Brownfield Development: Uncertainty, Asymmetric Information, and Risk Premia

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Abstract: This paper shows that brownfield redevelopment occurs at a lower than socially optimal rate due to a stigma effect. A theoretical framework is employed, incorporating asymmetric information showing this stigma within the brownfields market generates a first-mover problem. Developers require a risk premium on their rate of return to offset this stigma, which discourages investment. Asymmetric information further widens the gap between offer and asking prices, reducing successful transactions. Implications of the theoretical framework are explored using a survey of real estate developers in the Denver metropolitan area. Brownfield developers’ typical characteristics along with their risk and stigma premiums are quantified and found to be substantially in excess of cleanup costs.

Keywords: brownfield; information asymmetry; risk; uncertainty; land use; real estate

1. Introduction

Due to differences in regulation, production techniques, and heavy industrial use in the past [1], communities have found themselves left with sites, the redevelopment of which is desirable due to its location and attributes, but is difficult to attract individuals willing to tackle the uncertainty and obstacles associated with the potential clean up [2–7]. As defined by the House of Representatives, “... The term ‘brownfield site’ means real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant” [8].

While there are numerous benefits to the redevelopment and reuse of brownfield sites [9–13], these redevelopment efforts are undertaken at a much lower rate than is socially desirable, even when there are government incentives operating in the market. This underutilization of brownfield land contributes to greater urban sprawl and subsequently greater greenhouse gas emissions as individuals are less likely to use public transportation while experiencing longer commutes [14]. Meanwhile, brownfield neighborhoods suffer from lower property values and subsequent lower property tax revenues. Brownfield redevelopment occurs at low rates due to several different factors. Developers tend to fear the legal liability for contamination, face uncertain cleanup standards, have difficulty finding funding for redevelopment, and deal with complicated regulatory requirements [2–4,15,16].

The fundamental issues driving these complications are the uncertainty associated with the level of contamination for the site which determines the cost of cleanup, and future liability concerns. Specifically, the market for brownfields suffers from a form of Akerlof’s lemons problem [15,16]. There exists an information asymmetry between the buyers and sellers of potentially contaminated property. The seller of the site knows significantly more about the potential contamination level than the prospective buyer, generating an information asymmetry. Due to the uncertainty surrounding the status of the property, a buyer will offer a lower price than the seller is willing to accept, leading the
mutually beneficial transaction to fail. This information asymmetry leads many buyers and sellers to drop out of the market, which consequently becomes thin [17,18]. The effects of this information asymmetry persist even when more information about the property has been revealed in the form of a stigma associated with being a brownfield. As with the “Market for Lemons”, this thinning of the market lowers the average quality of brownfield sites on the market. Additionally, the market for brownfields also suffers from a first-mover problem [17]. Due to the perceived risk associated with brownfield sites, developers cannot expect to receive the full value of their property when they go to sell it even after remediation. These effects contribute to a lower level of brownfield remediation and therefore fewer transactions on which to base expectations and beliefs. This situation leads to profitable transactions and remediations not being undertaken, as potential buyers rely on noisy market data to estimate profitability and cleanup costs [19,20]. A formal model of this asymmetry is presented, incorporating the results from survey evidence.

Using a survey of real estate development professionals in the Denver metro area, this paper statistically quantifies the risk premiums associated with brownfield redevelopment. This analysis finds private sector buyers require additional compensation in the form of a higher rate of return above cleanup costs to consider a brownfield redevelopment project. A Probit analysis of the survey data finds that attitudes and previous experience with contaminated site remediation are significant determinants of willingness to invest in a contaminated site, while general characteristics such as property type and typical role played by the survey respondent are also important. The survey results also suggest that different types of contamination lead to different risk premia, which is likely associated with the familiarity and difficulty of dealing with different contaminants.

Section 2 reviews the challenges of brownfield redevelopment and introduces the theoretical framework, and Section 3 presents the survey data. Section 4 details the methodology and materials. Section 5 contains the two-tier analytical results. Section 6 details the implications of the survey results using the theoretical framework, and Section 7 concludes.

2. Brownfield Remediation: Informational Inefficiencies

Common potential brownfield sites may be—among others—an old gas station, industrial site, dry cleaner, or abandoned residential site with asbestos [21]. It is difficult to find exact numbers on how many brownfield sites are within an area, as contamination levels vary, and locals may be unsure about how to classify a specific property. Another difficulty arises from property owners who would rather not report potential contamination unless required to do so. Brownfield sites are generally only reported as such when a developer or site-owner applies for a federal grant to help remediate the property or participates in a voluntary cleanup program held at the state level. The Environmental Protection Agency (EPA) estimates there are more than 450,000 brownfield sites in the United States. The U.S. Conference of Mayors in their 2008 survey find that 188 cities in the U.S. reported 24,896 brownfield sites, totaling conservatively 83,949 acres of land [21]. At the federal level, the EPA has received grant applications for 1383 brownfield properties since 2002, while Colorado alone has seen 1162 applications for its voluntary cleanup program (VCUP) since 1994 [10,22].

Considering these statistics, it is apparent that brownfield remediation is occurring at a much lower rate than necessary to significantly reduce the growing stock of contaminated sites. Numerous benefits to brownfield remediation have been identified and are typically quantified via their effect on housing prices and tax revenue for the local government. McCluskey and Rausser [12] find that property owners near hazardous waste sites experience lower housing appreciation rates after the EPA identified the site, and this reduction in housing values relative to other non-contaminated areas may be reversed if the brownfield site is cleaned. Using a hedonic pricing model paired with high resolution and high frequency data, it has been found that a cleaned brownfield site increases nearby property values by 5–11.5% [10]. Importantly, this impact on housing prices is sensitive to the perception of the risk itself, and the uncertainty of the level of contamination.
In recognition of a growing environmental problem, the United States passed the Comprehensive Environmental Response, Compensation, and Liability Act [23]. This act created some issues for brownfield remediation, as it allows the government to assign liability to current owners of sites even if they were not the original polluting party. To reduce the uncertainty involved with the potential liability for future developers of smaller scale projects, the Small Business Liability and Brownfields Revitalization Act [8] was passed in 2002. The goal of the Brownfields Act was to primarily reduce the associated liability risk that developers and investors face when considering a contaminated property. State level governments in the U.S. have also implemented their own grants and methods to reduce the uncertainty associated with contamination and liability of these properties, such as Voluntary Cleanup Programs (VCPs). VCPs help private parties navigate the cleanup process by introducing state oversight and coordination, which in turn reduces the perceived risk of liability [5]. This liability relief from both cleanup costs and claims by third parties is of relatively high value to developers when surveyed [7]. However, these programs have fees associated with them for the private developer, who essentially pays the government to perform oversight [24]. Additionally, states such as Michigan have begun creating programs which invest in brownfield redevelopment, with the idea that increased future tax revenues will cover the costs of the program. However, Bendor et al. [25] find that a simulated investment of $500,000 per year will take six years for the benefits to outweigh the costs.

