

Real Property Damages and Rubber Rulers

BY ALBERT R. WILSON

DURING THE PAST TWO DECADES, MANY ARTICLES AND COURT cases have involved alleged diminution and damages to the value of real property resulting from a disamenity that influences a geographic area of values. “Alleged” is the key word because highly suspect analytical techniques frequently are the basis of the argument that a given disamenity results in a diminution or damage. Notably, at least two of these techniques—hedonic analysis and contingent valuation—are “rubber rulers,” techniques that may be deliberately or inadvertently manipulated to achieve a preconceived result.

This article discusses the fundamental concepts of damage and diminution to value, and appropriate and inappropriate methods for identifying and measuring diminution and damage if they exist. It also describes a set of three analytical steps required to demonstrate a damage to value.

CONSISTENTLY LOWER SALES PRICES AND DIMINUTION IN VALUE

The first step is determining if properties in a given area sell for less than comparable properties in an otherwise similar area. Analysts can demonstrate consistently lower sales prices in a given geographic area using methods such as paired sales analysis for properties in the subject area and similar properties not in the area, or by testing the null hypothesis that property is not selling for a lower price in the subject area using appropriate statistical tests on validated sales data. Other methods could include comparison of sales prices to appraisals based on comparable properties from other similar areas.

A lower sales price level is not necessarily a diminution in value or a damage to value. It is possible that an area may simply be a lower-valued area; that is, an area subject to a locational premium.¹ A diminution in value implies that a higher price level existed before a typical market participant recognizes a disamenity, and a lower price level emerges after the disamenity becomes known. To establish a diminution in value related to a disamenity, analysts would need to demonstrate that higher values prevailed in the area before market knowledge of the disamenity; and that no other negative-value



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influencing conditions occurred or, if other influences did exist, to account for all of them to isolate the influence of the relevant disamenity.

A diminution in value is a necessary but not sufficient condition for a damage.

DISAMENITY DOESN'T ALWAYS CAUSE DAMAGE TO VALUE

Damage to value is a time-sensitive, ownership-specific issue. Though the value of a property may decrease because of market recognition of a disamenity, a property owner does not automatically suffer damage. Consider the following definitions.

- *Real estate value*—“The present worth of the future benefits that accrue to real property ownership.”²
- *Market value*—“The most probable price, as of a specified date, in cash, or in terms equivalent to cash, or in other precisely revealed terms, for which the specified property rights should sell after reasonable exposure in a competitive market under all conditions requisite to a fair sale, with the buyer and seller each acting prudently, knowledgeably, and for self-interest, and assuming that neither is under undue duress.”³ Note: “A market value appraisal is also based on whatever the ‘normal’ or ‘typical’ conditions are in the marketplace for the property appraised in a time frame that is consistent with the date of value in the appraisal.”⁴
- *Damage*—“Loss or harm due to injury to persons, property, or reputation.”⁵

Damage to market value can then be defined as a diminution in the market value imposed on an owner resulting from an injury recognized by the market after the purchase of property.

A damage is specific to an owner who purchases a property before the condition that led to a diminution becomes apparent to the market, and is limited to the amount by which that owner’s “present worth of future benefits” is diminished. A damage to a subsequent owner generally is not possible if the normal or typical market participant was aware of the disamenity. It is the knowledge of the market that governs, not the knowledge of the individual owner—unless that owner knows of the

disamenity and its likely impact on value before it becomes general market knowledge (an insider-knowledge issue).

A researcher can quantify a damage by analyzing the property’s market value as if the disamenity does not exist; and given that it exists, the unimpaired or less impaired vs. the impaired market values.⁶

Analysts should not assume that a given disamenity causes a diminution or damage to value. For example, consider a plant site that had groundwater contaminated with chlorinated solvents, a nitric acid spill in surface water and allegations that radioactive waste was buried on the plant site with residential properties on two sides. These issues were highly publicized and accompanied by a local real estate recession, but during a study covering a 10-year period, analysts could not show that this situation diminished nearby residential property values using an appropriate set of statistical tests. Anecdotal interviews of buyers and sellers further supported this finding.⁷ Similarly, analysts frequently cite high-voltage power lines as a cause of nearby property value diminution, but authors Martin Wolverton and Steven Bottemiller, among others, have shown exceptions to that rule.⁸

Many allegations of a diminution in value are based on hedonic analysis and contingent valuation techniques. Neither technique is scientifically valid or reliable, and both are subject to manipulation to achieve desired results. They are rubber rulers that can be stretched to provide results compatible with the objectives of the researcher, client or lawyer.

