Received December 2010
Accepted March 2011

A meta-analysis of the effect of environmental contamination on non-residential real estate values

Jesse Saginor
College of Architecture, Texas A&M University, College Station, Texas, USA
Robert Simons
Cleveland State University, Cleveland, Ohio, USA, and
Ron Throupe
Burns School of Real Estate & Construction Management, Daniels College of Business, University of Denver, Denver, Colorado, USA

Abstract

Purpose – This paper seeks to reduce the lack of quantitative research by addressing diminution in value to non-residential property resulting from environmental contamination.

Design/methodology/approach – This meta-analysis extracts data from approximately a dozen peer-reviewed articles and 100 case studies from real estate appraisers in the USA. A dataset containing 106 contaminated non-residential observations is examined using Regression (OLS). Forward (stepwise) and backward selection was performed. The dependent variable included percentage loss and dollar amount. The independent variables were contamination type, US region, land use type, distance from the source (mostly contaminated subjects), passage of time, year, urban or rural, market conditions, litigation, and indemnification.

Findings – The model adjusted R squares range from 37 percent to 66 percent. Approximately a third of cases had no loss. This research used petroleum case studies as the reference category for comparison with other types of contamination. The following variables were statistically significant in all four models: Creosote/PCB and Other contamination. The following were significant in two models: Other land use, 30-year mortgage rate, Rural location, TPH, Multiple contamination, TCE, Under-remediation, and Mineral extraction region. Finally, the following variables were significant in one model at least at a 90 percent level of confidence: Heavy metals, Industrial Midwest region, and pre-1995 sale.

Practical implications – Properties in the remediation phase show less of a loss in value. Selective case studies within the same period of the clean-up cycle make the best comparables. The US regional location was less important.

Originality/value – This is the first empirical research using a meta-analysis to study damage effects for non-residential property affected by contamination.

Keywords Meta-analysis, Commercial property, Detrimental conditions, Environmental contamination, Damages, Asset valuation

Paper type Research paper

Journal of Property Investment & Finance
Vol. 29 No. 4/5, 2011
pp. 460-478

1463-578X
DOI 10.1108/14635781111150349

I. Introduction

This research addresses the overall effects of the influence of environmental contamination on commercial and industrial property values. Environmental sources that influence property values include superfund sites, leaking underground storage tanks, landfills, air and water pollution, pipeline ruptures, nuclear power plants, overhead transmission lines, roads, and several other urban nuisance uses. The study begins with summarization of a literature review of approximately a dozen peer-reviewed journal articles, which produced a total of 20 observations (see Appendix). An additional 108 cases were provided by an extensive appraisal transaction database from practicing appraisers. Research findings are combined and distilled into a data set of 106 observations that contains information about each study's dollar property value loss (the dependent variable), with the independent variables being type of contamination, information, urban or rural environment, local and national market conditions, information about the contaminative event, remediation, and several other variables. Regression analysis is used to determine the effect of contamination and other independent variables on sales price, expressed in dollars or percent.

Contamination affects property values through its impact on the real estate bundle of rights. These rights include the rights to possess, enjoy, control, and dispose of real property. A loss can occur in ways other than the discounted sale, such as inability to access capital, finance or refinance, delay of sale, etc. See Simons *et al.* (1999), or Jackson (2001) for a review of how a loss can occur. The sales prices studied in this research are the net proceeds in the disposal part of the real estate bundle of rights (realized capital loss) not considering the timing of sale.

Meta-analysis has traditionally been used for clinical studies and has not been widely applied to real estate. Unlike published work on residential property that relies upon regression analysis, most commercial and industrial studies employ case study methodologies and the site being studied is typically also the source of contamination. Other results are limited to the specific models and discussed in depth in their respective section. These results include varying levels of significance depending on the type of contamination and geographic region. This paper aims to extrapolate similarities across the available data.

II. Existing literature

There has been one meta-analysis of similar scope on the effect of contamination on residential property values, one meta-analysis strictly for air pollution, and two comprehensive literature reviews on the effect of contamination on commercial and industrial real estate values. These analyses and reviews are described below. In addition, Simons (2005) conducted a literature review of over 100 peer-reviewed articles on proximity influence (both positive and negative) for residential and commercial property, which is a partial source of the data set for this study. Despite several excellent international studies, the data set consists of the literature pertaining to the USA due to issues with finding comparable economic indicators for non-US studies.

Simons and Saginor (2006) conducted a meta-analysis of the effects of environmental contamination and positive amenities on proximate residential real estate property values in the USA. Contamination sources include leaking underground storage tanks, superfund sites, landfills, water and air pollution, power lines, pipeline ruptures, nuclear power plants, animal feedlots, and other urban nuisances. The study summarized a literature review of 75 peer-reviewed journal articles and selected case studies. A data set of 290 observations that contain information about each study's loss (the dependent variable), with the independent variables being distance from the source, type of contamination, urban or rural environment, geographic region, market conditions, and several other variables, was prepared. Ordinary Least Squares (OLS) was used to determine the effect of contamination variables on reduction in property value. Broad contamination types, amenities, selected economic regions, distance from the source, information, research method, and several other variables were statistically significant.

Smith and Huang (1995) conducted a meta-analysis of 37 air pollution studies providing 86 estimates of marginal willingness to pay (MWTP) for reduction of PM10 (air pollution particulate of ten microns in diameter) taking place from 1982-1984. The hedonic meta-analysis provides an average of the marginal values estimated under specific circumstances across several US cities employing the OLS and MAD econometric models. Using the MAD estimator, a one unit reduction of PM10 (ug/m^3) resulted in an average MWTP (price increase) of $110 (in 1992 dollars), or about 0.1 percent of property value for each unit reduction in air pollution. Their study was based on reconstructed data, and there were influential outliers that affected the results substantially. Their approach validates the use of OLS and related statistical techniques for this type of study.

Two other literature reviews on the broad subject of contamination and property values have recently been published in peer-reviewed journals[1]. Both are thorough and logical, but neither of the studies made an attempt to statistically compare results, opting instead for a descriptive approach within contamination types or land use categories.