Even with these programs created by state and federal governments, the private developers fear of liability, the uncertainty surrounding potential contamination, and the associated costs of information gathering create a general market condition similar to George Akerlof’s market for lemons [15,16]. The market for lemons refers to a product market where the buyer of the good has less information about quality than the seller, which leads the information lacking potential buyer to offer an average price for the good regardless of quality. The developer will not know the true extent of the contamination until they purchase the property and have begun the remediation process. Because of this, the developer requires an additional return on their investment to compensate them for the higher risk associated with potentially contaminated properties. This risk premium is directly connected with the stigma associated with brownfield sites, since it persists even when the developer knows and will be compensated for the cost of cleanup. Stigma in this context refers to the general fear of liability, potential costs, and difficulty selling properties which have been identified as brownfields by those involved in both the redevelopment and purchasing of these properties [26].

This leads higher quality properties to trade for less than their value or not at all, while lower quality properties will trade for higher prices than their true value. This affects the developer’s perceptions of the true quality of properties in the brownfield market, which lowers the average price and further suppresses transactions. This self-reinforcing cycle of low development in the market for brownfields is the result of rational decision making by individuals but is not socially optimal as the level of redevelopment is too low. Lang and Nakamura’s work on redlining describes a similar situation with banks [19]. Neighborhoods with lower levels of development do not have enough transactional data to provide banks with good estimates on lending risk, so they underprovide credit by offering too high of interest rates or not disbursing loans at all. This combination of low development activity and inefficient market pricing generates a first mover problem, where transactions which would be beneficial to the community as a whole from both a redevelopment and informational perspective are not undertaken because the benefit to the developer only stems from the post-remediation value of the site [17].

A further potential complication arises from the possibility of having an economically significant stigma effect associated with a property post remediation, as buyers of remediated properties may be worried the cleanup was not sufficient and they will be liable in the future. This makes the initial transaction before cleanup less likely, due to the potentially lower returns to a developer interested in remediating the property to sell it.

There are more potential complications for brownfield remediation beyond the contamination. Tureckova et al. [27] using factor analysis on a general set of brownfields in the Czech Republic find that
the property ownership, size, and distance from the local governing body are significant determining factors in remediation potential. Ownership in this case refers to public, private, or a public–private partnership. Given these potential market frictions in redeveloping brownfield properties, the empirical analysis is employed to understand what affects the discrepancy in valuation for brownfield properties and the magnitudes of these effects.

3. Survey Data

A survey was sent to 900 real estate development professionals in the Metro Denver area (in Supplementary Materials). The mailing list was developed from the membership of professional associations including Certified Commercial Investment Member, Counselors of Real Estate, the Society of Industrial and Office Realtors, and the Denver Metro Commercial Association of Realtors, supplemented by the commercial real estate developer directory maintained by the Colorado Real Estate Journal. These individuals were chosen to generate a representative real estate development professional’s required rate of return.

The survey had a response rate of 17.2%, with a total of 155 surveys returned. Overall, 149 contained sufficient information to be used for analysis. Not all respondents answered all questions, thus restricted-subsamples were used to analyze certain questions. The survey gathered background information on the respondent’s development roles, the typical types of properties they develop and invest in, and their attitude toward and experience with contaminated properties. Summary statistics for the survey data are shown in Table 1.

| Table 1. Developer survey—summary of background information responses. |
|---------------------------|---------------------------|---------------------------|
| Q1: role type             | Count | Percentage of Total |
| Broker only               | 45    | 30.20%            |
| Broker among others       | 78    | 52.35%            |
| Developer only            | 14    | 9.40%             |
| Developer among others    | 55    | 36.91%            |
| Investor only             | 6     | 4.03%             |
| Investor among others     | 65    | 43.62%            |
| Financier only            | 0     | 0.00%             |
| Financier among others    | 11    | 7.38%             |

| Q2: typical property type experience | Count | Percentage of Total |
|--------------------------------------|-------|---------------------|
| Single-family residential only       | 6     | 4.03%               |
| Single-family residential among others| 52    | 34.90%              |
| Multi-family residential only        | 8     | 5.37%               |
| Multi-family residential among others| 61    | 40.94%              |
| Retail only                          | 4     | 2.68%               |
| Retail among others                  | 68    | 45.64%              |
| Office only                          | 3     | 2.01%               |
| Office among others                  | 80    | 53.69%              |
| Industrial only                      | 14    | 9.40%               |
| Industrial among others              | 73    | 48.99%              |
Table 1. Cont.

| Q3: typical transaction size | Count | Percentage of Total |
|-----------------------------|-------|---------------------|
| Less than $250,000 only     | 7     | 4.70%               |
| Less than $250,000 among others | 29    | 19.46%              |
| $250,000–$1 million only   | 36    | 24.16%              |
| $250,000–$1 million among others | 55    | 36.91%              |
| $1 million–$5 million only | 27    | 18.12%              |
| $1 million–$5 million among others | 63    | 42.28%              |
| Greater than $5 million only| 8     | 5.37%               |
| Greater than $5 million among others | 29    | 19.46%              |
|                              | 37    |                     |

While a response rate of 17.2% is a potential source of bias, there are several factors recognized in the literature which may have contributed to a lower response rate. Furthermore, there are features of this paper’s survey responses that suggest bias is not a significant problem in the present case. Mail-in surveys tend to have lower response rates than email or telephone, and individuals in real estate may work for firms that have policies which prevent them from responding to any survey [28,29]. Additionally, this survey required respondents to submit numerical values for potential investments, which may have deterred individuals due to complexity and effort. As shown in Table 1, the sample appears to have more brokers than developers, investors, and financiers, but most respondents noted they fulfill more than one role. Given the range of responses, there does not appear to be any systematic bias in property types or transaction size. The sample also does not appear to be biased towards those who are experienced and deal with contaminated property, as half the sample has no experience with contaminated properties but 69% of respondents would invest in one if “the economics makes sense”.