THE FIRST RUBBER RULER: REGRESSION MATHEMATICS AND HEDONIC ANALYSIS

Regression is a statistical method for the estimation of the dependent variable from a set of independent variables. To form the regression relationship, the analyst chooses a set of independent variables from—in the case of real estate—a very large set of possible variables. This hypothetical relationship hopefully expresses the analyst’s interest and research objectives.⁹ It can never totally and completely represent all the independent variables influencing the price of a specific piece of real estate.

There are three basic components of a regression relationship important to the following discussion: the dependent variable, for our purposes generally the sale price; the

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independent variables, generally factors chosen by the analyst that are believed to influence the value of the dependent variable; and the coefficients of the independent variables, the multipliers estimated by the regression mathematics in a manner that will minimize the difference between the calculated value of the sale price using the regression model and the actual value of the sale price from the database used in developing the model.

Hedonic analysis is an interpretive technique put forth by economists, not competent statisticians. This method argues that the coefficients of the regression may be quantitatively interpreted as the marginal contribution of the specific independent variable to the sale price. This requires that two interrelated assumptions be satisfied. First, that the predictor variable have a cause-effect relationship to the sale price, a relationship allegedly measured by the statistical significance of the coefficient.¹⁰ Second, that the coefficient is quantitatively accurate; that is, it represents only the contribution of that variable to the sale price. The interrelationship is that the size of the coefficient may be inflated by omitted variables, among other things, causing the statistical significance and apparent impact on sale price to increase. This contribution from omitted variables may influence the statistical significance to the point where the omission of variables makes an otherwise totally insignificant variable appear to be significant.

The claim of a causal relationship based on the statistical significance of the predictor variable in the hypothetical regression relationship is unsupported by regression mathematics.

“The existence of a statistical relation between the response variable Y and the explanatory or predictor variable X does not imply in any way that Y depends causally on X. No matter how strong is the statistical relation between X and Y, no cause-and-effect pattern is necessarily implied by the regression model. ... Regression analysis by itself provides no information about causal patterns and must be supplemented by additional analyses to obtain insight about causal relations. ... A major limitation of observational data is that they often do not provide adequate information about cause-and-effect relationships.”¹¹

Of 37 frequently cited hedonic analysis papers indicating damage to value, none based that assertion on any analytical tests other than the claimed statistical significance of the independent variable said to represent damage or diminution. For these alleged independent variables, it was found that the mean 95 percent confidence interval was plus or minus 139 percent.¹² Mathematically, a confidence interval greater than or equal to 100 percent includes zero and the coefficient must be treated in the regression analysis as a zero value.

If any variable that makes an actual contribution to the sale price is excluded from the hypothetical regression relationship, some of its contribution will be included in the coefficients of those variables that remain. How much will be included in a given coefficient is unknown and unknowable. Therefore the coefficient of the included variables do not represent just the contribution of that variable to the sale price, but the contribution of that variable and the omitted variables, and is not quantitatively meaningful in the sense required by the hedonic analysis. Note that the inflation of the coefficients by omission of variables may not be of any major importance to the prediction of the sale prices, just to hedonic analysis.

