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Mortgage-Equity Analysis in Contaminated Property Valuation

The theory and methods of valuing contaminated property center on understanding and quantifying the unique risks associated with this property type. This article presents a brief overview of the characteristics of the market for contaminated property, and demonstrates risk quantification through an income capitalization technique referred to as mortgage-equity analysis. Two capitalization procedures, Ellwood and discounted cash flow, are used to illustrate how mortgage-equity analysis can estimate value diminution resulting from increased risks associated with contamination.

Mortgage-equity analysis provides a framework that allows for adjustments to the key parameters necessary for estimating the effects of contamination on real property value. This framework offers a mechanism to address one of the most difficult tasks and a primary concern of appraisers in analyzing contaminated property, the quantification of risk and stigma.[1] Other contamination-related effects on property value, such as any reduction in value due to remediation costs, require the expertise of nonappraisers such as environmental engineers. Appraisers typically do not estimate these costs, but can usually measure their effect on value in a relatively straightforward manner as a capital expenditure.

Risk quantification, on the other hand, involves the complexities of measuring the perceptions of market participants. Adverse changes in these perceptions produce a stigma effect. For income-producing properties, key market participants include mortgage lenders and equity investors. Uncertainties regarding regulatory compliance requirements, the cost and duration of contamination cleanup and potential lost property income during remediation are reflected in changes in investor return requirements and loan underwriting criteria. In some cases, these uncertainties are offset by indemnifications from the party responsible for the contamination. These indemnifications, if properly structured and enforced, would

1. James A. Chalmers and Thomas O. Jackson, "Risk Factors in the Appraisal of Contaminated Property," *The Appraisal Journal* (January 1996): 44–57.

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hold other parties harmless from future remediation costs and other potential liabilities. It is important to note that market perceptions may or may not accurately reflect realities concerning the extent and cost of the contamination. These perceptions do, however, influence property values.

By incorporating lending and equity investment parameters, mortgage-equity analysis can be used to quantify the effect of contamination-related risk and uncertainty on commercial and industrial property values. In addition, this technique can quantify risk and property value diminution for undeveloped land through the land residual approach. In this approach, the improved property value is estimated through risk-adjusted capitalization or yield rates, which, after deducting development costs and risk-adjusted entrepreneurial profit, leaves a land residual value that reflects the contamination. The sales comparison approach could also be useful in analyzing risk and stigma, but most often is severely hampered by the lack of sufficient data. The cost approach is least useful, and by itself does not offer a clear vehicle for estimating contaminated property value diminution.

MARKET CHARACTERISTICS

The recent market for contaminated property can be characterized by an emerging group of knowledgeable investors who understand the risks associated with this property type; lenders who are more willing to finance transactions involving these properties; and a more flexible regulatory environment with risk-based cleanup standards and brownfields programs.[2] The risk and return requirements of equity investors, who purchase contaminated property prior to remediation and hold it through cleanup and closure, provide benchmark information for valuing contaminated property. Lenders may make adjustments to their underwriting standards to compensate for the increased risk involved in a contaminated property, or, in some cases, may deny a loan altogether. The property value effects of the perceptions and reactions of these market participants can be quantified through mortgage-equity analysis.

Equity Investors

The perceptions and requirements of equity market participants are important determinants in developing any analysis of real estate value, and are particularly important in the quantification of risk-related effects on property value due to contamination. As noted, the recent and emerging market involving contaminated property has attracted a group of knowledgeable investors who seek out contaminated property and hold it through remediation until resale.[3] Accordingly, their investment return is dependent on the resale, or reversion, of the property after completion of the remediation. This suggests that yield capitalization, which specifically considers future changes in income and value, would be an appropriate valuation framework.

The risk factors that vary the return requirements of these investors include the completeness of the characterization of the level and extent of the contamination; the existence and strength of indemnifications provided by responsible parties against future liabilities; compliance status with respect to the appropriate state and / or federal regulations; the strength of the appropriate regulatory framework; the cost and timing of the remediation effort; and the market for the future use of the property, considering any use restrictions that may be imposed as a condition of regulatory compliance. In general, the more uncertainty, the higher the required return, the lower the value, and the greater the diminution in property value due to the contamination.

In the income capitalization approach, the increased equity return requirement, over the market return for an uncontaminated but otherwise similar property, can be measured as a risk premium adjustment to the equity yield rate. Through the mortgage-equity framework, this can be translated into changes to the overall yield rate and the overall capitalization rate.

Mortgage Lenders

Transactions involving contaminated property, like other real estate transactions, are typically leveraged in that they have a debt component. For contaminated property, and the additional risk involved, lenders may

2. Thomas O. Jackson, Mark E. Dobroski, and Trevor E. Phillips, "Analyzing Contaminated Real Estate in a Changing Market," *The Journal of Real Estate Finance* (Fall 1997): 67–72.

