DISSERTATION

RISK & RETURN
IN
REGIONAL DEVELOPMENT

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WE HEREBY RECOMMEND THAT THE DISSERTATION PREPARED UNDER OUR SUPERVISION BY EMILY BONNER ENTITLED RISK & RETURN IN REGIONAL DEVELOPMENT BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY.

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ABSTRACT OF DISSERTATION

RISK & RETURN IN REGIONAL DEVELOPMENT

This dissertation is written in an attempt to expand the frontier of research in the sphere of risk and return associated with development and re-development issues facing regional economies. The premise of this study is to provide a "micro-foundations" view of the decisions facing the individual actors of local economies. Consequently, by analyzing the decisions faced at the micro level, this dissertation can provide public policy makers with varying insights into the mindset of private agents in a local economy. The result will be and increased understanding as to their role in addressing inefficiencies. In the absence of efficient diversification, in an effort to reduce the overall risk exposure of the economy, social planners expose their economy to an improper balance of risk and return, thus leading to greater inefficiency.

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CHAPTER I: INTRODUCTION

Section 1.0 BACKGROUND

The composition of and trends in regional development provide a useful analogy to the financial literature of risk and return. Risk, in traditional terms, is viewed as a 'negative'. Webster's dictionary, for instance, defines risk as "exposing oneself to danger or loss". However, as Damodaran (1999) explains, the Chinese symbols for risk give a much better description of the meaning of this term, risk: the first symbol is the symbol for "danger", while the second is the symbol for "opportunity", making risk a mix of danger and opportunity.

Regional development issues must be examined in this type of framework or mindset in order to provide a more useful examination of the tradeoff between risk and opportunity, or return, to the public at large. When risk is considered to be a prospective "opportunity" in the appropriate context, we can better understand and develop the proper strategy or objectives to achieve a desired outcome.

The foundation of Modern Portfolio Theory captures this fundamental relationship of risk and return as the most essential connection that must be understood and maintained in order to provide needed efficient diversification in all aspects of an economy. This theoretical relationship was first established in a rigorous model put forth by Harry Markowitz in 1952, for which he later won the Nobel Prize in Economics.

Diversification, in a pure financial investment connotation, implies a balance for which is only attainable by dividing funds among securities of different industries or of different classes in order to reduce risk exposure of individual instruments, while achieving greater returns. Diversification and its implications can be understood in the context of this dissertation, specifically pertaining to regional development issues, by addressing the significance of the age old proverb, “don’t put all your eggs in one basket”.

Modern Portfolio Theory has demonstrated how proper diversification procedures can eliminate “nonsystematic risk” (i.e., firm-specific risk), however, “systematic risk” (i.e., market risk) can not be eradicated. By extending the idea of diversification to this milieu, we can assume there is then the possibility of eliminating any “project specific” risk, but no means to eliminate the general “economy” risk. However, this notion provides great theoretical power for the role of the “social planner” decision/policy maker. It is then the intent of this dissertation to underscore the importance of the notion of a proper diversification strategy and how it is necessary in this setting in order to achieve a socially efficient, thriving regional economy.

The risk of any project or proposal in a regional economy is the element of risk that it adds to the economy’s portfolio. In order to achieve the desired socially efficient outcome, it is necessarily imperative to measure risk accurately and appositely within the context of the project and local economy. The anticipated level of risk will then translate into required rates of return and hurdle rates of the project. It is a generally accepted rule in the financial literature that one should invest in projects that yield a return greater than the minimum acceptable hurdle rate. A simple representation of the hurdle rate is that it equals the rate or return expected from a riskless asset or project plus any associated risk premium specific to the project at hand, which is an increasing function of the riskiness of the project. This would then imply the hurdle rate should be higher for riskier projects. In addition, returns on projects should be measured based on cash flows generated and the timing of these cash flows; they should also consider both positive and negative side effects of these projects. Therefore, the exact method and accuracy of the risk premium measurement is of the essence. As will be demonstrated in much of this dissertation, when the risk premium is not properly estimated, it can lead to a lack of socially efficient outcomes. Consequently, in the event of such market failures in a regional economy, it will be demonstrated that the implications that emerge include the possibly of needed direct policy intervention.

Risk profiles, which outline the delicate relationship between risk and return, have been assessed in a wide variety of research fields. Specifically, such growth/variance considerations have long been explored in financial portfolio research, however, little has been accomplished in the context of regional development.

Much of the literature put forth on risk and return in regional development has focused on employment and the mix of industries in an economy, providing a view from the amorphous "social planner" perspective. Because employment as it is a fundamental component of economic development, much of the current trends in the research focus on growth in the job base as the primary concern from the planner perspective.

Michael Conroy (1974) presented an important study applying financial portfolio modeling techniques to regional employment data which has been influential for researchers who have been investigating the relationships between diversity, economic growth, and economic instability (Lande, 1994). Barth et al. (1975) addressed the risk and return of employment stability from the perspective of policy makers. They maintained that stability in employment, and other measures of return in a region, do affect the general welfare of a region's economy. Lande (1994) presented research on the relationship between employment growth and instability. Again, risk and return in the context of employment portfolios and their impact on a regional economy were examined. He concluded that it is possible to identify the consequences of changes in industrial structure for regional growth and instability and to identify the impact that firms will have on the regional economy.

This trade-off of risk and return is one of the most fundamental factors playing a vital role in how/why local economies develop, redevelop, and diminish away. The purpose of this three-interrelated topic dissertation is to address how risk and return affect local economies in a broad set of topics. In contrast to the current regional development literature which considers risk from a planner perspective, this dissertation will present the microeconomic foundations of a range of actors involved in local economic development. This will be accomplished in an effort to understand the risk/return decisions faced by the participants in local economies.

The initial area of study in this dissertation will address the rise and fall of what have come to be known as "Ghost Towns." This is important in the discussion of risk in regional development because of the nature of these types of economies. Due to the unique characteristics typifying the booming development of these locales, risk of a tapered life in these economies played a critical role in their development and subsequent plummeting cycle.

The next two areas of research are interrelated in that while new development space in terms of real estate resulting in greater spatial needs for what seems to be an incessantly expanding society, there are some considerable benefits to be found in the redevelopment of vacant contaminated property sites. This return to be generated is not without the accompanying risk. The third chapter will examine the role of risk and the required return specific to the contaminated property redevelopment sector.

The consequential flip side of that issue will be addressed Chapter IV. The argument to be made in this chapter is to address the issue of conservation. If society as a whole deems open lands as socially beneficial in their pursuit, and if the desire to mitigate urbanization is present, what is the socially efficient method of valuing conservation of open lands?

Therefore, the essence of these two chapters is to address the rising habitable population issues at hand. If more vacant and unutilized land could be redeveloped, expansion of growth into undeveloped frontiers could be mitigated. The other side of this issue can be accomplished by maintaining open land for conservation purposes in the avenue of conservation easements.

Section 1.1 FIRST PAPER OVERVIEW: THE ECONOMICS OF GHOST TOWNS

The purpose of this chapter is to explain the boom and bust cycles of past and present rural communities. This examination will include historical ghost towns which are an intriguing application of how local communities can quickly develop and subsequently also rapidly fade away. In addition, the ghost town rise and fall will be evaluated against other regional decaying areas, although transpiring in a more lethargic manner. Specifically, the West Virginia coal mining towns and the Midwestern agricultural based communities will be pursued as contrasting variations of local community cycles of extinction.

The ghost towns of the American West are both intriguing historical artifacts and reflections of unique economic forces at work. This study develops linked labor and housing market models balancing the wages, rents, and local amenities of isolated boomtown sites to better understand the sources of such communities' dramatic cycles. High variance boomtowns provide a unique context for investment in housing and other foundational local markets, leading directly to the unusually transient local development trends in ghost town settings.

As a result of the unique labor market and fixed investment characteristics of these types of locations, the model predicts that while excess profits can be generated from this Ricardian rent type of environment, it is known to be for only a finite period. Consequently, investment will be limited as a result of this uniquely finite time horizon as well. The limited fixed investment is thus a crucial element as hypothesized by the models of this chapter which provides theoretical the elucidation as to why such communities experience a bust period seeming to be just as overt as their initial rise.

Colorado based case studies using historical census data are used to illustrate the relevance of the model. Comparisons with more modern rural settings in Appalachia and the Midwest suggest that the model provides a framework to better understand the process of rural decline more generally.

Section 1.2 SECOND PAPER OVERVIEW: RISK PREMIA OF BROWNFIELD INVESTMENT

The scope of this research is to examine the risk and associated required return needed for the initiation of contaminated property re-development ventures. In addition, the purpose of this study is to offer insights into the minds of real estate development professionals, while proposing the ensuing policy implications needed for the emergence of re-development in almost every metropolitan city.

Brownfields are uniquely challenging development sites in the modern urban landscape, as their environmental stigmas make private investors reluctant to engage in such efforts. Brownfield developers are effectively shouldering both extra costs and risks for broader community benefits. A survey was sent to 900 real estate development professionals in the Denver metro area. Through the results of this instrument, this study estimates these additional costs and risks through descriptive statistical analyses of risk premiums. The results suggest that private redevelopment efforts indeed face significant hurdles, whether actual or perceived. Furthermore, evidence provided from the findings of this study suggests the current Brownfield market is that of a likely asymmetrically informed market. The implication of this asymmetry is that of substantively higher required rates of return necessary to persuade these real estate professionals to enter the market.

The premise of this article is to suggest that significant redevelopment potential exists for Brownfield sites, which would result in direct increases in economic activity in the site itself as well as indirect job creation and increases in neighborhood property values. Therefore, the hypothesis of this study is that asymmetric information is a hurdle that must be addressed through policy intervention. In doing so, greater redevelopment initiatives will provide relatively superior socially efficient outcomes to arise.

Section 1.3 THIRD PAPER OVERVIEW: CONSERVATION EASEMENTS & REAL OPTIONS THEORY

Conservation easements are a rapidly growing tool being used to preserve raw or undeveloped lands all across the United States. Their role in preventing the perpetual continuation of urban sprawl is quite substantial. However, despite this inherently market-based approach to limiting the spread of urbanization, there appears to be inefficiencies occurring. The imperfect nature of the market, due to what seems to be translating into social and private costs and benefits differing, is potentially lessening the extent of the allocation of these conservation strategies.

The contribution of this chapter is to provide an enhanced model for the use of rigorously defining the parameters necessary to accurately characterize the appropriate pricing from the private landowner perspective in order to achieve the maximum benefit for society. Chapter IV will address the needed optimal pricing strategies that are crucial to the understanding of how a regional economy can efficiently conserve the socially optimal amount of open land in a rapidly urbanizing region notwithstanding this market imperfection.

While recent literature has produced varying pricing strategies in an effort to efficiently price conservation easements, there has yet to be a clear consensus among experts in this area as to the appropriate valuation procedure. Therefore, the contribution of Chapter IV is to impart a more complete representation of the considerations to be made, by incorporating optionality features of conservation easements in a game theoretic framework, thereby providing an efficient process of valuing and thus pricing conservation easements.

Therefore, the central thesis of this dissertation is to evaluate risk and return in an array of regional development settings. Each chapter will provide the foundation by which individual economic agents make decisions. A resulting implication to be addressed is the matter of market efficiency. Thus, the implications of inefficiency will be discussed when the appropriate tradeoff does not exist.

CHAPTER II: THE ECONOMICS OF GHOST TOWNS

Section 2.1 INTRODUCTION

"Ghost towns" are common terminology for completely depopulated communities, leaving scant evidence of their previous existence beyond the decaying buildings themselves. While such sites are ubiquitous in the Western United States, Appalachian towns have also experienced this phenomenon. All are typically found in isolated plains or mountain locations. Most of these towns were based on intensive mining booms typifying the extractive industries of the 19th and early 20th centuries, while some were oriented towards extensive ranching practices.

The rapid rise and fall of these communities are obviously linked to the parallel boom and bust of the local industries. Such booms and busts usually required both the quick acquisition, and the often equally rapid dispersion, of critical labor supply in isolated, difficult circumstances. From the dust of Tombstone to the brutal high-altitude conditions of Leadville, the living and working conditions of such boom towns were often inhospitable at best. Some compensating wage differentials were clearly required, but what was their source? Furthermore, given the large amount of quick wealth that was often generated in such settings, it is surprising that localities remained so narrowly dependent on single industries.

This study develops linked local labor and housing/fixed investment market models to frame the understanding of the sources and dynamics of ghost town's dramatic cycles. Negative amenities clearly constrain the ability of firms to attract labor. Yet extractive industries also generate a significant amount of quasi-rents (here termed "supra-profits") from two sources. First, by definition, extraction occurs on fixed resources, such as grazing land property or mining claims on a particular mineral vein. Ownership of these varying quality resources generate varying amounts of Ricardian rents, leading to supra-profits. Second, sunk capital creates further quasi-rents, and thus additional divisible supra-profits. Both need to be shared between management and workers. Given the inhospitable settings, management is particularly likely to share an unusually large proportion of such supra-profits with its workers to offset local negative amenities.

Busts can occur due to resource depletion, such as overgrazing, or sudden drops in demand, such as for molybdenum. Supra-profits can thus dissipate quickly, leading to rapid depopulation. Normally, transition and information cost difficulties hamper quick adjustment, but these industries naturally attract workers with low mobility costs, accelerating in- and out-migration. These same mobility characteristics, along with the well-understood uncertainty regarding the viability of the primary local economic base, led to little local diversification and predominantly short-term investment perspectives.

The latter phenomenon is a specific focus of this work, as labor market supra-profits are modeled into a joint wage/rent and housing investment framework. Limited horizons lead to reductions in the quality and quantity of critical sectoral and infrastructural needs, as investors in these sectors will seek combinations of low-fixed-cost installations alongside requirements for higher short-term returns to offset the anticipated future decline of the local economic base. This chapter examines the housing market from this perspective, exploring the implications for communities of possessing an especially transient local economic base.

We first analyze historical census data for Rocky Mountain mining communities, and then consider parallels with their modern day Appalachian and Midwestern counterparts. By examining the historical local conditions such as population, male/female ratios, average wages, the number of dwellings, and other information, we test the predictive and explanatory power of the investment framework taken here.

The paper's principal finding is that a linked labor and housing model can help explain key demographic as well as labor and housing market phenomena in Ghost Town settings. Further, this model has applicability in the less extreme settings of more modern Appalachian mining and Midwestern agricultural communities, resulting in greater understanding of the process and speed of rural community decline.

Section II first develops a local labor market model of supra-profits balancing amenities, then introduces the implications of such varying supra-profit flows for the local wage/rent and housing markets. Section III provides empirical applications through an analysis of historical census data of each area. Section IV concludes with implications emanating from the theoretical framework and empirical results.

Section 2.2 THE BASIC MODEL

a) The Ghost Town Labor Market

The following framework constructs a local labor market model to incorporate the balance between supra-profit-sharing for workers and negative amenities, based loosely on the foundations developed by Weiler (2001). The formal model focuses on the distribution of product market supra-profits, with firm capital intensity modulating the share of supra-profits that workers can effectively leverage. Generally, such supra-profits will generate labor market queues in a region with no negative amenities, but our focal areas are presumed to have substantial need for compensating differentials over and above workers' marginal products. These supra-profits are distributed to the point where they just offset the negative amenity to meet a firm's labor needs. The implications for local investment of such labor market supra-profits in a boom/bust community are formally developed in the following subsection.

We first develop the local labor market structure that produces the necessary supra-profit flows to attract and retain critical local workers. The local economy is set in continuous time. Firms first establish their profit-maximizing demand for labor. Homogeneous workers then maximize expected lifetime income by choosing whether to apply for jobs in the focal extractive industry, with short-run adjustments occurring around these foundations.

Labor supply is assumed to be perfectly elastic at a given reservation wage, hence all firms face an inexhaustible supply of workers at the reservation wage. The demand for labor stems from the prospective employment sector. A representative primary sector firm is modeled as a firm having ownership of a scarce resource, such as a specific mining claim, thereby able to obtain Ricardian rents. In this case, the firm has possession of a fixed, depletable resource, facing a constant elasticity function

$$P = Z\,Q^{(-1/b)} \tag{1}$$

based on b, whose inverse proxies for the value of the owned mining claim and thus the vein's potential Ricardian rent. The resulting price "premium" above a break-even competitive market price for the mined product generates the divisible supra-profits. The sector is also characterized by a constant-returns-to-scale Cobb-Douglas production function, with capital and labor as inputs.

$$Q = K^{a} L^{1-a} \tag{2}$$

The wage determination process assumes that the negotiating group of workers has the power to set wages given the known labor demand function of the firm:

$$\text{Max (w)} : [\, L(w) / N \,]\, w \; + \; [\, 1 - (L(w)/N) \,]\, w_{reservation} \tag{3}$$

L(w) represents the number of workers hired by the primary sector at a bargained wage, while N indicates the number seeking such positions. The model thus maximizes the expected income of a worker applying for a primary sector job, which will feature a share of product market Ricardian rent generating supra-profits.

Negotiation is based explicitly on the level of negative amenities that need to be offset. Insider/outsider models can justify such a worker-driven wage determination process. In the Weiler (1997) case studies, insiders in key positions were shown to have a large amount of leverage in implicit or explicit wage determination, since the information they possess about the production process and their cooperation in maintaining high productivity and training new workers is crucial to the success of the primary firm. Similar factors are likely to be in play in most ghost-town-type extractive industry settings; in fact, the noted case studies were themselves largely based on the modern West Virginia coal-mining industry.

Profit-maximization by the primary industry yields the following demand for labor

$$L_1 = a^{a(b-1)}\,(1-a)^{b-a(b-1)}\,r^{-a(b-1)}\,w_1^{\,a(b-1)-b}\,(1 - (1/b))^{b}\,Z^{b} \tag{4}$$

where r represents the exogenous cost of capital. Total costs are equal to

$$T = w_1 L_1 + rK = a^{a(b-1)} (1-a)^{(1-a)(b-1)} r^{-a(b-1)} w_1^{(a-1)(b-1)} (1 - (1/b))^b Z^b \tag{5}$$

Primary sector profits are equal to

$$\Pi_1 = (1 / b-1)\, T \tag{6}$$

Using the wage bargain described above, the resulting primary sector wage is

$$w_1 = w_r \; [(a+b-ab) / (a+b-ab-1)] \tag{7}$$

which is greater than the reservation wage. As noted above, product market supra-profits are determined by the representative firm's ownership of the scarce resource, principally through the price premium elasticity, b, while labor's ability to secure such rewards is defined by production capital-intensity, a. Again, both features are likely to be relevant in ghost-town-type settings. Ownership of the fixed resource, such as a copious gold vein, along with the geographic limitations of the relevant market area (such as gold in California or Colorado) suggest that rents are being generated in these settings. Labor's cooperation in extracting the resource, not least because of local geographic disamenities limiting labor supply, is also likely to be crucial.

Short-term adjustments can occur around these equilibrium foundations. The model's dynamic adjustment process is detailed empirically in Weiler (2000) for the case of modern-day blue-collar sectors. Theoretically, the following extension to the equilibrium model above introduces sticky short-term adjustment into the model through a mobility cost factor, m. Given a steady-state industrial structure and level of unemployment, a region will have a fixed number of workers in that area. However, if labor demand changes, workers will be eventually either pushed or pulled from the local labor force, which will entail some cost. This cost leads to a short-run kink in labor supply, creating adjustment periods. One can model this effect by introducing such a kink in the labor supply curve at the current level of employment. Mobility costs are equal to m, so the vertical kink ends at w_r+m and w_r-m. Short-run labor supply returns to its perfectly elastic state at those levels.

