Appraisal Journal*, 1992, 60:2, 155–62.

Murdoch, J. C. and M. A. Thayer, Hedonic Price Estimation of Variable Urban Air Quality, *Journal of Environmental Economics and Management*, 1988, 15, 143–46.

Murdoch, J. C., H. Singh and M. Thayer, The Impact of Natural Hazards on Housing Values: The Loma Prieta Earthquake, *The Journal of the American Real Estate and Urban Economics Association*, 1993, 21:2, 167–84.

Nelson, J. P., Airports and Property Values, *Journal of Transport Economics and Policy*, 1980, 14:1, 37–52.

——., Three Mile Island Residential Property Values: Empirical Analysis and Policy Implications, *Land Economics*, 1981, 57:3, 363–72.

Nelson, A. C., J. Genereux and M. Genereux, Price Effects of Landfills on House Value, *Land Economics*, 1992, 68:4, 359–65.

O'Byrne, P. H., J. P. Nelson and J. J. Seneca, Housing Values, Census Estimates, Desequilibrium and the Environmental Cost of Airport Noise: A Case Study of Atlanta, *Journal of Environmental Economics and Management*, 1985, 12, 169–78.

Orland, B., J. Vining and A. Ebreo, The Effect of Street Trees on Perceived Values of Residential Property, *Environment and Behavior*, 1992, 24:3, 298–325.

Palmquist, R. B., Estimating the Demand for the Characteristics of Housing, *The Review of Economics and Statistics*, 1984, 66, 394–404.

——., Welfare Measurement for Environmental Improvements Using the Hedonic Model: The Case of Nonparametric Marginal Prices, *Journal of Environmental Economics and Management*, 1988, 15, 297–312.

Pennington, G., N. Topham and R. Ward, Aircraft Noise and Residential Property Values Adjacent to Manchester International Airport, *Journal of Transport Economics and Policy*, 1990, 24:1, 49–59.

Priestley, T. and G. Evans, *Perceptions of Transmission Lines in Residential Neighborhoods: A Case Study in Vallejo, California*, Southern California Edison Company, 1990.

Rhodeside and Harwell, Inc., *Perceptions of Power Lines: Residents' Attitudes*, Report prepared for the Virginia Power Company, Richmond, Virginia, 1988.

Rikon, M., Electromagnetic Radiation Field Property Devaluation, *The Appraisal Journal*, 1996, 64:1, 87–90.

Rosen, S., Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition, *Journal of Political Economics*, 1974, 82, 34–55.

Saint-Laurent, Josée, *Évaluation de l'exposition résidentielle aux champs électromagnétiques générés par une ligne à haute tension et perceptions des risques potentiels*, Master's thesis, Laval University, September 1996.

Simons, R. A., The Effect of Pipeline Ruptures on Noncontaminated Residential Easement-holding Property in Fairfax County, *The Appraisal Journal*, 1999, 67:3, 255–63.

Smith, V. K., and W. H. Desvousges, The Value of Avoiding a LULU: Hazardous Waste Disposable Sites, *The Review of Economics and Statistics*, 1986, 68, 293–99.

Uyeno, D., S. W. Hamilton and A. J. G. Biggs, Density of Residential Land Use and the Impact of Airport Noise, *Journal of Transport Economics and Policy*, 1993, 27:1, 3–17.

Zeiss, C., Waste Facility Impacts on Residential Property Values, *Journal of Urban Planning and Development*, 1989, 115:2, 64–80.

Zeiss, C., Incinerator Impacts on Residential Property Sales: Beyond Price Effects, *Journal of Urban Planning and Development*, 1990, 116:2, 80–97.

The author thanks the Appraisal Division of the City of Brossard as well as the Unité Expertise immobilière of the TransÉnergie Group, Hydro-Quebec Corp., for their support throughout the study. The author also thanks Marius Thériault, Alain Bolduc and Josée Bouchard. The author would like to dedicate this article to the late William Kinnard Jr., whose advice and comments greatly enhanced its quality.

François Des Rosiers, Laval University, Canada or Francois.Desrosiers@fsa.ulaval.ca.