“HPV (Hedonic Property Value) regressions have two characteristics making them a fertile area for data mining (specification searching) to obtain desired signs as well as the selective reporting of unrepresentative results,” authors Scott Atkinson and Thomas Crocker state. “A pattern of considerable data mining in order to obtain significant coefficients with desired signs seems to pervade the HPV literature. ... Our empirical results indicate that the specification uncertainty caused by co-linearity is small for structural variables (e.g. floor space, age, and lot size) but substantial for neighborhood variables (e.g. air pollution, school quality, and crime); intolerance to measurement error is great for both types of variables.”¹³

To illustrate the frailties of hedonic analysis, consider an investigation of a water utility benzene contamination incident on property values. Analysts used approximately 1,900 sales in the regression, but several sales were missing the year built—a datum necessary for calculating the age variable. In cases where it was missing, the regression considered the properties to be some 87 years older than their actual age. After the hedonic analyst corrected the

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year built for all homes except the one that was in the allegedly impacted area, the analyst concluded to a 13 percent diminution in property values in the area that the utility served. When the one remaining missing year built was corrected using the analyst's correction procedure, the diminution in value disappeared. The correction of one single item of data in the approximately 20,900 items of data used in the study resulted in a reversal of findings with virtually no change in the regression's explanatory power or precision as measured by the proponent's measure of r^2 .¹⁴

This particular hedonic analysis also improperly uses dummy variables in a cross-product independent variable that would independently lead to incorrect results. The error is common in hedonic analysis, and well documented.¹⁵

In examining the hedonic analysis for the *DeSario v. Industrial Excess Landfill* case, covered in several articles published in *The Appraisal Journal*,¹⁶ authors report that the analysis used geographic bands defined radially outward from the landfill location and assigned each property location according the band it fell within. Using this method, hedonic analysis shows a diminution in value for properties in all but the most distant measurement band. However, if instead of bands the analysis uses the measured distance of each property to the landfill, the diminution in value disappears except for the very closest properties, reducing the estimated property damages from millions to tens of thousands. The two approaches had virtually the same r^2 .¹⁷ This same phenomena appears in an analysis by author Arthur Nelson.¹⁸

For any given set of data and regression specification, analysts can show that a simple change in specification or small adjustment in data can provide significantly different values for the coefficient of the independent variable of interest, generally without a significant change in the usual measures of the appropriateness of the hedonic analysis that economists use, such as r^2 . Manipulating hedonic analysis to achieve a desired result is not difficult and, therefore, hedonic analysis is a rubber ruler with the appearance of scientific precision—an appearance that is wholly unjustified.

A SECOND RUBBER RULER: CONTINGENT VALUATION

The use of the contingent valuation method, or hypothetical market survey, has gained prominence recently in valuation literature. This method calls for setting up a hypothetical transaction involving an alleged disamenity such as a cell phone tower, adjacent gas station or pipeline right-of-way, then surveying individuals who play the part of buyers to determine how much they would discount a property's value when close to the alleged disamenity. This methodology is based on the contingent valuation, or CV, method sometimes used in natural resource damage cases where rights that are assigned values are not traded in a traditional market.

The list of requirements outlining how to properly conduct a CV study is quite lengthy and very expensive to fulfill.¹⁹ Failing to meet the requirements results in the degradation of the results even beyond the already high error rates normal to the method. Essentially, however, they are moot because even strong advocates of CV as an approach for valuing public and quasi-public goods clearly state that the methodology is not applicable to private goods.²⁰

The results of a hypothetical market survey tend to be useless for other reasons as well. For example, most hypothetical market surveys consider only the buyer's side of the relationship; that is, how much the buyer wants the seller to take off the purchase price. Surveys rarely examine the seller's side and collect little or no information about whether a discount would receive serious consideration, let alone acceptance.²¹

Through manipulation of specific words or phrases, interviewer bias, respondent selection and other methods, researchers can obtain virtually any desired result.

A SPECIFIC EXAMPLE: THE EFFECT OF CELL PHONE TOWERS ON RESIDENTIAL PROPERTY VALUES

An article investigating the value of residential properties near cell phone towers reports: "The opinion survey results were generally confirmed by the market sales analysis using a hedonic house price approach. The results of the sales analysis show prices of properties were reduced by around 21 percent after a CPBS (Cellular Phone Base Station) was built in the neighborhood."²² This article provides an excellent example of issues outlined previously:

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Bias

The article appears to be biased in favor of a high damage result. First, it rejects two studies conducted by professional appraisers who could find no statistically significant differences among property values of homes near and not near cell phone towers.²³ Second, because they believed respondents close to cell phone towers were unwilling to provide honest answers, authors discounted survey results from respondents near the towers in favor of significantly higher results from respondents who were in areas without towers.²⁴

Survey

The article contains no evidence that the survey was pre-tested to measure respondent understanding, bias or other critical issues as recognized survey protocols require. Further, there is no evidence of testing to ensure the survey would provide a comprehensive understanding of respondents' answers. For example, the survey included no questions to determine if respondents were providing unbiased and well-considered answers, and no questions about whether an owner would accept the indicated discount.