Consider first the effect of a negative employment shock. Local ties, both financial and psychic, can lead to significant mobility costs in the face of declining employment possibilities. Due to such costs, the reservation wage falls to w_r-m before workers will leave the local labor force for the informal sector or other regions. This decline in the reservation wage will decrease the local wage, even given constant negative amenities. Conversely, a positive shock will turn the focus of reservation wages to those of the workers who need to be attracted from outside the labor force, or w_r+m. Therefore, given a positive employment shock, wages will rise in the short-term up along the labor supply kink. Over time, as mobility costs are overcome, local labor markets will adjust back to the equilibrium foundations.

The unique features of the focal boomtowns suggest that such labor supply kinks will be small. Most of the workers who consider such positions necessarily accept transient lifestyles. In fact, the model suggests that such workers are precisely those who will tend to naturally select into such positions, and their lower mobility costs will reduce the risk of reduced wages for all local workers. Therefore, adjustments are undertaken quickly, with depletion of product market supra-profits or extractive supply leading to quick depopulation of the bust-town. Just as quickly, these workers will gravitate towards the next boomtown, assuming that supra-profits are sufficient to attract workers to the new negative amenity environments. There is a sharp contrast with the empirical results in Weiler (2000), the latter indicating that Appalachian mobility costs are considerably higher.

This understanding of precipitous local cycles leads to a reluctance by local firms and workers to invest into the local community. The local community is built around the economic base generated by the focal extractive firm. Sudden depletions or product price reductions can easily cause a town's economic base to evaporate. Therefore, any investment in related trade and service activities will be minimal and transitory, explaining the dependence of such towns on similarly transient local traders. Developing any alternative economic base immediately necessitates the disproportionate sharing of any potential supra-profits to attract workers to a negative amenity environment, steering alternative investment flows away from such areas.

The following section develops a framework to understand these limited incentives for longer-term investment in terms of the local housing market. While important in itself for determining the viability of a local community, housing investment also represents a proxy for the rational decision to limit investment in critical local foundational sectors and infrastructure in the face of dependence on a narrow and highly uncertain product market.

b) Amenities and Investments in Ghost Towns

In the context of the unique factors influencing a boom/bust type of location, both firms and workers face distinctive combinations of wages and rents required for equilibrium. As a result, wages and rents are a direct function of the amenity setting characterized by an extraction economy, where high variance of economic prospects are expected by both workers and firms.

The model presented in this chapter is developed from and is an extension of Roback (1982), Rosen (1979), and Mueser and Graves (1995). Workers and firms are presumed rational and, therefore, choose to locate in this boom/bust setting in order to maximize utility and profits respectively. Workers are assumed to be identical in their preferences for wages, and in fact are focused more on offered wages relative to rents than would be typical. The type of worker drawn to this setting is a transient, lower skilled laborer seeking the short-run elevated wage potential of a booming site. The utility maximization problem for the representative worker, given some level of amenities, A, in this setting is to choose quantities of x, the sum of the commodity consumed, and l, the amount of residential land consumed, to satisfy a budget constraint:

$$\text{Max U } (x, l; A) \text{ subject to } W + I = x + lr \tag{8}$$

The wage income is signified by W, where $W = w\bar{h}$, w being the hourly wage and $\bar{h}$ being a fixed quantity of l'abor supplied.[1] The rent rate is denoted as r. Non-labor income is represented by I. (Roback, 1982). Utility-equalizing combinations of wage and rent, holding amenities constant, are seen in the representative indirect utility function, V. There are an infinite number of such indirect utility functions, one for each level of amenity, that leave workers indifferent among locations; areas with desirable amenities will experience in-migration driving up rents and driving down wages, and conversely.

[1] The higher wages might be expected to lead to greater work effort, particularly given the expectation that such long hours would be temporary.

In the case of ghost towns, the utility-equating V' function is to the right of V for an amenity neutral location. If the V' function were not to the right of V, thus providing higher w at the same r, workers would have no incentive to move to this type of negative amenity setting. This relationship is embodied in Figure 2.1, with V representing isoutility combinations of w and r for the representative worker. V(A) shifts to the right when amenities are lacking to become $V(A_G<A_{typical})$, A_G signifying the undesirable amenity bundle workers associate with a location destined to become a ghost town. Hence, a higher wage will be paid in a ghost town location than in a positive amenity location, as a necessary compensating differential to attract and retain workers in difficult settings. The source of these compensating differentials is the supra-profits developed in the labor market model above.

The firm's objectives are to minimize costs subject to the production function, since they are generally selling their tradable good at a constant national price. The firms produce good X given constant-returns-to-scale, therefore, $X = f(l, N; A)$, where l is the land utilized in the production process, and N is the total number of workers in the town (Roback, 1982). In equilibrium, the firm's cost function reflects the fact that higher wages paid to workers must be offset by lower rents at the optimal level of production. In the boom/bust context, the representative firm sees positive locational amenities during booms due to their unique ability to capture excess supra-normal profits. Therefore, the cost function in this environment making firms indifferent between this location and others is reflected in line $C(A_G>A)$.

The Boomtown equilibrium will depend on the expected size of the boomtown's core industry return stream balanced against the anticipated longevity and uncertainty of the boom itself. Capital will be allocated over space to equalize the risk-adjusted rate of return. Therefore, the net present value (NPV) of capital investments will be the same in all places despite different time patterns of returns from those investments. In terms of the boomtown, the longer the expected return stream and the lower the uncertainty of that return in a specific area, the more capital will flow in. This is reflected by the $C(A_G)$ Permanent dashed line in Figure 2.1. The more uncertain case is represented by the $C(A_G)$ Temporary dashed curve, reflecting the fact that the locational amenity for firms is smaller with a consequently smaller amount of capital moving into the "boom" location.

The rent effect is, in general, ambiguous; it will depend on how "bad" the Ghost Town amenities are for workers, relative to how "good" the Ghost Town amenities are for firms (e.g., how much gold relative to how unpleasant the weather). The wage will, however, be higher with certainty since both the increase in demand for labor and the decrease in supply of labor work in the same direction. Both worker and construction behavior are fundamentally influenced by the perceived transiency of the boom. Workers obtain higher wages for both the negative amenity and volatile employment prospects. Given the ambiguous rent effect, builder perspectives on such transiency are likely to translate into a low incentive to provide durable place-specific investments in housing and commercial district construction.

The model provides several testable hypotheses. First, one should observe higher and more variable wages in boomtown settings. Additionally (deletion), the model predicts, ceteris paribus, reduced quantity and quality of permanent dwellings and other types of fixed capital investment in locations destined to become ghost towns. Thus, increases in (deletion) low quality housing would be expected, with rents being relatively high for that quality of housing; followed by subsequent declines in the housing stock as the production amenity dissipates in Ghost Town settings. In-migrants will self-select to be those with lowest moving costs, with single males being the predominant type of Ghost Town resident. Finally, population movements not explained by linear trends are also more likely in Ghost Town settings, due to the quick responses of labor supply discussed earlier.

Section 2.3 EMPIRICAL APPLICATIONS

The primary source of data for this study is the United States Historical Census Data Browser assembled by the University of Virginia. Relevant categories and comparable data began with the 1870 tabulation, with analyses thus focused on the last 3 decades of the 19th century.

Three Ghost Town communities are examined. To establish a useful empirical benchmark, we consider the Rocky Mountain region which featured many mining communities in the late 19th and early 20th centuries. Colorado has an extensive mining heritage, beginning with the discovery of gold in 1859, later including coal, gypsum, limestone, silver, and molybdenum. Given these results, the implications for Appalachia mining and the Midwestern farming communities are then explored to help understand the potentially broader implications of the model for rural community decline.

a) Rocky Mountain Region

Background. Colorado mining towns exhibited remarkably large boom and bust swings with similar patterns in many extractive locales. While they enjoyed immense and thriving boom phases, their ultimate bust eras were equally substantial. The boom years fostered massive development for the mountain communities. Not only were laborers drawn to the sites, but others seeking to cash in on newly demanded services for the new dwellers rushed in. General stores, taverns, blacksmiths, medical and dental practices, inns, and many other service-related businesses blossomed. Houses were built, and the economies would have seemed to be sustainable.

However, the ripple effects were extensive when the mine ore began to dwindle. The once thriving economies became Ghost Towns seemingly overnight. Buildings were left vacant, deteriorating rapidly–some were literally dismantled and burned to provide heat in the cold winters often prevalent. Laborers and service workers moved on to the next booming location. With laborers fleeing in the extractive industries, the support businesses were quickly left without consumers, causing them to also abandon the community.

As an initial case study empirical analysis, we analyze the effects of the classic boom/bust economy of Lake County, Colorado. Perhaps more than any other county in Colorado, Lake County is the richest in mining history. Lake County was an original county dating back to the creation of the Colorado Territory in 1861, and ranked as Colorado's second most populous county in the late 1800's. The discovery of gold in 1860 in the California Gulch led to a rush of prospectors across the infamous 13,180-foot Mosquito Pass to seek their fortunes. Leadville's gold rush began a series of prospecting cycles. The Silver Boom began in 1877, then quickly collapsed with the repeal of the Sherman Silver Purchase Act in 1893. Molybdenum began the next boom cycle in 1918, as the Climax Mine became the largest underground molybdenum mine in the world.

In addition, Teller County, Colorado is examined due to the discovery of Gold in the town of Cripple Creek in 1890. Railways were already beginning to extend to Cripple Creek from all directions by 1891. By the time the town was officially incorporated in 1892, there were over 5,000 Gold Camp residents. Approaching the turn-of-the-century, expanding throughout Cripple Creek were 73 saloons, 49 grocery stores, 34 churches, 20 meat markets, 14 bakeries and 11 laundries. "Today the fame of the Cripple Creek Gold Camp ranks with London, Paris and other money centers of the world, for, while the great money centers may handle and control more of the world's assets, Cripple Creek actually adds more new money to the treasury of the world than any other place. Nearly $2,000,000 are added every month to the world's wealth by the product from the hills within The District of Cripple Creek" (Cripple Creek Times, 1904).

The area's mines were responsible for making the region the fourth largest gold producing location in the world. In the first year of production, mines reported about $250,000 taken from the ground. By 1893, miners had dug up $3 million in gold ore, and by 1899 about $59 million in ore was extracted from the site. Toward the conclusion of the gold rush, area mines had produced $432 million.

Around the turn of the century, assay offices were as prevalent as general stores. Service related industries also began to flourish due to the increased new demands of the miners. Wooden store fronts lined the dusty streets and tent cities quickly sprang up. In 1896, the town burned to the ground in the series of two fires. Brick buildings then replaced the old wooden shops. Most of these brick buildings have been refurbished and now exist as casinos filled with visitors trying to hit a modern-day jackpot.

Table 2.1, in the appendix, illustrates the differences in demographic and labor market attributes for Lake County, Teller County, Arapahoe County, and the State of Colorado as a whole. Lake County's population was dominated by the Leadville area from its inception, and was also geographically consistent beginning in 1879. Arapahoe County included Denver from 1870-1900. In 1902, Arapahoe County split apart and formed portions of Denver, Adams and Washington Counties. Therefore, Arapahoe will serve as a benchmark up until 1900. In 1900, Arapahoe County was the most populous county in Colorado. To incorporate local market dynamics for the early 20th century, Lake, Teller, and Colorado data are extended through the 1920 census.

Historical Census Analysis. Based on the model and the census data information available, our principal hypotheses for a boom/bust area include: 1) an overall high mean wage along with a high wage variance, 2) a high population variance, 3) a high male/female ratio with a high male/female ratio variance, and 4) greater variability in the number of dwellings. Table 2.1 summarizes the cross-sectional and time-series data, as well as key descriptive statistics.

Manufacturing wages were the only wage data available, but should be reflective of the market rate for manual workers in the area. The overall mean wage in Lake County and Teller County across both its booms and busts was greater than Arapahoe County and Colorado as a whole. In terms of the higher overall mean wage hypothesis, the 1890 data point from Lake County may be particularly instructive, as this was a year in the middle of the Silver Boom. Wages were 30% greater than in Arapahoe County, 42% greater than the state average, and 59% greater than Lake's own 1870-1900 mean.

Teller County wage data even more clearly confirms the model's hypotheses regarding wage dynamics. As noted in the historical background, the key decennial shift was from 1890 to 1900 with the gold boom. Indeed, Teller wages increased by 37% in the same decade which saw wages *decline* in all the other focal counties, as well as for the state as a whole. In 1900, the average wage was 31% higher than Arapahoe County and the State of Colorado as a whole, and was 17% greater than the sample period average in Teller County.

Variance that can not be explained by a standard linear trend model is a simple benchmark for variability for such short time series. Linearity avoids the ad hoc specification of an exponential trend; nevertheless, results using the latter are substantively similar to those using linear trends. Nevertheless, this metric is still limited, as demonstrated in the case of wage variability. Wages are clearly more variable in Lake and Teller over 1870-1920, but the unexplained variance measure does not properly capture these cycles. In contrast, total population displays more concrete variance in Lake and Teller; the calculated unexplained variance is 0.9999 in Lake and 0.9847 in Teller as compared to Arapahoe County's 0.0617 and Colorado's 0.0061.

Clearly, both Lake and Teller Counties experienced a much greater degree of variation in population size. Lake County encountered this during the last part of the 1800's, a characteristic that continued even more strongly into the early 20th century with the effects of the silver bust. Lake's population rises in 1880, then again in 1900, but then decreases dramatically in 1920. Teller County had substantial increases in population each decade approaching the 1890-1900 era, and then sharply fell in the following years. In contrast, Colorado and Arapahoe's populations steadily increased throughout each decade.

Lake's male/female ratio is also distinctive. Total male population peaked in Lake County in 1880, but the female population lagged behind until its eventual peak in 1900. In every census year, the male/female ratio was higher in Lake than Arapahoe and Colorado, and generally displayed greater unexplained variance, with a particularly distinctive spike in 1880. Interestingly, as the bust took hold in the early 1900's, the male/female ratio approached "normal" statewide levels. These findings are themselves indicative of an isolated boom/bust economy. Prospecting-focused males are the dominant initial and highly variable population base, given their lower mobility costs as they seek short-term manual labor opportunities with high, but risky, rewards. The female population arrives later, more slowly, and more steadily. While Teller gender ratio levels are somewhat lower than Lake's, they still exceed both Arapahoe's and Colorado's levels in the critical 1900 boomtown census count by 40% and 18% respectively.

Finally, the data also indicates the short-term nature of fixed investment in the Lake and Teller boom/bust economies, as represented by the variability of the number of dwellings. While the number of dwellings steadily increases in linear proportions in Arapahoe and Colorado, both Lake and Teller experienced much greater variability, with unexplained variance at 0.5684 and 0.3296 respectively. The number of dwellings increases until 1900 for both counties, and then begins to decline as the extraction period draws to an end. Dwellings are rarely considered to be non-durable short-term investments. However, their absolute decline in the first two decades of the 20th century by nearly 31% and 36% respectively in Lake County, and even more dramatically for Teller County at a rate of 47% and 51% respectively, suggest that such construction was indeed focused on the short-term.

b) Implications for Appalachia and the rural Midwest

Appalachian Coal. Like the Rocky Mountains, the mountain areas of West Virginia are home to abundant extractable resources as well, with coal being the primary target. In contrast to the Rocky Mountain expanse, the Appalachian mining regions have evolved in a manner that is less dramatic. Appalachian towns have declined more slowly than one would expect based on their employment conditions.

West Virginia was blessed with enormous reserves of energy rich bituminous coal. These coal deposits occur in fifty-three of the fifty-five counties. Underlying the topography of the state are sixty-two individual veins of coal which are considered economically feasible to mine. As indicated by historical records, early settlers seemed to be quite aware of the rich black natural resources in the western sections of Virginia. Coal is reported to have been mined as early as 1810 when a mine was operated near Wheeling, in the northern panhandle. Coal has continued to grow in production since that time, with wage rates among the highest in blue-collar occupations. Over the last 30 years, however, technological improvements have led to decreasing needs for labor and cleaner burning oil has been substituted for coal in many applications. Hence, mining employment fell steadily in the latter stages of the 20th century. Yet despite the disappearance of many of the coal-based jobs in the region, coal towns have declined more slowly than would be expected by the histories of their Rocky Mountain brethren.

Home ownership, and the endogenous network/roots that come with it, seems to be a critical reason for the disparity between the boom and bust patterns across the regions. Formal/informal networks and interregional mobility costs play a major role in determining the ability of a local labor market to adjust to a given shock. Given high home ownership rates and the importance of local networks highlighted in Weiler (1997), migration involves a significant sacrifice. These high worker transition costs are underscored by the relatively slow adjustment to labor market shocks, as seen econometrically in Weiler (2000). However, much of the housing in such hilly terrain is based on fabricated and mobile homes, which have less longevity than typical flatland dwellings. The implications of this are clearer when compared to the slower transitions of flatland farming communities.

Midwest Farming. The Midwestern agriculture region is another useful example of an initially promising rural setting founded on a localized natural resource-based economy which later stagnated. Farm employment has continually contracted since the end of World War I, and even current farm households only receive 10% of their income from on-farm activities. Yet in contrast to the Rocky Mountain mining boom towns, the Midwest has experienced a much slower decay. The period of adjustment is at the opposite end of the spectrum as compared with towns like Leadville and Cripple Creek, Colorado; Appalachian coal areas seem to occupy an intermediate point in the spectrum of rural community decline.

The context provided by the Homestead Act of 1862 further highlights the contrasts between the varying boom/bust behavior, especially for the polar extremes of Colorado mining towns and Midwestern plains communities. In the Colorado data, the overall state and flatlands of Arapahoe County were most affected by the inflow of Homesteaders, creating the boom of the late 19th century in agricultural eastern Colorado (Abbott, Leonard, and McComb, 1994). Yet despite the apparent legal advantages for booming Plains communities, the mining towns nevertheless showed considerably more evidence of boom (and bust) than the areas that were most heavily shaped by homesteading.

Nevertheless, homesteading and the Plains' agricultural base likely had a related effect on investment behavior. Built upon an understanding of the model presented in this chapter, the Midwest had considerably more investment in more durable housing and commercial structures than either the Ghost Town or Appalachian settings. These investments were based on the perception of far longer-term, as well as more stable, returns to the local farming industry.

As emphasized by Glaeser and Gyourko (2004), investments in durable structures will tend to significantly slow the adjustment of areas in economic decline. The contrast of the very slow transitions of Midwestern farming towns with the polar case of boom/bust Rocky Mountain Ghost Towns and the intermediate case of Appalachian mining communities conform to model expectations. Combining the joint labor and housing market model of boom/bust-towns employed here with Glaeser and Gyourko's compelling durable housing arguments result in a better understanding of the process of decline in rural communities.

Section 2.4 CONCLUSION

Ghost town economies are shaped by the unusually high-variance cycles in extractive industry settings, coupled with the positive amenities for firms during boom windows alongside on-going negative locational amenities for workers in these often harsh, isolated settings. The models offered here provide a perspective that incorporates these features, leading to situations where both firms and workers have especially narrow short-term perspectives on investment and labor returns. The result are economies with little diversification, rapid cycles, and fixed investment that is both limited and easily disposable.

The increased variance around the cycle indicates the greater amount of risk perceived and realized in these settings. The increased risk translates to an increased risk premium associated with investment in this economy, thereby inflating the required rate of return necessary by private agents.