Hsiang-te Kung, PhD, and Charles F. Seagle

Impact of Power Transmission Lines on Property Values: A Case Study

Studies have been conducted in an attempt to link electromagnetic radiation to some forms of cancer and other health risks. Each study has produced differing levels of evidence as to the validity of this theory. This research project endeavors to analyze the impact of power transmission lines on residential property values and the marketability of real estate in Memphis and Shelby County, Tennessee. Public knowledge of a possible connection between electromagnetic radiation and health risks such as cancer would probably have a profound effect on the real estate market for homes located in close proximity to power transmission lines.

The purchase of a home is often the biggest single investment a person will ever make. This is not an investment that is taken lightly, and any homeowner wants to protect the value and future benefits of ownership.[1] Regular maintenance, landscaping, and home additions can protect and enhance the value of property. External factors, however, such as the presence of adverse conditions or features adjacent to property that are beyond a homeowner's control can and do affect property values.[2] Examples of adverse external factors are dumps, landfills, factories that produce noise and bad odors, neighbors who allow their property to deteriorate, and of course power transmission lines.

There are two ways in which power transmission lines may adversely affect property value or marketability. The first is the mere presence of the transmission towers, which create an eyesore, as well as easements and encroachments on properties. The second, somewhat latent, is not as widely known. Since the late 1970s, studies have been conducted to attempt

1. American Inst. of Real Estate Appraisers, *The Appraisal of Real Estate*, 9th ed. (Chicago: American Inst. of Real Estate Appraisers, 1987), 35–41.
2. Ibid.

Hsiang-te Kung, PhD, is currently associate professor of geography and planning at Memphis State University, Memphis, Tennessee. An author of several articles, Mr. Kung received a PhD from the University of Tennessee at Knoxville and has seven years of environmental planning experience.

Charles F. Seagle is a real estate appraiser. He received a BA in geography from Memphis State University.

This research was supported through grants from the Memphis State University Office of Sponsored Programs and Memphis Area Association of Realtors Education Foundation.

to determine whether there is any connection between electromagnetic radiation emitted by power transmission lines and possible health hazards such as cancer.[3] The presence of these possible health hazards, if known to the general public, could certainly lead to a decrease in demand for properties located near transmission lines and in turn lower property values in these areas.

LITERATURE REVIEW

The cornerstone study of electromagnetic fields (EMFs) and their connection with health hazards was conducted in the 1970s by Nancy Wertheimer and Ed Leeper in Denver, Colorado.[4] In their study, Wertheimer and Leeper compared the EMF exposure of 344 children who died of cancer over a 23-year period from 1950 to 1973 with those of an equal number of children who did not get cancer born at approximately the same time as the cancer victims. Wertheimer and Leeper concluded that the children who lived in high-exposure homes (i.e., homes in close proximity to the power transmission lines) were two to three times more likely to contract some form of cancer, particularly leukemia, lymphomas, and nervous system tumors, than were the children who lived in lower exposure homes (i.e., homes not in close proximity to power transmission lines).

The results of this study were greeted with both skepticism and heightened interest in the research community. Skeptics agreed that too many assumptions were made as to the intensities of EMFs, and that actual measurements were not made. Nonetheless, the results led to more studies that used better control measures.

One such study was conducted in the Denver metropolitan area by David A. Savitz.[5] Savitz's goal was to replicate the study of Wertheimer and Leeper using more controlled measures and a greater level of thoroughness. It was generally thought that this study would disprove the results of Wertheimer and Leeper. It merely improved and refined them, however, giving greater weight to the evidence that there may be some connection between exposure to EMFs and some forms of cancer.[6]

Other studies were expanded to include electromagnetic radiation emitted from household appliances such as hairdryers and electric blankets.[7] Still another study, conducted in England, produced evidence that persons living or working near electromagnetic fields are subject to more depression and a greater incidence of suicide.[8]

Research conducted by Kavet and Banks indicated that EMFs do have some effects on cell membranes and tissues.[9] The biological responses *in vitro* are sensitive, not only to the magnitude of the radiation, but