In actuality, this paper’s response rate is remarkably high for real estate surveys [30–33]. The National Association of Realtors and Commercial Real Estate Development Association typically experience response rates of 5% or less to their online surveys where they invite pools of 40–70,000 realtors to participate [31,32]. Taking this into account, a higher response rate would be preferable but may be difficult to achieve. Of course, there is always potential for improvement by increasing the size of the subject pool and reconsidering survey incentives in any future surveys on brownfield redevelopment.

A broker would be defined as an intermediary in the sale or transaction who receives a fee for their services. A developer takes on the actual development by improving the site and by adding or replacing buildings. Investors and financiers contribute capital to use in the transactions. In total, 82% identified themselves as brokers, with 30% being solely brokers, while 52% of respondents categorized themselves as brokers among other roles. Responses were spread evenly between all five property types, with respondents not showing a high level of specialization in any specific development. Respondents tend to cluster around medium size transactions of $1-$5 million, with even tails into smaller and larger transactions.

The next set of questions assess the risk-tolerance level of the respondents, as shown in Table A1. Respondents were asked whether they had ever purchased property with environmental contamination issues, of which 64% indicated they had not, 8% unintentionally bought contaminated property, and 28% had purchased contaminated sites intentionally. It was then asked whether they purchase contaminated property, and if they would consider doing so. Fifteen percent said they will never willingly purchase contaminated property, 69% indicated they try to avoid it but will purchase contaminated property if the economics makes sense, and 16% specified they would invest in both clean and contaminated properties. Combining these two sets of responses suggests that, while most respondents would consider purchasing contaminated property if the economics makes sense, the majority had not done so.
Similarly, survey respondents were asked if they would continue with a project when the initial Phase I environmental site assessment shows on-site environmental issues. Overall, 86.6% indicated they would further investigate and continue to pursue the investment. However, when a follow up question was asked suggesting that the Phase II investigation reflected on-site contamination, those who would be willing to continue pursuing the investment dropped to 42.9%. This shows an aversion to dealing with a contamination issue.

The remainder of the survey asked respondents to consider a well-defined property type that was typical for them, and to tell what rates and other parameters they would set as criteria for the investment decision if the property was clear of contamination. They noted their overall capitalization rate, reversion or terminal capitalization rate, discount rate, and anticipated investment holding period. Then, the same property respondents were asked to revise their criteria if the property had known cleanup costs equal to 15% of the clean property purchase price. Three types of contamination were posed: gasoline contamination, dry cleaning contamination, and degreasing/solvent contamination. They were asked: whether they would still consider investing, what their required capitalization rates and discount rate would be, what their expected holding rate would be compared to their typical, and whether these responses already considered a purchase price lowered by the expected amount of cleanup cost.

Differences in capitalization rates are the chosen measure for most of the empirical and theoretical analysis. This formulation is useful because it may be easily parameterized with the survey. In focusing on the capitalization rate and net operating income (NOI), loan principal/interest, capital expenditures, and depreciation/amortization are excluded. This takes the debt, access to equity capital, and other financial aspects of a project out of the analysis and focuses on the direct relationship of market price per income dollar generated, allowing a direct comparison across projects, and is a common metric in the real estate industry:

\[
\text{Capitalization Rate} = \frac{\text{NOI}}{\text{Market Price}}
\]  

(1)

4. Materials and Methods

Given the theoretical framework described in Section 2 and the survey data presented in Section 3, two sets of testable hypotheses were formulated. Figure 1 is a visual representation of the analytical process. The decision of whether to invest in contaminated properties is first explored, and then, given an individual is willing to invest, what return on investment is required to incentivize a developer to work with brownfields.

![Figure 1. Analysis of the survey data.](image)

The first set of hypotheses concerns the binary choice of whether to invest in a representative contaminated property net of cleanup costs, and are presented in Table 2. A priori, it is expected
that those who have experience in dealing with contaminated properties and related services such as voluntary cleanup programs in the past will be more willing to invest in future contaminated land redevelopment, as their own experience provides them with greater market information. It is also expected that the role in which the developer specializes will affect their willingness to invest, as brokers may inherently have a different level of risk than a developer who focuses on the actual cleanup. Finally, differences in willingness to invest are expected based on property type, as residential and commercial properties require different standards of cleanup compared to industrial properties.

Table 2. Hypotheses on investor characteristics.

| Hypothesis | Empirical Implication |
|------------|-----------------------|
| Experience with contaminated land remediation and programs leads to a greater willingness to invest in contaminated property. | The coefficients on experience with voluntary cleanup programs and prior accidental purchases of contaminated land will be positive, indicating greater willingness to invest. |
| Transaction role affects their willingness to invest. | Significant coefficients on dummy variables representing different roles such as broker and developer, indicating different willingness to invest. |
| Typical transaction type affects their willingness to invest. | Significant coefficients on dummy variables representing different property types, indicating different willingness to invest. |

This first set of hypotheses is addressed using Probit analysis. A Probit model is appropriate when the dependent variable is a binary choice, which in this case is the investment decision. Three types of potential contamination are considered: gasoline, dry cleaning chemicals, and solvent contamination. Survey data on the respondent’s familiarity with voluntary cleanup programs, attitudes toward contamination screening, typical transaction roles, property types and transaction sizes are employed to estimate Equation (2):

\[ \text{Invest}_i = \beta_0 + \beta \text{Role}_i + \beta \text{Type}_i + \beta \text{Size}_i + \beta \text{VCP}_i + \beta \text{Screen}_i + \beta \text{Attitude}_i + \epsilon_i \]  

The second set of hypotheses concerns the requirements of developers who indicate they are willing to invest in contaminated properties, and are presented in Table 3. It is expected there is a significant stigma effect present in the market for contaminated land, even after accounting for cleanup costs. This stigma effect will present itself as an increase in the capitalization rate developers require for contaminated properties relative to clean properties, even when told they will be compensated for cleanup costs. Further expectations are that there will be a greater variance in required capitalization rates across the sample of developers, due to the lack of representative market transactions upon which to base their expectations of profitability and cleanup costs. This variance reflects widely varying individual perspectives on the exact same property proposition. These hypotheses are addressed using differences in means testing. Difference in means testing is a statistical comparison of the required rates of return for clean and contaminated properties within the sample to see whether they are significantly different. The results of this analysis are presented in Section 5.