The results of the survey also are inconsistent. For example, many of the respondents with homes near towers—51.4 percent—said the cell towers had no influence on value; but 71 percent said that they would pay less for a home in the area. If the survey is honestly representative of the area residents, these results would strongly indicate something other than a cell phone tower is undesirable about the area. Researchers apparently do not investigate this issue.

Another major concern is that survey results are not statistically meaningful with respect to the universe of residents. The survey was conducted by mail and—though the response rate after prompting was reasonable at 46 percent—by definition, mail survey respondents are not randomly selected; they are self-selected. As the Blue Ribbon Panel report and the *Reference Guide on Survey Research*²⁵ note, a mail survey does not provide a scientifically reliable basis for drawing any generally applicable conclusions concerning the population as a whole.

Hedonic analysis

There is no reported attempt to test the null hypothesis of no effect except by the professional appraisers, and authors discount these analyses. Therefore, they are assuming, in the face of contrary evidence, that the cell towers negatively influence value.

Authors use at least six regression models to achieve the four reported results. This practice strongly implies specification searching to achieve a desired result. It appears the authors choose to ignore the survey's indications of another problem in the area and keep searching for specifications that support preconceived notions. Hedonic analysis is a nearly perfect tool for exactly this type of manipulation, whether conscious or unconscious.

Except for gross land area, gross living area and age, no other recognized factors of value consistently appear in the regressions. In the reported models, authors inconsistently use factors such as whether the property is single family or multifamily, the type of siding or roof construction and the quality of the property. Authors also fail to consider other key value-influencing factors including the number of bedrooms, bathrooms and garage spaces. In addition, authors include income-producing property such as rental units in the same regression database as owner-occupied property sales. A regression model that does not consistently use recognized factors of market value and clearly separate distinct types of property— income producing vs. owner-occupied—is highly suspect.

General

In their literature review, authors note that high-voltage overhead transmission lines have a reported impact on value ranging from positive—i.e., increasing the value of neighboring properties—to negative. In a separate study, one of the paper's authors cite a maximum negative influence on value of 20 percent for properties 10 meters from a high-voltage tower, declining rapidly to zero at 100 meters.²⁶ Further, authors state that according to another study, 50 percent of all high-voltage studies indicate no impact on value and 50 percent indicate between 2 percent and 10 percent negative impact.²⁷ For a less obtrusive artifact, the authors report a significantly greater damage estimate: 10 percent to 23 percent for properties within 300 meters.

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CONCLUSION

It is relatively common for damage to be confused with diminution, and a diminution to be confused with a simple locational preference. But these phenomena are not the same—a locational preference is not necessarily a diminution, and a damage cannot exist without a diminution in value. Damage is specific to the owner and the period of ownership relative to market recognition of the event that allegedly causes the damage.

Analysts must use proven methods such as classic market data analysis of arms-length and verified sales or specific statistical tests of the null hypothesis of no lower value to identify an area of lower values. Demonstrating diminution relies on these methods, which provide sound indications that—but for the alleged disamenity—a higher value would reasonably be expected in the area of demonstrated lower values.

Damage to value is specific to the property owner who purchases the property before the disamenity causing the damage becomes known in the market, and is specific only to that owner, and not to successors, because the future market will have recognized the disamenity and adjusted values accordingly. The damage may not affect an owner immediately; market recognition of a damaging impact determines the date of damage.