3. Thomas O. Jackson, "Investing in Contaminated Real Estate," *Real Estate Review* (Winter 1997): 38–41.

adjust their underwriting standards by reducing the loan-to-value ratio, increasing the interest rate, or shortening the amortization period. Further, and perhaps more frequently, lenders will require an increased level of personal guarantees from the borrower and/or indemnifications from the borrower or other responsible party with respect to future environmental liabilities. These reactions vary considerably by region and the specifics of the contamination and the property. The analysis of lender perceptions, therefore, should be done on a property- and location-specific basis.

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Nevertheless, generalizations from surveys and experience indicate that the most likely underwriting standard to change is the loan-to-value ratio.[4] The least likely is the interest rate. Lenders may also adjust the amortization period for the loan. Overall, though, the most frequent lender reaction to the mortgageability of contaminated property is a yes/no decision, without any adjustment to the credit underwriting standards. This, of course, is equivalent to reducing the loan-to-value ratio to zero.

Brownfields

Brownfields programs target underutilized urban properties that have some environmental impairment. The remediation and return of these properties to productive use serves several public policy objectives by promoting the efficient use of downtown and other existing urban areas. In concept, the catalyst for the remediation and redevelopment of brownfields properties would be some form of incentives, such as assurances or at least regulatory streamlining, by the public sector. The incentives could reduce environmental risk, and perhaps result in a property meeting the investor return requirements. A critical point with respect to this currently popular initiative is that the local real estate market must be capable of supporting the end use of the remediated property. The brownfields incentives, although important, would be ineffective without sufficient underlying market demand for the redevelopment use.

MEASURING VALUE DIMINUTION

As explained above, reductions in property value due to contamination are a function of the market's perception of the additional risks involved in a contaminated property that would not be present in an uncontaminated but otherwise similar property. The key sets of market participants are equity investors, lenders, and users. The contamination-related risks may be reflected in increased equity investor return requirements, changes in lenders' underwriting criteria, and reduced income due to lowered occupancies or rents that may result from the concerns of tenants or other property users. The framework presented here focuses on investors and lenders.

Investor and lender risk adjustments can be reflected in corresponding changes in income and yield capitalization rates. The disaggregation of capitalization rates into mortgage and equity components allows for adjustments in the key mortgage and equity parameters that reflect the increased risk from contamination perceived by these market participants. As capitalization rates are adjusted upward to reflect this increased risk, property value decreases. Investors will pay less for the same cash flow in order to achieve a higher return, or yield, and lenders will seek a more secure position through credit underwriting adjustments, thereby increasing the cost of capital, and reducing property value.

In adjusting the mortgage-equity parameters to reflect the increased risks associated with the contamination, environmental factors must be reviewed on a property-specific basis. As noted, these factors include the level of characterization of the contamination; the regulatory status of the site, cost, and length of the remediation effort; approvals and financing of the remediation plan; effects on the use of the property during remediation; the availability of indemnifications by financially sound responsible parties; and any post closure property use restrictions. Once this information has been assembled and reviewed, the mortgage and equity adjustments can be determined either through comparative sales/case studies or through surveys of investors and lenders.

If sales/case studies are used, they must be carefully analyzed for comparability to the subject on each of the relevant environmental risk factors. In addition, the sales of contaminated property must be matched against

4. Patricia R. Healy and John J. Healy, Jr., "Lenders' Perspectives on Environmental Issues," *The Appraisal Journal* (July 1992): 394–398.

another set of sales of similar but uncontaminated property in order to extract market-based risk adjustments. In the second method, lenders and investors are surveyed as to their investment and lending criteria applicable to the property as if uncontaminated. After a review of the relevant environmental risk factors and remediation assumptions, they are asked about any changes to these criteria as a result of the contamination. The differences in the two sets of survey responses provide the adjustments necessary for the mortgage-equity analysis.

Estimating Value Diminution Through the Ellwood Procedure

Mortgage-equity analysis has traditionally been accomplished through the Ellwood procedure, a technique originally developed by L. W. Ellwood.[5] The Ellwood technique estimates the overall capitalization rate (R_O) on the basis of assumptions concerning mortgage and equity requirements, including the required equity yield (Y_e); total change in income (D_i) and value (D_O) over the holding period; and the anticipated pattern of income change—constant ratio (compound annual growth), *J*-factor change, or straight-line change. Real estate investor surveys indicate that the most typical expectation is for changes in income to occur at a compound annual growth rate. This pattern would be reflected in the constant ratio assumption and the *K*-factor adjustment in the Ellwood framework.

Table 1 presents a mortgage-equity analysis of a hypothetical property with and without the effects of contamination. The resulting difference in the final property value estimates indicate the value diminution resulting from the contamination. The uncontaminated, or baseline, assumptions in this analysis include a 2% annual increase in income and value, a 9% mortgage interest rate (Y_m), a 70% loan-to-value ratio (*LTVR*), a 20-year loan amortization period, and a Y_e of 17% over a 10-year holding period. This analysis produces four estimates of R_O. Excluding the level income assumption, they range from 10.14% to 10.19%. Applying the R_O estimated with the constant ratio income pattern of 10.17% to the property's net operating income (*NOI*) of $600,000 produces an estimated value, without the effects of contamination (V_O), of $5.9 million. This is also referred to as the unimpaired value, and establishes a baseline from which to estimate property value diminution (*PVD*).