Table 3. Hypotheses concerning the risk premium.

| Hypothesis | Empirical Implication |
|------------|-----------------------|
| Investors require a risk premium to incentivize them to invest in contaminated properties even when cleanup costs are known and compensated. | Positive and significant coefficients on capitalization/terminal rates for gasoline, dry-cleaning, and solvent contaminated properties relative to clean properties. |
| Due to poor market information, developers have widely different expectations of profitability and cleanup costs. | The variance for the contaminated property capitalization/terminal rates will be significantly greater than for clean properties. |
5. Results

The first set of hypotheses addressing what factors influence these individuals’ willingness to invest is evaluated with a Probit analysis of the survey data. All variables are binary, with summary statistics for the variables of interest reported in Table 4. As multicollinearity is likely a concern, Table A2 contains a correlation matrix of all variables employed in the analysis and shows the independent variables are only mildly related. Those choosing to invest are assigned a value of 1 while not investing is assigned a value of 0. The effect of role type is explored with Broker as the reference category. Avoid Maybe and Buy Both refer to investor attitudes in relation to those who indicated they would not buy contaminated properties. The reference category for property type contains single family and multi family properties. The reference category for transaction size is $1–5 million, as most individuals fell into this category. The VCP reference category contains those who have never dealt with a VCP program. Never purchased is an indicator variable capturing if an individual has not purchased a contaminated property. Screen Phase1 refers to those who always choose to check for contamination when making a purchase. The “Contam” variables capture whether individuals are willing to continue with the transaction if contamination is found onsite or offsite during a Phase I or II assessment.

Table 4. Summary statistics.

|                        | N   | Mean | St.Dev |
|------------------------|-----|------|--------|
| Gas Invest             | 135 | 0.726| 0.448  |
| Dry Invest             | 130 | 0.508| 0.502  |
| Solvent Invest         | 128 | 0.547| 0.5    |
| Avoid Maybe            | 149 | 0.691| 0.464  |
| Buy Both               | 149 | 0.161| 0.369  |
| Accidental Purchase    | 149 | 0.081| 0.273  |
| Broker                 | 149 | 0.826| 0.381  |
| Developer              | 149 | 0.463| 0.5    |
| Investor               | 149 | 0.477| 0.501  |
| Financier              | 149 | 0.074| 0.262  |
| Office and Retail      | 155 | 0.645| 0.48   |
| Industrial             | 149 | 0.584| 0.495  |
| Less 1mil              | 155 | 0.652| 0.478  |
| BT 1mil 5mil           | 149 | 0.604| 0.491  |
| Greater 5mil           | 149 | 0.248| 0.433  |
| VCP Helpful            | 149 | 0.282| 0.451  |
| VCP NoHelp             | 149 | 0.168| 0.375  |
| Screen Phase1          | 149 | 0.537| 0.5    |
| P1 Contam Onsite       | 147 | 0.857| 0.351  |
| P1 Contam Offsite      | 144 | 0.542| 0.5    |
| P2 Contam Onsite       | 137 | 0.467| 0.501  |

The results of the Probit analysis are displayed in Table 5, which reports marginal effects for ease of interpretation. The full Probit results can be found in Table A3. The coefficients reported in Table 5 can be interpreted as the change in the probability an individual will invest. For example, in Regression (1), an individual who signals they “buy both” types of properties is 29% more likely to invest compared to those who signaled they do not purchase contaminated properties.

In terms of individual attributes, those who operate as investors are less likely to invest in contaminated properties compared to brokers. This could be capturing a perceived higher financial risk, which is interesting considering that those who signaled the role of Developer do not show the same hesitation. Those who indicated they deal with Office and Retail properties are more likely to invest in a contaminated property. This may be due to the ease of cleanup compared to homes, which may have more stringent requirements for use. Transaction size is not significant in determining their likelihood to invest.

Comparing individual attitudes towards contaminated properties, individuals who signaled they are willing to purchase contaminated properties if the economics make sense and those who signaled they “buy both” are more willing to invest than those who stated they will not purchase contaminated
properties. However, looking at Regressions (2) and (3), those who fall into the Avoid Maybe category are no longer more likely to invest. It is speculated this could be due to lower familiarity with dry cleaning and solvent contamination.

Table 5. Investment choice Probit marginal effects.

| Variables          | (1)       | (2)       | (3)       |
|--------------------|-----------|-----------|-----------|
|                    | Gas       | Dry       | Solvent   |
| Avoid Maybe        | 0.228 *** | 0.126     | 0.037     |
|                    | (0.061)   | (0.111)   | (0.104)   |
| Buy Both           | 0.289 *** | 0.274 **  | 0.294 **  |
|                    | (0.095)   | (0.136)   | (0.140)   |
| Accidental Purchase| -0.146    | -0.032    | -0.151    |
|                    | (0.093)   | (0.134)   | (0.127)   |
| Developer          | -0.034    | 0.050     | 0.107     |
|                    | (0.057)   | (0.082)   | (0.079)   |
| Investor           | -0.134 ** | -0.140 *  | -0.132 *  |
|                    | (0.055)   | (0.078)   | (0.078)   |
| Financier          | 0.178     | 0.030     | 0.147     |
|                    | (0.242)   | (0.147)   | (0.160)   |
| Office & Retail    | 0.184 *** | 0.097     | -0.082    |
|                    | (0.059)   | (0.085)   | (0.080)   |
| Industrial         | -0.111 *  | -0.030    | 0.067     |
|                    | (0.057)   | (0.087)   | (0.080)   |
| Less 1mil          | -0.067    | -0.085    | -0.021    |
|                    | (0.064)   | (0.094)   | (0.089)   |
| Greater 5mil       | -0.029    | -0.048    | 0.022     |
|                    | (0.068)   | (0.099)   | (0.095)   |
| VCP Helpful        | 0.241 *** | 0.101     | 0.185 **  |
|                    | (0.082)   | (0.091)   | (0.092)   |
| VCP NoHelp         | 0.258 *** | 0.010     | -0.027    |
|                    | (0.093)   | (0.103)   | (0.099)   |
| Screen Phase1      | -0.083    | -0.046    | -0.034    |
|                    | (0.059)   | (0.080)   | (0.078)   |
| P1 Contam Onsite   | 0.248 *** | 0.132     | 0.167     |
|                    | (0.074)   | (0.132)   | (0.118)   |
| P1 Contam Offsite  | 0.155 *** | 0.197 **  | 0.166 **  |
|                    | (0.056)   | (0.078)   | (0.073)   |
| P2 Contam Onsite   | 0.155 *** | 0.211 *** | 0.187 *** |
|                    | (0.058)   | (0.075)   | (0.071)   |
| Observations       | 126       | 121       | 119       |

Standard errors in parentheses and *** p < 0.01, ** p < 0.05, * p < 0.1.