Therefore, three steps necessary to demonstrate a damage to value resulting from a disamenity are:

1. Does an area of lower values exist? That is, are values in the subject area lower than the norm for the property type and market?
2. Are the lower values a result of a specific disamenity? Because of the complexity of forces operating in the real estate market, this point may be difficult to demonstrate. One key factor would be to show that higher values in the area preceded the diminishment in values, and the decline followed market recognition of the disamenity.
3. Did the owner purchase before the disamenity became known in the market? If the purchase occurred after market knowledge, analysts can presume that the price paid reflects the existence of the disamenity and no damage to that owner exists.

Hedonic analysis and hypothetical market surveys are no better than rubber rulers—measurement devices that ana-

lysts can stretch knowingly or unknowingly to achieve a desired result while maintaining the superficial appearance of scientific validity. These methods are not scientifically valid or reliable.

That they are not reliable usually can be demonstrated by simply repeating the experiment, but using a slight legitimate alteration—in the wording of a CV survey, for example. A lack of reliability in hedonic analysis models may be demonstrated by changing a model specification to include common and well-understood value influences such as bedrooms, baths, age or other variables that were omitted in the original hedonic analysis. This will almost always result in an important reduction in the size and apparent significance of the damage variable. Occasionally, it may be necessary to critically examine the database or look at alternative model specifications, changing the distance measurement from artificial distance bands to more natural direct distance, for instance. These simple and very logical changes generally will provide very different results, and very frequently with the same measure of reliability as claimed in the original analysis. ■

- 1 Peter Bowes, Douglas C. Brown, Albert R. Wilson, “Damage to Market Value and Locational Premium,” *Real Estate Issues*, Vol. 29, No. 4, Winter 2005–2006.
- 2 *The Dictionary of Real Estate Appraisal, Fourth Edition* (Chicago: Appraisal Institute, 2002).
- 3 *Ibid.*
- 4 *Uniform Standards of Professional Appraisal Practice, 2002 Edition*, Advisory Opinion 22 (Washington, D.C.: The Appraisal Foundation, 2002).
- 5 *The Merriam-Webster Dictionary*, (Springfield, Mass.: Merriam-Webster Inc., 1998).
- 6 The phrase “less impaired” addresses the emerging issue of properties that have been remediated to a standard appropriate for a specific use, but not remediated to an unimpaired environmental condition.
- 7 Albert R. Wilson, “Proximity Stigma: Testing the Hypothesis,” *The Appraisal Journal*, June 2004.
- 8 Marvin L. Wolverton, Steven Bottemiller, “Further Analysis of Transmission Line Impact on Residential Property Values,” *The Appraisal Journal*, July 2003.
- 9 Note: All regression relationships are hypothetical expressions of the analyst’s idea of how various elements as represented by predictor variables might influence the value of the dependent variable. This

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statement becomes obvious when one considers the variation among real estate regression models. Some regressions use a relationship that includes bathrooms and half-baths but not bedrooms; others include house size, lot size, number of bedrooms and baths, and size of garage—but not house style, age, condition, type of heat or other variables cited frequently as important to value. Published regression relationships used in hedonic analysis may contain from one or two to 90 or more independent variables. Leading textbooks on the issue of multiple regression model construction and application generally agree that such models are hypothetical in the sense that analysts choose which variables to include or exclude. Also see endnote 11.