As noted, table 1 also presents an analysis in which the lending and investing criteria have been adjusted to reflect increased contamination risks. In this analysis, the equity investment criteria have been adjusted to reflect an increase in Y_e of 500 basis points, and the mortgage component has been adjusted to reflect a decrease in the *LTVR* from 70% to 50%. In this example, value increases more rapidly than income due to the reduction in risk following remediation. As can be seen, these risk adjustments result in an R_O range of 13.10%–13.24%, excluding the level income assumption, which will be reconciled at 13.14%, consistent with the constant-ratio income pattern. Applying this adjusted R_O to the property's *NOI* of $600,000, which is assumed to be unaffected by the contamination, results in an estimated impaired value (V_c) of $4.6 million. This equates to a *PVD* of $1.3 million, or 29% of the unimpaired value.

Estimating Value Diminution Through the Discounted Cash Flow Procedure

The Ellwood procedure has been criticized as too complex, requiring many difficult calculations, and as being limited in that only a few prescribed income patterns can be accommodated.[6] Ellwood's critics note that his formula and tables were developed before the inexpensive computers and software that now make discounted cash flow (DCF) techniques easier.[7] However, most DCF analyses are not primarily concerned with estimating value on the basis of mortgage and equity interests, and adapting them for mortgage-equity analysis significantly increases their complexity. The real advantage of DCF analysis over Ellwood is greater accuracy when there is an anticipation of an irregular income stream over the holding period, such as an increasing *NOI* followed by a decrease.

Table 2 presents a mortgage-equity analysis through a DCF procedure that is comparable to, and based on the same as-

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5. Appraisal Institute, *The Appraisal of Real Estate,* 11th ed. (Chicago, Illinois: Appraisal Institute, 1996): 748–762.
6. Wayne Kelly, Donald R. Epley, and Phillip Mitchell, "A Requiem for Ellwood," *The Appraisal Journal* (July 1995): 284–290.
7. The analyses in table 1 are from a spreadsheet model, with the interim calculations based on the equations in the addenda to *The Appraisal of Real Estate*, 11th ed., and in Charles B. Akerson, *Capitalization Theory and Techniques* (Chicago, Illinois: American Institute of Real Estate Appraisers, 1984): 153–156.

TABLE 1 Property Value Diminution Analysis Through Ellwood Procedure

General Mortgage-Equity Formula: $$R_O = \frac{Y_e - M(Y_e + P\,1/SFF - R_m) - D_O\,1/SFF}{1 + D_I J \text{ or } K\text{-factor}}$$

As if uncontaminated		With contamination	
Mortgage:			
M or *LTVR*	0.7000	Mortgage or loan-to-value ratio	0.5000
Y_m	9.00%	Mortgage interest rate	9.00%
Amortization period:	20	Years	20
Equity:			
Y_e	17.00%	Equity yield rate	22.00%
Additional inputs:			
D_O	0.2190	Change in value during period	0.5750
D_i	0.2190	Change in income during period	0.2190
Projection period:	10	Years	10
Interim calculations:			
P	0.296968	Percent paid off during period	0.296968
SFF	0.044657	Sinking fund factor at Y_e	0.034895
R_m	0.109546	Mortgage constant	0.109546
J	0.3012	*J*-factor, Ellwood premise	0.2457
J	0.3255	*J*-factor, straight-line premise	0.2959
K	1.0681	*K*-factor	1.0618

Overall capitalization rate (R_O) by income pattern

Pattern	Adjustment factors	Estimated R_O	Adjustment factors	Estimated R_O
Level income	n/a	10.86%	n/a	13.95%
Constant-ratio	1.0681	10.17%	1.0618	13.14%
Ellwood	0.3012	10.19%	0.2457	13.24%
Straight-line	0.3255	10.14%	0.2959	13.10%

Value estimates

Net operating income (*NOI*)	$600,000	$6,000
Overall capitalization rate (R_O)	10.17%	13.14%
Value as if uncontaminated (V_O)	$5,900,249	
Value with contamination (V_c)		$4,565,957
Property value diminution (*PVD*)		**$1,334,292**

Note: Mortgage parameters calculated on an annual payment basis.

sumptions as, the Ellwood analysis in table 1.[8] This DCF model discounts the property *NOI* by Y_e and adjusts for annual debt service and loan repayment at the end of the holding period through the use of R_m and percent of the loan paid during the period (*P*), also factors in the Ellwood formula. Reversion is based on the aggregate change in value (D_O), assumed to change proportionate to the aggregate change in income over the period. As with the previous illustration, this change equals 21.9%. As can be seen, the resulting unimpaired property value of $5,900,226 is nearly identical to that produced by the Ellwood model, with minor rounding errors.