Individuals who indicated they always screen for contamination when considering a property were no more likely to invest than those who only screen at the lenders request, or if contamination was suspected. The “Contam” variables show generally that those who indicated they would continue an investment even after finding potential contamination during a screening are more likely to invest. However, for dry cleaning and solvent contamination, individuals were no more likely to invest if they had indicated they would continue with an investment after a Phase I contamination screening found potential contamination, which could be due to lack of familiarity with these contamination types. Those who indicated they would consider an investment even after the more in-depth Phase II screening found contamination were approximately 15–20% more likely to invest.

Looking at previous experience with contaminated land, the empirical analysis shows that an accidental purchase of a contaminated property in the past does not affect their present willingness to invest in contaminated properties. This means that a potentially negative experience has not decreased their willingness to invest in these properties. Additionally, the results show that a positive or negative experience with a Voluntary Cleanup Program increases their willingness to invest in gasoline contaminated properties, and a positive experience increases willingness to deal with solvent contamination. This result indicates that regardless of success, more experience in dealing in these properties is likely to adjust expectations positively, as individuals begin to overcome the lack of information in the market through their own experiences.
The second set of hypotheses is focused on the stigma effect and market information and analyzed with difference-in-means testing. The results are shown in Table 6. Judged at a 95% confidence level, the tests indicate statistically significant differences between the two cases for all the rates used in the study, supporting the hypothesis that investors do require a premium in the rate of return required when investing in contaminated property as compared to investing in a clean property.

Table 6. Difference in means of clean and contaminated property responses.

| Capitalization Rate | Clean | Gas | Clean | Dry-Clean | Clean | Solvent/Degreaser |
|---------------------|-------|-----|-------|-----------|-------|-------------------|
| Mean                | 10.44 | 12.37 | 10.5 | 12.89 | 10.69 | 13.91            |
| Variance            | 6.47  | 18.77 | 7.28 | 25.05 | 7.55  | 24.44            |
| Observations        | 71    | 51   | 55    | 55      | 55    | 55               |
| t-Statistic         | 5.489 | 4.622 | 5.233 |         |       |                  |
| p-Value             | \(p < 0.0000\) | \(p < 0.0000\) | \(p < 0.0000\) |       |       |                  |

| Terminal Rate       | Clean | Gas | Clean | Dry-Clean | Clean | Solvent/Degreaser |
|---------------------|-------|-----|-------|-----------|-------|-------------------|
| Mean                | 11.17 | 13.18 | 11.08 | 13.1     | 11.19 | 13.59            |
| Variance            | 11.34 | 22.73 | 11.36 | 19.73    | 11.43 | 25.85            |
| Observations        | 46    | 33   | 35    | 35       |       |                  |
| t-Statistic         | 5.388 | 4.353 | 3.749 |         |       |                  |
| p-Value             | \(p < 0.0000\) | \(p < 0.0000\) | \(p > 0.0007\) |       |       |                  |

| Discount Rate       | Clean | Gas | Clean | Dry-Clean | Clean | Solvent/Degreaser |
|---------------------|-------|-----|-------|-----------|-------|-------------------|
| Mean                | 10.67 | 12.65 | 10.91 | 13.82    | 10.91 | 13.91            |
| Variance            | 29.61 | 40.95 | 39.32 | 68.35    | 39.32 | 73.13            |
| Observations        | 30    | 22   | 22    | 22       |       |                  |
| t-Statistic         | 3.579 | 3.362 | 3.224 |         |       |                  |
| p-Value             | \(p < 0.0000\) | \(p < 0.0000\) | \(p = 0.0041\) |       |       |                  |

| Holding Period      | Clean | Gas | Clean | Dry-Clean | Clean | Solvent/Degreaser |
|---------------------|-------|-----|-------|-----------|-------|-------------------|
| Mean                | 8.30  | 7.48 | 8.97  | 8.04      | 8.83  | 8                 |
| Variance            | 28.58 | 25.90 | 35.46 | 30.98     | 32.68 | 28.81            |
| Observations        | 76    | 54   | 54    | 60        |       |                  |
| t-Statistic         | 2.456 | 2.251 | 2.141 |         |       |                  |
| p-Value             | \(0.0164\) | \(0.0285\) | \(0.0364\) |       |       |                  |

1 Mean values for clean properties differ as the responses of those who indicated they would invest given that type of contamination with their clean property values are compared, as opposed to the entire sample.

The existence of this risk premium is compelling, as respondents were told that the cleanup costs associated with the contaminated properties were both known and compensated. This premium therefore represents additional uncertainty that remains purely as the stigma surrounding these properties. The analysis finds a capitalization rate premium of 2.3% for gasoline contamination, 2.5% for dry cleaning, and 2.96% for degreasing/solvent as compared to a clean property investment. This difference in the premium and holding periods between the different types of contamination could stem from the information differentials concerning the difficulty of cleanup. Gasoline contamination may be dealt with more frequently, and therefore investors while still uncertain about the property, may have more information resources available to them as compared with dry cleaning and degreasing/solvent contamination.

Additionally, the variance in capitalization rates ranges from two to four times higher when considering contaminated properties when compared to clean properties. This wide range of estimates lends support to the hypothesis that the lack of information in the market leads potential investors to have high uncertainty about the potential returns, reflected in the much greater capitalization rates. Potentially profitable investments thus may not be undertaken. Notably, the average holding period for contaminated properties is lower and statistically significant, implying respondents who are willing to invest in these properties are more concerned with immediate value recovery, as they see less long-term value in holding and/or using the property.

The results of the empirical analysis provide support for the hypotheses. Information and general attitudes towards contaminated investment appear to be the most significant factors in developers’ willingness to invest, as opposed to their typical roles and transaction types. Furthermore, developers
working in the market for contaminated properties require a risk premium to incentivize them to invest above and beyond cleanup costs, and high variance in required returns highlights widely varying perceptions of identical property propositions. These results imply increasing the remediation of brownfield properties could benefit from the provision of additional information about contamination characteristics and typical returns, which are usually provided by existing market transactions but are underprovided within the typical brownfield market relative to the broader social optimum.

6. Theoretical Implications

In this section, a hypothetical transaction is employed to explore the implications of the stigma effect found with the empirical analysis. As a comparison, the market result achieved by real estate development professionals is contrasted with that of a social optimum (SO). The SO does not suffer from the stigma effect, because under the SO condition market participants have perfect information about the quality of the site.