While testing the full range of hypotheses of this theoretical structure is difficult given data limitations for the key periods of inquiry, such as the late 19th and early 20th century, historical census data can allow assessment of indirect indicators of boom/bust consequences. Initial inquiries regarding Lake and Teller counties in Colorado, home to the infamous high-altitude towns of Leadville and Cripple Creek, suggest that the paper's perspective can indeed help explain the ghost town phenomenon of boom and bust.

More slowly decaying extractive regions, such as coal mining in Appalachia and farming in the rural Midwestern United States, seemingly face similar difficulties in the late 20th and early 21st centuries, as downtown areas and infrastructure are slowly fading. Such areas are indicative of a spectrum of evolution and devolution, a spectrum that can be better understood in the context of the present modeling effort.

The role of risk in this setting allowed for elevated profit potential. This in and of itself is not a "market failure". Greater profits were achieved by the owner of the mine and also the worker in part due to the riskiness of the setting. In this case, government intervention in this dramatic cycle is perhaps unnecessary. Both agent types were compensated for the associated risks of the market in these locations.

CHAPTER III: CONTAMINATED PROPERTY INVESTMENT: WHAT IS REQUIRED BY INVESTORS TO DEVELOP URBAN BROWNFIELD SITES?

Section 3.1 INTRODUCTION

The perceived risk involved in redevelopment of Brownfield sites is heavily weighted in investor decisions. Although there are numerous grants, loans, tax credits and job training assistance tools available through federal and state environmental programs, developers are hesitant to initiate activity on land which has been deemed to be a "Brownfield". This extremely problematic stigmatization is currently overshadowing many redevelopment initiatives considered necessary for stabilization and growth of a vast number of cities across the United States.

The Environmental Protection Agency (EPA) defines a "Brownfield" site as real property, where the expansion, redevelopment, or reuse may be complicated by the presence of a hazardous substance, pollutant, or contaminant. The 2002 Brownfields Law further defines the term to include a site that is "contaminated by a controlled substance; contaminated by petroleum or a petroleum product excluded from the definition of 'hazardous substance'; or mine-scarred land." (www.epa.gov)

Vacant and underutilized sites do not maximize public or private economic opportunity, and can negatively affect the community. Site redevelopment is an opportunity to stimulate the local economy and enhance the community by adding more attractive buildings, beautifying neighborhoods, and providing needed goods and services. However, Brownfield sites have environmental stigmas associated with past or current uses which can act as barriers to redevelopment. This is true not only for the contaminated site, but also for the surrounding properties adjacent to the locale.

Consequently, the various impediments associated with Brownfield investment not only include the costs of the actual clean-up, but also there appears to be hesitation by investors in these markets due to the lack of information available about these properties. Specifically, as will be shown in this chapter, buyers in these markets have demonstrated that they require an additional premium due to what can only be explained by a "stigma" element associated with Brownfield sites. Buyers appear to be reluctant to enter these markets because they do not have complete information as to the actual scope or extent of the contamination issues at hand.

Since the ground-breaking work of George Akerlof, it is commonplace to argue that asymmetric information is an important source of market failure in competitive markets. This so-called *lemons problem* affects a large gamut of markets, including the classic example of the secondary market for automobiles, insurance markets, labor markets, financial markets and, in fact, even the market for thoroughbred yearlings (Chezum and Wimmer, 1996).

The market for contaminated property is thus alleged to be somewhat analogous to Akerlof's lemons model. Akerlof assumed that sellers know precisely the value, but buyers have no way of knowing the "quality" until they own it. A "lemons" problem of sellers being unwilling to sell promising sites at a discount could be a factor in the struggle to find buyers willing to engage in contaminated property transactions.

As demonstrated by Akerlof (1970), there are many markets in which buyers use some market statistic to judge the quality of the prospective purchases, in many cases there is an incentive for sellers to market poor quality merchandise. As a result, there tends to be a reduction in the average quality of the goods and also in the size of the market. In the case of contaminated property investment, this would imply either that the valuation of the underlying properties did not reflect full information or that the market did not trust the valuations due to uncertainty and prior bad experience.

An additional implication of the lemons model is the resulting thinner market. As will be shown in this study, many potential buyers simply are not willing to consider contaminated property purchases. As a result, many potential buyers drop out of the market and it becomes subsequently thinner. This then translates into further reductions in information sharing and increased noise and risk for those left willing to enter this market.

Moreover, it is perceived that in these markets of asymmetric information social and private returns differ, and therefore, in some cases, governmental intervention may increase the welfare of all parties. (Akerlof, 1970) Segerson (1994) examined the role of allocation of responsibility among buyers and sellers. As she demonstrated, inefficiencies can arise from either buyer misperceptions regarding the level of contamination or the possibility that one or both parties will be "judgment proof". Furthermore, the judgment proof problem alone implies that sellers will face insufficient abatement incentives, i.e., the seller will choose a level of abatement that is less than the socially efficient level. This then leads to buyers systematically underestimating marginal changes in contamination levels, which contributes further to the buyer misperceptions and exacerbates the effects of the problem leading to even less abatement (Segerson, 1994).

This study will examine the magnitude and bases of investment obstacles (whether real or perceived) that currently discourage or hinder the private sector from not only participating in, but also investing economic resources in the clean-up and redevelopment of, sites that are, or are potentially subject to the current laws of Brownfield sites. Many Brownfield sites may be available and in need of development, but people view them as problems to be avoided. As a result, this chapter will conclude with a discussion of policy intervention strategies that may be necessary to mitigate this estimated market failure.

This chapter presents data which will address the criteria necessary to induce developers to transform an underutilized Brownfield site into a higher and better use, incorporating research findings from a developer survey and a range of statistical analyses.

As demonstrated by much of the research and the findings of this study, buyers require additional compensation to induce them to deem these types of projects profitable. Furthermore, buyers are also reluctant to get involved because of the lack of information being translated between the buyers and sellers, with the sellers knowing what problems are present, but being unwilling to sell at the associated discount.

The focus of this chapter will then be to address the numerous concerns which are translated into rate of return calculations identified by the private sector (e.g., real estate brokers, real estate developers, financiers, and investors) as barriers to participation in the redevelopment of Brownfields. Specifically, Section 3.2 will focus on the major issues and current research surrounding Brownfield development and provide insights as to what is being done currently and what has already been accomplished. Section 3.3 will set up the theoretical/conceptual framework for the study. Then, Section 3.4 will expand upon the purpose and findings of the survey data. Statistical analyses will be applied to the data in Section 3.5 in order to test the specific hypotheses of the study. Finally, Section 3.6 will provide a summary and conclusions with a discussion of some implications of the results of the analyses.

Section 3.2 BACKGROUND OF THE ISSUES

The current scope of this problem is rather extensive. Every major city and most small towns suffer from the environmental scar called “Brownfields”. The EPA estimates that there are more than 450,000 Brownfields in the United States. According to the U.S. Conference of Mayors (2000), of the cities that could estimate acreage, 201 cities reported the size of Brownfields ranging from a quarter of an acre to a single site measuring 1,300 acres, of which all are currently abandoned or underutilized. These polluted sites cause large portions of major cities to be filled with an urban scar. Because of the potential threat of environmental liability and the potential stigma associated with this type of investment, these sites are difficult and costly to redevelop.

In many cities, Brownfields are a major obstacle to urban redevelopment. Cleaning up U.S. Brownfields may cost $650 billion dollars, roughly the equivalent of $2,100 for every child, woman and man in the US. (www.envirotools.org) This price does not even include the indirect costs of reduced economic development (e.g., it is estimated that cities lose tax dollars totaling around $120 -380 million due to lost income from idle Brownfield sites). (www.envirotools.org)

Because Brownfield sites have become exceedingly prevalent throughout the United States, they are now presenting a substantial hindrance to development in certain areas. In addition, most Brownfield sites are generally abandoned industrial or commercial sites; therefore, the responsible party may not be available to pay the costs of cleanup. According to the Brownfields Revitalization and Environmental Restoration Act of 2001, these sites may lie fallow indefinitely unless someone is willing to take on the risk associated with purchasing contaminated land and has the financial resources to pay for site investigation and cleanup.

An additional matter relevant to this discussion regarding seller abatement inefficiencies is the arduous situation that has become known as "mothballing". Mothballing is the practice of certain potential sellers fencing-off contaminated property indefinitely to delay or avoid cleanup costs. It is simply more beneficial to continue to forfeit property taxes than to incur the liability and clean-up costs associated with the contaminated property.

However, this issue has recently become a thing of the past. In early 2005, the Financial Accounting Standards Board (FASB) responded to previous loopholes in current disclosure laws by issuing an interpretation of Financial Accounting Standards No. 143, Accounting for Asset Retirement Obligations (AROs), known as FAS 143 Interpretation No. 47, which accounts for Conditional Asset Retirement Obligations (FIN 47). The interpretation clarifies that companies are now required to recognize a liability for the fair value of the conditional ARO. AROs are legal obligations associated with the retirement of a tangible long-lived asset. Long-lived assets include property, industrial or manufacturing plants and equipment. "Asset retirement" means "other-than-temporary removal from service," whether through sale, abandonment, recycling or disposal, at or before the end of the asset's productive life.

FIN 47 is effective for fiscal years ending after December 15, 2005, for companies reporting for a fiscal year, and December 31, 2005, for companies reporting for a calendar year. In the near future, FIN 47 will affect the way companies account for environmental conditions at their properties and facilities and will likely accelerate the cleanup, transfer and redevelopment of contaminated sites.

Jackson (2002) recently investigated the consequence of contamination on industrial property values. Sales data were collected from southern California from 1995-1999 and properties were listed as contaminated, previously contaminated or non-contaminated. Other property characteristics were also included to control for other affects on values. A negative effect on industrial property's value was found to be significant; roughly a 30% decline on value can be attributed to contamination. Using an econometric approach Jackson was able to reveal

> "the temporary nature of ... the stigma effect for contaminated industrial real estate. Not a single model analyzed led to an indication that the price effects of environmental contamination persist subsequent to remediation and cleanup. This is also consistent with findings from survey research..." (p198).

The analysis revealed no significant difference in the sale price of properties that had been previously contaminated as compared to similar properties that had never been contaminated.

A further set of research has revealed an influence on property values which can be attributable not only to actual contamination but perceived contamination as well. Gayer and Viscusi (2002) examined a relationship between housing prices and information on local hazardous waste sites. A hedonic property model was used with the perceived risks being measured by the amount of publicity (newspaper) given to the contaminated property. Data collected for this research was borrowed from a previous paper studying housing sales in Grand Rapids, Michigan from 1988-1993. However, data on homes sold less than once were omitted from the study. Their addition to the data set was an inclusion of newspaper articles on hazardous waste sites sorted by date. The reasoning behind this was to obtain a measure of publicity before and after the sale of home occurred; and to determine any correlation that existed. The publicity was measured by the aggregate number of articles written about a particular site and by the number of words in each article. Their results produced an interesting conclusion: newspaper articles on a given site tended to have a positive effect of $100 - $200 on the neighboring properties. This most likely occurred because once the contamination story was published, the probability of cleanup increased. The articles may be relaxing those perceived fears about contamination risks when drawing attention to the cleanup efforts. The results may imply the adjustment back to fair value begins just before actual cleanup.

McCluskey and Rausser (2003) also examined the role of a hazardous waste sites and how they influence the surrounding housing appreciation rates. An interesting feature of this study was that there was no significant difference in the housing appreciation rates of those homes located in close proximity to a contaminated site and the homes located farther away until new information was revealed about the site. The role of publicity was substantial. Their findings, from the Dallas housing market, suggested that cleanup of a location signaled danger to human health and the exposure of cleanup procedures taking place then negatively affected the appreciation rates of surrounding home values (i.e., They alleged a contrary conjecture to the findings of Gayer and Viscusi (2002).)

The perceived risk of environmental contamination liability is one of many factors that may influence an investor's willingness to purchase a Brownfield site. In addition, even if there are parties willing to take the risk, they are sometimes unable to bring the necessary resources to the site because lenders may be unwilling to issue loans on properties with unknown contamination, and which therefore provide uncertain collateral for the loan.

Research by Adair *et al.* (1998) showed that perceived total return is the primary factor influencing investment decisions with those investors retaining their investments in redevelopment locations doing so in expectation of achieving above average returns. Rental growth arising from occupier demand, and capital appreciation reflecting investor demand according to McGreal *et al.* (2000), are the primary factors by which new redevelopment projects are evaluated. At the urban level, the potential performance of a city's property market is an important element of an investment decision. Investors will likely be attracted to a city if rental and capital growth is strong. However, empirical evidence suggests that there are factors to be considered other than performance indicators (Guy *et al.*, 2002). Callender and Key (1996) argue that geographic location to the contaminated vicinity appears to have a stronger influence on investment flows than economic performance.

Among the principal barriers to investment in redevelopment are perceptions of negative returns (Adair *et al.*, 1998). Adair *et al.* (2002) emphasized that private sector investment is opportunity driven; consequently, it must then show returns commensurate with the level of risk taken. Therefore, efficient and amenable markets for land and property are essential to impel investment into redevelopment proposals. The findings of Adair *et al.* (1998) stressed that the private sector will invest in areas where it is "comfortable" and the appropriate rates of return are achievable within the risk framework.

The issue of potential market failures is an ongoing concern given that this market is not that of a typical market. Specifically, this market is characterized by an absence of the many players needed for a conventional market which is a result of the probable "lemons" problem. If monopsony power exists, this would be advantageous in pushing down the price and enabling redevelopment to occur, but not so advantageous for the seller which might have a current loan to repay, or is reliant on the cash earnings from the sale for further business operations, or perhaps would not like to sell the property at such suppressed price and would prefer to let the property remain vacant.

It is important to note here in the case at hand, this lack of information can be subsided if the buyer is willing to pay the up front expense of environmental site investigations. Site assessment and due diligence provide initial information regarding the state of a given parcel of land. A site assessment evaluates the health and environmental risks of a site and the due diligence process examines the legal and financial risks. According to the EPA, the purpose of a Phase I site assessment is to identify the type, quantity, and extent of potential contamination at a Brownfields site. In addition, financial institutions virtually always require a site assessment prior to lending money to potential property buyers to protect the institution's role as mortgage holder.

The Phase I site assessment is generally performed by an environmental professional. Cost for this service depends upon size and location of the site, and is typically around $2,500. Site assessments typically identify:

- Potential contaminants that remain in and around a site;
- Likely pathways that the contaminants may move through; and
- Potential risks to the environment and human health that exist along the migration pathways.

Due diligence typically identifies:

- Potential legal and regulatory requirements and risks;

- Preliminary cost estimates for property for purchase, engineering, taxation and risk management; and
- Market viability of redevelopment project.

A further analysis is then available if the Phase I site investigation reflects any potential for existence of contamination issues. The Phase II site investigation is a report that is based on information previously collected and may involve sampling and testing the air, water, soil and buildings for various hazardous substances. According to the EPA, the goal of this site investigation is to reveal evidence of historical spills and leaks of hazardous waste or petroleum and to determine the source, nature and extent of contamination.

Nonetheless, even given the relatively inexpensive preliminary Phase I assessment available to provide pertinent information about specific properties, many buyers have yet to take full advantage of such research. Thus, the result is a market of pervasively uninformed buyers all having great hesitation to enter because they do not understand or have full information as to the extent of the contamination issues that could be present.

Section 3.3 CONCEPTUAL FRAMEWORK

The hypothesis of this study is that respondents tend to categorize themselves into two distinct groups: those willing to invest in contaminated properties and those unwilling to invest. It is expected that the respondents will further categorize themselves as to the holding period commitment and the required rates of return for this type of investment. This will translate to additional interpretations as to whether some investors hold monopsony power in purchasing contaminated properties, or whether some sellers hold monopoly power in the sale of contaminated property.

In this study many considerations must be taken into account in the process of analyzing investor decisions. First and foremost, the investor is assumed to apply the appropriate discounting analysis procedure which includes present value calculations given the expected cash inflows and outflows of the project. To that end, many other factors play an important role in the appropriate rates to be applied in decision criteria for investment in contaminated property.

A crucial aspect of conventional market valuation analysis is that it must include the element of any potential additional perceived risk associated with investment in contaminated property. This translates into a significant component of the decision process being the element of pervasive imperfect information in the market. As outlined by Scorsone and Weiler (2004), market failures, stemming from imperfect information, are pervasive. Also, they assert, according to the information economics literature, three forces influence the likelihood of imperfect information: (1) nonrivalrous consumption, (2) high up-front fixed costs, and (3) the inability to prevent information revelation. In particular, the high up-front fixed costs of obtaining information are quite extensive. And, according to Scorsone and Weiler (2004) it is extremely difficult to recoup information-related costs after they are incurred. Therefore, in the case of Brownfield investment, the addition of information-related costs narrows the profit margin yet further, which leads to an even greater reduction in the amount of feasible transactions.

Given the nature of this likely asymmetrically informed market, buyers will then rely on their perception of the available properties as having either a high probability of contamination issues or a low probability of such issues. If the purchaser perceives that investment in such property has a high probability of requiring necessary clean-up related expenses, then the buyer will require additional compensation in the form of a premium in the required rate of return.

The representative investor is assumed to make a decision based on the discounted cash flows (DCF) of the potential project. DCF analysis involves the projection of a series of periodic cash flows to the development property. For this projected cash flow sequence, an appropriate, market-derived discount rate is applied to establish an indication of the present value of the income stream associated with the property. In the case of development properties, estimates of capital outlays, development costs, and anticipated sales income are estimated to arrive at a series of net cash flows that are then discounted over the projected development period. In the case of development of contaminated property, clean-up costs are among the capital outlays to be estimated. In addition to the overall capitalization rate to be estimated, a reversion/terminal value must be calculated which is based on the net income for the year following the last year of the DCF analysis or the net income of the last year of the DCF analysis.

DCF analysis considers available market evidence and typically reflects the thought processes, expectations, and perceptions of investors and other market participants. Because expectations and perceptions of market participants influence the decision-making process of DCF, there exists what could be a substantial stigma element that if significant enough, the potential investor of Brownfield property will simply drop out of the decision process. The initial decision would then be represented by:

$$NPV_i^1 = [\sum_{t=1}^{T} E(r)_i - E(c)_i]/[1 + R(o)_i] \tag{9}$$

Where, $E(r)_i$ is the expected revenues to be generated from the property under consideration, $E(c)_i$ represents all relevant outlays. This element includes any additional perceived risk that might be present due to potential information asymmetry issues. The cash flows are then discounted by the appropriate discount rate, $R(o)_i$.

If the net present value as calculated by the potential purchaser is positive, then the property will be purchased. The difference lies then in whether or not the risk element is prodigious enough to negate the decision. If the individual finds the risk element not sufficient enough to repudiate consideration of the investment decision, this individual will then make the decision on the margin, or based on the expected value of the particular project.

Recent valuation literature in the U.S. (Appraisal Institute, 1992; Kinnard, 1992; Mundy, 1992b,c; Patchin, 1992) has emphasized the necessity to use the framework on income capitalization to identify the deductions from unimpaired market value (i.e., market value as if non-contaminated), in order to estimate the market value of a contaminated property. This approach persists today with a few exceptions outlined by Kinnard, Worzala, Bond, and Kennedy (2002). The general framework, they claim, is the need to estimate unimpaired value ("as if non-contaminated") of a property, and then to deduct the following elements:

- Present value of the estimated cost to remediate (typically obtained from environmental engineers or technicians);
- Present value of the difference between expected revenues as if unimpaired and expected revenues as if impaired, stemming from a combination of reductions in occupancy and rent;
- Present value of increased operating expenses, including (but not restricted to): (1) increased insurance; (2) increased interest on debt; and (3) monitoring costs anticipated after remediation;
- Present value of holding costs: (1) insurance; (2) property taxes; and (3) repairs and maintenance.