The information in table 2 can also be used to estimate an equivalent Y_O though an internal rate of return (*IRR*) routine. This is calculated at 12.17%. Reversion in this context is estimated by capitalizing the year 11 *NOI* by the 10.17% capitalization rate estimated through the Ellwood model. This assumes that the going-in and terminal rates are the same. Accordingly, the property cash flow (equity and reversion) is discounted at Y_O in the right side of table 2 to produce an identical estimate of the unimpaired value (V_O) at $5.9 million.

Table 3 presents a corresponding DCF analysis of the same property with the equity and mortgage contamination risk adjustments. As with the previous examples, the analysis reflects two adjustments: an increase in the Y_e of 500 basis points, or from 17% to 22%; and a decrease in the *LTVR* from 70%

8. This DCF procedure is similar to the illustration presented in Wayne Kelly, Donald R. Epley, and Phillip Mitchell, "A Requiem for Ellwood," *The Appraisal Journal* (July 1995): 288.

TABLE 2 Baseline (As If Uncontaminated) DCF Analysis

Year	Cash Flow (*NOI*)	Debt Service Adjustment (see below)	Present Value Factor @ Y_e	*PV* of Debt Service Adjusted @Y_e	*PV* of *NOI* @ Y_e	Cash Flow (*NOI* and Reversion)	Present Value @ Y_O	*PV* of Cash Flow @ Y_O
1	$600,000	0.076683	0.8547	0.065541	$512,821	$600,000	0.8915	$534,907
2	$612,000	0.076683	0.7305	0.056018	$447,074	$612,000	0.7948	$486,413
3	$624,240	0.076683	0.6244	0.047878	$389,757	$624,240	0.7086	$442,315
4	$636,725	0.076683	0.5337	0.040922	$339,788	$636,725	0.6317	$402,215
5	$649,459	0.076683	0.4561	0.034976	$296,226	$649,459	0.5632	$365,751
6	$662,448	0.076683	0.3898	0.029894	$258,248	$662,448	0.5021	$332,592
7	$675,697	0.076683	0.3332	0.025550	$225,139	$675,697	0.4476	$302,440
8	$689,211	0.076683	0.2848	0.021838	$196,275	$689,211	0.3990	$275,021
9	$702,996	0.076683	0.2434	0.018665	$171,112	$702,996	0.3557	$250,088
10	$717,056	0.076683	0.2080	0.015953	$149,174	$717,056	0.3172	$227,415
11	$731,397							
Property reversion:						$7,192,370	0.3172	$2,281,070
Equity reversion:		–0.726872	0.2080	–0.15217				
Change (D_O):		0.2190						
Sum:				0.206017	$2,985,614			
Value as if uncontaminated (V_O):					$5,900,226	Value (V_O):		$5,900,226

$$\text{Value } (V_O) = \frac{\text{Sum of } PV \text{ of CF @ } Y_e}{(1 = M) + (\text{Sum of } PV \text{ of } DS \text{ adjusted @ } Y_e)}$$

Equity yield rate (Y_e): 17.00%

Mortgage interest rate (Y_m): 9.00%

Mortgage constant (R_m): 0.109546

Percent paid off during period (P): 0.296968

Mortgage ratio (M or *LTVR*): 0.7000

Debt service adjustment calculations:

for equity cash flow *DS* adjustment = $(M \times R_m)$

for equity reversion *DS* adjustment = $-((1 + D_O) - (M \times (1 - P)))$

Overall yield rate (Y_O): 12.17%

Going-in cap rate (R_O) (from Ellwood model) : 10.17%

Terminal cap rate (R_t) (applied to year 11 *NOI*): 10.17%

Note: Income growth at 2% per year.

to 50%. The *PVD* effect is to decrease value from $5.9 to $4.6 million, or by 29%. This was the same result produced by the Ellwood model. This similarity is due to the income and value growth assumptions. Income growth is based on a 2% compound annual growth rate in the DCF model, and is reflected in the Ellwood model through the constant-ratio (*K*-factor) adjustment. The 57.5% increase in value used in both models reflects the application of the unadjusted R_O of 10.17% to the year 11 *NOI* for reversion. The DCF analyses in tables 2 and 3 also show the corresponding increase in the overall yield rate (Y_O), from 12.17% to 16.65%, reflect the contamination risk adjustments.

Value Diminution Relationships

The foregoing conceptual and methodological framework can be used to illustrate more generalized relationships between contamination-related risk adjustments and *PVD*. As explained, the contamination-related loss in property value is a function of the risks perceived by market participants. These risk perceptions may result in a higher equity yield rate, more conservative credit underwriting, or both. More conservative credit underwriting could be through a lowered *LTVR*, shorter amortization period, increased interest rate, or loan denial.