For simplicity, consider two different types of sites: clean and contaminated. Clean sites have never been environmentally contaminated. Contaminated sites are known to be currently impaired from previous use and require cleanup for future use. There are two forms of impairment associated with a contaminated site: the actual physical contamination of the site, and the stigma associated with a brownfield property. It is assumed both site types have the same dimensions and characteristics in the absence of contamination. Both parcels are assumed to have a vacant building, which in the absence of contamination could be used to generate rental income. The net operating income (NOI) for both properties will be the same once the contamination is remediated, which is assumed to be $100,000.

Comparing first the market result with that of the SO for a clean property, where referencing the survey results, developers expect a capitalization rate of approximately 10%. Plugging this into Equation (1) with the assumed NOI shows developers in the market are willing to purchase a clean property with these characteristics for $1 million (MM). This price is competitive, as any developer who offers a lower price will be supplanted by another willing to offer a higher price, until the capitalization rate is reduced to the minimum of 10%. Since the developers know that the site is not contaminated, the SP result will be identical for clean sites.

For contaminated sites, cleanup costs are set to 15% of the property’s market price in accordance with the survey. Specifically, the survey asks developers to consider a contaminated site where cleanup costs are known and compensated. This enters into the formulation as a reduction of the market price that the developers pay:

\[
\text{Market Price} - \text{Cleanup Costs} = \$1MM - \$150K = \$850K
\]

In the absence of the stigma effect, the contaminated site will sell for $850K, which allows the developer to maintain their 10% capitalization rate. However, as found by the survey, developers require an additional risk premium to invest willingly in brownfield properties. Being the first mover and responsible for the cleanup, the developer views the transaction as being inherently riskier. A risk premium of 3% (via the survey) increases their capitalization rate, and decreases the maximum price they are willing to pay for the property:

\[
\text{Stigmatized Market Price} = \frac{\$100K}{13\%} - \$150K = \$619,200
\]

Under the SO, market participants do not suffer from the stigma effect, since they have perfect information about the quality of the contaminated site. The SO recognizes the cleanup costs of 15% and nets this directly from the purchase price, setting the market price to $850K. This large discrepancy between the SO and market result leads to fewer transactions occurring in the market. This initial state of low redevelopment may continue in perpetuity, due to the lack of remediations available for potential developers to base their expectations on. This is similar to the work of Lang and Nakamura...
(1993), who show banks may systematically overestimate the riskiness of providing loans to perpetually disadvantaged communities due to a lack of market transactions upon which to base appraisals, effectively underfunding the community and keeping it in a perpetual state of low development and decline. While private actors may be practicing rational decision-making based on the information available to them, Lang and Nakamura showed the overall market may be operating inefficiently, with credit being underprovided and mutually beneficial loans not being dispersed. In this case, our market imperfection is the low rate of brownfield remediation.

Therefore, it is critical to incentivize these developers to begin redeveloping these properties to increase the level of information within the market. Specifically, it is possible to quantify the value of increased information to the developer:

\[ V(I) = E[P_P|I] - E[P_A] = P \]  

Equation (5) represents the value to the developer of the gap generated by this informational asymmetry between buyer and seller [21]. \( P_A \) represents the value of the property ex-ante when the buyer considers all information they have available, while \( P_P \) represents the valuation of the property post transaction where the buyer is now able to glean more information about the true contamination level of the property. Subtracting the ex-ante valuation from the post valuation gives the true value of information (P) about the property to the buyer. Using the developer’s private market valuation of $619,200 for the contaminated property versus the true value of $850,000, the property is undervalued by $230,800. Therefore, the developer should be willing to pay any price up to P for more information regarding the true value of this property.

An additional problem which presents itself is that the developer cannot rely on attaining the clean property price if they sell the remediated property. As noted in the survey results, developers typically expect to hold the contaminated property for a shorter period than a clean property, most likely engaging in value recovery (fix and flip). After cleanup, the contaminated site price over time will trend towards the clean price as opposed to immediately. The sale price will be lower than the true market value if the parcel is brought to market quickly, as the prospective buyer of the cleaned brownfield is unsure about the adequacy of the cleanup and the stigma effect lingers (McClusky and Rausser 2003b). The market price (x) over time will fall between the range:

\[ \text{Market Price} = \text{Clean} \geq x \geq \text{Stigmatized} = \$1MM \geq x \geq \$769,200 \]  

The first mover problem for a site that has been recently remediated is modeled in the game tree below (Figure 2) with two stages. Focusing on the resale of the property, the game tree has two players: the Developer (D) who owns the recently remediated property and the Buyer (B) of the remediated property. The Developer goes first, and the Buyer responds in Stage 2 of the game. The Developer is modeled as having three choices: sell the property immediately after cleanup (Period 1), sell the property in Period 2 (a five-year hold), or sell the property in Period 3 (a ten-year hold). Payoffs for the Developer are generated by calculating the Net Present Value (NPV) of all cash flows and costs (R) to the property over time:

\[ \text{NPV}_i = \frac{\sum_{t=0}^{n} \frac{R}{(1+r)^t}} { } \]  

For example, if the Developer sells the property immediately for the full price (FP) of $1MM, then they gain a 30% return on their initial investment of $769,200. This value of 30% is represented by 0.3 on the far-left side of the game tree. However, it is unlikely that the Developer will ever receive such an offer because the buyer questions the quality of cleanup.
Considering the stigma effect, it is assumed that the Buyer will require a higher capitalization rate depending on how quickly the property is brought to market in order to incentivize the perceived risk:

$$12\% \text{ Cap Rate} = \frac{\$100K}{12\%} = \$833,300$$  \hspace{1cm} (8)

The Buyer is always going to offer the lowest price possible since they are trying to compensate for the perceived additional risk of dealing with a previously contaminated property. The Developer will only receive low price (LP) offers in Period 1, medium price (MP) offers in Period 2, and finally the full price (FP) offer in Period 3. If the Developer accepts LP, then they would only receive an 8% return on cost. The value of the Period 2 and 3 payoffs depends on the Developer’s discount rate, which our survey finds to be approximately 13%. Therefore, the Developer faces 10% and 9% returns in Periods 2 and 3, respectively, and should choose to sell the property in Period 2.