In addition, these authors go on to describe how the present value is calculated as a function of the anticipated duration of the remediation period, plus the marketing period (for sale or rental) forecast when remediation is completed. Also, during that period of time, the discount rate, or capitalization rate, that is applied is adjusted upward to reflect the perception of increased risk associated with the existence or suspicion of on-site contamination. Also, a further deduction is made for post-remediation "stigma" which is subtracted from the figure that remains after deducting the present value of the sum of estimated costs to remediate, estimated revenue reductions and estimated increased operating expenses and holding costs from the unimpaired value estimate.

Given the multifaceted nature of the investment decision when considering an impaired property, the discounted value of the cash flows to be estimated is expressed as the following:

$$NPV_i^2 = NPV_i^1 - \sum \{E(c)_r - E(c)_{pr} - [E(r)_U - E(r)_I] - E(c)_o - E(c)_h\}/[1 + R(o)_i] \quad (10)$$

where, $E(c)_r$ represents the estimated remediation cost, $E(c)_{pr}$ is any anticipated post-remediation "stigma" associated with the property. The next term in brackets symbolizes the difference between expected revenues as if unimpaired and expected revenues as if impaired, $E(c)_o$ is the expected increase in operating expenses, and $E(c)_h$ represents the expected costs of holding the property. If the NPV of the project at this stage is positive, then the venture in question will be undertaken by the representative decision maker.

At this time it is important to discuss the derivation of the appropriate capitalization rate. This discounting rate is assumed to be calculated using the Band of Investment (BOI) approach. The BOI approach is a commonly used technique for driving the overall capitalization rate using the financial components of debt and equity. This takes a weighted average of what the investor wants as a return on equity (down payment) invested in the property and what the lender is looking for in a return on the loan it makes to the investor so that the investor can buy the property. A necessary extension to this approach is the upward adjustment of this capitalization rate to reflect the perception of increased risk associated with the existence of contamination on the property. The formula for calculating the capitalization rate with this band-of-investment technique is:

$$R(o) = [LTVR \times R(d)] + [ETVR \times R(e)] + [R(c)] \tag{11}$$

Where R(o) is the overall capitalization rate that will be applied to the subject property's net operating income in order to value the subject LTVR , or loan-to-value ratio, which is the percentage of the property value that the lender is willing to make as a loan. R(d) represents the capitalization rate for the debt, which means it is the rate of return the lender wants on the money it is loaning. ETVR indicates the equity-to-value ratio, which is the remaining percentage of the purchase price not covered by the mortgage loan that the investor must put into the property as equity or down payment to complete the purchase. R(e) is the capitalization rate for the equity, the rate of return the investor wants on the invested equity in money earned by the property. R(c) is then taken to embody the risk premium element associated with the existence of or suspicion of contamination impediments. R(c) is a function of the probability associated with the pervasiveness of contamination on such property. It is thus assumed, given this market deficient in information sharing, the investor perceives two classes of properties – "clean" or "dirty". This probability is calculated by each investor based on their perception of the property given the lack of available information as to the exact condition of the site. Therefore,

$$R(c) = [(p_i)*D] + [(1-p_i)*C] \tag{12}$$

Where, D represents the additional capitalization rate required with a "dirty" or contaminated property and C represents the capitalization rate necessary given a "clean" site. From this, it can thus be concluded that given this lack of information sharing in the market, all capitalization rates will be driven up. This is an important element which is analogous to the lemons model, given this upward pressure on the overall capitalization rate, the trading "price", or NPV of the investment is thus lowered.

According to Akerlof's model, we can assume that buyers will then base their evaluation of the property on the average "quality" of all properties available. For better quality properties, a would-be seller would then rather hold onto their property since it is worth more than (poorly informed) demanders are willing to pay. However, embodied by the model, we can also conclude that buyers are ultimately unsatisfied since the average quality of properties traded is less than they expect. As a result, only the poor quality properties are brought to the market so the average quality of properties traded is lower than the overall average of the entire stock of properties.

The end result is a market characterized by the lack of pareto optimal transactions. Both buyers and sellers would be willing to trade with a higher price for a higher quality property. However, the seller has no way of convincing the buyer that their property is not a "lemon". This is representative of the lack of trust in information sharing seemingly pervasive in this type of market. Therefore, the affairs of the market may deteriorate even further if buyers learn overtime that average quality falls short of the perceived previous average and subsequently drop their price offers accordingly. Therefore, the quantity supplied (which is a function of the price) and quality will fall even further, and so an even larger number of pareto optimal transactions will be foregone.

Section 3.4 SURVEY METHOD AND PROCESS

The four-page survey, with cover letter, insert, and consent form, was sent to 900 real estate development professionals in the Metro Denver area. The survey is located in Appendix 3.A1. The mailing list was developed from the membership of professional associations including the CCMI, 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.

A total of 155 surveys were returned, thus a response rate of 17.2%. Of these, 149 contained sufficient basic information to be maintained in the database used for analysis. Not all of these respondents answered all questions, so more restricted sub-samples served as the basis for analyses involving certain questions. A detailed view of all summary statistics is outlined in Appendix 3.A2.

The survey elicited background information on respondents' development roles, typical property types, and experience with and attitude toward contaminated properties. The initial question asked the respondents to identify themselves in the following roles: broker, developer, financier, and investor. They were asked to indicate any and all roles that apply.

The broker role in a real estate context would be defined as an intermediary in the sale or transaction who receives a fee for their services. A developer would then take on the entrepreneurial function of improving land for use by adding or replacing buildings. Investors and financiers then contribute the capital for use in these transactions.

The role of "broker" was the primary role of 30.2% of the respondents, while 82.5% of those participating in the survey indicated the role of a broker along with one or more of the additional three roles.

Next, those surveyed were asked about the type of property they generally deal in. The choices available were: single-family residential, multi-family residential, retail, office, and industrial. They were asked to indicate any and all relevant categories. The survey then was formulated to identify the typical transaction size of the respondents.

A summary of the role type, typical property type, and experience responses are provided in Table 3.1 (a more complete categorization of these responses is located in Appendix 3.A3).

Table 3.1: 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%
	123	
Developer only	14	9.40%
Developer among others	55	36.91%
	69	
Investor only	6	4.03%
Investor among others	*65*	43.62%
	71	
Financier only	0	0.00%
Financier among others	11	7.38%
	11	
Q2: typical property type experience	Count	percentage of Total
Single-family residential only	6	4.03%
Single- family residential among others	52	34.90%
	58	
Multi- family residential only	8	5.37%
Multi- family residential among others	61	40.94%
	69	
Retail only	4	2.68%
Retail among others	68	45.64%
	72	
Office only	3	2.01%
Office among others	80	53.69%
	83	
Industrial only	14	9.40%
Industrial among others	73	48.99%
	87	
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%
	36	
$250,000-$1million only	36	24.16%
$250,000-$1million among others	55	36.91%
	91	
$1million-$5million only	27	18.12%
$1million-$5million among others	63	42.28%
	90	
Greater than $5million only	8	5.37%
Greater than $5million among others	29	19.46%
	37	

The next section of preliminary questions was designed to address the risk-tolerance level of those responding. Initially, the respondents were questioned as to whether they had ever purchased property with environmental contamination issues. 63.8% indicated never having acquired such property, and 8% bought this type of property unknowingly. However, 27.5% intentionally obtained environmentally contaminated property.

The respondents were then asked to answer as to whether or not they ever buy contaminated property or if they would even consider the prospect. Of the total respondents, 14.8% said they "will never buy contaminated property," 69.1% indicated they "try to avoid contamination, but will invest if the economics make sense," and 16.1% specified they would "invest in contaminated ("Brownfields") properties as well as 'clean' properties." When the respondents were asked whether they will proceed with a project when the initial Phase I environmental site assessment shows on-site environmental issues, an overwhelming 86.6% indicated they would "further investigate and continue to pursue the investment," however when the follow-up question was posed suggesting the Phase II investigation also reflected on-site contamination, those who would "typically continue to pursue the investment" dropped to 42.9%.

The core of the survey instrument asked respondents to consider a well-defined property type that was typical for them, and to tell what hurdle rates and other parameters they would set as criteria for the investment decision if the property were clean: overall capitalization rate, reversion or terminal capitalization rate, discount rate, and anticipated investment holding period.

Then, for the same property, respondents were asked to consider the effect on their criteria if the property required known clean-up costs equal to 15 percent of the "clean" purchase price. For each of three cases --- gasoline contamination, dry cleaning contamination, and degreasing/solvent contamination --- respondents were asked:

1. Whether they would still consider investing (yes or no);
2. What their required capitalization rates and discount rate would be under these conditions;
3. What their expected holding period would be;
4. Whether these responses would already take into account a purchase price lowered by the expected amount of clean-up cost.

A potential real estate investor determines their overall capitalization rate by taking the Net Operating Income (NOI) and dividing it by the sales price (e.g., If the property has a NOI of $125,000, and the price is $1,125,000; ($125,000/ $1,125,000) = 11.1% cap rate.) The reversion/terminal capitalization rate is the rate used to estimate the resale or reversion value at the end of the holding period. Typically, the NOI is used from the year following the last year of the holding period that is capped. The discount rate to be applied is used to convert cash flows into present values which are determined by considering three factors:

1. A multi-period, dollar weighted average total return expected by the investor in the form of a "going-in" Internal Rate of Return (IRR).
2. It is also composed of the risk-free rate plus a risk premium that accounts for risk in the cash flow projection.

3. In addition, it is typically equal to the return investors could typically earn on average in other investments of similar risk to the subject property.

The typical investor in contaminated property expects a higher overall capitalization rate, or a higher *ex-ante* rate. Additionally, the *ex-post*, reversion/terminal rate is expected to be essentially the same as the overall capitalization rate. This would be the case because the reversion/terminal rate should reflect the full value at the end of the project that was anticipated to be the value at the beginning of the project.

Given the high transactions costs associated with commercial real estate relative to other capital market assets and the perceived illiquidity of the market, in part due to entry barriers, the expectation would be that holding periods for commercial real estate would be much greater than for stocks and bonds. (Collett, 2000) The average holding period for commercial real estate has been estimated to be around 5.25 years. (Collett, 2000) More specifically, one of the attempts of this study is to establish whether the holding period for contaminated property is greater than or less than that of similar clean property investments. The general hypothesis would be that investors in contaminated property tend to engage in this type of transaction in order to "fix and flip." Therefore, their underlying purpose in investing in contaminated property is to clean the property, providing value added to the site, up to the point of reuse standards and then sell with the associated expected profit.

Table 3.2 reflects the summary results concerning differential investment criteria under the clean scenario and the three contamination scenarios. The main conclusion is that, even when clean-up costs are netted out, investors and developers still require a significant rate-of-return "premium" for contaminated properties.

Table 3.2: Developer Survey – Summary of Mean Return Requirements

	If the property is CLEAN	If there is a GASOLINE contamination problem	If there is a DRY CLEANING contamination problem	If there is a DEGREASING/ SOLVENT contamination problem
Would you still consider investing?	N/A	98 - Yes 37 - No	66 - Yes 64 - No	70 - Yes 64 - No
Your overall cap rate	10.23%	12.51%	12.83%	13.19%
Your reversion/terminal cap rate	10.95%	12.97%	12.84%	13.49%
The discount rate you would apply	10.28%	15.74%	17.41%	16.78%
Investment holding period?	9.11 years	7.42 years	8.07 years	8.03 years
Would you also deduct the cleanup costs directly from the resulting purchase price?	N/A	98 - Yes 5 - No	76 - Yes 5 - No	79 - Yes 5 - No

More specific conclusions, from the summary in Table 3.2 and from further investigation, include:

- Respondents are more willing to consider a gasoline problem than a dry-cleaning or solvent problem, require a lower return differential, and expect a shorter holding period.
- The cap rate differential is 2% to 2.5% for dry-cleaning and gasoline contamination, 3% for a solvent problem.

Section 3.5 STATISTICAL ANALYSES

A variety of methods will be presented in the following section, all of which are intended to test the overall hypothesis and to further clarify subsequent hypotheses. The purpose of this chapter is to analyze the actual risk premium associated with investment in contaminated property by development professionals. In addition, the intent is to determine if in fact there is an additional premium required, does the premium vary by development professional type.

Initially, difference in means testing will be applied in order to test the primary hypothesis of whether there is an actual premium required to entice developers to engage in Brownfield transactions. Next, Cluster Analysis is used in an attempt to determine if responses tend to group together, or be similar, based on their role in the development of real estate process. As a follow up to Cluster Analysis, probit regressions will be estimated in order to affirm or deny the findings of the clustering procedures.

a) Differences in Means Testing

The initial test was directed to determine whether the overall cap rate, reversion/terminal rate, discount rate and holding period applied were statistically different when comparing clean property with investment in contaminated property. Statistical significance was examined using a 95% confidence level. Therefore, significance is reported when the p-value is less than .05, which will conclude the responses applied to clean property as compared with the responses applied to contaminated property are significantly different in their means. A summary of these findings is located in Appendix 3.B1.

The results of this test indicate that all are statistically significant, which provides unequivocal evidence to support the hypothesis that investors do in fact apply a premium in the rates of return required when investing in contaminated property over and above that required when contemplating investment in a similar clean property. This implies a positive value for the risk premium element expressed in the previous section, R(c). Therefore, this test of the difference in means provides convincing evidence as to the obstacle generated by the stigma element over and above that of general uncertainty in investment decision-making.

The data was broken up into further subsets isolating the views of each respondent type. The difference in means of each category was calculated in order to determine whether this hesitation to invest and/or require huge rates of return was global or potentially specific to a particular investor type. The detailed summary of the results can be found in Appendix 3.B3. Some key findings include:

- Sub-sample analysis shows that there is no measurable difference between the rate-of-return differential required by those who develop properties into residential uses, and those who develop them into non-residential uses.
- For <u>gasoline</u> and <u>solvent</u> contamination, those with an "investor" role require higher overall cap rates than non-investors; other role-based comparisons do not give conclusive results.

- For dry-cleaning contamination, "developers" and "investors" require higher cap rate than "brokers" and "financiers"; other comparisons are inconclusive.
- Those who play only a broker role express cap rate differentials measurably lower than those with participation roles: 2% lower for gasoline, 3% lower for dry-cleaning and solvent contaminated properties.

Next, the difference in means of rates applied which were associated with respondents which answered certain questions on the survey in a contaminant averse manner as opposed with those who answered in a more tolerant approach were examined. The initial question considered asked the respondents if they have ever purchased a property with contaminant obstacles; 64% of the responses indicated they had not. Among the additional focal questions measuring the tolerance of the surveyor, 14-24% indicated little to no lenience for environmental contamination issues on the potential property of which they will consider purchasing.

Statistical significance of differences in responses was found in the following categories:

- In the majority of the focal questions, the holding period among all contaminant types was found to be statistically different.
- The overall cap rate is consistently found to be dissimilar when examining the degreasing/solvent contamination problem.
- The reversion/terminal cap rate differences yield some shifting results. Overall, it is not found to provide insight into the disparity among averse versus tolerant behavior.

- The discount rate applied to investment in contaminated property was found to provide mostly conclusive results which translate into a difference in the mean rates associated with the two investor attitudes.

b) Cluster Analysis

i) Introduction

Cluster Analysis was then applied in an attempt to explain why some market participants are willing to invest in contaminated property and some are not willing to engage in this activity. Specifically, as follow-up to the previous discussion, Cluster Analysis was also used to try to isolate aversion behavior by role type or other characteristics of the individual respondents.

Cluster Analysis has been applied to many areas of research. Kaufman and Rousseeuw (1990) assert that cluster analysis is the art of finding groups in data. Everitt, Landau, and Leese (2001) and Gordon (1999) provide examples of the use of cluster analysis. These include the refining or redefining of diagnostic categories in psychiatry, the detection of similarities in artifacts by archaeologists to study the spatial distribution of artifact types, the discovery of hierarchical relationships in the field of taxonomy, and the identification of sets of similar cities so that one city from each class can be sampled in a market research task.

In addition, the activity that is commonly referred to as "data mining" relies extensively on cluster analysis methods. A.R. Hoen (2002) applied this methodology to explain linkages among diverse sectors in different regions, countries, or time periods.

Pennings and Leuthold (2000) use this procedure to examine the role of farmers' behavioral attitudes and the heterogeneity associated in futures contracts usage.

Cluster analysis has recently begun to emerge in the specific area of real estate research. To date, most work is addressing "clusters" in spatial patterns of real estate investment. Goetzmann and Wachter (1995) found cluster analysis to be a useful tool for selecting groupings of cities for portfolio diversification. Jackson (2002) applied this type of analysis to study local retail property markets in the United Kingdom. The aim of this paper was to investigate the development of a classification of local retail property markets based on rental growth rates. Again, this paper addresses "clustering" as in a geographic sense. The author suggests diversification procedures in an attempt to reduce risk of investment given her findings.

Cluster analysis attempts to determine the natural groupings (or clusters) of observations. This method can also be referred to as "classification" or "discriminant analysis". Hierarchical cluster analysis is comprised of agglomerative methods and divisive methods that find clusters of observations within a data set. The divisive methods begin with all of the observations in one cluster and then advances to split, or partition, them into smaller clusters based on similar characteristics.

There are several general types of cluster analysis methods, and within each are rather specific methods. Average linkage clustering has been chosen as the most appropriate method given the type of data collected in this study. Average linkage clustering finds the average similarity of observations between groups as the measure between groups. The average distance is calculated from the distance between each point in a cluster and all other points in another cluster. The two clusters with the lowest average distance are joined together to form the new cluster.

ii) Results

Using average linkage clustering procedures, clusters of respondents were established based on their responses to the question of the overall cap rate, reversion/terminal cap rate, and discount rate they would apply when investing in contaminated property (e.g., issues of gasoline, dry cleaning, or solvent) as compared with the rates they would apply when investing in a parallel clean property. A summary of the findings is located in Appendix 3.B4.

Four clusters were found to be present when analyzing the differentials asserted by respondents of the overall capitalization rate to be applied when investing in each of the three contaminant types. The first cluster consisted of 72.73% of the respondents identifying themselves as a broker. This response of "broker" could either be their sole role or it could be that they identified themselves as a broker as well as one or more of the other roles. Upon further examination of cluster one, the general attitude toward investment in contaminated property appears to neither be overwhelmingly in favor of or adverse to this proposition. The average of their responses to the five questions of the survey designed to assess the risk tolerance of the investors indicated 56.36% of the responses to these questions were answered in a risk avoidant manner. In addition, on average the differential applied between the overall capitalization rate of clean property and contaminated property was found to be 3.318%. The interpretation would then be that on average the survey respondents would apply a 3.318% higher overall cap rate when investing in property with a gasoline, dry cleaning, or solvent contamination issue.

The implication of the findings reported in cluster one suggests that those in a Broker role are divided in their level of risk tolerance in the contaminated property market. One potential reason for this inconsistency could be because a wide variety of real estate development professionals engage in "broker" types of activities. Therefore, the results reflect the intrinsic character of the wide spectrum of respondents in this role type.

Cluster two is the largest among the clusters found in this initial procedure. This cluster consisted of 72% of the respondents identifying themselves as a "broker," with 37.5% of this group indicating that broker is their sole role type. When examining cluster two further, the general attitude toward investment in contaminated property would appear to be quite negative. For those questions intended to assess the tolerance of the respondent, this group provided responses in which 68% of the answers were made in a risk-averse manner.