---

3. Robert Pool, "Is There an EMF-Cancer Connection?" *Science*, v. 249 (September 1990): 1096–1098.
4. Ibid.
5. David A. Savitz and Debra L. Zuckerman, "Childhood Cancer in the Denver Metropolitan Area 1976–1983," *Cancer*, v. 59 (1987): 1539–1542.
6. Pool, 1096–1098.
7. David A. Savitz, Esther M. John, and Robert C. Kleckner, "Magnetic Field Exposure from Electric Appliances and Childhood Cancer," *American Journal of Epidemiology*, v. 131, no. 5 (1990): 763–773.
8. Stephen F. Perry, "Environmental Power-Frequency Magnetic Fields and Suicide," *Health Physics*, v. 41 (August 1981): 267–277.
9. Robert I. Kavet and Robert S. Banks, "Emerging Issues in Extremely Low-Frequency Electric and Magnetic Field Health Research," *Environmental Research*, v. 39 (1986): 386–404.

also to the waveshape and frequency of the radiation. On the other hand, studies on animals and humans are inconclusive. They fail to produce results comparable with the cell results and attest to the need for more research.[10]

In general, while all of the previously noted studies manifest varying levels of health hazards in relation to electromagnetic fields (as a result of differences in control groups and measures as well as techniques), they all suggest that there is some evidence to support a link between electromagnetic fields and health problems such as cancer.

METHODS AND PROCEDURES

The study discussed in this article was an attempt to analyze the spatial relationships between power transmission lines and property values in Memphis and Shelby County, Tennessee. Using power line maps available from Memphis Light, Gas, and Water (MLGW), neighborhoods transected by high tension lines were identified. Once these areas had been identified, individual homes directly under or adjacent to these power lines were surveyed to collect data on real or perceived influences on the property's value or marketability. This survey addressed both the issue of possible health hazards and the negative aesthetic impact of power lines.

Information was gathered concerning any differences between prices paid for homes directly under or adjacent to power transmission lines, and prices paid for homes in the same neighborhoods but located further away from the power transmission lines. The data were gathered from recognized local real estate services (e.g., Chandler and Chandler Residential Report, Memphis Association of Realtors Multiple Listing System), and used comparable types of housing as they could be located.

All data obtained through surveys, research, and personal observations were used to formulate a computerized map to show the spatial distribution of residential houses adjacent to transmission power lines as well as a computerized database (i.e., attribute data file) for the residential real estate property, called a Geographic Information System (GIS). Included in the database for the GIS are locations, distance to transmission power lines, square footage, type of housing, and information listed in the current Multiple Listing System (MLS) near the power lines. The database established by using the GIS can easily be updated.

In addition to the database construction of residential real estate value affected by power lines, a questionnaire was developed to survey homeowners who lived in houses directly adjacent to the power transmission lines. The responses to the following questions were used to determine the amount of influence the presence of power lines has on value.

1. When you purchased your home, did you consider the close proximity of the power lines and towers as a negative influence either as an eyesore (aesthetic negative) or as a potential health hazard?
2. If so, did either factor influence the price you were willing to pay for your home?
3. There is some evidence that these types of power lines and the electromagnetic radiation

While all of the previously noted studies manifest varying levels of health hazards in relation to electromagnetic fields, they all suggest that there is some evidence to support a link between electromagnetic fields and health problems such as cancer.

10. Maria A. Stuchly, "Human Exposure to Static and Time-Varying Magnetic Fields," *Health Physics*, v. 51, no. 2 (1986): 215–225.

they emitted may cause some forms of cancer. Were you aware of this when you purchased your home?

4. If you had been aware of such evidence (i.e., the possibility of a link between the electromagnetic field emissions from power lines and some cancers) would it have adversely affected the price you would have been willing to pay for your home? or

   Would this information have caused you to look elsewhere for comparable housing distant from power transmission lines?

5. Do you think that if this information about the possible link between power lines and their electromagnetic fields to cancers was more widely publicized that the market for homes located near such power lines likely would decline?

The results of this questionnaire were compiled, analyzed, and reconciled along with market information into a summary and conclusion.[11]

DISCUSSION

The results of the survey provide the basic information in this discussion. Of 80 homeowners in 2 adjacent neighborhoods in east Memphis and Shelby County who were polled, 47 complete responses were received and analyzed. In response to question 1, 25 homeowners (53%) said that they consider the presence of the transmission lines and towers an eyesore, while 22 (47%) did not. In response to the second half of the question, no homeowners considered the presence of the transmission lines and towers as a possible health hazard. In other words, every single homeowner who responded said they did not consider the transmission lines or towers a health hazard.