Overall, this may decrease the willingness of Developers to participate in value recovery as they will have to increase their holding period to recover the most value possible. To further understand the loss of efficiency in the market one can consider the case in which the developer receives the full price for the remediated property. Ceteris paribus, it would be in the Developers best interest to immediately sell the property after remediation as payoffs are discounted over time. Using this assumed discount rate, the effects of this stigma effect on resale value are shown in Table 7. The private market result gives the Developer a 21.7% lower return on cost if they sell their property in Period 1, and a 6.4% lower return if they sell in Period 2. In Period 3, the returns are equivalent, as the stigma effect has dissipated over the ten-year waiting period.

| Table 7. Stigma pricing effects and efficiency loss (r = 13%). |
|---------------------------------------------------------------|
| Stigmatized Price | Full Price | Difference in Return |
|-------------------|------------|----------------------|
| Period 1 (t = 0)  | 8.3%       | 30%                  | -21.7%               |
| Period 2 (t = 5)  | 9.9%       | 16.3%                | -6.4%                |
| Period 3 (t = 10) | 8.8%       | 8.8%                 | 0                    |

These results are sensitive to the rate of stigma decay. For example, if instead the stigma effect reduces 50% instantly after remediation (boosting sale price) and in each period after, the developer will be interested in selling the property immediately. However, it is still inefficient as compared to the social optimum. Additionally, not every developer will be affected by the first mover problem to the same degree. For example, if the developer is interested in redeveloping the site to rent or plans to occupy the building themselves, then they are less concerned with the extended holding
It primarily makes it difficult for companies or individuals who specialize in remediating these properties, as they must find additional ways to maintain their capitalization rate and may not be interested in managing the property while the value recovers. These developers may require an even lower original purchase price for the contaminated property, or depending on the costs associated with cleanup, may expect to be paid to take the property and remediate it due to the large negative value of the site itself.

7. Conclusions

The results of the survey clearly show the main driving factor in developers’ willingness to invest in contaminated properties is not their role or typical transaction type, but rather their attitudes and previous experience with contaminated properties. This finding already indicates the importance of information within such a thin transactional market. Furthermore, even among those willing to invest in such properties, there is a risk premium associated with redeveloping brownfield when compared to clean property. Real estate development professionals require a 2–3% risk premium in this market when considering potentially contaminated sites, even after being compensated for remediation costs with a reduced purchase price. This implies the risk premium is influenced by nonpecuniary factors which do not represent actual resource costs. The stigma associated with potentially contaminated properties drives the risk premium, as the lack of information in the market leads participants to have highly variable perceptions of the post-sale prospects for the representative property.

The brownfield situation yields a process remarkably parallel to Akerlof’s classic lemons model, where many potential sellers drop out due to a dissatisfaction in their potential sale price, which then potentially leads the average quality of property in the market to decrease along with a thinning of the market. Fewer transactions within this market provide little information to potential buyers, who then base their expectations on noisy market data, biasing profitability and cleanup cost estimates as they are unable to properly assess the true market probabilities. This context creates a first-mover problem, further compounding the entrenched difficulty associated with remediating a contaminated property.

Based on these results, the market for brownfield sites is operating inefficiently relative to the social optimum. This problem has many implications, such as inefficient resource use and pollution as greenfield land further from the urban core is substituted for these stigmatized properties. Furthermore, unremediated brownfields depress housing and neighborhood values, as well as decrease potential property tax revenues. Local and state governments can help bridge this informational gap by maintaining easily accessible databases containing information on brownfield properties and expanding incentives for developers in order to minimize the stigma effect for both the initial purchase and the potential sale post cleanup. While the survey response rate was a seemingly low 17.2%, the lack of obvious bias in the respondent pool and the trend in low response rates for surveys within real estate make the analysis of this survey valuable. The findings encourage opportunities for future research incorporating potential survey incentives to improve response rates.

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### Table A1. Developer Survey—Summary of Risk Tolerance and Experience Responses.

| Question                                                                 | Count | Percentage |
|--------------------------------------------------------------------------|-------|------------|
| Q4: Have you ever purchased a property with environmental contamination issues (excluding asbestos and lead-based paint) |       |            |
| No experience                                                            | 95    | 64.19%     |
| Yes, bought unknowingly                                                   | 12    | 8.1%       |
| Yes, bought intentionally                                                | 41    | 27.7%      |
| Q5: Which best describes you?                                            |       |            |
| Will never purchase contaminated property                                 | 22    | 14.66%     |
| Avoid unless economics make sense                                        | 103   | 68.66%     |
| Invest in both types of properties                                       | 24    | 16%        |
| Only invest in Brownfield                                                | 1     | 0.66%      |
| Q7: Have you ever dealt with a property that had a “No Further Action” letter from a state Voluntary Cleanup program? |       |            |
| I don’t know what a VCP is                                               | 21    | 13.82%     |
| No                                                                       | 63    | 41.45%     |
| No, I don’t deal with contaminated properties                            | 1     | 0.66%      |
| Yes, lowered my risk and required rate of return                         | 42    | 27.63%     |
| Yes, did not lower my risk or required rate of return                    | 25    | 16.45%     |
| Q10: When initially evaluating an investment, do you screen for onsite environmental issues |       |            |
| As part of initial inspection                                            | 75    | 46.01%     |
| Always done prior to seeking funding                                     | 80    | 49.08%     |
| Only if requested by lender                                              | 8     | 4.91%      |
| Only invest in contaminated property                                     | 0     | 0%         |
| Q11: If a Phase I environmental investigation shows potential problems onsite, do you further investigate and continue to pursue the investment? |       |            |
| Yes                                                                      | 126   | 85.71%     |
| No                                                                       | 21    | 14.29%     |
| Q12: If a Phase I environmental investigation shows potential offsite contamination originating property, do you continue to pursue the investment? |       |            |
| Yes                                                                      | 78    | 54.17%     |
| No                                                                       | 66    | 45.83%     |
| Q13: If a Phase II environmental investigation shows potential onsite contamination, do you typically continue to pursue the investment? |       |            |
| Yes                                                                      | 64    | 46.72%     |
| No                                                                       | 73    | 53.28%     |
Table A2. Matrix of correlations.