Farber (1998) focused on the theory and empirical outcomes for about 50 articles mostly on landfills, solid waste, superfund sites and other large projects, on residential property values. He used studies dated back to the 1960s. His analytical framework was from the public benefit-cost perspective, and covered the theory and methodology issues for both revealed preferences, (e.g. for actual sales using hedonic regression analysis) and stated preferences (using contingent valuation analysis). He found considerable agreement in the gradient effects across three post-announcement studies with good public information. He also determined that sanitary landfills and coal-fired utilities had comparable loss gradients. He concluded that chemical refineries and nuclear power plants had roughly comparable gradients and that the zonal effects of refineries and sanitary landfills were quite comparable and substantial (Farber, 1998). Factors found to affect property value included type of facility, distance, information (relative to an opening or closing date), thin markets, and the employment effects of the source.

Jackson (2001) considered 45 articles that dealt with the effects of environmental contamination on real estate, covering real estate appraisal theory, and sales price analysis. The appraisal theory coverage includes stigma, mortgage financing, marketability of frozen assets, risk premium adjustment to the discount rate, market demand, and timing of sale with respect to remediation. Other transaction-specific items, notably the possibility of third-party lawsuits and indemnification of buyers by sellers, are also addressed. In terms of the quantitative review, Jackson reviewed about 20 articles that had empirical results for residential and commercial property affected by landfills, petroleum, superfund sites, and similar uses. His articles included hedonic regression analysis, case studies, and reported appraisal outcomes. The residential studies were published beginning in 1982. He looked at effects over time, distance, within different markets, sales price discounts (some found no effects) and other reported effects on transaction rates and seller financing. Jackson offers no final observations on the consistency of the findings, other than that 15 studies showed negative effects and four showed no effects, and that intervening factors may play a role. He calls for a more systematic study and additional research for non-residential property.

To summarize, the literature reviews and consideration of the theory concerning the effects of contamination on property values reveal that the effect of contamination or another amenity on property value is based on several factors, including: land use type, distance from the source, pathway, passage of time, existence of the condition, information, calendar year, urban or rural environment, and market conditions. In some cases, indemnification and the presence of litigation may also play a role. Unlike a pure meta-analysis paper (Simons and Saginor, 2006), the study type (e.g. regression, case study, survey) cannot be controlled for because all results used case studies as the research methodology. However, we are able to add seller indemnification and seller-provided below-market financing deal terms as dummy variables.

III. Model and data

The review of the literature on this topic has revealed a number of factors that can affect the price of commercial real estate from environmental contamination. The dependent variable is the real change in property value in 2004 dollars. The regression model for this study is expressed as:

$$\begin{aligned}\text{DIMVAL} = {} & \beta_0 + \beta_1\text{RELVAL} + \beta_2\text{GEO} + \beta_3\text{CONTCOND} + \beta_4\text{SOURCE} \\ & + \beta_5\text{CONTTYPE} + \beta_6\text{LITIG} + \beta_7\text{TERMS} + \beta_8\text{URB} + \beta_9\text{UNEMP} \\ & + \beta_{10}\text{INDEM} + \beta_{11}\text{CHINLU} + \beta_{12}\text{ACRES} + \varepsilon \qquad (1)\end{aligned}$$

where these factors are variables or vectors as follows:

- DIMVAL = Property value diminution variation in 2004 dollars (dependent variable). An alternative specification is DIMPERC the real loss in percent.
- REALVAL = Unimpaired property value in 2004 dollars.
- GEO = US economic geographic location based on Salomon Brothers definitions: Farmbelt, Industrial Midwest, Mid-Atlantic Corridor, Mineral Extraction, New England, Northern California, South, and Southern California.
- CONTCOND = Influence condition is either in remediation or ongoing (ongoing), is the result of a sudden event (sudden), or is in post-remediation (NFA Postrem).
- SOURCE = A dummy variable if the pollution comes from the subject Property (0) or is proximate (1).
- CONTTYPE = Type or source of contamination: including asbestos (ASBESTOS) benzene (BENZ); an unspecified chemical

(CHEM); creosote/PCB. (CREOPCB); diesel, methane, and/or natural gas (GAS); dioxin and PCB (DIOXPCB); heavy metals such as mercury and arsenic (METAL); multiple types of contamination (MULTIPLE); other, unspecified type of contamination (OTHER); petroleum (PETROL); Trichloroethylene (TCE); toxic or volatile type of contamination (TOXIC); and total petroleum hydrocarbons (TPH).

LITIG = The study was conducted for or the sale was part of litigation.

TERMS = A dummy variable if the sale was known to have terms favorable to the buyer (1), such as seller financing, otherwise (0).

UNEMP = Unemployment rate in the county of sale in 1999.

URB = Intra-urban market location urban (urban), suburban (suburban), rural (rural) or mixed (mix) market where sale was recorded.

INDEM = A dummy where the property buyer received indemnification from the seller (1), zero otherwise.

CHINLU = A dummy variable (index) where the property had a change in land use from the prior use (1), otherwise (0). An alternative configuration has land use type (retail, industrial, residential/vacant).

ACRES = Size of the parcel in acres.

ε = Error term.

IV. Data set

The data set came from two source areas. The first is the comparable sales data set of case studies from practicing appraisal firms. The original data set included 115 contaminated sales since 1988 and contained approximately 20 variables concerning the transaction, including environmental conditions, location, and terms. Each case study yielded one observation. The smaller data set came from published case studies since 1980 and had similar information, although not always in such detail. Some articles contained sales that were in the comparables data set, and double counts were removed. A list of these articles is included at the end of this paper. Each article yielded between 1-8 observations. Economic proxy variables (interest rate, unemployment), locational (region of USA, intra-metropolitan location), were added to the combined data set, and dollar values normalized to 2004 using the national consumer price index (CPI-U). Outliers were identified and missing data holes were filled as appropriate.

The contamination types covered were numerous, and are shown on Table I. Petroleum contamination, asbestos, heavy metals and hydrocarbon fuels were the most common categories.