Of the 25 affirmative responses to question 2, 7 homeowners (28%) said that the presence of transmission lines and towers affected the price they were willing to pay for their homes. The presence of transmission lines and towers did not affect the price 18 homeowners (72%) were willing to pay, however.

Some interesting and enlightening responses were received to questions 3 and 4. Of the 47 homeowners surveyed, none had any knowledge of the possible evidence connecting power transmission lines to certain health risks such as cancer. This led to question 4 and some predictable responses. If these homeowners had been aware of the potential health risks associated with the presence of the electromagnetic fields emitted by transmission lines, 41 (87%) said that the price they had been willing to pay for their home would have been adversely affected or they would have looked in other areas for comparable housing. For two respondents (4%), access to such information might have had an influence on the price paid for their home or where they were willing to buy a home. Only one respondent would not have changed either the price paid for the home or the location of the home as a consequence of such information.

The last question posed in the survey was an opinion question. In light of the information concerning the connection between the electromagnetic fields of power trans-

11. K. William Chandler, *Chandler and Chandler Residential Sales Report, Memphis and Shelby County Homes, Duplexes, Condominiums, and Lots* (1989 and 1990).

mission lines to possible health risks such as cancer, what did the homeowners think would happen to the market for homes located in close proximity to power transmission lines if this information were widely publicized and known to the general public? Forty-three respondents (91%) said that they thought the market for these homes would decline, while one said that it would have no effect on the market for these homes.

An attempt was also made to gather information concerning any difference in prices paid for homes directly adjacent to power transmission lines and prices paid for homes in the same neighborhoods but further from the power transmission lines. Information was extracted from the subject neighborhoods using up-to-date sources (1989–1990 Chandler & Chandler residential reports), and using comparable housing as located.

In neighborhood A, two subject properties (i.e., properties adjacent to the power transmission lines) sold for $54,759 ($46.28 per square foot) and $55,350 ($49.64 per square foot), respectively. These prices fall in line with three comparable properties (i.e., properties of approximately the same age, size, and quality, located in the same neighborhood but not directly adjacent to the power transmission lines). These three properties sold for $56,900 ($44.66 per square foot), $55,500 ($51.48 per square foot), and $53,500 ($48.28 per square foot), respectively. The average price of the subject homes, $55,054 ($47.96 per square foot) compares favorably with the comparable homes, with an average price of $55,300 ($48.14 per square foot).

In neighborhood B, two subject properties sold for $67,000 ($54.96 per square foot) and $65,000 ($53.32 per square foot), respectively. These prices are in line with four comparable properties, which sold for $68,500 ($53.64 per square foot), $66,685 ($56.51 per square foot), $67,500 ($55.19 per square foot), and $65,500 ($51.65 per square foot), respectively. The average price of the subject homes was $66,000 ($54.14 per square foot) and again compares favorably with the comparable homes average of $67,046 ($54.25 per square foot).

Any slight difference in total price or price per square foot between the subject homes and the comparable homes should be attributed to differences in property condition, style, or buyer preference and seller motivation. This is supported by a comparison of select groups of only comparable properties and the resultant similar slight price differences. These differences are common in any real estate market.

CONCLUSION

Although there is evidence that the electromagnetic fields emitted from power transmission lines may cause some forms of cancer and that the presence of power lines and towers are an eyesore, these results reveal that the public in general is only aware of the latter. While survey results indicate little knowledge of potential health risks, they indicate a high degree of opinion change once informed about such evidence.

Market evidence further supports the fact that there is a lack of public knowledge about any health risks associated with power transmission lines because no measurable price differences could be detected between homes located adjacent to power transmission lines and comparable homes located further away.

More research needs to be conducted in the area of electromagnetic fields and their connection to health risks. The results must be more widely disseminated to the general public. Further, development in the future clearly should be restricted in the vicinity of power lines and should be kept a significant distance from power transmission lines and towers.[12]

12. Hsiang-te Kung and Paul M. Barelski, "Environmental Effects of Electromagnetic Radiation from Power Lines," unpublished paper, 1990.