The generalized effect of adjusting equity return requirements on value diminution is illustrated in figure 1. This figure is based on the unimpaired mortgage and equity parameters for the hypothetical property presented in tables 1, 2, and 3. Figure 1 shows the increase in *PVD*, measured as a percentage and in dollars, corresponding to increases in the equity yield requirement, as reflected in the equity risk premium over the unimpaired Y_e of 17%. For example, a 300-basis point risk adjustment to Y_e, indicating an adjusted Y_e of 20%, corresponds to a 7.2%

TABLE 3 Property Value Diminution Analysis Through DCF Procedure

Year	Cash Flow (*NOI*)	Debt Service Adjustment (see below)	Present Value Factor @ Y_e	*PV* of Debt Service Adjusted @ Y_e	*PV* of *NOI* @ Y_e	Cash Flow (*NOI* and Reversion)	Present Value @ Y_O	*PV* of Cash Flow @ Y_O
1	$600,000	0.054773	0.8197	0.044896	$491,803	$600,000	0.8572	$514,338
2	$612,000	0.054773	0.6719	0.036800	$411,180	$612,000	0.7348	$449,724
3	$624,240	0.054773	0.5507	0.030164	$343,773	$624,240	0.6299	$393,227
4	$636,725	0.054773	0.4514	0.024725	$287,417	$636,725	0.5400	$343,828
5	$649,459	0.054773	0.3700	0.020266	$240,299	$649,459	0.4629	$300,634
6	$662,448	0.054773	0.3033	0.016612	$200,906	$662,448	0.3968	$262,867
7	$675,697	0.054773	0.2486	0.013616	$167,971	$675,697	0.3402	$229,844
8	$689,211	0.054773	0.2038	0.011161	$140,434	$689,211	0.2916	$200,970
9	$702,996	0.054773	0.1670	0.009148	$117,412	$702,996	0.2500	$175,723
10	$717,056	0.054773	0.1369	0.007498	$98,165	$717,056	0.2143	$153,647
11	$731,397							
Property reversion:						$7,192,370	0.2143	$1,541,149
Equity reversion:		–1.223484	0.1369	–0.167494				
Change (D_O):		0.5750						
			Sum:	0.047391	$2,499,361			
Value with contamination (V_O):					$4,565,950	Value (V_O):		$4,565,950

$$\text{Value } (V_O) = \frac{\text{Sum of } PV \text{ of } CF \text{ @ } Y_e}{(1 - M) + (\text{Sum of } PV \text{ of } DS \text{ adjusted @ } Y_e)}$$

Equity yield rate (Y_e):	22.00%
Mortgage interest rate (Y_m):	9.00%
Mortgage constant (R_m):	0.109546
Percent paid off during period (P):	0.296968
Mortgage ratio (M or *LTVR*):	0.5000

Debt service adjustment calculations:

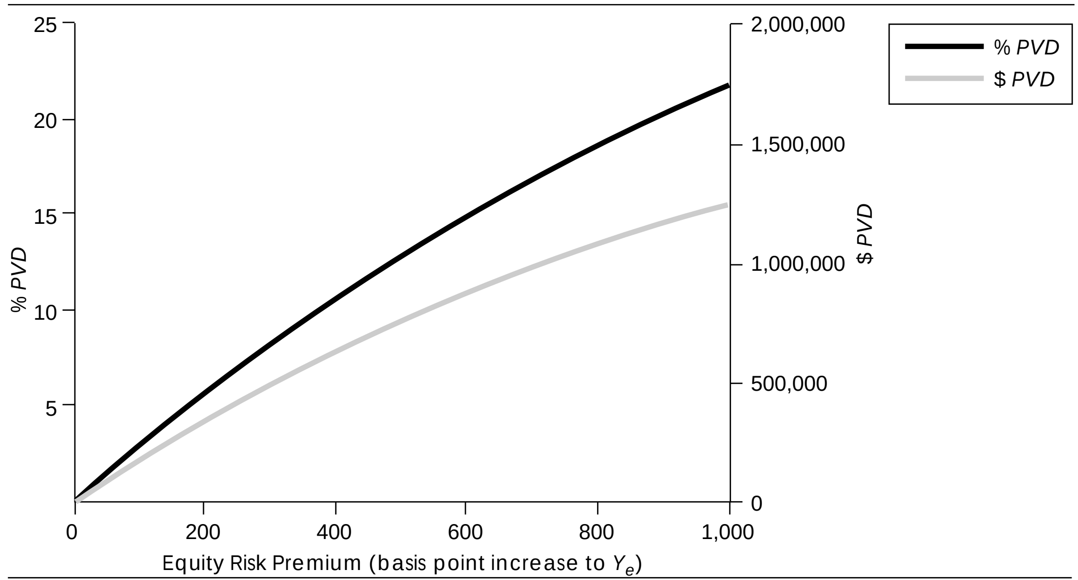
for equity cash flow *DS* adjustment = $(M \times R_m)$

for equity reversion DS adjustment = $-((1 + D_O) - (M \times (1 - P)))$

Overall yield rate (Y_O):	16.65%
Going-in cap rate (R_O) (from Ellwood model):	13.15%
Terminal cap rate (R_t) (applied to year 11 *NOI*):	10.17%
Value (V_O):	$5,900,226
Value (V_c):	$4,565,950
Property value diminution:	**$1,334,276**