The properties ranged in size from under an acre for a small gas station to 860,746 acres for a community shopping center with a mean of 26,643 acres. In 2004 dollars, the unimpaired values of the properties had a mean of $10,969,166. The highest unimpaired value was nearly $438 million for a landfill in Santa Clara County, California with a proposed use as a golf course. The lowest unimpaired value was $37,812 for a small

	n	Mean	Minimum	Maximum	Range	Std. deviation
ACRES	111	26,643	0	860,746	860,746	103,810
PERCTDIM	112	23%	0%	97%	97%	25.64
DIMVAL	110	$4,446,526	$ –	$420,000,000	$420,000,000	40,013,101
UNIMP2K4	108	$10,969,166	$37,812	$437,500,000	$437,462,188	54,425,468
SALEYR	108	1991	1983	2004	21	3.58
UNEMP2K	111	5.30	2.56	10.95	8.39	1.74
30yrrt	107	9.12	6.95	13.87	6.92	1.56
Valid *n*	106					
Geographic regions						
Northeast	2					
Industrial Midwest	24					
Mid-Atlantic	3					
South	25					
Farmbelt	4					
Mineral extraction	17					
Southern California	12					
Northern California	24					
USA	0					
Date contamination originally discovered in relation to significant US EPA legislation						
Pre-1995	93					
Contamination condition						
No remediation	55					
Under-remediation	45					
NFA Post-remediation	12					
Source of contamination						
Asbestos	14					
Chemical	2					
Creosote/PCB	3					
Dioxin/PCB	3					
Heavy metals	8					
Methane	6					
Multiple sources	8					
Not specified	9					
Other	3					
Petroleum/enzene/diesel	41					
TCE	4					
Toxic/volatile	6					
TPH	5					
Location						
Urban	87					
Suburban	23					
Rural	2					
Indemnification						
None	80					
Partial	17					
Full	15					
Terms of sale neutral						
Yes	101					
No	11					
Land use						
Commercial	48					
Industrial	26					
Other	26					
Retail	12					

Table I.
Descriptive statistics

warehouse in North Carolina. The sale year of the properties ranged from 1983 to 2004 with a mean of 1991, indicating that a majority of the sample found contamination before the federal government implemented more stringent environmental programs in 1995. The lowest 2004 unemployment rate of 2.56 percent was in Washington County, Minnesota and the highest unemployment rate of 10.95 percent was in Lake County, California. A majority of properties were located in urban areas and there were no explicit indications of indemnification or terms of the sale that were not neutral.

The change in property value (DIMVAL) is the dependent variable in this research, although a model was also run with percent diminution (DIMPERC, calculated as DIMVAL/REALVAL). An important independent variable is unimpaired property value price (REALVAL). If the change in property value was given in dollars rather than percent and no median sales price existed in the study, unimpaired property value was derived by dividing the dollar loss by the reported percentage reduction in value.

The geographic variable (GEO) comes from the economic region definitions set forth by David Hartzell and others from Salomon Brothers for the purpose of real estate portfolio diversification analysis in the late 1980s, and highlighted in Malizia and Simons (1991). The Salomon Brothers' *Economic Geography of the United States* has eight distinct geographic regions[2].

Condition (CONTCOND) focuses on the environmental condition of the affected property at the time the study was conducted. In some cases, as in an explosion or chemical spill, it happened suddenly at a single point in time with a definite date corresponding to it. In other cases, such as noise from a railroad or airport, the effect is ongoing. The effect is also ongoing if the source of contamination is presently in remediation. For some studies, the property was in post-remediation and/or had received "No Further Action" status. A dummy variable was created for each of these situations.

Source of contamination (SOURCE) is a dummy variable with a value of 1 where the property that sold is also the source of contamination (which was typical), zero otherwise. There are no other distance variables in this model.

There were 12 general types of contamination (CONTTYPE) based on the overall sample[3]. The groups were created because the expected effects of each contamination type were of a similar magnitude. These included asbestos (ASBESTOS), an unspecified chemical (CHEM), creosote/PCB (CREOPCB), dioxin and PCB (DIOXPCB), heavy metals such as mercury and arsenic (METAL), methane (METHANE), multiple types of contamination (MULTIPLE), non-specified type of contamination (NONSPEC), other type of contamination (OTHER), benzene, diesel, natural gas, and/or petroleum (PETROLEUM), total petroleum hydrocarbons (TPH), toxic or volatile type of contamination (TOXIC), and Trichloroethylene (TCE).

While some of the peer-reviewed articles were prepared by researchers with purely an academic interest in determining the property effects from an environmental source, some of the studies were involved in litigation, such as a class action suit in response to contamination. For the comparable data set of sales, an unknown number of observations were involved in litigation. Hence, a litigation dummy will be included in some model runs to determine if these sales were more likely to sustain larger losses.

Two other variables are inserted to control for variation in economic market conditions. The unemployment variable (UNEMP2K) used the 1999 unemployment rate in the county of sale (from the 2000 Census) and served as a proxy variable for local economic conditions on the demand side of the housing market. To control for the national economy and interest rates for the year of sale, the annual average rate of the conventional 30-year mortgage (CONV30RT) was included. High mortgage rates are generally associated with two contradicting factors: discount rates are high, and therefore investment feasibility is generally lower; and higher inflation is associated with increased real estate values.

The urban variable (URB) addresses intra-urban location of the sales area, as a proxy for market depth. This variable was specified as urban, suburban, rural, or mixed. Some studies mixed either urban and suburban or suburban and rural depending on the location of the contamination.

The (TERMS) variable is a dummy variable if the sale was known to have terms favorable to the buyer (1), such as seller financing, otherwise (0).

The INDEM variable was a dummy variable where the property buyer received indemnification from the seller (1), zero otherwise.

To account for change in land use (CHINLU) a dummy variable (index) was created where the property had a change in land use from the prior use (1), otherwise (0). To account for different non-residential land uses (USE) dummy variables were created to indicate whether the property was used for commercial, industrial, other, or retail use. Other uses included apartment buildings as well as vacant land. Finally to cover lot size, the variable ACRES indicated the size of the parcel in acres.

Some caveats apply to the data set. For example, some of the results are dated and may not be indicative of changes in either the market or existing laws. The disclosure laws from the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) changed in 1994 and again in 2003. The 1994 change required disclosure of environmental hazards to residents, which may also have heightened awareness of nearby contamination to prospective commercial buyers. The 2003 change, largely in response to possible terrorist threats, included several chemicals that were not sources of contamination, but nearby existing hazards (EPA Legislative Website). Despite the changes in laws and market behavior, there is no indication that it affected the results of each included study as well as the overall study.

V. Regression diagnostics

The data for negative amenities were checked for multicollinearity between independent variables and report the VIF and TOL indicators along with the model results. No variables had multicollinearity problems, since all scored well below the VIF cutoff of 10.0. The data set was also screened for outliers. To test for heteroscedasticity, we ran scatter plots of the residuals of the dependent variable. Minimal fanning or cone-shaped patterns were evident. However, there was one notable outlier with a large loss present below the trend line. This outlier contributes largely to the significance of the "other source of contamination" variable in the following models. Further inspection reveals the outlier to be the case of a former animal research and development facility contaminated with the Ebola virus.