| Variables               | (1)  | (2)  | (3)  | (4)  | (5)  | (6)  | (7)  | (8)  | (9)  | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) | (20) | (21) |
|-------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Gas Invest              | 1.00 |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Dry Invest              | 0.63 | 1.00 |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Solv Invest             | 0.62 | 0.78 | 1.00 |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Avoid Maybe             | 0.20 | 0.01 | -0.03| 1.00 |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Buy Both                | 0.25 | 0.29 | 0.34 | -0.54| 1.00 |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Accidental Purchase     | -0.05| 0.03 | -0.05| 0.11 | -0.07| 1.00 |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Broker                  | -0.12| -0.22| -0.18| 0.11 | -0.12| -0.07| 1.00 |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Developer               | 0.19 | 0.20 | 0.22 | 0.08 | 0.34 | 0.11 | -0.29| 1.00 |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Investor                | -0.07| -0.13| -0.07| 0.06 | 0.04 | -0.02| 0.07 | 0.23 | 1.00 |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Financier               | 0.11 | 0.03 | 0.14 | 0.08 | 0.03 | 0.02 | 0.06 | 0.18 | 0.30 | 1.00 |      |      |      |      |      |      |      |      |      |      |      |      |
| Office & Retail         | 0.25 | 0.12 | -0.00| 0.08 | 0.03 | -0.03| -0.09| 0.12 | 0.14 | 0.06 | 1.00 |      |      |      |      |      |      |      |      |      |      |      |
| Industrial              | 0.12 | 0.08 | 0.22 | 0.04 | 0.10 | -0.07| 0.11 | 0.03 | 0.05 | 0.19 | 0.11 | 1.00 |      |      |      |      |      |      |      |      |      |      |
| Less 1mil               | -0.17| -0.17| -0.08| -0.13| 0.06 | -0.11| 0.45 | -0.32| 0.03 | -0.16| -0.16| 0.10 | 1.00 |      |      |      |      |      |      |      |      |      |
| Between 1mil 5mil       | 0.13 | 0.01 | -0.06| 0.09 | 0.07 | 0.08 | 0.01 | 0.11 | 0.12 | 0.23 | 0.16 | -0.31| 1.00 |      |      |      |      |      |      |      |      |      |
| Greater 5mil            | 0.19 | 0.14 | 0.21 | 0.09 | 0.20 | -0.05| -0.28| 0.21 | 0.00 | 0.28 | 0.13 | 0.19 | -0.27| 0.19 | 1.00 |      |      |      |      |      |      |
| VCP Helpful             | 0.28 | 0.22 | 0.33 | -0.12| 0.30 | -0.05| -0.13| 0.17 | 0.04 | 0.13 | 0.09 | 0.23 | 0.03 | -0.05| 0.17 | 1.00 |      |      |      |      |      |      |
| VCP NoHelp              | 0.16 | 0.00 | 0.01 | 0.08 | 0.06 | -0.01| -0.05| 0.07 | 0.02 | 0.19 | 0.19 | 0.11 | -0.12| 0.22 | 0.23 | -0.12| 1.00 |      |      |      |      |      |
| Screen Phase1           | 0.08 | -0.03| -0.01| 0.03 | -0.01| -0.05| 0.12 | 0.03 | 0.08 | 0.01 | 0.17 | -0.14| -0.09| 0.14 | 0.06 | 0.06 | 0.06 | 1.00 |      |      |      |      |
| P1 Contam Onsite        | 0.51 | 0.33 | 0.37 | 0.38 | 0.20 | 0.10 | 0.26 | 0.12 | 0.17 | 0.20 | -0.02| 0.04 | 0.14 | 0.19 | 0.08 | 0.12| 1.00 |      |      |      |      |      |
| P1 Contam Offsite       | 0.35 | 0.40 | 0.38 | -0.07| 0.25 | 0.06 | -0.09| 0.01 | -0.14| -0.05| 0.07 | 0.26 | -0.01| 0.12 | 0.13 | 0.13 | -0.04| 0.12 | 0.22 | 1.00 |      |      |
| P2 Contam Onsite        | 0.49 | 0.44 | 0.46 | 0.08 | 0.18 | 0.05 | -0.25| 0.28 | 0.06 | 0.24 | 0.01 | 0.10 | -0.24| 0.00 | 0.21 | 0.25 | 0.03 | -0.07| 0.35 | 0.32 | 1.00 |
### Table A3. Investment Choice Probit Analysis.

| Variables            | (1)  | (2)  | (3)  |
|----------------------|------|------|------|
| Avoid Maybe          | 1.83*** | 0.46 | 0.15 |
|                      | (0.59) | (0.42) | (0.43) |
| Buy Both             | 2.31*** | 1.01* | 1.22** |
|                      | (0.86) | (0.52) | (0.61) |
| Accidental Purchase  | −1.17 | −0.12 | −0.63 |
|                      | (0.78) | (0.50) | (0.54) |
| Developer            | −0.27 | 0.18 | 0.44 |
|                      | (0.46) | (0.31) | (0.33) |
| Investor             | −1.07** | −0.52* | −0.55* |
|                      | (0.48) | (0.30) | (0.33) |
| Financier            | 1.42 | 0.11 | 0.61 |
|                      | (1.95) | (0.55) | (0.67) |
| Office & Retail      | 1.48*** | 0.36 | −0.34 |
|                      | (0.55) | (0.32) | (0.34) |
| Industrial           | −0.89* | −0.19 | 0.28 |
|                      | (0.49) | (0.32) | (0.34) |
| Less 1mil            | −0.53 | −0.31 | −0.09 |
|                      | (0.53) | (0.35) | (0.37) |
| Greater 5mil         | −0.23 | −0.18 | 0.09 |
|                      | (0.54) | (0.37) | (0.39) |
| VCP Helpful          | 1.93** | 0.37 | 0.77* |
|                      | (0.75) | (0.34) | (0.40) |
| VCP NoHelp           | 2.06** | 0.04 | −0.11 |
|                      | (0.83) | (0.38) | (0.41) |
| Screen Phase1        | −0.67 | −0.17 | −0.14 |
|                      | (0.48) | (0.30) | (0.32) |
| P1 Contam Onsite     | 1.98*** | 0.67 | 0.69 |
|                      | (0.71) | (0.50) | (0.50) |
| P1 Contam Offsite    | 1.24** | 0.73** | 0.69** |
|                      | (0.51) | (0.31) | (0.32) |
| P2 Contam Onsite     | 1.24** | 0.78** | 0.77** |
|                      | (0.51) | (0.30) | (0.32) |
| Constant             | −3.11*** | −1.58** | −1.35** |
|                      | (1.11) | (0.65) | (0.59) |
| Observations         | 126 | 121 | 119 |

Standard errors in parentheses and *** p < 0.01, ** p < 0.05, * p < 0.1.

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