At first glance, cluster two would seem to be inconsistent with the findings of cluster one; however, cluster two reflects a much larger number of respondents in general and thus a much larger number of broker only respondents. As a result of the identification of 37.5% of the cluster being in the sole role of a broker, a clearer and more generalized result is obtained as to their average consensus of the risk aversion attitudes of brokers.

Cluster four appears to offer further insight into the mentality of each role type. 66.67% of this cluster identified themselves to be an "investor." Of those in cluster four, 88.33% of the responses to the five "attitude" questions indicate an aversion to investment in contaminated property. Additionally, the differential between investment in clean property as compared with contaminated property indicated that those in cluster four would apply a 6.278% higher overall capitalization rate when investing in contaminated property.

Cluster four illuminates the hesitation in the mind of the investor when putting up the money for this type of transaction. The investor role type would then appear to require a substantial return on their "risky" investment. Therefore, this reflects the general attitude of the decision maker holding access to the necessary funds to complete these types of transactions.

In the next grouping of clusters, responses were linked in terms of the reversion/terminal capitalization rate thought to be applied. Cluster three consisted of almost 70% identifying themselves as a "developer." Here, 42.73% of the general attitude type responses were tolerant of contaminated property investment. Also, a differential of only 0.482% was applied for the reversion/terminal cap rate on investment of contaminated property.

The dramatic difference between the results of this cluster with the majority of the cluster associated in the role type category of developer versus the cluster mentioned earlier with the dominant category of role type being investor, suggests developers more clearly understand the risk involved in contaminated property ventures. Consequently, developers, in contrast to the consensus of investors, are then able to assign a more rational rate of return required for the transaction. This rate of return is thus formed out of the return needed to compensate for the inherent risk associated with the transaction, but not over and above the necessary rate of return which would be due to a "stigma" element.

The final grouping of clusters was based on responses to the discount rate to be applied in contaminated and clean properties. Cluster two consisted of 71.43% brokers and 42.86% as investors. Again, recall that respondents may classify themselves as being in one or more of the role types. Now, 67.71% of the attitude responses were made in an averting manner, and the differential applied to the discount rate was on average 2.857%.

The results of this grouping indicate, as above, en bloc brokers and investors would appear to be more risk averse in their decision-making. They have shown in their responses a lack of willingness to deal in this type of market. As a result, they require additional compensation to engage in these ventures.

c) Probit Regressions

Subsequently, probit regressions were estimated in an attempt to isolate investor type as a potential reason for disparity among averse responses and tolerant responses. Given the binary nature of much of the survey data, the probit regression model seemed to be a natural choice. A detailed summary of the regression output is located in Appendix 3.B5.

When asked the broad question of whether the respondents have ever invested in property with environmental contamination issues, brokers were found to display significant responses which indicated they would not be open to this possibility. However, those in the developer role appeared to be willing to engage in this type of venture.

Then, when asked to describe their level of tolerance, those identifying themselves in the broker role were found to have statistically significant negative responses indicating either they will not ever buy contaminated property or they avoid this type of transaction.

In the follow-up question of whether the respondent has ever walked away from a potential deal solely due to environmental contamination exposure, the developer role was again found to display significance translating into a tolerant response that would evaluate the costs and benefits before walking away from the deal.

Finally, the attitudes were examined that translates into the direct question of would they still consider investing if gasoline, dry cleaning, or degreasing/solvent contamination issues were found on the potential property. While the majority of the relationships tested did not render statistically significant results, the lack of significance found in the data inherently sheds light upon the nature of the inconclusive responses of those surveyed. No one category of investors in any type of contaminant was found to result in noteworthy coefficients. This finding illuminates the lack of conclusive evidence that readily defines one investor type as being more or less tolerant of property contamination.

Section 3.6 CONCLUSIONS

Overall, the conclusion is that there is a premium on the rate of return required by private decision makers considering redevelopment of Brownfield properties, a premium that may vary somewhat according to the role of the decision maker, but in general is at least 2 %. An important aspect is that this premium requirement appears to exist *even when the clean-up costs are known and compensated.* Therefore, the premium seems to be generated by additional factors that do not represent true resource costs, namely "stigma" elements associated with contamination and past contamination. The stigma may stem from undefined perceived risk that goes beyond normal cost risk, perhaps from insecurity or poor information about liabilities, as well as uncertainty regarding the ultimate resale value of the property. A related source of potential stigma is the often indeterminate duration required to address contamination issues, both in terms of science and regulations that are out of the developer's control.

The results of the Cluster Analysis procedures appear to be consistent with some of the Probit regression results. Specifically, both cluster groupings found to be present and the Probit regression results suggested that brokers display significant responses indicating they would not be open to the possibility of investing in contaminated property. In addition, further regression results indicated statistically significant negative responses indicating they would *never* be open to transactions of this nature.

The results of both analyses suggest that brokers tend to avoid these types of transactions. Brokers may not be as willing to get involved in redevelopment efforts unless they were to see more of the potential returns to be generated by the project. As with any rational decision maker, if the appropriate risk premium is not included in the return generated by such risky project, they will chose to avoid this transaction.

This would appear to be significant because although a broker would not likely share in the possibility of substantial gains, on the other hand, they would not be responsible for the burden of the costs. It would seem that these factors would be offset, but according to these findings, this is not so in the mind of the broker.

An additional finding that appears to be quite interesting is that within each grouping and within each cluster, the holding period given is always greater for investment in clean property. This conclusion is again consistent with initial hypotheses and also findings previously reported in this study. Investors with a high level of risk tolerance, those that tend to engage in contaminated property transactions, hold property with a narrower timeframe in mind. In contrast, the more risk averse the investor, the longer the holding period for property assets. The risk averse investor tends to seek transactions which generate long-run, relatively stable, returns. Therefore, this finding is consistent with the theoretical literature of risk-aversion in investment criteria.

The role of imperfect information is substantial in this study. The sellers of contaminated property appear to be unwilling to sell promising sites at a discount. This is what is required by investors; as was found by their overall capitalization rates to be applied to contaminated property versus clean property. For a more numerical example, see Appendix 3.C1. In general, these finding suggests a significant role for public policy in addressing the market failure of imperfect information that appears to be found in contaminated property transactions.

The premise of this chapter is to suggest that significant redevelopment potential exists for Brownfield sites, resulting in direct increases in economic activity in the site itself as well as indirect job creation and increases in neighborhood property values. However, as established in the inherent results of this survey, redevelopment depends on narrower rates-of-return calculations by private investors, who must add explicit cleanup costs as well as implicit risk premia to their calculus. Furthermore, site redevelopers derive none of the spillover benefits to neighboring property values indirectly generated by their investment.

This divergence between private and community costs and benefits suggests possible roles for the public sector in supporting socially-beneficial Brownfield redevelopment opportunities. Specifically, in the absence of this efficient market, policy makers need to develop methods to provide some needed incentives to the private parties likely to engage in these transactions. This could be accomplished through risk-sharing schemes, whereby government bodies agreed to reduce the liability and information asymmetry costs to the private investor, thereby reducing associated riskiness and the return required by the investor. In addition, public or private insurance policies could be formed to reduce the risk premia calculated by the private real estate development professional.

Therefore, due to the additional risk premia applied to these endevours without cause or reason beyond a lack of information between transactors, the market is today inefficient. As established in this chapter, perceptions need to be influenced in order to reduce the required rate of return by the individual investor. Until this market failure is corrected, a socially suboptimal amount of Brownfield redevelopment initiatives will take place.

CHAPTER IV: CONSERVATION EASEMENT VALUATION: A REAL OPTIONS AND GAME THEORETIC APPROACH

Section 4.1 INTRODUCTION

All across the western United States urban encroachment and development pressures are taking their toll. According to the Colorado Department of Agriculture, in Colorado alone approximately 140,000 acres have been taken out of production since 1987 and escalated more recently to an overwhelming 270,000 acres per year since 1992.

Currently, communities are exploring the use of agricultural conservation easements as an effort to stop these growing losses. A conservation easement is a growing tool that can be used in an effort to conserve which will offer benefits to farmers and ranchers, their land and the public at large.

A conservation easement is a legal agreement between a property owner and a qualified land conservation organization that restricts the type and amount of development that may take place on a property, and it may also prohibit the ability of a landowner to transfer or sell water or mineral rights appurtenant to a property (Lampe, 2004). The conservation easement is passed on by the landowner to a tax-exempt charitable organization or to a governmental entity. An agricultural conservation easement would typically: limit the property to farm or ranching uses; limit construction or placement of buildings on the property, except those used for agricultural purposes or dwellings for the rancher and his family and employees; prohibit the surface disturbance or removal of minerals in any manner that adversely affects the land's agricultural potential; and can also prohibit the separate transfer of water rights apart from the land

(Lampe, 2004). The landowners are then able to reserve to themselves and their heirs the right to own, operate, and manage the agricultural property consistent with sound agricultural and management practices, in addition to retaining the ownership and use of water rights for agricultural purposes (Lampe, 2004).

While conservation easements are a market-based solution for the complex issue of allocating land with significant social benefit for preservation, the conservation easement market is not a standard market. The unique supply and demand factors have unusual features that raise ongoing questions about the efficiency of these markets. A heterogeneous set of public and private actors that seek to represent public interest values compose the demand side of the market. The supply side is composed of mostly farmers or ranchers that must weigh the opportunity cost of the potential development value with the compensation to be generated by an easement.

Conservation easements provide a tax reduction for private landowners to supply a public good. This tax reduction will come at the cost of there being no further option for the landowner to sell for development. If one landowner chooses to sell an easement, there are certain social benefits and social costs that arise. In this event, the surrounding public at large will enjoy the benefits of certain future beautiful views, open space availability, and the absence of future noise, pollution, traffic, and other congestion effects that may threaten the character of an urbanizing environment (Ingerson, 1995 & Tibbets, 1998). However, these benefits do not occur without some competing costs as well. Foremost, to maintain the same level of services as before the easement, the property tax burden previously supported by the development value of the conserved property must be shifted to other properties (Haight, 1999; King and Anderson, 2003). In addition, it has been widely documented in the literature that the value of these conservation amenities is capitalized into the prices of adjacent and nearby properties (Brunstad, Gassland, and Vardal, 1999; Hamilton, 1976; Brueckner, 1990; Singell and Lillydahl, 1990; Skaburskis and Qadeer, 1992; Ready, Berger, and Blomquist, 1997; Geoghegan, Bockstael, and Wainger, 1995; Smith, Poulos, and Kim, 2002). Because the portion of the land's value arising from future land development opportunities is usually held by a nonprofit, land trust, organization, it is not taxable, and the town's tax base decreases as a result of the easement, ceteris paribus (Anderson and King, 2004). In order to provide a constant level of service, the town must increase its marginal tax rate, shifting some of the burden of preserving land to town residents, specifically then, to the landowner of the adjacent parcel (Brighton and Cooper, 1994). Haight (1999) attributes property tax increases of up to $14.19 on $100,000 property to conservation easements in four Vermont towns.

Because the marginal private benefit can differ from the marginal social benefit, and additionally, the marginal private cost can differ from the marginal social cost, inefficiencies are thought to be occurring in these markets. With an effort to estimate these private versus social factors and the needed policy intervention to this proposed market inefficiency, conservation easements could become more prevalent and more land may possibly be set aside for preservation rather than continued sprawl.

This study will serve a theoretical basis for the formulation of the private benefits and costs. The chapter will address efficient pricing of conservation easements from the perspective of the private landowner.

The basis of this, for the most part, supply-side study rests on the foundation that private benefits, rather than the desire to provide a public good, will drive the conservation decision; moreover, people will not conserve land that is of high public value if it is not in their private financial interest (Anderson & King, 2004).

In addition to this theoretical estimation of private costs and benefits, this paper will address the potential usefulness of Real Options and their impending value to these markets. Real options are opportunities to acquire or develop or dispose of property at an investment cost determined (or estimated) in the present with the benefits to be delivered in the future (Patel, 2005).

Section 4.2 SURVEY OF THE LITERATURE

Two different approaches to valuing conservation easements have recently appeared in the literature, with differing conclusions. Specifically, studies using real options theory have generally found conservation easements to be undervalued, while studies based on game theory find them to be overvalued.

Capozza and Sick (1994), Pindyck (1991), Dixit and Pindyck (1994), and Capozza and Li (1994) have all applied real options theory as a method of determining valuation of agricultural land to be converted into urban land. Specifically, Capozza and Sick (1994) apply spatial and asset pricing theories to develop a model of land prices given the risk structure of the land all in an attempt to analyze the effects of changes in systematic risk on the value of the option to convert agricultural land. Dixit and Pindyck (1994) have provided a general framework of the irreversible investment decision criteria under uncertainty. Capozza and Li (1994) discuss a more formal approach to investment involving choice in terms of timing and intensity. Each of these studies show that the price of land awaiting conversion to urban uses increases with the growth rate of urban rents and unsystematic risk but decreases with risk aversion.

As Capozza and Sick (1994) maintain, raw or agricultural land is a real asset with an attached perpetual option to convert to urban uses. However, there is also an intrinsic attached perpetual option to conserve. Buist, Michos, and Tegene (1995) introduce the ongoing concern over proper valuation of conservation easements. They note that conventional valuation procedures may actually systematically overprice easements exaggerating the returns a parcel would generate if converted to urban use. However, as presented by Tegene, Wiebe, and Kuhn (1999), these standard valuation techniques ignore the option value of waiting to convert at some optimal time in the future. This lapse in consideration of the full intrinsic value in the choice of timing causes systemic failure of past models to capture the full scope of the issue.

As a result, Tegene, Wiebe, and Kuhn (1999) applied financial options theory to the valuation of conservation easements. Using a Black-Scholes model approach, they found conservation easements to be currently *under*-priced, and therefore, proposed that landowners should be reluctant to sell easements at the current prices offered. This study argued that past valuation methods overlook the significant option component of the value of convertible agricultural land. They assert that there is still need for further careful study and consideration before appropriate compensation levels can be accurately determined.

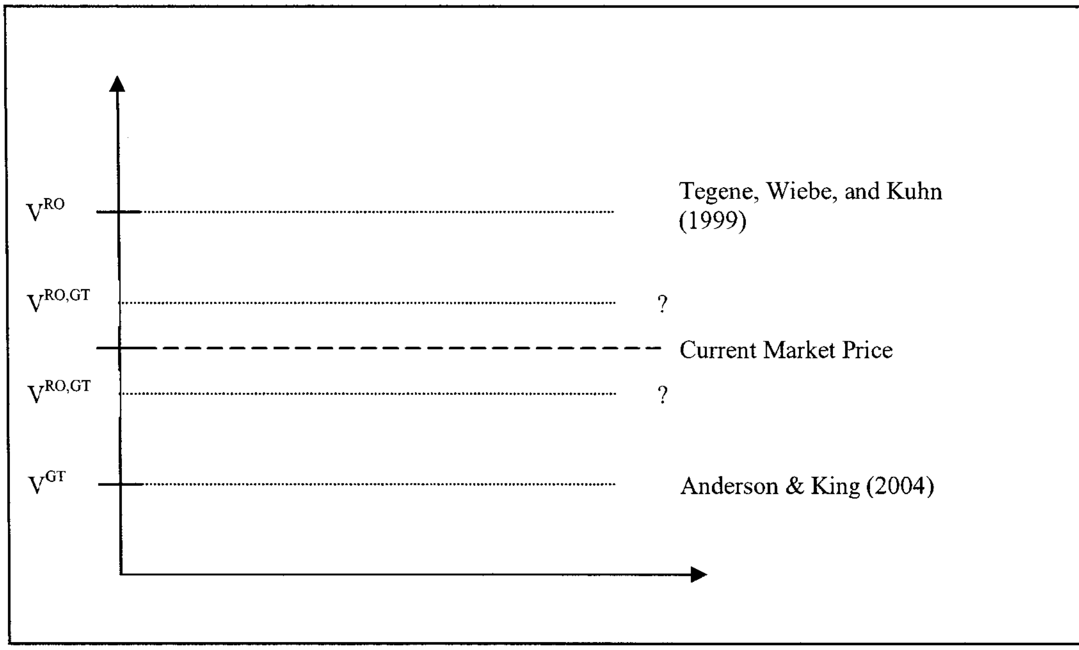
More recently, Anderson and King (2004) modeled a conservation easement game in which self-interested landowners had to consider whether it is worth paying the additional taxes on the development value of the land to preserve the opportunity to sell the land into development in the future. In contrast, they found that current conservation easements do not always lead to optimal conservation, and argue that they even reduce social welfare. In essence, they assert conservation easements are currently *over*-priced based on social welfare judgments. Although, they include a social component to their estimation of the efficient easement price, the conclusion that easements are currently over-priced results from the private incentive components of their model.

Therefore, this inherent incongruity in the literature of proper valuation of conservation easements lends there to be need of combining approaches. Specifically, this paper will analyze the effects of strategic behavior modeled with the irreversible investment decision that includes the value of the option to defer conversion. This use of real options theory in a game theoretic approach for conservation easement purposes has yet to be addressed in the literature; therefore, this paper will serve as a theoretical frontier for the use of a real option along with the strategic considerations necessary in determining the value of conservation initiatives. In essence, to approach this issue in a more complete manner, the combination of the two paradigms must be examined. If both approaches are taken into account, qualitatively we will have a much more robust method of valuing conservation easements optimally.

The use of real options in terms of a game theoretic type of approach has been increasing applied in the corporate finance literature recently. Wu and Xuan (2005) examined the strategic timing of technological innovation using a game-theoretic and real option approach. Imai and Watanabe (2004) applied a real option approach in a game to examine the interaction between managerial flexibility and competition. Thijssen, Huisman, and Kort (2002) applied this type of model to research on symmetric equilibrium strategies of a duopoly making investment decisions. And, most notably, Grenadier (1996) examined development cascades and overbuilding in real estate markets using this combined approach.

Figure 4.1 illustrates the current divergence in the literature on how conservation easements should be priced. The central focus of this study is to examine the disparity of outcomes in the models of Tegene, Wiebe, and Kuhn (1999) versus Anderson and King (2004).

Figure 4.1: This figure illustrates the expected value of conservation easements given the various approaches.



Section 4.3 THE GENERAL MODEL

The model developed in this paper follows the general framework of Anderson and King (2004) and Tegene, Wiebe, and Kuhn (1999), but it differs in that it combines both paradigms resulting in a more complete model. This paper will then provide a game theoretic approach using real options theory in order to further the understanding of what leads to optimal, private outcomes.

a) Assumptions and Set-up of the Model

The setting of the game is as follows. There exist two identical and adjacent landowner's, *i* and *j*, each of which possess the option to sell a parcel of land for the purpose of conversion or conservation. We will consider this representative parcel of land to be found near an approaching urban area. Therefore, each landowner has before them three choices: (1) keep the land for current agricultural/undeveloped use, (2) sell the easement and forego the option of later development value, (3) sell the land for the current development value. Although non-landowners may be affected by conservation decisions, in this simple model, they do not have a strategic opportunity to affect the payoffs of conservation and are therefore not active players in the game.

It is important to discuss at this point that decisions (2) and (3) presented above are irreversible. The latter decision presents substantial sunk costs in terms of infrastructure and development structures to be placed on the land, which are virtually impossible to remove in an effort to restore to the previous agricultural vacancy of the land. In addition, the former decision is irreversible in that when contractually conveying an easement it is almost always binding in perpetuity.

This issue of irreversibility, as noted by Tegene, Wiebe, and Kuhn (1999) is important in that these decisions not only forfeit the potential agricultural use and choice of land use for the future, but also entail giving up possible new information in the future – such as changes in government policies or food or housing prices – that might influence the timing and profitability of converting. Therefore, is these decisions were fully reversible, there would not exist this additional opportunity cost of converting today instead of waiting to keep the option available for a future conversion decision.