VI. Research questions

We want to understand which types of contamination have larger or smaller effects on property values. We are also interested to see if patterns of commercial and residential property damages are similar. Finally we would like to determine if indemnification and remediation affect discounts and whether the macro-location of a case study (e.g. part of the USA) is critical when selecting case studies for the valuation of damages.

VII. Results

Four models were run. The model with 106 valid observations was run twice; once with the diminution in value as the dependent variable and the other with the diminution in percent as the dependent variable. Each of these models was later run using stepwise regression analysis. Of the 106 observations included in the models, 31 had zero property loss. These observations are included in all of the models to accurately reflect effects of contamination on property value. The reference categories for both models were as follows: South region, no remediation of the contaminated site, petroleum contamination, urban location, and commercial use. A positive parameter estimate means losses from contamination are larger, and a negative number means losses decrease, relative to the combined reference categories. This model structure also means we cannot provide independent loss estimates for petroleum contamination, or other reference category factors.

The base model included all sales affected by negative proximity influences. Tables II and III contain results for the full models. For the model with diminution in percent as the dependent variable, the *F* statistic was 2.6, and the adjusted *R* squared was 0.36. The *F* stat is quite low, but the *R* squared is reasonable, given the number of observations and variables

For the model with DIMPERC as dependent variable (Table II), the following variables had statistically significant results:

(1) UR: property losses due to a commercial site under remediation were 13.2 percent[4] less than a site with no remediation. This was statistically significant at a 99 percent level of confidence, holding all else constant. The price discount is calculated by converting the regression coefficients to a percentage of sales price using the relationship that percent discount $=100$ ($e^{beta}-1$).

(2) CONTTYPE: type of contamination, compared with a property that contained or was proximate to petroleum contamination, which is the reference category:

- OTHER: Other forms of contamination of a unique variety, such as Ebola, had the expected positive sign, indicating that property losses from other forms of contamination produced losses 53 percent greater than losses from petroleum contamination. This result was statistically significant at a 99 percent level of confidence.
- CREOSOTE/PCB: Creosote and PCBs had a significant, negative effect on property values, resulting in losses 38.5 percent greater than losses from petroleum.
- MULTIPLE: Multiple sources of contamination containing at least 3 different sources resulted in losses that were 25.2 percent greater and significant at a 99 percent level.
- METHANE: Contamination resulting from methane was significant at a 95 percent and resulted in losses that were 26 percent higher.
- METALS: Contamination from heavy metals such as lead and mercury had a significant, negative effect on property value. The effect amounted to losses 20.5 percent greater than losses from petroleum.
- NONSPEC: Unspecified sources of contamination were significant at a 90 percent level with losses that were 16.8 percent greater.

	B	Std. error	Beta	t	Sig.	Tolerance	VIF
(Constant)	0.479	0.229		2.093	*0.040*		
Real 2004 $Value	0.000	0.000	−0.063	−0.655	0.514	0.666	1.502
Pre-1995	0.016	0.092	0.021	0.172	0.864	0.398	2.515
Northeast	−0.150	0.180	−0.082	−0.830	0.410	0.635	1.574
Industrial Midwest	0.060	0.092	0.099	0.653	0.516	0.267	3.745
Mid-Atlantic	0.117	0.163	0.078	0.719	0.475	0.524	1.908
Farmland	−0.021	0.122	−0.016	−0.170	0.866	0.704	1.421
Mineral Extraction	0.076	0.099	0.106	0.766	0.446	0.323	3.100
Southern California	−0.106	0.107	−0.129	−0.987	0.327	0.358	2.796
Northern California	−0.054	0.085	−0.088	−0.637	0.526	0.323	3.091
Under-remediation	−0.142	0.052	−0.280	−2.719	*0.008*	0.580	1.725
NFA Postrem	−0.098	0.093	−0.114	−1.047	0.299	0.515	1.943
Distance	−0.074	0.070	−0.125	−1.046	0.299	0.430	2.328
Asbestos	0.052	0.093	0.071	0.564	0.574	0.388	2.574
Heavy metals	0.229	0.113	0.228	2.033	*0.046*	0.490	2.039
TCE	0.135	0.157	0.090	0.862	0.392	0.566	1.768
Methane	0.298	0.142	0.253	2.109	*0.039*	0.426	2.350
Toxic/volatile	0.107	0.138	0.082	0.776	0.440	0.557	1.796
Multiple	0.290	0.108	0.307	2.694	*0.009*	0.473	2.112
TPH	0.112	0.115	0.095	0.975	0.333	0.647	1.546
Dioxins/PCB	0.014	0.162	0.008	0.087	0.931	0.788	1.268
Creosote/PCB	0.486	0.153	0.323	3.165	*0.002*	0.591	1.691
Chemical	0.245	0.179	0.134	1.367	*0.176*	0.643	1.556
Other	0.752	0.137	0.499	5.483	*0.000*	0.741	1.350
Not specified	0.184	0.109	0.205	1.683	*0.097*	0.413	2.419
Literature	0.179	0.126	0.178	1.415	*0.162*	0.388	2.574
Suburban	0.004	0.063	0.007	0.066	0.948	0.589	1.698
Rural	0.773	0.260	0.299	2.974	*0.004*	0.607	1.649
Partial indem	−0.045	0.065	−0.066	−0.692	0.491	0.672	1.488
Full indem	0.000	0.075	−0.001	−0.005	0.996	0.562	1.781
2000 Unemployment rate	−0.024	0.019	−0.167	−1.279	*0.205*	0.359	2.789
30-year mortgage rate	−0.017	0.023	−0.109	−0.773	0.442	0.307	3.254
Neutral Sale Terms	0.033	0.079	0.039	0.420	0.676	0.713	1.403
Retail Use	0.045	0.078	0.057	0.574	0.568	0.620	1.613
Industrial Use	−0.036	0.073	−0.060	−0.487	0.628	0.406	2.462
Other Use	−0.113	0.066	−0.186	−1.699	*0.094*	0.515	1.942
Acres	0.000	0.000	−0.047	−0.512	0.610	0.733	1.364

Notes: Dependent variable: DIMPERC; Reference Categories: South, no remediation, petroleum, urban, commercial use; $n = 106$, df = 71, adjusted R square = 0.36, R square = 0.58, F stat = 2.6

Table II. Full model (dependent variable = Dim percent)

(3) RURAL: Contamination occurring in rural areas resulted in losses that were 53.8 percent greater than contamination in urban areas. This finding was significant at a 99 percent level.