Note: Income growth at 2% per year

FIGURE 1 Effect of Equity Risk Premiums on Property Value Diminution

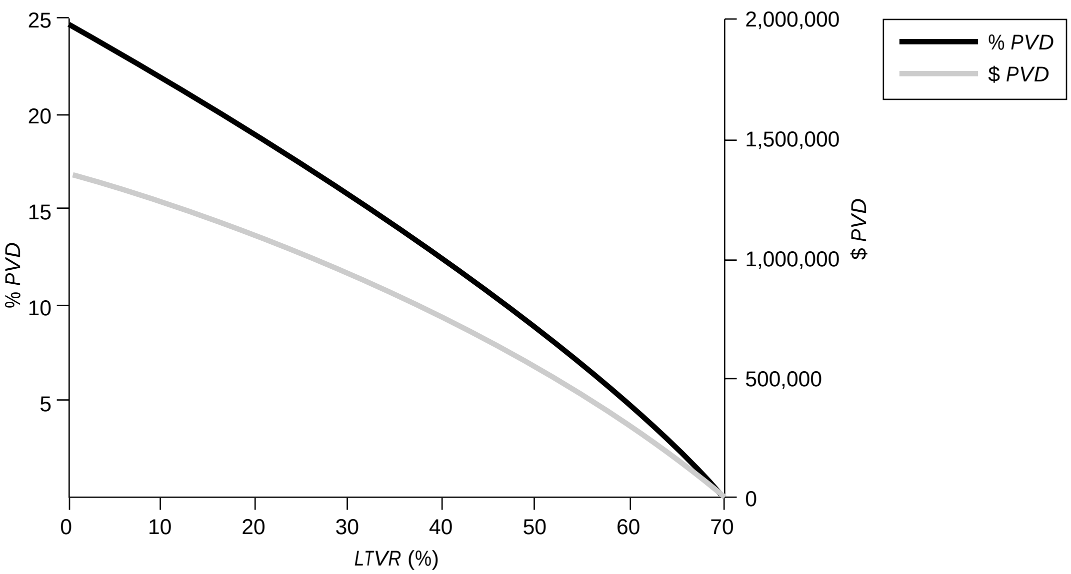


Note: *PVD* relative to unimpaired value of $5.9 million reduction in the property's unimpaired value. The upper end of the risk range, with a 1,000-basis point adjustment, produces a value diminution of over 20%.

Figure 2 depicts the relationship between the most frequently adjusted mortgage parameter, the *LTVR*, and *PVD*, again measured as a percentage and in dollars. The figure shows the decline in *PVD* as the *LTVR* approaches the assumed market level, applicable to a similar but uncontaminated property, of 70%. At the other end of the scale, the *LTVR* of 0% corresponds to the denial of a loan on the property due to the risk associated with the contamination. This total lack of mortgageability results in a *PVD* of nearly 25%. Value diminution would be independent of any additional reductions due to increased equity yield requirements.

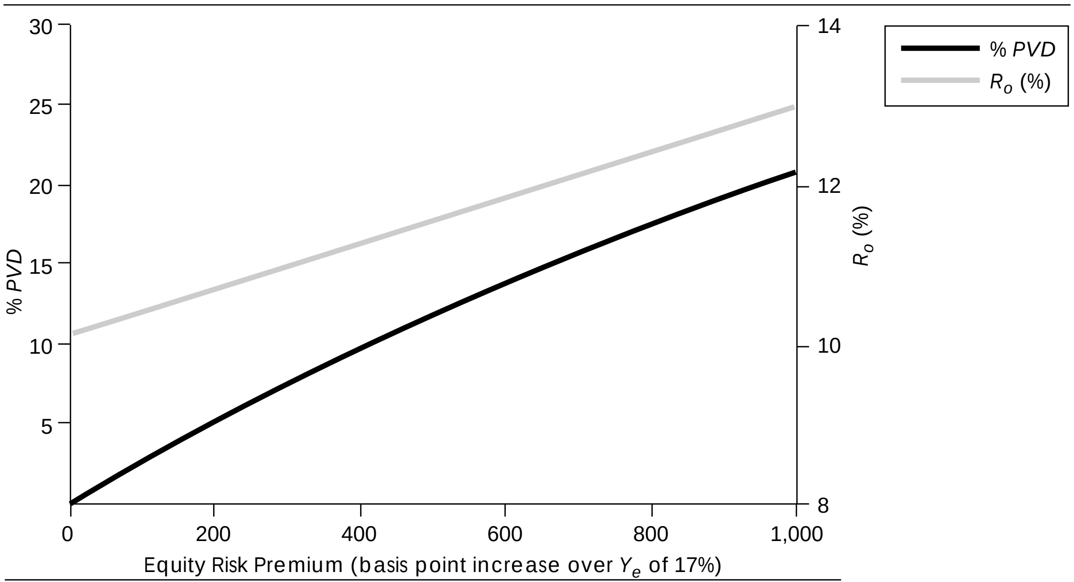
Figures 3 and 4 depict the effects of the same range of equity and mortgage risk adjustments on R_O, and again on *PVD*. The overall capitalization rate is a key measure of risk and return in real estate valuation, and is a commonly used gauge of market expectations and perceptions with respect to a property or