Michael Rikon

Electromagnetic Radiation Field Property Devaluation

The *Criscuola* v. *Power Authority of the State of New York* decision by the New York State Court of Appeals seems to provide the means to obtain damages due to diminution of property values as a result of proximity to an electromagnetic radiation field (EMF). This article explores ramifications of the decision and its application to valuation problems.

When New York State's highest court, the Court of Appeals, handed down *Criscuola* v. *Power Authority of the State of New York*[1] last year, many hailed the decision as the missing piece of the puzzle that would provide the means to obtain monetary damages because of diminution of property values caused by proximity to an electromagnetic radiation field (EMF).

One year later, the aggressive use of the holding can be observed in many different types of lawsuits. The *Criscuola* doctrine is also being used in inverse condemnation cases and in a host of other situations as diverse as the fertile imagination of learned counsel would allow.

Much has been written in legal periodicals about *Criscuola* and its potential application to any litigation involving the use of land. It is therefore necessary to carefully explore the decision to consider its application to valuation problems.

EMINENT DOMAIN CONTEXT

Criscuola arose in the context of a pure eminent domain taking; that is, there was a condemnation of a strip of property through the Criscuola brothers' farm in rural New York. The appropriation was by the Power Authority of the State of New York for a 345-KV power transmission line, involving a 160-foot corridor crossing the property diagonally in an east–west direction approximately midway of its depth.

The claimants filed a claim for damages seeking just compensation, not only for the six acres directly taken for the pow-

1. *Criscuola v. Power Authority of the State of New York,* 81 NY2d 649, 602 NYS2d 588, 621 NE2d 1199 (1993). Also reported, *ATLA Law Reporter* 23, no. 33, 37; *Toxic Law Reporter* 8, no. 20; *Indoor Pollution Law Report* 7, no. 5; *Mealey's Litigation Reports, Toxics Torts* 2, no. 14; *EMF Litigation News* (November 1993); and *Microwave News* (Sept./Oct. 1993, Nov./Dec. 1993, Jan./Feb. 1994).

Michael Rikon is a partner in Goldstein, Goldstein & Rikon, P.C., in New York City. He received a BS in business administration from the New York Institute of Technology, a JD from Brooklyn Law School, and an LLM from New York University, School of Law. Mr. Rikon was a consultant to the New York State Commission on eminent domain procedure law.

erline, but for the loss in value sustained by the remaining 94 acres because of the remainder's loss of market value. Condemnation lawyers refer to these two types of damages in partial takings as direct and consequential.

Claimants alleged that the consequential damages arose as a result of the public's perception of health risks associated with high-voltage powerlines, a fear known as "cancerphobia." One of the owners testified that he never would have bought the property if it had had a high-voltage powerline across it. Claimants' expert valuation witness, an MAI-designated appraiser, testified that because of the public's cancerphobia, the market value of the remainder was worth half of its prevesting value.

The trial court, the New York State Court of Claims, held that the Criscuolas were only entitled to recover for the direct takings, and awarded $5,400, plus $543 for hardwood trees taken down, a total of $5,943. The court ruled that to recover for consequential damages, the claimant must first prove that powerlines cause health problems by a preponderance of the credible scientific evidence. If scientific proof supported the cancerphobia of the public, the claimant must then also establish that this reasonable apprehension has affected the purchaser's willingness to pay the fair market value of the property.

On appeal, the trial court's decision was affirmed by the Appellate Division.[2] The Appellate Court, in affirming *Criscuola*, relied on a companion case involving another parcel located in a different county that was also taken by the Power Authority for the same Marcy–South powerline that was decided by another appellate court of equal jurisdiction.[3]

Criscuola moved for, and received permission to appeal to New York State's highest court, the Court of Appeals. The Power Authority argued, once again, that existing law required that the claimants must first prove by a preponderance of the evidence that health fears were scientifically reasonable, and that the claimants (who were joined with all other Marcy–South claimants) could not convince the trial judge, who heard a bevy of impressive and certainly expensive expert witnesses, that there was a basis in scientific evidence for a fear of exposure to the fields emitted by powerlines.