(4) UNEMPLOYMENT: The local unemployment rate was significant and negative. This result was against theory given that increased unemployment should have a negative effect on property value.

(5) OTHERUSE: Other land uses, such as vacant land or apartment buildings, have smaller losses than commercial land. This was significant at a 90 percent level.

Table III.
Full model (dependent variable = dim value)

	B	Std. error	Beta	T	Sig.	Tolerance	VIF
(Constant)	− 1202441.08	1123427.193		− 1.070	0.288		
Real 2004 $Value	0.00	0.003	− 0.022	− 0.286	0.776	0.666	1.502
Pre-1995	− 962883.05	450080.647	− 0.215	− 2.139	*0.036*	0.398	2.515
Northeast	− 347294.33	885340.116	− 0.031	− 0.392	0.696	0.635	1.574
Industrial Midwest	325919.23	451366.452	0.088	0.722	0.473	0.267	3.745
Mid-Atlantic	− 314617.33	799864.834	− 0.034	− 0.393	0.695	0.524	1.908
Farmland	152817.37	600623.279	0.019	0.254	0.800	0.704	1.421
Mineral Extraction	591303.72	485396.250	0.136	1.218	0.227	0.323	3.100
Southern California	− 527748.38	526740.759	− 0.106	− 1.002	0.320	0.358	2.796
Northern California	− 149637.48	416768.280	− 0.040	− 0.359	0.721	0.323	3.091
Under-remediation	59755.57	256804.652	0.019	0.233	0.817	0.580	1.725
NFA Postrem	360054.09	458065.143	0.069	0.786	0.435	0.515	1.943
Distance	109466.21	345582.127	0.031	0.317	0.752	0.430	2.328
Asbestos	− 76559.72	455327.763	− 0.017	− 0.168	0.867	0.388	2.574
Heavy metals	− 35831.53	552257.338	− 0.006	− 0.065	0.948	0.490	2.039
TCE	1454974.18	769910.040	0.159	1.890	*0.063*	0.566	1.768
Methane	202946.15	694354.627	0.028	0.292	0.771	0.426	2.350
Toxic/volatile	− 78950.40	675344.020	− 0.010	− 0.117	0.907	0.557	1.796
Multiple	679295.61	528449.240	0.118	1.285	*0.203*	0.473	2.112
TPH	1683019.48	563220.792	0.235	2.988	*0.004*	0.647	1.546
Dioxins/PCB	133072.87	794788.385	0.012	0.167	0.868	0.788	1.268
Creosote/PCB	1086794.68	752984.165	0.119	1.443	*0.154*	0.591	1.691
Chemical	282327.98	880248.166	0.025	0.321	0.749	0.643	1.556
Other	6647758.34	672817.247	0.727	9.880	*0.000*	0.741	1.350
Not specified	− 342898.48	535914.384	− 0.063	-0.640	0.524	0.413	2.419
Literature	− 600789.02	620474.387	− 0.098	-0.968	0.336	0.388	2.574
Suburban	42834.85	308907.624	0.011	0.139	0.890	0.589	1.698
Rural	597055.63	1275296.400	0.038	0.468	0.641	0.607	1.649
Partial indem	148211.55	319404.062	0.036	0.464	0.644	0.672	1.488
Full indem	− 171126.21	367885.929	− 0.039	− 0.465	0.643	0.562	1.781
2000 Unemployment rate	36651.79	92563.537	0.042	0.396	0.693	0.359	2.789
30-year mortgage rate	231306.86	110978.360	0.238	2.084	*0.041*	0.307	3.254
Neutral Sale Terms	− 101491.38	389221.335	− 0.020	− 0.261	0.795	0.713	1.403
Retail Use	− 9715.62	385102.715	− 0.002	− 0.025	0.980	0.620	1.613
Industrial Use	− 9983.26	360499.428	− 0.003	− 0.028	0.978	0.406	2.462
Other Use	− 363723.49	325025.840	− 0.099	− 1.119	0.267	0.515	1.942
Acres	− 0.48	1.073	− 0.033	− 0.447	0.657	0.733	1.364

Notes: Dependent variable: DIMVAL; Reference categories: South, no remediation, petroleum, urban, commercial use; $n = 106$, df = 71, adjusted R square = 0.58, R square = 0.73, F stat = 5.0

For the model with diminution in value as the dependent variable, the F statistic was 5.0 with an adjusted R squared of 0.58. The R squared in particular was improved over the previous model. We attribute the differing results between logarithmic and linear forms as a dependent variable to a size effect. The analogy would be a retail center with a localized contamination such as a dry cleaner. When the damages are spread over the value of the entire center, the percentages (rather than dollar amount) of economic damages based on value diminish accordingly.

The following variables had statistically significant results for the model where diminution in value was the dependent variable (Table III):

(1) PRE1995: Properties where the contamination existed before the implementation of important US federal environmental guidelines in 1995 had the expected negative sign and was significant at the 95 percent level. The parameter estimate was quite large at approximately $962,883, supporting the concept that market participants adjust purchase prices over time as they learn and understand the type of contamination and the ability to remediate with better science and methods over time.
(2) CONTTYPE: for the various types of contamination compared to petroleum:
   - TCE: Properties contaminated with TCE showed property losses in value of nearly $1.5 million more than for properties contaminated by petroleum. This result was significant at a 90 percent level; supporting that notion that TCE as a newer contaminant in comparison to petroleum is less understood by market participants.
   - TPH: Results for TPH were similar to TCE with greater statistical significance. Losses were $1.68 million greater for TPH than for petroleum and were significant at a 99 percent level.
   - OTHER: "Other types" (including the Ebola virus) of contamination had the greatest losses and the highest significant. The loss for other types of contamination was $6.6 million greater than petroleum, and was significant at a 99 percent level.
(3) 30YRRT: For the 30-year mortgage rate, property value decreases as the mortgage rate increases, which was significant at a 95 percent level? This could indicate that change in commercial property values is more sensitive to decreases based on lower perceived investment returns than increases based on inflation.

VIII. Stepwise analysis

Tables IV and V contain results for both models with the same data, where stepwise regression was used to generate the models. The stepwise threshold for these models accepted variables at the 95 percent level of confidence and stopped accepting variables at a 90 percent level. For the stepwise model with diminution in percent as the dependent variable, the adjusted R squared was 0.41, and the F statistic was 11.3.