FIGURE 2 Effect of Loan-to-Value Ratio Adjustments on Property Value Diminution



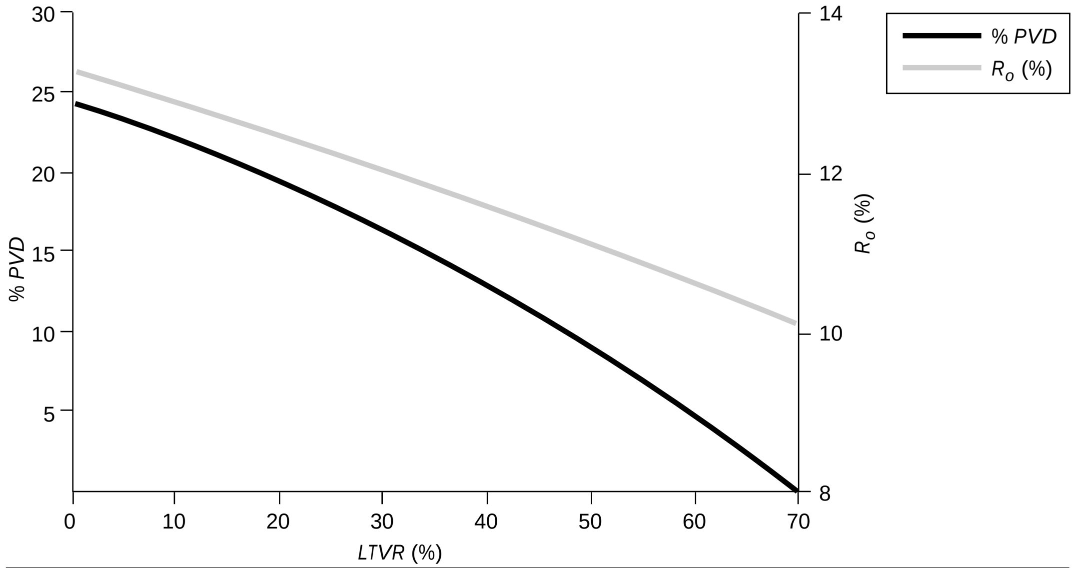
Note: *PVD* relative to unimpaired value of $5.9 million

FIGURE 3 Effect of Equity Risk Premiums on Property Value Diminution and Overall Capitalization Rate



Note: *PVD* relative to unimpaired value of $5.9 million

FIGURE 4 Effect of Loan-to-Value Ratio Adjustments on Property Value Diminution and Overall Capitalization Rate



Note: *PVD* relative to unimpaired value of $5.9 million

Mortgage-equity analysis provides a vehicle for adjusting the key valuation parameters to reflect the perceptions and requirements of market participants more accurately, and measure the effect of contamination-related risk on real estate value.

property class. As was shown in table 1, the unimpaired R_O, reflecting the base level of risk and return for the property without any contamination-related effects, was 10.17%. The market's perception of the contamination-related risk effects, resulting in increases in the required equity yield and in reductions in the *LTVR*, is ultimately reflected in corresponding increases in the applicable R_O at each successive risk level. In figure 3, the upper end of the range of equity risk premiums, at a 1,000-basis point increase to Y_e, corresponds to an adjusted R_O of approximately 13% and a *PVD* of over 20%. Figure 4 shows that the loss of financing, with an *LTVR* of 0%, corresponds to a *PVD* of nearly 25%.

The information in figures 1 through 4 depicts the effect of *PVD* from changes in either Y_e or the *LTVR* independently. In seriously contaminated properties, both the mortgage and equity parameters will be adjusted. The examples in tables 1 and 3 had adjustments to both sets of parameters. Figure 5 visually depicts the combined effect of adjusting Y_e and the *LTVR* simultaneously. The analysis in this figure is again based on the hypothetical property and its specific characteristics that have been analyzed heretofore. The reader is cautioned that the results displayed in the tables and figures in this article would vary, depending on the particular characteristics of the property under study.