The cost of the sale of an easement is the absence of any future developability value (U). The cash flow stream from the sale is uncertain, however the decision is irreversible. Most importantly, the payoff from any landowners' sale depends on the strategy of its competitor. If only one landowner converts the parcel, it achieves the (perhaps temporary) payoffs of a monopolist. If both landowners convert, the landowners receive the payoffs of a duopoly and each landowner must determine the optimal exercise strategy fully cognizant of its competitor's similar calculation.

In the model, each landowner will contemplate the expected value of their land, based upon the strategies of the adjacent landowner and the associated payoffs.

b) Simultaneous Entry Equilibrium Conditions: Private Payoffs

First, the value of each parcel to its respective landowner will be derived, then the derivation of the equilibrium set of exercise strategies with the landowners choosing their individual roles will be examined. Valuation of the expected payoffs for each landowner will include the option value analogous to a call option of a dividend paying stock. As noted by Tegene, Wiebe, and Kuhn (1999), the parcel owner can turn the land into urban land (buy an asset) for an exercise price (the foregone agriculture value plus any conversion costs). The deferment of the conservation/conversion decision is assumed to create flexibility for the landowner given the uncertain market demand yielding development value and easement value.

Therefore, let us examine the payoff values given a simultaneous entry game. To examine the effect of a real option in this model, it will be shown that when the developability value is uncertain, the landowners will enjoy certain benefits from deferring the option until greater information is known. This real option type of analysis includes a positive value in the real option to defer the sale until time two.

The options of each are directly competitive; each has the ability to sell the rights for any future development while then realizing certain benefits in the form of tax reductions. The public and private benefits provided by parcel i and/or j depend on the unique features of the parcel, specifically, the conservation status of other surrounding parcels, the development status of other surrounding parcels, and the real estate market. Consistent with Anderson and King (2004), each parcel will then be described by three attributes: income value, developability, and public value.

In each given period, an undeveloped parcel provides its owner an income from non-development use, such as farming or lumber. In addition, the undeveloped parcel provides the owner and the public with the benefit of non-market amenities, specifically in the form of open space or privacy that would otherwise be extinguished if developed. The amount of this "income" will be scaled using an index, A.

The second element is developability, which represents the desirability value of the property for a conversion or development usage. This variable would then include locational and also physical features of the parcel. If the land is converted to development use, the landowner receives urban rents from the sale, U.

The final feature of the parcel measures its public value, while this paper will address this component qualitatively; it is not part of the decision model.

The model assumes a tax rate, t, and each landowners parcel contributes a portion α of the taxes needed to cover the total town budget. The decision that then arises for each landowner is whether they should sell an easement for conservation purposes or to hold onto the rights to sell for development at a future date.

The model is a two period model in which the decision to be made occurs at time t_0, with a payoff received at the end of period, t_1. The payoff to be received, as represented in Figure 4.2, is the sum of the payoff in the first period t_1 plus the present value of the remaining perpetual payment to be received at times 2, .., ∞. Each landowner is assumed to have value of the land for pure agricultural use which will provide a perpetuity of A (net cash flow before taxes). Hence,

$$V_i = A + \frac{A}{r} \tag{13}$$

The value of the parcel of land for urban use is discounted at rate r as well, assumed to be random and growing in perpetuity:

$$V_i = E(\tilde{U}) + \frac{E(\tilde{U})}{r} \tag{14}$$

Equation (13) implies the parcel has a present value of a stream of agricultural returns which will be realized if no conversion takes place. Equation (14) represents the present value of the stream of urban returns from the date of conversion onward. As implied by the work of Tegene, Wiebe, and Kuhn (1999), the option value is equal to the present value of the stream of development returns, U. This is the amount of compensation a rational, well-informed landowner would require to give up the future right to develop the parcel. Therefore, the strike price is the value of A. When the value of U exceeds the value of A, the landowner will exercise the option to convert. The option value is thus the difference between the value of U and A. Therefore, the social planner must include this value when deriving the appropriate easement price.

The timing of the decision faced by each landowner will not only be influenced by the value of variables A and U, but also the decision criteria of the adjacent property owner. In a simultaneous-play model, each state would yield expected values for each payoff given the strategy of the other player. In a Nash equilibrium, each landowner's exercise strategy is optimal, conditional on its competitor's strategy.

The payoff structure of the matrix will be examined based upon the decisions of landowners *i* and *j* expressed with the variables used above. Each landowner must decide at time t_0 if and when they will convert; i.e., this is without the option to change their mind at time t_1. Following the approach of Gibbons (1997), both landowners *i* and *j* will choose the following:

1) Landowner *i* chooses an action a_1 from a set of feasible actions A_1. Simultaneously, landowner *j* chooses an action a_2 from a set of feasible actions A_2.
2) After the landowners choose their actions, they receive payoffs: $V_1(a_1, a_2)$ to landowner *i* and $V_2(a_1, a_2)$ to landowner *j*.

Therefore, $A_1 \equiv A_2 \equiv \{D_1, D_2, C_1, C_2, N\}$

where, D_1 = convert the land for urban use in period 1
D_2 = convert the land for urban use in period 2
C_1 = conserve by conveying the easement in period 1
C_2 = conserve by conveying the easement in period 2
N = do nothing by deferring the decision to a later period

Twenty-five outcomes are thus plausible in this five-by-five game. Figure 4.2 illustrates the payoff values attainable by landowner *i* given the competitive strategy of landowner *j*. The payoff of both landowners converting the land for urban use would include the given land's urban conversion price less the taxes to be paid on the property.

If landowner *i* and landowner *j* sell the future developability rights of their land and select to convey an easement, they will each receive a payoff in the sum of the easement price, E, the agricultural revenues of continued use of the land, A, and the value associated with being within close proximity to other conserved land, π_2.

In the case where both landowners decide to postpone the decision until the next period, N, they both will then receive a payoff in the sum of the agricultural revenue less the taxes to be paid on the property.

However, if each landowner chooses to pursue a differing strategy, further parameters must then be defined to address the competitive nature of the outcomes. If one landowner converts the land for urban use while the other conveys the land as an easement, the developability value payoff to the former is now more monopolistic in nature. This first-mover advantage to development conversion will be captured in the variable π_1. In addition, the landowner adjacent to the conserved property will enjoy certain benefits by being adjacent to a conserved parcel of land. This increment for proximity to conserved land will be reflected in the element π_2. The payoff will again be less the taxes associated with the parcel. However, in this case the shifted tax burden must be paid as well, αA, which is the conserved parcel's tax to be shifted to the landowner not conserving. By one landowner conveying the easement and receiving tax incentives for such move, the other landowner must then pay an incremental amount of additional taxes to compensate for the lack of tax revenue from the conserved parcel. The payoff to the latter will then include the easement price to be received plus the agricultural returns associated with continued agricultural use of the land.

If one landowner converts the land for urban use and the other decides to defer the decision until more information is revealed in a later stage, the landowner who converts for development use will gain the developability value plus the incremental advantage of being the first to convert to urban use, π_1, less the taxable value of the parcel. The payoff the landowner that postponed the decision will include the agricultural returns less the tax on the property.

In the case where one landowner conveys the easement and the other landowner postpones the decision until a future period, the first landowner will receive a payoff from the easement sale price and the agricultural revenue generating activity. The second landowner that chose to wait will receive the agricultural returns plus the close proximity to conserved land value increment, π_2, less the tax on the land and the shifted tax burden associated with the loss in tax revenue when the former landowner conveyed the easement, αA.

Figure 4.2: This figure illustrates a payoff matrix in a two-period game.

		j				
		D_1	D_2	C_1	C_2	N
	D_1	I	II	III	IV	V
	D_2	VI	VII	VIII	IX	X
i	C_1	XI	XII	XIII	XIV	XV
	C_2	XVI	XVII	XVIII	XIX	XX
	N	XXI	XXII	XXIII	XXIV	XXV

Therefore, in this simultaneous play model, the payoffs obtained in each strategy choice defined by Figure 4.2 are as follows:

I) If both players convert the land for urban use in period 1, (D_1, D_1):

$$V_i = \left(E(\tilde{U}) + \frac{E(\tilde{U})}{r} \right)(1-t) \tag{15}$$

$$V_j = \left(E(\tilde{U}) + \frac{E(\tilde{U})}{r} \right)(1-t) \tag{16}$$

II) If player *i* converts the land for urban use in period 1 and player *j* converts the land for urban use in period 2, (D_1, D_2):

$$V_i = \left(E(\tilde{U}) + \frac{E(\tilde{U})}{r} \right)(1-t)(1+\pi_1) \tag{17}$$

$$V_j = \left[\left(A + E(\widetilde{U})\right) + \left(\frac{A}{r} + \frac{E(\widetilde{U}) - A}{r}\right)\right](1-t) \tag{18}$$

III) If player i converts the land for urban use in period 1 and player j converts the land for conservation use in period 1, (D_1, C_1):

$$V_i = \left[(E(\widetilde{U}) - \alpha A) + \left(\frac{E(\widetilde{U}) - \alpha A}{r}\right)\right](1+\pi_1)(1+\pi_2)(1-t) \tag{19}$$

$$V_j = \left(A + E + \left(\frac{A+E}{r}\right)\right) \tag{20}$$

IV) If player i converts the land for urban use in period 1 and player j converts the land for conservation use in period 2, (D_1, C_2):

$$V_i = E(\widetilde{U})\left((1+\pi_1)(1-t)\right) + \left[\frac{E(\widetilde{U}) - \alpha A}{r}\left((1+\pi_1)(1+\pi_2)(1-t)\right)\right] \tag{21}$$

$$V_j = \left[\left(A(1-t) + \frac{A+E}{r}\right)\right] \tag{22}$$

V) If player i converts the land for urban use in period 1 and player j defers the decision to a later period, (D_1, N):

$$V_i = \left(E(\widetilde{U}) + \frac{E(\widetilde{U})}{r}\right)(1+\pi_1)(1-t) \tag{23}$$

$$V_j = \left(A + \frac{A}{r}\right)(1-t) \tag{24}$$

VI) If player i converts the land for urban use in period 2 and player j converts the land for urban use in period 1, (D_2, D_1):

$$V_i = \left[\left(A + \frac{A}{r}\right) + \left(E(\tilde{U}) + \frac{E(\tilde{U}) - A}{r}\right)\right](1-t) \tag{25}$$

$$V_j = \left(E(\tilde{U}) + \frac{E(\tilde{U})}{r}\right)[(1+\pi_1)(1-t)] \tag{26}$$

VII) If player i converts the land for urban use in period 2 and player j converts the land for urban use in period 2, (D_2, D_2):

$$V_i = \left[\left(A + \frac{A}{r}\right) + \left(E(\tilde{U}) + \frac{E(\tilde{U}) - A}{r}\right)\right](1-t) \tag{27}$$

$$V_j = \left[\left(A + \frac{A}{r}\right) + \left(E(\tilde{U}) + \frac{E(\tilde{U}) - A}{r}\right)\right](1-t) \tag{28}$$

VIII) If player i converts the land for urban use in period 2 and player j converts the land for conservation use in period 1, (D_2, C_1):

$$V_i = \left[(A - \alpha A) + \left(\frac{A - \alpha A}{r}\right) + \left[\left(\frac{E(\tilde{U}) - \alpha A - A}{r}\right)(1+\pi_1)\right]\right](1+\pi_2) \times (1-t)] \tag{29}$$

$$V_j = (A + E) + \left(\frac{A+E}{r}\right) \tag{30}$$

IX) If player i converts the land for urban use in period 2 and player j converts the land for conservation use in period 2, (D_2, C_2):

$$V_i = \left[\left(A + \frac{A}{r}\right) + \left[\left(\frac{E(\tilde{U}) - \alpha A - A}{r}\right)(1+\pi_1)(1+\pi_2)\right]\right](1-t) \tag{31}$$

$$V_j = \left[(A(1-t)) + \left(\frac{A+E}{r}\right)\right] \tag{32}$$

X) If player i converts the land for urban use in period 2 and player j defers the decision to a later period, (D_2, N):

$$V_i = \left[\left(A + \frac{A}{r}\right) + \left[\left(E(\tilde{U}) + \frac{E(\tilde{U}) - A}{r}\right)(1+\pi_1)\right]\right](1-t) \tag{33}$$

$$V_j = \left(A + \frac{A}{r}\right)(1-t) \tag{34}$$

XI) If player i converts the land for conservation use in period 1 and player j converts the land for urban use in period 1, (C_1, D_1):

$$V_i = \left(A + E + \left(\frac{A+E}{r}\right)\right) \tag{35}$$

$$V_j = \left[(E(\tilde{U}) - \alpha A) + \left(\frac{E(\tilde{U}) - \alpha A}{r}\right)\right](1+\pi_1)(1+\pi_2)(1-t) \tag{36}$$

XII) If player i converts the land for conservation use in period 1 and player j converts the land for urban use in period 2, (C_1, D_2):

$$V_i = \left(A + E + \left(\frac{A+E}{r}\right)\right) \tag{37}$$

$$V_j = \left[(A - \alpha A) + \left(\frac{A - \alpha A}{r}\right) + \left[\left(\frac{E(\tilde{U}) - \alpha A - A}{r}\right)(1+\pi_1)\right]\right](1+\pi_2) \times (1-t)] \tag{38}$$

XIII) If player i converts the land for conservation use in period 1 and player j converts the land for conservation use in period 1, (C_1, C_1):

$$V_i = \left(A + E + \left(\frac{A+E}{r} \right) \right)(1+\pi_2) \tag{39}$$

$$V_j = \left(A + E + \left(\frac{A+E}{r} \right) \right)(1+\pi_2) \tag{40}$$

XIV) If player i converts the land for conservation use in period 1 and player j converts the land for conservation use in period 2, (C_1, C_2):

$$V_i = \left(A + E + \left[\left(\frac{A+E}{r} \right)(1+\pi_2) \right] \right) \tag{41}$$

$$V_j = \left[((A - \alpha A)(1-t)) + \frac{A+E}{r} \right](1+\pi_2) \tag{42}$$

XV) If player i converts the land for conservation use in period 1 and player j defers the decision to a later period, (C_1, N):

$$V_i = \left(A + E + \left(\frac{A+E}{r} \right) \right) \tag{43}$$

$$V_j = \left[(A - \alpha A) + \left(\frac{A - \alpha A}{r} \right) \right](1-t)(1+\pi_2) \tag{44}$$

XVI) If player i converts the land for conservation use in period 2 and player j converts the land for urban use in period 1, (C_2, D_1):

$$V_i = \left[\left(A(1-t) + \frac{A+E}{r} \right) \right] \tag{45}$$

$$V_j = E(\tilde{U})((1+\pi_1)(1-t)) + \left[\frac{E(\tilde{U}) - \alpha A}{r} ((1+\pi_1)(1+\pi_2)(1-t)) \right] \tag{46}$$

XVII) If player i converts the land for conservation use in period 2 and player j converts the land for urban use in period 2, (C_2, D_2):

$$V_i = \left[\left(A(1-t) \right) + \left(\frac{A+E}{r} \right) \right] \tag{47}$$

$$V_j = \left[A + \left(\frac{A - \alpha A}{r} \right) + \left[\left(\frac{E(\tilde{U}) - \alpha A - A}{r} \right) (1+\pi_1)(1+\pi_2) \right] \right] (1-t) \tag{48}$$

XVIII) If player i converts the land for conservation use in period 2 and player j converts the land for conservation use in period 1, (C_2, C_1):

$$V_i = \left[\left((A - \alpha A)(1-t) \right) + \frac{A+E}{r} \right] (1+\pi_2) \tag{49}$$

$$V_j = \left(A + E + \left[\left(\frac{A+E}{r} \right) (1+\pi_2) \right] \right) \tag{50}$$

XIX) If player i converts the land for conservation use in period 2 and player j converts the land for conservation use in period 2, (C_2, C_2):

$$V_i = \left[\left((A)(1-t) \right) + \left[\left(\frac{A+E}{r} \right) (1+\pi_2) \right] \right] \tag{51}$$

$$V_j = \left[\left((A)(1-t) \right) + \left[\left(\frac{A+E}{r} \right) (1+\pi_2) \right] \right] \tag{52}$$

XX) If player i converts the land for conservation use in period 2 and player j defers the decision to a later period, (C_2, N):

$$V_i = \left[\left(A(1-t) \right) + \left(\frac{A+E}{r} \right) \right] \tag{53}$$

$$V_j = \left[A + \left[\left(\frac{A-\alpha A}{r} \right)(1+\pi_2) \right] \right](1-t) \tag{54}$$

XXI) If player i defers the decision to a later period and player j converts the land for urban use in period 1, (N, D_1):

$$V_i = \left(A + \frac{A}{r} \right)(1-t) \tag{55}$$

$$V_j = \left(E(\tilde{U}) + \frac{E(\tilde{U})}{r} \right)(1+\pi_1)(1-t) \tag{56}$$

XXII) If player i defers the decision to a later period and player j converts the land for urban use in period 2, (N, D_2):

$$V_i = \left(A + \frac{A}{r} \right)(1-t) \tag{57}$$

$$V_i = \left[\left(A + \frac{A}{r} \right) + \left[\left(E(\tilde{U}) + \frac{E(\tilde{U}) - A}{r} \right)(1+\pi_1) \right] \right](1-t) \tag{58}$$

XXIII) If player i defers the decision to a later period and player j converts the land for conservation use in period 1, (N, C_1):

$$V_i = \left[(A-\alpha A) + \left(\frac{A-\alpha A}{r} \right) \right](1+t)(1+\pi_2) \tag{59}$$

$$V_j = \left(A + E + \left(\frac{A+E}{r} \right) \right) \tag{60}$$

XXIV) If player i defers the decision to a later period and player j converts the land for conservation use in period 2, (N, C_2):

$$V_i = \left[A + \left[\left(\frac{A - \alpha A}{r} \right) (1 + \pi_2) \right] \right] (1 - t) \tag{61}$$

$$V_j = \left[\left(A(1-t) \right) + \left(\frac{A+E}{r} \right) \right] \tag{62}$$

XXV) If player i defers the decision to a later period and player j defers the decision to a later period, (N, N):

$$V_i = \left(A + \frac{A}{r} \right) (1-t) \tag{63}$$

$$V_j = \left(A + \frac{A}{r} \right) (1-t) \tag{64}$$

In the payoff values given postponement of any decision, the value of the option to defer is expressed as being equal to the foregone net operating cash inflow to be received if the landowner converted the land for urban use. This element captures the essence of the *flexibility* value of postponing one more period. As Tegene, Wiebe, and Kuhn (1999) show, the main cause of a postponed decision when payoffs are uncertain is not simply risk aversion, it is delayed because the opportunity cost of development includes an option value of agricultural land – the value of the ability to avoid downside outcomes while still retaining a claim on favorable outcomes. They conclude that both growth and uncertainty create a value to waiting and affect the timing of conversion.

Furthermore, to the extent that greater information revelation becomes available if the landowner foregoes their decision in the first period, in the context of conservation easements, more compensation is thus required to entice one or both parties to move. The abandonment option, the real option available in corporate finance allowing greater flexibility in decision-making resulting from information revelation, is somewhat similar in context to the option in this game. The abandonment option adds value to the holder by granting flexibility in the decision to terminate a proposed project. Thus, the option to defer the decision to sell the parcel as an easement or to sell for development use increases the expected value of holding the land for one more period.