	B	Std. error	Beta	t	Sig.	Tolerance	VIF
(Constant)	0.174	0.032		5.454	0.000		
Other	0.671	0.115	0.445	5.835	0.000	0.973	1.028
Under-remediation	−0.115	0.040	−0.227	−2.906	0.005	0.928	1.077
Multiple	0.171	0.073	0.181	2.343	0.021	0.953	1.049
Rural	0.586	0.196	0.227	2.988	0.004	0.983	1.017
Industrial Midwest	0.164	0.048	0.270	3.413	0.001	0.907	1.102
Mineral Extraction	0.167	0.057	0.233	2.924	0.004	0.890	1.124
Creosote/PCB	0.284	0.116	0.189	2.448	0.016	0.952	1.051

Notes: Dependent variable: DIMPERC; $n = 106$, df = 71, adjusted R square = 0.41; R square = 0.45; F stat = 11.3

Table IV. Stepwise regression for diminution in percent

	B	Std. error	Beta	T	Sig.	Tolerance	VIF
(Constant)	−1,065,115.22	533,180.72		−1.998	0.049		
Other	6,500,310.92	533,255.85	0.710	12.190	0.000	0.972	1.029
Mineral Extraction	878,249.49	267,192.69	0.202	3.287	0.001	0.878	1.139
TPH	1,678,535.53	429,323.62	0.234	3.910	0.000	0.918	1.089
30yrrt	149,911.88	57,805.84	0.154	2.593	0.011	0.934	1.071
Creosote/PCB	1,530,717.98	529,421.39	0.167	2.891	0.005	0.986	1.014
Other Use	−584,848.28	223,235.85	−0.159	−2.620	0.010	0.900	1.111
TCE	1,220,421.12	529,323.46	0.133	2.306	0.023	0.987	1.014

Notes: Dependent variable: DIMVAL04; $n = 106$, df = 71, adjusted R square = 0.66, R square = 0.68; F stat = 29.4

Table V.
Stepwise regression for diminution in value

In general, the stepwise regressions were is more parsimonious because it excludes or includes variables based on a set threshold in relation to the overall model, thus resulting in a higher explanatory power than the backward selection models.

For the stepwise model with DIMPERC as dependent variable (Table IV), the following variables had statistically significant results for the model where diminution in percent was the dependent variable: the Constant term, Other type of contamination, Multiple contamination, creosote/PCB, Under remediation, Rural location, Industrial Midwest and Mineral Extraction regions. With the exception of Under remediation, the other variables were associated with increased property damages. All were statistically significant at 95 percent level of confidence or greater.

For the stepwise model with DIMVAL as dependent variable (Table V), the adjusted R squared was 0.66, and the F statistic was 29.4. In addition to the constant term, several variables had statistically significant results for the model. Three types of contamination were significant: Other type of contamination, TPH, and creosote/PCB. The mortgage rate, other land use, and the Mineral Extraction region were also significant. With the exception of other land use, the other variables were associated with increased property damages. All were statistically significant at 95 percent level of confidence or better.

It appears that at least part of the increase model efficiency provided by stepwise is that it allows some, but not all, of the economic regions to be in the models.

IX. Conclusions and policy recommendations

This paper has analyzed the effect of contamination on commercial property using a mixed data set of published peered review literature and appraisal sales data set of case studies. The data set included 106 commercial property transactions with a mean value of $11 million and an average size of 27 acres from throughout the USA. The average diminution in property value attributable to contamination was 23 percent. Approximately a third of the property sales reveal no value loss. We performed both forward (stepwise) and backward selection using OLS. We also attempted to reconcile the results with various models and different operating assumptions. A comparison of the models within this research is presented in Table VI.

The model adjusted R squares range from 37 percent to 66 percent. The variables set included the location categories, contamination type, transaction terms, indemnification, land use type, project size, and economic control variables. The

	Model 1 DP	Model 2 DV	Model 3 DP step	Model 4 DV step	Overall
Real 2004 $Value					
Pre-1995		−962,883			1
Northeast					
Industrial Midwest			0.164		1
Mid-Atlantic					
Farmland					
Mineral extraction			0.167	878,249	*2*
Southern California					
Northern California					
Under-remediation	−0.142		−0.115		2
NFA Postrem					
Distance					
Asbestos					
Heavy metals	0.229				*1*
TCE		1,454,974		1,220,421	2
Methane					
Toxic/volatile					
Multiple		*679,295*	0.171		*2*
TPH		1,683,019		1,678,536	2
Dioxins/PCB					
Creosote/PCB	0.486	*1,086,795*	0.284	1,530,718	*4*
Chemical	*0.245*				
Other	0.752	6,647,758	0.671	6,500,311	*4*
Not specified	0.184				*1*
Literature	*0.179*				*1*
Suburban					
Rural	0.773		0.586		*2*
Partial indem					
Full indem					
2000 Unemployment rate	− *0.024*				*1*
30-year mortgage rate		231,307		149,912	2
Neutral Sale Terms					
Retail Use					
Industrial Use					
Other Use	−0.113			−584,848	*2*
Acres					

Notes: Parameter estimates significant at 0.10 or better, 0.1-0.2 in italics

Table VI. Comparison of the four models

model runs showed some similarities in terms of significant variables, but 16 variables were significant in at least one model. Some variables appeared to be the most robust. The following variables were statistically significant in all four models: Creosote/PCB and Other contamination (Ebola virus). Not surprising, as Flynn *et al.* (2001) explains why these types of contaminant are the most feared by the public. The following were significant in two models: Other land use, 30 year mortgage rate, Rural location, TPH, Multiple contamination, TCE, Under remediation, and Mineral Extraction Region. Finally, the following variables were significant in one model at least at a 90 percent level of confidence: Heavy metals, Industrial Midwest region, and pre-1995 sale.

This research serves as a baseline for future research of damage effects for commercial property affected by contamination. This research used petroleum case studies as reference for comparison to other types of contamination, and results show that some contaminants indeed have produced a greater detriment in value than petroleum. These results support Bell *et al.* (2008), which shows that it is important to use similar detrimental conditions and in this case like-kind contamination scenarios when possible for commercial property damage valuation. The results from the current research also demonstrate, as expected, that properties in the remediation phase show less of a loss in value in comparison to properties, which are not yet in a remediation phase. These results again support Bell, who suggests carefully selecting case studies which are within the same period of remediation within the real estate damages clean-up cycle make the best comparables.