NEW YORK STATE COURT OF APPEALS DECISION

The Court of Appeals held otherwise, and reversed in a decision by Judge Bellacosa, who stated:

> We are satisfied that there should be no requirement that the claimant, as a separate and higher component of its market value proofs, must establish the reasonableness of a fear or perception of danger or of health risks from exposure to high-voltage powerlines. The issue is a just compensation proceeding (citations omitted). This consequence may be present even if the public's fear is unreasonable. Whether the danger is a scientifically genuine or verifiable fact should be irrelevant to the central issue of its market value impact. Genuineness and proportionate dollar effects are relevant factors, to be sure, but in the usual evidentiary framework. Such factors should be left to the contest between the parties' market value experts, not magnified and escalated by a whole new battery of electromagnetic power engineers, scientists or medical experts. "Adverse health effects *vel non* is not the issue in eminent domain proceedings: full compensation to the landowner for property taken is" (citations omitted). As the Court of Appeals of Kansas has noted, "Logic and fairness . . . dictate that any loss of market value proven with a reasonable degree of probability should be compensable, regardless of its source. If no one will buy a residential lot because it has a high-voltage line across it, the lot is a total loss even though the owner has the legal right to build a house on it. If buyers can be found, but only at half the value it had before the line was installed, the owner has suffered a 50% loss."[4] Thus, relying on *Willsey*, the Supreme Court of Kansas concluded, and we agree, that evidence of fear in the marketplace is admissible with respect to the value of property taken without proof of the reasonableness of the fear."[5]

KEY HOLDING

In the key holding, once again, the New York Court of Appeals ruled:

- There should be no requirement that the claimant must establish the reason-

2. *Criscuola* v. *Power Authority of the State of New York*, 188 AD2d 951, 592 NYS2d 79 (3d Dept., 1992).
3. *Zappavigna* v. *State of New York*, 186 AD2d 557, 588 NYS2d 585 (2d Dept., 1992).
4. *Willsey* v. *Kansas City Power*, 631 P2d 268, 277–278.
5. *Ryan* v. *Kansas Power & Light Co.*, 815 P2d 528, 533.

ableness of a fear or perception of danger or of health risks from exposure to high-voltage power lines, and

- Whether the danger is a scientifically genuine or verifiable fact should be irrelevant to the central issue of its market value impact.

APPLICATION TO NONCONDEMNATION CASES

It is this marketplace evidence rule that has sparked the plaintiff's bar to apply *Criscuola* to noncondemnation situations. Indeed, *Criscuola* is being applied against the City of New York by homeowners who live in Staten Island and are unable to sell their homes because of the largest landfill in the country. The noxious smell and unsightliness of this mountain of garbage has created a well-publicized fear of cancer to would-be home buyers.

Fear in the real estate marketplace is also argued as a reason for not allowing construction for a CellularOne Tower in Glen Cove, Long Island. Community Board Two in Greenwich Village, New York, uses this reason to oppose the construction of a power substation the Transit Authority plans to build. The State of Connecticut General Assembly's Committee on Transportation is considering the potential EMF property devaluation that may be caused by Amtrak's electrification of railroad lines within the state.

The argument being advanced in these situations is that even though the best-informed experts cannot say for sure that EMF causes cancer, everyone agrees that if a powerline is constructed next door, local real estate values may suffer substantial devaluation.

Litigation is currently proceeding in New York against Consolidated Edison and against the Long Island Lighting Company, seeking damages for inverse condemnation, trespass, and injunctive relief. Similar inverse condemnation claims are being filed across the country. The number of property devaluation claims continues to grow geometrically.

CRISCUOLA FORMULA

Judge Bellacosa wrote in *Criscuola* that "evidence of fear in the marketplace is admissible with respect to the value of property taken without proof of the reasonableness of the fear."[6]

A claimant, however, is not relieved from giving any proof to establish claims and just compensation damages. *Criscuola* v. *Power Authority of the State of New York* mandates that a claimant must still establish some prevalent perception of a danger emanating from the objectionable condition.