Consequently, when we compare the value of the land according to Tegene, Wiebe, and Kuhn (1999), this study reflects the inherent nature of both the game theoretic approach and real options theory approach. Tegene, Wiebe, and Kuhn (1999) showed that the option value is equal to the amount of compensation a rational, well-informed landowner would require to give up the future right to develop the parcel. Therefore, as presented in this chapter, the option value is now equal to not only the developability value, but also includes the tax elements to be paid and competitive choice variables; specifically, the incremental value for proximity to conserved land and the incremental value of first-mover advantage.

By merely applying one technique, the true intrinsic value of the land has not been adequately explained in the literature thus far. The pure game theory approach, as put forth by Anderson and King (2004), captures the competitive nature of two landowners and argues that a fair price, given that perfectly competitive type market is actually less than that currently being offered.

Market inefficiency will result unless and until the true value of deferment in decision-making, in anticipation of greater information to be revealed, becomes accurately represented in the calculation of easement pricing. If this element is not considered in the valuation of a given parcel of land, the price offered for the easement is less than the true efficient value needed to compensate the landowner for the parcel. Therefore, this facet can not be neglected by society if it desires to maximize the benefits created by conserving the efficient amount of acreage in the coming years.

Section 4.4 CONCLUDING REMARKS

This paper provides a link between the usefulness of real options theory and its relevance in terms of a game theoretic application. Because conservation easements are increasingly becoming an important part of regional conservation efforts, it is quite important to debate the current pricing of these contracts in order to maximize net social and private benefits.

The essence of this paper is to maintain that the use of both approaches in a combined framework will better serve the public and also private interests in maximizing total surplus. The accumulation of the various aspects of this model will better explain in both a descriptive and enormity sense the attributes needed to properly price conservation easements.

This combined approach provides further richness to the theory of optimal pricing of easements. Previous work has focused on simply one aspect of value attributed to easement pricing. As stated previously, Tegene, Wiebe, and Kuhn (1999) applied only options theory to the value of conservation easements and found conservation easements to be currently *under*-priced, and therefore, proposed that landowners should be reluctant to sell easements at the current prices offered. This is quite logical, as with any option available to decision-makers, the option provides enhancement to the value of the underlying asset. Therefore, it was not surprising to find the addition of this component of decision-making flexibility, to increase the value of the property in question. In contrast, Anderson and King (2004) modeled a conservation easement game finding that conservation easements are currently *over*-priced based on social welfare judgments. The value of the easement in this case is thought to be less because it does not capture the inherent value of dynamic decision making flexibility. By combining the two paradigms, this paper then provides a more complete understanding of the incentives and necessary easement valuation from the perspective of the private landowner in conservation easement decisions.

Because optionality adds value to the decision making process, this element must be properly accounted for in the valuation of the decision criteria. The increase in value arises from the flexibility added to change a decision in a later period once the subsequent state of nature appears. Therefore, further work in this study will be performed in an effort to estimate the added value of decision making through the use of a Monte Carlo simulation providing the Net Present Value estimates with and without flexibility.

CHAPTER V: SUMMARY

Section 5.1 REVIEW OF CHAPTERS

This dissertation is written in an attempt to expand the frontier of research in the sphere of risk and return associated with development and re-development issues facing regional economies. The premise of this study is to provide a "micro-foundations" view of the decisions facing the individual actors of local economies. Consequently, by analyzing the decisions faced at the micro level, this dissertation can provide public policy makers with varying insights into the mindset of private agents in a local economy. The result will be and increased understanding as to their role in addressing inefficiencies. In the absence of efficient diversification, in an effort to reduce the overall risk exposure of the economy, social planners expose their economy to an improper balance of risk and return, thus leading to greater inefficiency.

Risk should be thought of as not only a "danger," a warning or caution in decision making, but also as an "opportunity" in the potential for greater returns to be generated by means of added compensation for the additional element of riskiness of such project or transaction. In an efficient market, risk is effectively calculated in the mind of the decision makers. In a market tainted by inefficiency, appropriate risk premia can not be accurately calculated, which inevitably leads to a lack of market-clearing and socially optimal outcomes. Therefore, the contribution to be provided by this dissertation is to expand the awareness of efficiency issues in regional development and to address the intervention activities required to bring about efficiency in markets lacking such attribute currently. Each chapter addressed varying regional development issues all of which are linked in the analysis of risk and return and market inefficiency. The central theme of this study is to examine the critical role of riskiness and associated return of each of the three regional economy phenomena: ghost towns, Brownfield redevelopment, and conservation easements. The end result of each is then to address when and where government intervention is required due to any market inefficiencies. When economic agents are not adequately compensated, inefficiency will result. Intervention, in the presence of inefficiency, can be accomplished in a variety of schemes. As previously discussed, this list includes, but is not limited to, profit-sharing initiatives, direct policy legislative action, and insurance to compensate for some of the added risk.

Three main topics concerning these issues were introduced. These include an emanation of boom and bust cycles, redevelopment of contaminated properties, and conservation issues in an effort to limit development in order to preserve a certain lifestyle.

Chapter I, the Introduction, includes a brief summary of the focus and purpose of the dissertation. In addition, an epigrammatic synopsis of each chapter was presented.

Chapter II contains an examination of how and why local economies can experience dramatic booming stages and then subsequently bust as quickly. This chapter develops linked local labor and housing/fixed investment market models to frame the understanding of the sources and dynamics of ghost town's dramatic cycles. A principal finding of this chapter is that ghost town economies are shaped by the unusually high-variance cycles in extractive industry settings, coupled with the positive amenities for firms during boom windows alongside on-going negative locational amenities for workers in these often harsh, isolated settings. The models offered in this chapter provide a perspective that incorporates these features, leading to situations where both firms and workers have especially narrow short-term perspectives on investment and labor returns. The result are economies with little diversification, rapid cycles, and fixed investment that is both limited and easily abandoned.

These economies generated substantial returns in the short-run. In part, this return was generated by the added riskiness of the projects and locales. The owner of the scarce resource as well as the transient worker gravitated to the location providing elevated return potential. Because the resource and returns were finite, agents quickly moved toward the next setting providing short-run elevated return potential.

Chapter III addresses the requirements by investors to develop urban contaminated property. Data was presented in this chapter to address the criteria necessary to induce developers to transform an underutilized brownfield site into a higher and better use, incorporating research findings from a developer survey and a range of statistical analyses. The premise of this chapter is to suggest that significant redevelopment potential exists for Brownfield sites, resulting in direct increases in economic activity in the site itself as well as indirect job creation and increases in neighborhood property values. However, the principal conclusion of this study is that there is a premium on the rate of return required by private decision makers considering redevelopment of Brownfield properties, a premium that may vary somewhat according to the role of the decision maker, but in general is at least 2%. In addition, this premium appears to be generated by additional factors that do not represent either true resource costs or regular risk premia, namely "stigma" elements associated with contamination and past contamination.

This additional required rate of return due to "stigma" creates an inefficient market. This chapter is thus written in an attempt to bring light to the problem and address the needed intervention required to achieve a socially optimal amount of redevelopment projects for existing Brownfield sites.

Chapter IV examines recent tactics in the current literature of optimal pricing of conservation easements. This chapter provides a link between the usefulness of real options theory and its relevance in terms of a game theoretic application. Because conservation easements are increasingly becoming an important part of regional conservation efforts, it is quite important to provide a more complete understanding of the appropriate incentives needed in order to entice landowners to conserve rather than continue urban development and sprawl. The essence of this chapter is to maintain that the use of both approaches in a combined framework will better serve the public and also private interests in maximizing efficiency from all perspectives of this debate.

Chapter V offers a summary and conclusions of the study, while providing some insights into the micro-perspectives of community development presented in each chapter.

Therefore, the value-added of this dissertation is a detailed analysis of how and why risk matters in regional economies. The central conclusion is that risk, viewed as either opportunity or danger, presents regional economic agents with alternative strategies to manage. If viewed as an opportunity, in an efficient and diversified portfolio, a necessary and meaningful return will follow. In the event this exchange is inefficient, public policy and/or private interests must step into achieve a socially efficient outcome.

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APPENDIX

Chapter II

FIGURE 2.1

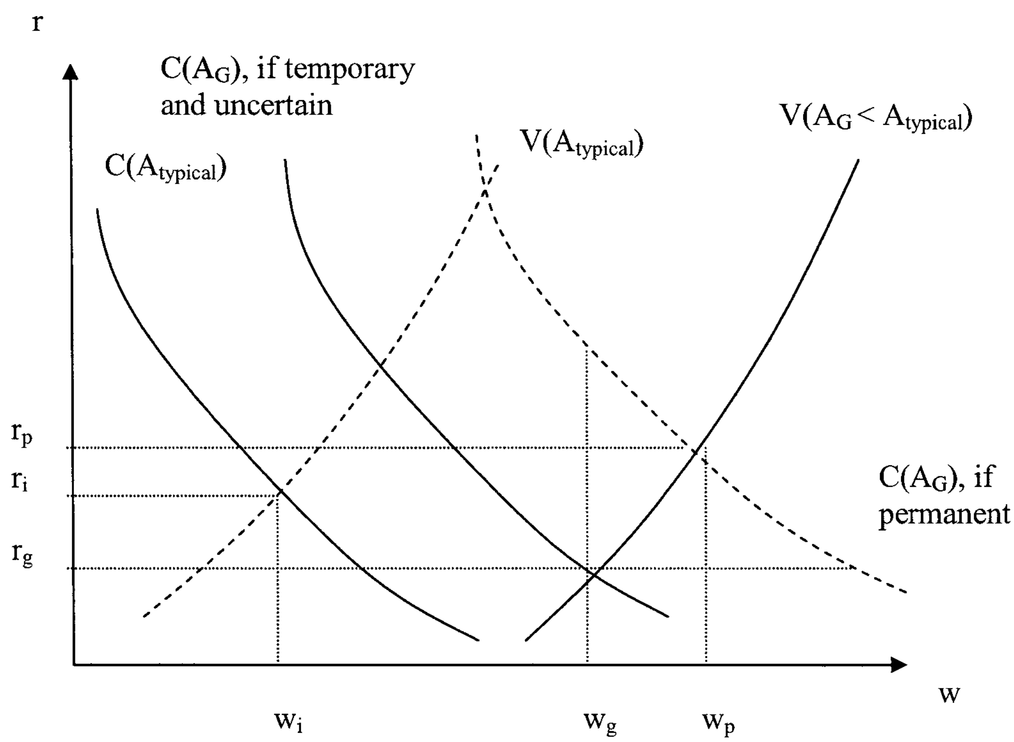

TABLE 2.1 Historical Census Data:
Lake County, CO, Teller County, CO, Arapahoe County, CO, and the State of Colorado

	Average wage per worker	Total Population	Male/ Female Ratio	No. Dwellings	Population per Dwelling	Males per Dwelling	Population * Average Wage) per Dwelling
Lake County							
1870	378	522	2.87	*	*	*	*
1880	517	23,563	3.47	*	*	*	*
1890	1,019	14,663	1.62	2,992	4.9007	3.0294	4,992
1900	648	18,054	1.63	4,103	4.4002	2.7302	2,851
1910	787	10,600	1.33	2,852	3.7167	2.1248	2,927
1920	1,286	6,630	1.22	2,853	2.3239	1.2766	2,989
1870-1900:							
MEAN	640	14,201	2.40	3,548	4.6505	2.8798	3,921
UNEXPLAINED VARIANCE	0.6217	0.6706	0.3981	n/a	n/a	n/a	n/a
1870-1920:							
MEAN	773	12,339	2.02	3,200	3.8354	2.2902	3,440
UNEXPLAINED VARIANCE	0.3682	0.9990	0.2785	0.5684	0.0628	0.0494	0.9881
Teller County							
1870	454	2,051	1.64	*	*	*	*
1880	223	12,684	1.46	*	*	*	*
1890	588	30,395	1.36	5,977	5.0853	2.9341	2,988
1900	805	29,002	1.43	7,684	3.7743	2.2237	3,037
1910	830	14,351	1.22	4,099	3.5011	1.9207	2,906
1920	1,500	6,696	1.13	1,999	3.3497	1.7799	5,025
1870-1890:							
MEAN	421	15,043	1.49	5,977	5.0853	2.9341	2,988
UNEXPLAINED VARIANCE	0.8692	0.0204	0.0316	n/a	n/a	n/a	n/a
1870-1920:							
MEAN	689	15,746	1.39	5,147	4.1592	2.3585	3,389
UNEXPLAINED VARIANCE	0.2155	0.9847	0.1159	0.3296	0.2011	0.1060	0.4331
Arapahoe County							
1870	700	6,829	1.82	*	*	*	*
1880	535	38,644	1.55	*	*	*	*
1890	785	132,135	1.34	23,122	5.7147	3.2766	4,485
1900	614	153,017	1.02	31,107	4.9191	2.4861	3,019
MEAN	658	82,656	1.43	27,115	5.3169	2.8814	3,752
UNEXPLAINED VARIANCE	0.9999	0.0617	0.0850	n/a	n/a	n/a	n/a
State of Colorado							
1870	603	39,864	1.65	*	*	*	*
1880	456	194,327	1.98	*	*	*	*
1890	720	412,198	1.47	81,127	5.0809	3.0230	3,658
1900	613	539,700	1.21	120,364	4.4839	2.4537	2,747
1910	969	799,024	1.17	183,874	4.3455	2.3423	4,211
1920	1,219	939,629	1.10	211,103	4.4510	2.3341	5,426
1870-1900:							
MEAN	598	296,522	1.5770	100,746	4.7824	2.7383	3,202
UNEXPLAINED VARIANCE	0.8785	0.0092	0.4664	n/a	n/a	n/a	n/a

1870-1920:							
MEAN	763	487,457	1.4300	149,117	4.5903	2.5383	4,010
UNEXPLAINED VARIANCE	0.2632	0.0061	0.2701	0.0209	0.3794	0.2638	0.3914

Chapter III

Appendix 3.A1

SURVEY COVER LETTER

Dear Participant:

As a real estate professional, you have been selected to participate in a research study regarding the impacts of environmental conditions on real estate transactions. The study is intended to sample a cross-section of the real estate investment community. We are therefore interested in your response regardless of your specific experience, and regardless whether you seek, avoid, or are neutral to such "Brownfields" investments.

This survey is completely voluntary; all we ask is that you complete and return the enclosed survey, which should take only 5 minutes for your time. There is no risk to this survey and all individual responses will remain confidential. The overall survey results should benefit the broader real estate community by clarifying possibly overlooked opportunities for redevelopment at Brownfield sites.

Enclosed in the survey is a separate sheet for you to provide optional contact information, which can be returned in the same stamped envelope as the survey. This information will allow us to mail you an advance copy of the summary results shortly after the survey is tabulated. We will also solicit a few follow-up phone or in-person interviews of approximately 10-15 minutes. Only participants who indicate an interest in such a conversation will be interviewed, and any comments will remain completely confidential. Finally, you can also opt to be entered in a random drawing for a round of golf for four at the Englewood Golf Course on the same sheet.

This study is being jointly conducted by the Center for Research on the Colorado Economy (CRCE) at the Economics Department at Colorado State University, and Development Research Partners Inc. of Littleton, Colorado. The study is funded with a grant from the U.S. Economic Development Administration to study urban opportunities with regard to Brownfields sites, as part of a larger "Matching Retail Gaps with Brownfield Opportunities"project. At the conclusion of the research project in late 2003, research reports on Brownfield redevelopment opportunities and impacts will be available to all participants and the wider public on CSU's Center for Research on the Colorado Economy website (http://www.colostate.edu/programs/CRCE/).

If you have any questions regarding the survey questions, intent, confidentiality, or any other related issue, please contact Jesse Silverstein, Development Research Partners, 303-991-0074, jesse@DevelopmentResearch.net. Questions about participants' rights may be directed to Celia S. Walker (CSU) at (970) 491-1563.

Thank you very much for your help in completing this important project.

Sincerely,
Stephan Weiler, Robert Kling, and Jesse Silverstein
Stephan Weiler – CSU Economics Department
Robert Kling – CSU Economics Department
Jesse D. Silverstein – Development Research Partners

CONTAMINATED PROPERTY INVESTMENT SURVEY

Thank you for participating in this research effort. Your professional experience and judgement are important to us. Please answer the following questions as thoughtfully as possible; be as specific as possible even if you see ambiguities in a question; and please answer from your own personal perspective as a real estate professional.

1. Would you describe yourself as a . . . ? (check all that apply)
- ❑ broker
- ❑ developer
- ❑ financier
- ❑ investor

2. What types of property do you typically deal in? (choose all that apply)
- ❑ single-family residential
- ❑ multi-family residential
- ❑ retail
- ❑ office
- ❑ industrial

3. What size transaction do you typically seek? (choose all that apply)
- ❑ smaller than $250,000
- ❑ $250,000 to $1 million
- ❑ $1 million to $5 million
- ❑ larger than $5 million

4. Have you ever purchased a property with environmental contamination issues (excluding asbestos & lead based paint)?
- ❑ No
- ❑ Yes, bought it unknowingly
- ❑ Yes, bought it intentionally

5. Which best describes you? (answer one)
- ❑ Will not ever buy contaminated property
- ❑ Try to avoid contamination, but will invest if the economics makes sense.
- ❑ Invest in contaminated ("Brownfields") properties as well as "clean properties.
- ❑ Only invest in contaminated ("Brownfields") properties.

6. Do you intentionally seek contaminated property as an investment?
- ❑ Yes
- ❑ No

7. Have you ever walked away from a potential deal solely because environmental contamination was present?
- ❑ Not always; I will gladly evaluate the potential cost of remediation.
- ❑ No, but I have a limited tolerance for such issues.

Continued ⇒

- ❑ Yes, immediately upon the appearance or disclosure of environmental issues.
- ❑ Yes, after further investigating the extent of environmental problems.
- ❑ Yes, but only after I determined that remediation cost made the deal infeasible.

8. 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 "voluntary cleanup program" is.
- ❑ No, have never been in that situation
- ❑ No, I don't deal with contaminated properties.
- ❑ Yes, it lowered my risk and my required rate of return.
- ❑ Yes, but it did not lower my risk or my required rate of return.

9. Have you ever used Environmental Insurance for a property transaction? (Answer all that fit)
- ❑ No, I don't deal with contaminated properties.
- ❑ No, have never been in a situation that warranted it.
- ❑ No, it's not worth the cost.
- ❑ Yes, but at someone else's request, i.e.- a lender
- ❑ Yes, it lowered my risk and my required rate of return.
- ❑ Yes, but it did not lower my risk or my required rate of return.
- ❑ Yes, but it increased my required rate of return.
- ❑ I don't know what "environmental insurance covers, never dealt with it.

10. When initially evaluating an investment, do you screen for on-site environmental issues (the most fitting answer)
- ❑ As part of initial property inspection.
- ❑ A phase I environmental investigation is always done prior to seeking funding.
- ❑ Only if requested by lender or other financial partner.
- ❑ Only invest in contaminated property

11. If a Phase I environmental investigation shows potential problems <u>on-site</u>, do you further investigate and continue to pursue the investment?
- ❑ Yes.
- ❑ No.

12. If a Phase I environmental investigation shows potential <u>off-site</u> contamination originating from the property, do you continue to pursue the investment?
- ❑ Yes.
- ❑ No.

13. If a <u>Phase II</u> environmental investigation shows potential on-site contamination, do you typically continue to pursue the investment?
- ❑ Yes.
- ❑ No.

Continued ⇒

14. Considering again your answer or answers to Question 2, please mark the <u>one</u> type of investment that you <u>most often</u> deal in:

- ❑ Multi-family residential
- ❑ Retail
- ❑ Office
- ❑ Industrial

Please consider a fully typical property that you would consider for investment in this category, in terms of property characteristics, price, intended holding period, etc., assuming no contamination problems.