The current commercial results can also be compared with residential findings from Simons and Saginor (2006). Apparently, region of the US is much less important as a controlling factor for commercial properties (where the current models showed 0-2 US regions to be statistically significant) than it is for residential properties (where three-to-four regions were significant in Simons and Saginor's 3 models). The overall results of this study are a reminder that the study of damage effects for source and non-source property may require separate considerations for commercial properties. Also, these results suggest that the physical location of a case study in comparison to a subject property being evaluated need not be from the same general region or local in nature. Case studies are developed that are generally similar in detrimental conditions. As stated by Orel Anderson (2010) "Finding identical transactions is impractical if not impossible and, as such, data that is other-similar becomes the objective". The selection of relevant case studies is better focused on the type of contaminant or detrimental condition. Also, where the property is within the detrimental condition lifecycle of pre-, during-, or post-remediation and a need to take into consideration if indemnification is part of any transaction (whereas it is likely that very few if any residential transactions are indemnified because they are almost never the source property for contamination). Finally, additional research on commercial property valuation and contamination is warranted to examine whether the toxicities of the past, on average, show a consistent diminution in value or whether, as some argue, that contamination is now better known, can be better managed, and may lead to a lower diminution on property values. Also of interest is whether more recently used or acknowledged toxic chemicals have higher rates of value reduction than older and possibly more understood contaminants. An example would be evaluating TCE in comparison to a more familiar petroleum-related chemical such as Benzene. Future research of commercial properties within the study of detrimental conditions is warranted to develop comprehensive data sets for analysis. These data can fuel an analysis to rank which contaminants or conditions lead to greater damage potentials for commercial properties.

Notes

1. Boyle and Kiel (2001) also provide an excellent article reviewing over 30 hedonic studies and their effect on residential property. Their study is not reviewed here because we focus on commercial studies.

2. New England consists of all states east of New York. The Industrial Midwest stretches from New York to Pennsylvania, West Virginia, Ohio, southern Michigan, central and northern Indiana and Illinois and southeastern Wisconsin, including Milwaukee. The Farmbelt includes northern Michigan and Wisconsin, extreme southern Indiana and Illinois, Missouri, Iowa, Minnesota, North and South Dakota, Nebraska, and Kansas. The Mid-Atlantic Corridor covers Delaware, Maryland, and New Jersey. The South runs from Virginia and Kentucky south to the gulf states of Florida, Mississippi, and Alabama. It also includes Arkansas but not Louisiana. Based on Louisiana's oil industry, it is part of the Mineral Extraction region, which also includes Texas, Oklahoma, and New Mexico, then moving northwest across Colorado, and west to east central Nevada, with Idaho and Montana as its northern border. Alaska is also included in the Mineral Extraction region. Southern California includes southern California, southern Nevada, and Arizona. Northern California includes northern California north of Los Angeles, northwestern Nevada, Oregon, Washington, and Hawaii.
3. The original model had 15 different types of contamination. Of these, only three types were statistically significant. At a 95 percent level of confidence, "other types of contamination" and TPH were significant. At a 90 percent level of confidence, only creosote/PCB was significant. No other types of contamination were significant when the threshold was lowered to an 85 percent level of confidence.
4. We have converted the results according to Halvesen and Palmquist (1980). We acknowledge that other methods of interpretation, such as reporting the untransformed "straight percentage", are also valid. Either way, the results are similar.

References

Anderson, O.C. (2010), "Fundamentals of environmental real estate damage valuation", *The Environmental Litigator*, pp. 3-5, 18.

Bell, R., Anderson, O.C. and Sanders, M.V. (2008), *Real Estate Damages: Applied Economics and Detrimental Conditions*, 2nd ed., Appraisal Institute, Chicago, IL.

Boyle, M. and Kiel, K. (2001), "A survey of house price hedonic studies of the impact of environmental externalities", *Journal of Real Estate Literature*, Vol. 9 No. 2, pp. 116-44.

Farber, S. (1998), "Undesirable facilities and property values: a summary of empirical studies", *Ecological Economics*, Vol. 24, pp. 1-14.

Flynn, J., Slovak, P. and Kunreuther, H. (2001), *Risk, Media and Stigma: Understanding Public Challenges to Modern Science and Technology*, Earthscan Publications, Oxford.

Halvesen, R. and Palmquist, R. (1980), "The interpretation of dummy variables in semi-logarithmic equations", *American Economic Review*, Vol. 70 No. 3, pp. 474-5.

Jackson, T. (2001), "The effects of environmental contamination on real estate: a literature review", *Journal of Real Estate Literature*, Vol. 9 No. 2, pp. 93-116.

Malizia, E. and Simons, R.A. (1991), "Comparing regional classifications for real estate portfolio diversification", *The Journal of Real Estate Research*, Vol. 6 No. 1, pp. 53-77.

Simons, R.A. (2005), "Peer-reviewed evidence on property value impacts by source of contamination", *When Bad Things Happen to Good Property*, Environmental Law Institute Press, Washington DC.

Simons, R.A. and Saginor, J. (2006), "A meta analysis of the effect of environmental contamination and positive amenities on residential property values", *Journal of Real Estate Research*, Vol. 71 No. 104, pp. 71-104.

Simons, R.A., Bowen, W. and Sementelli, A. (1999), "The price and liquidity effects of UST leaks from gas stations on adjacent contaminated property", *The Appraisal Journal*, Vol. 67 No. 2, pp. 186-94.

Smith, K.V. and Huang, J. (1995), "Can markets value air quality? A meta-analysis of hedonic property value models", *Journal of Political Economy*, Vol. 103 No. 1, pp. 209-27.

Further reading

Shulman, D. and Hopkins, R.E. (1998), *Economic Diversification in Real Estate Portfolios*, Salomon Brothers, New York, NY.

Wolf, F.M. (1986), *Meta-Analysis Quantitative Methods for Research Synthesis*, Quantitative Applications in the Social Sciences No. 59, Sage Publications, Newbury Park, CA.

Appendix. References of proximity to non-residential sources used in the meta-analysis

Closser, B.M. (2001), "Fuel-oil contamination of a residence: a case study in stigma", *The Appraisal Journal*, Vol. 69 No. 6, pp. 307-11.