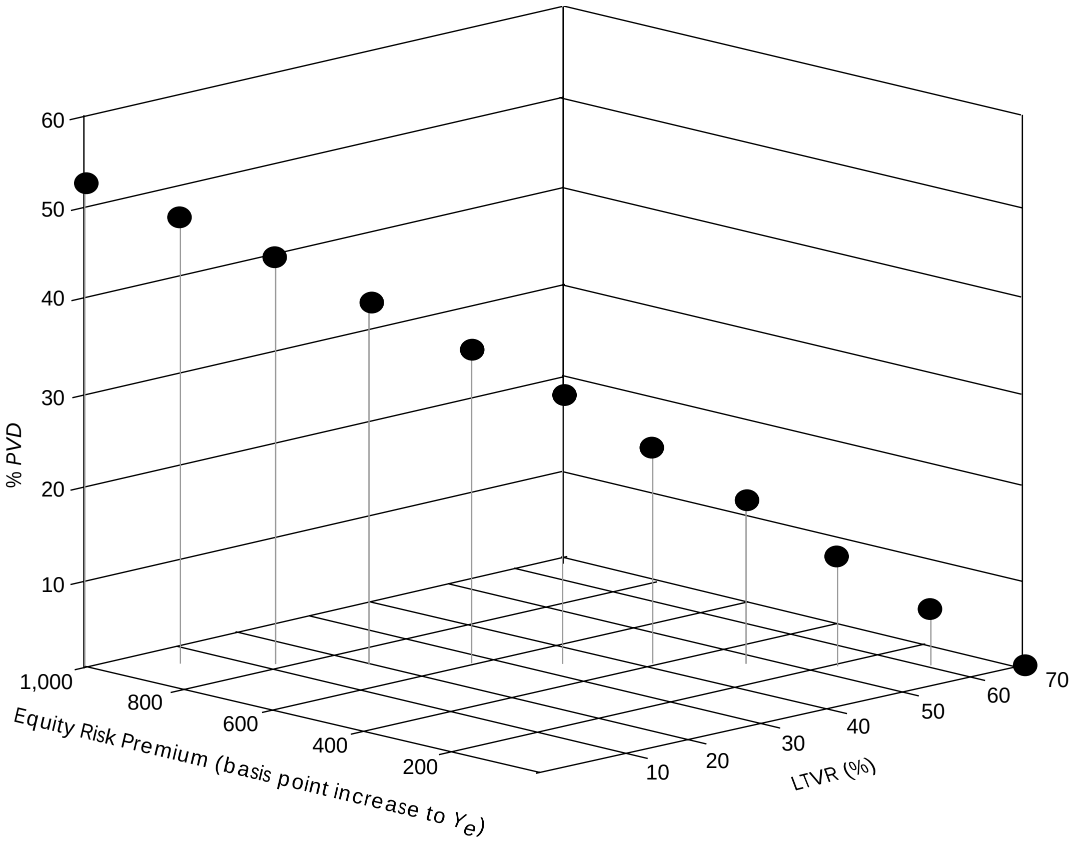
Accordingly, figure 5 shows the *PVD* effects of varying the *LTVR* from 70% to 0%, while at the same time varying the equity risk premium from 0 to 1,000 basis points, equating to a Y_e from 17% to 27%. These ranges of contamination risk adjustments result in a reduction in property value of over 50%. This maximum *PVD* corresponds to a Y_e of 27% and the loss of financing altogether. A set of adjustments in the middle of the ranges for the two variables: a risk premium of 400 to 600 basis points and an *LTVR* of 30% to 40%, resulting in a *PVD* of nearly 30%. (This can be determined by following a horizontal line from the data point to the *y*-axis.)

CONCLUSION

Investors, lenders, and the courts are more frequently asking appraisers to analyze the effects of environmental contamination on property value. This is due, in part, to the changing nature of the market for contaminated properties, with increased investor interest, greater availability of financing, and a more flexible regulatory environment. It is also due to the significant amount of litigation involving the market effects of contamination on property value. The key question in approaching this type of analysis is how to measure the unique risks associated with this property type.

These risks are reflected in the reactions and perceptions of key market participants. The analyses presented herein focused on two sets of key participants: equity investors and mortgage lenders. In this context, an old technique known as mortgage-equity analy-

FIGURE 5 Effects of Equity Risk Premiums and Loan-to-Value Ratio Adjustments on Property Value Diminution



sis provides a powerful and entirely appropriate framework. This technique, pioneered by Ellwood, provides a vehicle for adjusting the key valuation parameters to reflect the perceptions and requirements of market participants more accurately, and measure the effect of contamination-related risk on real estate value.

Appropriate risk adjustments, derived through surveys of investors and lenders with respect to the environmental history of the property under study or through extraction from sales of comparable contaminated properties, are input into the mortgage-equity model. This results in an adjusted set of income and yield capitalization rates, which reflect the contamination-related risks, and can be used to estimate the value of the property and its value diminution from an unimpaired baseline condition.

This approach was illustrated through two mortgage-equity procedures. The first technique, referred to as the Ellwood procedure, estimates the overall capitalization rate on the basis of assumptions concerning income and value growth, equity yield requirements, and financing parameters. The Ellwood model can accurately estimate appropriate capitalization rates in most circumstances, except when the anticipated income pattern over the holding period is irregular. In these cases, DCF analysis, if properly modified, can be used to measure value diminution.

Toward this end, a modified DCF model, incorporating many of the same elements of the Ellwood technique, was presented. These modifications to the DCF framework allow for the same mortgage and equity adjustments as Ellwood, without any limitations on the income patterns that can be accommodated. The application of this DCF model in valuing contaminated property was then demonstrated, with results nearly identical to those produced by Ellwood. Lastly, the graphics show generalized relationships between the mortgage and equity risk adjustments and corresponding *PVD* effects.