- 10 Statistical significance is normally measured by the studentized t-value. The t-value is a ratio that indicates the relative contribution of the coefficient to a reduction in the variance between the calculated and actual values of the dependent variable. The larger the coefficient, the greater the significance of that coefficient to the minimization of the variance.
- 11 John Neter, Michael Kutner, Christopher J. Nachtsheim, William Wasserman, *Applied Linear Regression Models, Third Edition* (Chicago: Irwin, 1996).
- 12 Author's research files. Articles were selected based on the frequency with which they were referenced in articles by hedonic analysts. The measure was calculated as: percentage range = $\pm 1.96 * ((\text{Coefficient Value} / \text{t-value}) / \text{Coefficient Value})$.
- 13 Scott E. Atkinson; Thomas D. Crocker; "A Bayesian Approach to Assessing the Robustness of Hedonic Property Value Studies," *Journal of Applied Econometrics*; Vol. 2, 27-45, 1987.
- 14 Authors' files on report and supporting data of Barton Smith, Ph.D., prepared in the case of *Mike Adalis et al v. Neighborhood Development Corporation et al*, 369th Judicial District, 93-0464.
- 15 Warren Rogers, "Errors in Hedonic Modeling Regressions: Compound Indicator Variables and Omitted Variables," *The Appraisal Journal*, April 2000.
- 16 Alan Richert, "Impact of a Toxic Waste Superfund Site on Property Values," *The Appraisal Journal*, October 1997; and "The Persistence of Contamination Effects; A Superfund Site Revisited," *The Appraisal Journal*, April 1999.
- 17 Authors' research files. Note: r^2 generally is not a meaningful measure of reliability of applicability.
- 18 Arthur C. Nelson, "Price Effects of Proposed Landfill on Single Family House Values," *Property Reserve Inc.*, March 1991.
- 19 *Federal Register*, Vol. 58, No. 10, Proposed Rules, Department of Commerce, 15 CFR Chapter IX, Natural Resource Damage Assessments Under the Oil Pollution Act of 1990, 58 FR 4601, Appendix I—Report of the NOAA Panel on Contingent Valuation, Jan. 15, 1993 (the "Blue Ribbon Panel report"). Also see endnote 21.
- 20 Richard T. Carson, Nicholas E. Flores, Norman F. Meade, "Contingent Valuation: Controversies and Evidence," *Environmental and Resource Economics*, Vol. 19, 2001. Also see Richard T. Carson, Nicholas E. Flores, Kerry M. Martin and Jennifer L. Wright, "Contingent Valuation and Revealed Preference Methodologies: Comparing the Estimates for Quasi-public Goods," *Land Economics*, February 1996. Also see endnote 7.
- 21 Albert R. Wilson, "Contingent Valuation: Not an Appropriate Valuation Tool," *The Appraisal Journal*, Winter 2006.
- 22 Sandy Bond, Ph.D., Ko-Kang Wang, "The Impact of Cell Phone Towers on House Prices in Residential Neighborhoods," *The Appraisal Journal*, Summer 2005.
- 23 "Two studies have been conducted to ascertain the adverse health and visual effects of CPBSs on property values. Telecom commissioned Knight Frank (NZ) Ltd to undertake a study in Auckland in 1998/00 and commissioned Telfer Young (Canterbury) Ltd to undertake a similar study in Christchurch in 2001. Although the studies show that there is not a statistically significant effect on property prices where CPBSs are present, the research in both cases involves only limited sales data analysis. Further, no surveys of residents' perceptions were undertaken, and the studies did not examine media attention to the sites and the impact this may have on salability of properties in close proximity to CPBSs. Finally, as the sponsoring party to the research was a telecommunications company it is questionable whether the results are completely free from bias." Bond, *ibid*, pages 260-261.
- 24 "In general, those people living in areas farther from CPBSs were much more concerned about issues related to proximity to CPBSs than residents who lived near CPBSs. ... Alternatively, the apparent lower sensitivity to CPBSs of case study residents compared to the control group residents may be due to cognitive dissonance reduction. In this case, respondents may be unwilling to admit, due to the large amounts of money already paid, that they may have made a poor purchase or rental decision in buying or renting property located near a CPBS. Similarly, the homeowners may be unwilling to admit there are concerns about CPBSs when the CPBSs were built after they had purchased their homes, because to do so might have a negative impact on property values." Bond, *ibid*, pages 265-266.
- 25 Shari Seidman Diamond; "Reference Guide on Survey Research," *Moore's Federal Practice: Reference Manual on Scientific Evidence* (Washington, D.C.: Federal Judicial Center, 1994 and later).
- 26 S.J. Bond, J. Hopkins, "The Impact of Transmission Lines on Residential Property Values: Results of a Case Study in a Suburb of Wellington, New Zealand," *Pacific Rim Property Research Journal*, Vol. 6, No. 2, 2000.
- 27 C. Kroll, T. Priestley, *The Effects of Overhead Transmission Lines on Property Values: A Review and Analysis of the Literature* (Washington, D.C.: Edison Electric Institute, 1992).