Fisher, J.D., Lentz, G.H. and Tse, K.S.M. (1992), "Valuation of the effects of asbestos on commercial real estate", *The Journal of Real Estate Research*, Vol. 7 No. 3, pp. 331-50.

Fisher, J.D., Lentz, G.H. and Tse, K.S.M. (1993), "Effects of asbestos on commercial real estate: a survey of MAI appraisers", *The Appraisal Journal*, Vol. 61 No. 4, pp. 587-99.

Folland, S. and Hough, R. (2000), "Externalities of nuclear power plants: further evidence", *Journal of Regional Science*, Vol. 40 No. 4, pp. 735-53.

Guntermann, K.L. (1995), "Sanitary landfills, stigma and industrial land values", *The Journal of Real Estate Research*, Vol. 10 No. 5, pp. 531-42.

Jackson, T.O. (2001), "The effects of previous environmental contamination on industrial real estate prices", *The Appraisal Journal*, Vol. 69 No. 2, pp. 200-10.

Neustein, R.A. (1992), "Estimating value diminution by the income approach", *The Appraisal Journal*, Vol. 60 No. 2, pp. 283-7.

Page, W.G. and Rabinowitz, H. (1993), "Groundwater contamination: its effects on property values and cities", *Journal of the American Planning Association*, Vol. 59 No. 4, pp. 473-81.

Patchin, P. (1994), "Contaminated properties and the sales comparison approach", *The Appraisal Journal*, Vol. 62 No. 3, pp. 402-9.

Simons, R.A., Bowen, W. and Sementelli, A. (1999), "The price and liquidity effects of UST leaks from gas stations on adjacent contaminated property", *The Appraisal Journal*, Vol. 67 No. 2, pp. 186-94.

Wilson, A.R. (1989), "Probable financial effect of asbestos removal on real estate", *The Appraisal Journal*, Vol. 57 No. 3, pp. 378-91.

About the authors

Jesse Saginor is an Assistant Professor in the Master of Science in Land Development Program at Texas A&M University. Dr Saginor is an Assistant Professor in the Department of Landscape Architecture and Urban Planning with a majority of his teaching responsibilities in the Master of Science in Land Development program. He is also a fellow of the Hazard Reduction and Recovery Center housed at Texas A&M. His research generally involves land and development/redevelopment. His specific research interests include economic development and theory, land use and property law, environmentally-contaminated real estate, local economic development policy and aging cities, inner-ring suburban planning and development issues, location theory, and GIS. His teaching interests include market analysis, real estate development, land use and property law issues, local economic development policy and implementation, and public-private partnerships.

Dr Saginor's recent publications include an analysis of the economics underlying recent eminent domain issues and the financial impact of leaking underground storage tanks on adjacent commercial properties. His articles have appeared in the *International Real Estate Review*, the *Journal of Real Estate Literature*, and the *Journal of Real Estate Research*. Current and future research includes an analysis of just compensation under eminent domain, coastal real estate development and the impact of natural disasters, the use of economic development corporations in Texas, and leveraging land development returns to finance transportation infrastructure improvements, among other research.

Dr Saginor's research focuses on real estate and economic development, property rights, public-private partnerships, and environmentally-contaminated real estate.

Robert Simons is a Professor and former Director of the Master of Urban Planning, Design and Development program at the Levin College of Urban Affairs at Cleveland State University in Cleveland, Ohio. He is also the faculty advisor for the Certificate Program in Real Estate Development and Finance, offered in conjunction with the Nance College of Business at CSU. During Fall 2005, he was a Fulbright Scholar at Wits University in Johannesburg, South Africa. He has also been a Lady Davis Scholar at the Technion (1999 and 2010-2011). He received his PhD from the University of North Carolina at Chapel Hill in City and Regional Planning, with an emphasis in real estate. He also holds a Master of Regional Planning and a Master of Science in Economics, both from UNC. His undergraduate degree in anthropology was earned at Colorado State University. He has been a member of the American Institute of Certified Planners (AICP) since 1983. Dr Simons is in the inner leadership group of the American Real Estate Society (ARES), and was program chair in 2009-2010 and will be President in 2011-2012. At the Levin College of Urban Affairs, Dr Simons teaches courses in real estate development, market analysis and finance, public economics, Ph.D. research methods and environmental finance. He has published over 50 articles and book chapters on real estate, urban redevelopment, environmental damages, housing policy and brownfields redevelopment. He authored a book entitled *Turning Brownfields into Greenbacks* (published by Urban Land Institute), and *When Bad Things Happen to Good Property* (published by Environmental Law Institute in 2006), and was the lead editor for an international research monograph on *Indigenous Property and Valuation* (2008, ARES). Another Adaptive Reuse book has been completed. Dr Simons has an active consulting practice, and has served as an expert witness in over 60 matters related to real estate, housing markets, and environmental contamination, including 30 depositions and several trial appearances.

Ron Throupe is an Assistant Professor in the Daniels College of Business at the University of Denver. He has 30 years of experience in the real estate and construction industry in various roles. He has been a licensed general contractor and is a certified general appraiser. While employed at major universitieshe serves as a consultant on valuation methods. He has also provided expert valuation and consultation services on a full-time basis as Director of Operations of Mundy Associates in Seattle and later Greenfield Advisors, a national real estate economics consulting and valuation firm. The firm is best known as the lead plaintiff experts for the Exxon Valdez litigation. He has recently been part of the Katrina Hurricane oil spills litigation and Celebrity Cruise line analysis and valuation for settlement. He is also a partner with the valuation firm American Valuation Partners and a valuation expert on high profile cases throughout the USA.

He is on the editorial board of the *Journal of Real Estate Sustainability*, of the *American Real Estate Society (ARES)*. Current research includes the valuation of distressed apartment complexes, eminent domain acquisitions, and contaminated property valuation.

He is frequently asked by media and real estate organizations to comment on current real estate market conditions. He was recently quoted on CNBC and the *Huffington Post*. He has made

presentations to the American Real Estate Society annual meetings, the Appraisal Institute special programs on distressed property, the National Hazard Mitigation Conference, the National Council of Real Estate Investment Fiduciaries, and Law Seminars International.

He is a member of the Royal Institute of Chartered Surveyors (RICS), a member of the research committee of NCREIF (National Council of Real Estate Investment Fiduciaries); Appraisal Institute Associate Member; a Fellow of the American Real Estate Society; and a member of the American Real Estate and Urban Economics Association. Ron Throupe is the corresponding author and can be contacted at: rthroupe@du.edu