Quoting the *Ryan* decision once again, the Court of Appeals stated that "no witness, whether expert or nonexpert, may use his or her personal fear as a basis for testifying about fear in the marketplace. *However, any other evidence that fear exists in the public about the dangers of high-voltage lines is admissible*" (emphasis added). Judge Bellacosa further stated:

> Claimants should have to connect the market value diminution of the property to the particular fear in much the same manner that any other adverse market effects are shown; e.g., by proffering evidence that the market value of property across which powerlines have been built has been negatively affected in relation to comparable properties across which no powerlines have been built (citations omitted).

EMF INVERSE CONDEMNATION

In an inverse condemnation (i.e., an EMF property devaluation claim), the damage calculation should be the same as if the property were condemned because the public perceives that there is a health risk when one lives in close proximity to a high-voltage power transmission line. This perception among the prospective purchasers of the property results in a substantial loss of value.

This cancerphobia affects the minds of any prospective purchaser, causing a loss of demand, a loss of market value, and thus damage to an EMF-affected property. Indeed, even if a prospective purchaser were certain that there was no risk to health, he or she still would not be disposed to acquire a property with such a limited resale potential.

One thing is certain: whether the danger is a scientifically genuine or verifiable fact is irrelevant to the central issue of its market value impact. Appraisers should be cognizant of not only the change in law, but of the market effect as well.

6. *Ryan* v. *Kansas Power & Light Co.*

It should not be difficult to establish that the market value of real property in close proximity to a high-voltage powerline is substantially lower than a comparable property unaffected by a powerline.

THE PUBLIC'S PERCEPTION—CANCERPHOBIA

According to an article by Ron Marx,[7] a public poll taken in 1993 by Cambridge Reports/Research showed that 63% of all adult Americans were aware of the EMF issue, up from 31% in 1989. Half responded that they were "extremely worried" about it. The public's perception of a problem is well established.

The reason for the growing awareness has been the increased reporting of residential and school cancer cluster investigations near powerlines, along with numerous studies of occupational exposure showing an increased frequency of cancer in workers who have had higher exposure levels to EMF.

Recently, an article in *The New York Times*, "Power Lines Raise Fears in Home Buyers,"[8] began, "When Marie Trizano takes people to see houses near powerlines, she says sometimes they won't even get out of the car." There have been hundreds of other similar articles in magazines and newspapers across the country.[9]

Homeowners who adjoin high-voltage powerlines have reported that their EMF-affected homes are unsellable at any price. An appraiser should be easily able to connect the market value diminution of the property to the public's fear of an EMF.

APPROACH TO VALUATION

The proper approach for an appraiser to take in valuing a parcel of land damaged by the visible presence of a high-voltage powerline will be a before-and-after valuation of similar properties. In other words, comparable unaffected properties will be selected and adjusted, with an appraiser considering location, market conditions, physical characteristics, conditions of sale, time, financing terms, and use. This sales comparison approach will provide or indicate a market value for the unaffected (before) property.

The appraiser will then attempt to find comparable sales of parcels similarly situated next to a powerline, if possible. It may be extremely unlikely that any recent sales of EMF-affected properties exist. Assuming that the appraiser's research does indicate some nonforeclosure or other distress sales of property in proximity to a powerline, these sales must be analyzed and compared with the subject property. The after (affected) property value is then subtracted from the before (unaffected) property value, and the difference will be the damages.

CONCLUSION

It is entirely possible to conclude after an EMF market study that most parcels of EMF-affected property will have a restricted resale value, and thus there will be damages in the full indicated value found by adjusted comparable properties not affected by high-voltage powerlines.

---

7. Ron D. Marx, "This ELF Could Be the Next Giant in Environmental Hazards," *Econ the Environmental Magazine for Real Property Hazards* (November 1993): 22.

8. *The New York Times*, "Power Lines Raise Fears in Home Buyers," *The New York Times*, Section 10 (July 11, 1993): 5.

9. See, for example, "Power Lines Short-Circuit Sales, Homeowners Claim," *The Wall Street Journal* (December 8, 1993): B1; *New York Newsday*, "Power Struggle—High-Tension Lines Creating Tension Among Some Buyers," *New York Newsday* (August 14, 1994): *Real Estate*, 1.