Now, what if an environmental investigation finds a hazardous materials problem contained on-site, with a cleanup cost equal to 15%* of what the initial purchase price would be if the property were clean? Please tell us how this would affect your decision-making, depending on whether the contamination is related to gasoline, dry cleaning, or degreasing solvents. Using a **single point value**, or a **range of values**, please indicate your investment criteria under each condition (write **NA** if the question or criterion does not relate to your decision process):

	If the property is CLEAN	If there is a GASOLINE contamination problem	If there is a DRY CLEANING contamination problem	If there is a DEGREASIN G/SOLVENT contamination problem
Would you still consider investing?	❑ Yes ❑ No	❑ Yes ❑ No	❑ Yes ❑ No	❑ Yes ❑ No
Your overall cap rate	___%	___%	___%	___%
Your reversion/terminal cap rate	___%	___%	___%	___%
The discount rate you would apply	___%	___%	___%	___%
Investment holding period?	___ years	___ years	___ years	___ years
Would you also deduct the cleanup costs directly from the resulting purchase price?	N A	❑ Yes ❑ No	❑ Yes ❑ No	❑ Yes ❑ No

* for example 15% equates to a $37,500 cleanup cost on a $250,000 investment; $150,000 on $1 million investment; $750,000 on $5 million investment.

Continued ⇒

If you marked more than one investment type in Question 2, now please indicate the second most common type that you deal in:

- ❑ Multi-family residential
- ❑ Retail
- ❑ Office
- ❑ Industrial

Please consider a fully typical property that you would consider for investment in this second category, in terms of property characteristics, price, intended holding period, etc., assuming no contamination problems.

Now, what if an environmental investigation finds a hazardous materials problem contained on-site, with a cleanup cost equal to 15%* of what the initial purchase price would be if the property were clean? Please tell us how this would affect your decision-making, depending on whether the contamination is related to gasoline, dry cleaning, or degreasing solvents. Using a **single point value**, or a **range of values**, please indicate your investment criteria under each condition (write **NA** if the question or criterion does not relate to your decision process):

	If the property is CLEAN	If there is a GASOLINE contamination problem	If there is a DRY CLEANING contamination problem	If there is a DEGREASIN G/SOLVENT contamination problem
Would you still consider investing?	❑ Yes ❑ No	❑ Yes ❑ No	❑ Yes ❑ No	❑ Yes ❑ No
Your overall cap rate	___%	___%	___%	___%
Your reversion/terminal cap rate	___%	___%	___%	___%
The discount rate you would apply	___%	___%	___%	___%
Investment holding period?	___ years	___ years	___ years	___ years
In addition to the above, Would you also deduct the cleanup costs directly from the resulting purchase price?	N A	❑ Yes ❑ No	❑ Yes ❑ No	❑ Yes ❑ No

* for example 15% equates to a $37,500 cleanup cost on a $250,000 investment; $150,000 on $1 million investment; $750,000 on $5 million investment.

This is the end of the survey. Please return it to us in the *postage-paid envelope provided. Thank you!*

Are you interested in the results of this survey?

If you would like to receive a summary of the results of this survey, we would be happy to send it to you when ready. Please provide the information requested below, and include this sheet with your survey or in a separately mailed envelope. If you return this results request sheet with your survey, the sheet will be immediately and permanently separated from the survey booklet and the anonymity of your survey answers will be fully protected.

On this sheet, please also indicate whether you would be willing to participate in a brief follow-up interview to gain further information on the issues we are studying. If such a follow-up conversation occurs, the confidentiality of your responses will be completely protected.

Finally, please let us know if you wish to be entered in a drawing for a round of golf for 4 at Englewood Golf Course. If you were to win the drawing, please note that the winner's name is potentially public information. However, your survey responses will obviously remain confidential.

YES, I would like to receive a summary of the results of this survey,

YES, I am willing to participate in a brief, confidential follow-up personal interview.

YES, I am willing to be entered in a drawing for a round of golf for 4 at Englewood Golf Course.

Name: ______________________________

Company: ______________________________

Address: ______________________________

____

Phone: ______________________________

e-mail: ______________________________

Appendix 3.A2

Self-identification according to role	Count	*Typical transaction size*	Count
Broker (only)	45	$250,000-$1mil and $1mil-$5mil	20
Broker + Developer + Investor	26	$1mil-$5mil and >$5mil	13
Broker + Investor	25	<$250,000 and $250,000-$1mil and $1mil-$5mil	12
Broker + Developer	17	$250,000-$1mil and $1mil-$5mil and >$5mil	8
Developer (only)	14	<$250,000 and $250,000-$1mil and $1mil-$5mil and >$5mil	7
Broker + Developer + Financier + Investor	7	<$250,000/ $250,000-$1mil	7
Investor (only)	6	<$250,000 and $1mil-$5mil	3
Developer + Investor	4	$250,000-$1mil and >$5mil	1
Broker + Financier + Investor	2	$250,000-$1mil	36
Broker + Financier	1	$1mil-$5mil	27
Developer + Financier + Investor	1	<$250,000	7
Blank	1	>$5mil	8
TOTAL	*149*	*TOTAL*	*149*

Type of property or properties dealt with			
Single-fam/ Multi-fam/ Retail/ Office/ Industrial	9	Multi-fam/ Retail/ Office/ Industrial	10
Single-fam/ Multi-fam/ Retail/ Office	3	Multi-fam/ Retail/ Office	3
Single-fam/ Multi-fam/ Retail/ Industrial	2	Multi-fam/ Retail/ Industrial	1
Single-fam/ Multi-fam/ Retail	1	Multi-fam/ Office/ Industrial	4
Single-fam/ Multi-fam/ Office/ Industrial	1	Multi-fam/ Office/ Other	1
Single-fam/ Multi-fam/ Office	4	Multi-fam/ Office	4
Single-fam/ Multi-fam/ Industrial	3	Multi-fam/ Industrial	3
Single-fam/ Multi-fam	12	Multi-family	8
Single-fam/ Retail/ Office/ Industrial	3	Retail/ Office/ Industrial	17
Single-fam/ Retail/ Office	3	Retail/ Office	7
Single-fam/ Retail/ Industrial	1	Retail/ Industrial	7
Single-fam/ Retail	1	Retail	4
Single-fam/ Office/ Industrial	4	Office/ Industrial	5
Single-fam/ Office	2	Office	3

Single-fam/ Industrial	3	Industrial	14
Single-family	6	*TOTAL*	*149*

Responses to attitude and experience questions; some respondents selected multiple responses to some questions, so totals sometimes exceed 149	*Count*	*Totals*
4. Have you ever purchased a property with environmental contamination issues (excluding asbestos & lead based paint)		
No	95	
Yes, I bought it unknowingly	12	
Yes, I bought it intentionally	41	
No response	1	149
5. Which best describes you ? (answer one)		
Will not ever buy contaminated property.	22	
Try to avoid contamination, but will invest if the economics makes sense.	103	
Invest in contaminated ("Brownfields") properties as well as "clean properties.	24	
Only invest in contaminated ("Brownfields") properties.	1	150
6. Do you intentionally seek contaminated property as an investment?		
Yes	7	
No	142	149
7. Have you ever walked away from a potential deal solely because environmental contamination was present?		
Not always; I will gladly evaluate the potential cost of remediation.	51	
No, but I have a limited tolerence for such issues.	46	
Yes, immediately upon the appearance or disclosure of environmental issues.	5	
Yes, after further investigating the extent of environmental problems.	33	
Yes, but only after I determined that remediation cost made the deal infeasible.	17	152
8. 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 "Voluntary Cleanup program" is.	21	
No, have never been in that situation .	63	
No, I don't deal with contaminated properties.	1	
Yes, it lowered my risk and my required rate of return.	42	
Yes, but it did not lower my risk or my required rate of return.	25	
no response	1	153
9. Have you ever used Environmental Insurance for a property		

transaction?		
No, I don't deal with contaminated properties.	13	
No, have never been in that situation that warranted it.	91	
No, it's not worth the cost.	5	
Yes, but at someone else's request, i.e.-a lender.	19	
Yes, it lowered my risk and my required rate of return.	6	
Yes, but it did not lower my risk or my required rate of return.	5	
Yes, but it increased my required rate of return.	1	
I don't know what a "Environmental insurance" covers, never dealt with it.	20	
no response	1	161
10. When initially evaluating an investment, do you screen for on-site environmental issues		
As part of initial property inspection.	75	
A phase I environmental investigation is always done prior to seeking funding.	80	
Only if requested by lender or other financial partner.	8	
Only invest in contaminated property.	0	163
11. If a Phase I environmental investigation shows potential problems on-site, do you further investigate and continue to pursue the investment?		
Yes	126	
No	21	
blank	8	149
12. If a Phase I environmental investigation shows potential off-site contamination originating property, do you continue to pursue the investment?		
Yes	78	
No	66	
blank	5	149
13. If a Phase II environmental investigation shows potential on-site contamination, do you typically continue to pursue the investment?		
Yes	64	
No	73	
Blank	12	149

Investment Criteria for Clean and Contaminated Scenarios, Primary Property Type	*Count Or Yes*	*No*	*Mean*	*Median*	*Mode*	*Max*	*Min*	*Blank*	Totals
14. Considering again your answer or answers to Question 2, please mark the <u>one</u> type of investment that you most often deal in:									
Multi-family residential	50								
Retail	29								
Office	31								
Industrial	43								
Land	1								
no response	4								158
14. If the property is CLEAN	136								
Your overall cap rate ___%			10.2	10	10	25	8	45	
Your reversion/terminal cap rate			10.9	10	10	23	6	91	
The discount rate you would apply			10.2	10	8	30	1	105	
Investment holding period? ___years			9.11	10	10	30	0.5	43	
14. If there is a GASOLINE contamination problem									
Would you still consider investing?	98	37						14	149
Your overall cap rate ___%			12.5	12	12	35	2	74	
Your reversion/terminal cap rate			12.9	12	10	30	6	99	
The discount rate you would apply			15.7	14	12	50	2	96	
Investment holding period? ___years			7.42	5	5	30	1	71	
Would you also deduct the cleanup costs directly from the resulting purchase price?	96	5						48	149
14. If there is a DRY CLEANING contamination problem									
Would you still consider investing?	66	64						19	149
Your overall cap rate ___%			12.8	12	12	35	2	97	
Your reversion/terminal cap rate			12.8	12	10	25	6	114	
The discount rate you would apply			17.4	14	12	50	2	111	
Investment holding period? ___years			8.07	7	5	30	1	94	
Would you also deduct the cleanup costs directly from the resulting purchase price? Yes/No	76	5						68	149
14. If there is a DEGREASING/ SOLVENT contamination problem									
Would you still consider investing?	70	58						21	149

Your overall cap rate ___%			13.1	12	10	35	2	93	
Your reversion/terminal cap rate			13.4	12	10	30	6	113	
The discount rate you would apply			16.7	15	20	35	2	109	
Investment holding period? ___years			8.03	7	10	30	1	88	
Would you also deduct the cleanup costs directly from the resulting purchase price? Yes/No	79	5						65	149

Investment Criteria for Clean and Contaminated Scenarios, Secondary Property Type	*Count Or Yes*	*No*	*Mean*	*Median*	*Mode*	*Max*	*Min*	*Blank*	*Totals*
15. If you marked more than one investing type in Question 2, now please indicate the second most common type that you deal in:									
Multi-family residential	17								
Retail	18								
Office	33								
Industrial	22								90
15. If the property is CLEAN									149
Your overall cap rate ___%			10.6	10	10	22	8	86	
Your reversion/terminal cap rate			11.2	10	10	20	6	109	
The discount rate you would			10.7	10.5	12	25	1	118	
Investment holding period?			9.24	10	10	30	1	87	
Would you also deduct the cleanup costs directly from the resulting purchase price? Yes/No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
15. If there is a GASOLINE contamination problem									
Would you still consider	59	21						69	149
Your overall cap rate ___%			12.6	12	12	20	6	103	
Your reversion/terminal cap rate			13.7	12	10	30	6	117	
The discount rate you would			15.5	15	20	30	2	115	
Investment holding period?			7.93	6	5	30	1	105	
Would you also deduct the cleanup costs directly from the resulting purchase price? Yes/No	58	1						90	149
15. If there is a DRY CLEANING contamination problem									
Would you still consider	43	35						71	149
Your overall cap rate ___%			12.7	12	12	20	6	113	
Your reversion/terminal cap rate			14.0	12	15	30	6	124	
The discount rate you would			17.0	12	12	50	2	122	
Investment holding period?			7.59	5	5	30	1	115	
Would you also deduct the cleanup costs directly from the resulting purchase price? Yes/No	48	1						100	149
15. If there is a DEGREASING/ SOLVENT contamination problem									
Would you still consider	43	32						74	149
Your overall cap rate ___%			13.1	12	12	20	6	112	
Your reversion/terminal cap rate			14.1	12	15	30	6	123	
The discount rate you would			16.6	15	25	35	2	120	
Investment holding period?			8.00	6	5	30	1	113	

Would you also deduct the cleanup costs directly from the resulting purchase price? Yes/No	48	2						99	149

APPENDIX 3.A3

Q1	Count	% of Total
Broker only	45	30.20%
Broker among others	78	52.35%
	123	
Developer only	14	9.40%
Developer among others	55	36.91%
	69	
Investor only	6	4.03%
Investor among others	65	43.62%
	71	
Financier only	0	0.00%
Financier among others	11	7.38%
	11	

Q2	Count	% of Total
Single-fam only	6	4.03%
Single-fam among others	52	34.90%
	58	
Multi-fam only	8	5.37%
Multi-fam among others	61	40.94%
	69	
Retail only	4	2.68%
Retail among others	68	45.64%
	72	
Office only	3	2.01%
Office among others	80	53.69%
	83	
Industrial only	14	9.40%
Industrial among others	73	48.99%
	87	

Q3	Count	% of Total
<$250,000 only	7	4.70%
<$250,000 among others	29	19.46%
	36	
$250,000-$1mil only	36	24.16%
$250,000-$1mil among others	55	36.91%
	91	
$1mil-$5mil only	27	18.12%
$1mil-$5mil among others	63	42.28%
	90	
>$5mil only	8	5.37%
>$5mil among others	29	19.46%
	37	

Complete Categorization

Broker/ Developer/ Investor	26	17.45%
Broker/ Investor	25	16.78%
Broker/ Developer	17	11.41%
Broker/ Developer/ Financier/ Investor	7	4.70%
Developer/ Investor	4	2.68%

Single-fam/ Multi-fam/ Retail/ Office/ Industrial	9	6.04%
Single-fam/ Multi-fam/ Retail/ Office	3	2.01%
Single-fam/ Multi-fam/ Retail/ Industrial	2	1.34%
Single-fam/ Multi-fam/ Retail	1	0.67%
Single-fam/ Multi-fam/ Office/ Industrial	1	0.67%

$250,000-$1mil/ $1mil-$5mil	20	13.42%
$1mil-$5mil/ >$5mil	13	8.72%
<$250,000/ $250,000-$1mil/ $1mil-$5mil	12	8.05%
$250,000-$1mil/ $1mil-$5mil/ >$5mil	8	5.37%
<$250,000/ $250,000-$1mil/ $1mil-$5mil/ >$5mil	7	4.70%

Broker/ Financier/ Investor	2	1.34%
Broker/ Financier	1	0.67%
Developer/ Financier/ Investor	1	0.67%
Blank	1	0.67%
TOTAL	*149*	

Single-fam/ Multi-fam/ Office	4	2.68%
Single-fam/ Multi-fam/ Industrial	3	2.01%
Single-fam/ Multi-fam	12	8.05%
Single-fam/ Retail/ Office/ Industrial	3	2.01%
Single-fam/ Retail/ Office	3	2.01%
Single-fam/ Retail/ Industrial	1	0.67%
Single-fam/ Retail	1	0.67%
Single-fam/ Office/ Industrial	4	2.68%
Single-fam/ Office	2	1.34%
Single-fam/ Industrial	3	2.01%
Multi-fam/ Retail/ Office/ Industrial	10	6.71%
Multi-fam/ Retail/ Office	3	2.01%
Multi-fam/ Retail/ Industrial	1	0.67%
Multi-fam/ Office/ Industrial	4	2.68%
Multi-fam/ Office/ Other	1	0.67%
Multi-fam/ Office	4	2.68%
Multi-fam/ Industrial	3	2.01%
Retail/ Office/ Industrial	17	11.41%
Retail/ Office	7	4.70%
Retail/ Industrial	7	4.70%
Office/ Industrial	5	3.36%
TOTAL	*149*	

<$250,000/ $250,000-$1mil	7	4.70%
<$250,000/ $1mil-$5mil	3	2.01%
$250,000-$1mil/ >$5mil	1	0.67%
TOTAL	*149*	

Appendix 3.B1
Difference in Means of Clean Responses and Contaminated Property Responses

	Overall Cap Rate		Reversion/Terminal Rate		Discount Rate		Holding Period	
	Clean	*Gasoline*	*Clean*	*Gasoline*	*Clean*	*Gasoline*	*Clean*	*Gasoline*
Mean	10.44366197	12.36619718	11.17391304	13.17934783	10.66666667	12.65	8.296052632	7.447368421
Variance	6.468209256	18.76934105	11.33574879	22.72961957	29.6091954	40.95086207	28.58118421	25.90385965
Observations	71	71	46	46	30	30	76	76
t Stat	-5.489019527		-5.387604501		- 3.578518375		2.456214758	
P(T<=t) two-tail	6.08631E-07		2.50597E-06		0.001239359		0.016354867	
	Clean	*Dry Cleaning*	*Clean*	*Dry Cleaning*	*Clean*	*Dry Cleaning*	*Clean*	*Dry Cleaning*
Mean	10.5	12.8872549	11.07575758	13.09848485	10.90909091	13.81818182	8.972222222	8.037037037
Variance	7.28	25.05328431	11.36126894	19.73413826	39.32467532	68.34632035	35.45676101	30.97973445
Observations	51	51	33	33	22	22	54	54
t Stat	-4.621491884		-4.352698434		- 3.362438652		2.250913384	
P(T<=t) two-tail	2.70764E-05		0.000128799		0.002946514		0.028563057	
	Clean	*Solvent*	*Clean*	*Solvent*	*Clean*	*Solvent*	*Clean*	*Solvent*
Mean	10.69090909	13.25	11.18571429	13.59285714	10.90909091	13.90909091	8.825	8
Variance	7.550841751	24.4375	11.42773109	25.84590336	39.32467532	73.13419913	32.68495763	28.81355932
Observations	55	55	35	35	22	22	60	60
t Stat	-5.232647673		-3.749307813		- 3.224127789		2.14143738	
P(T<=t) two-tail	2.79682E-06		0.000660086		0.004069031		0.036379303	

Appendix 3.B2
Statistics on Criteria Differentials between Contaminated and Clean Scenarios

Differentials for Primary Property Type (question 14)

	Differentials between GASOLINE and CLEAN				Differentials between DRY CLEANING and CLEAN				Differentials between SOLVENT and CLEAN			
	Overall Cap Rate	Reversion cap rate	Discount Rate	Holding Period	Overall Cap Rate	Reversion cap rate	Discount Rate	Holding Period	Overall Cap Rate	Reversion cap rate	Discount Rate	Holding Period
Mean	2.2	2.1	2.1	(0.7)	2.4	2.0	3.2	(1.1)	2.8	2.3	3.7	(0.8)
Median	2.0	1.0	1.5	0.0	2.0	0.8	2.0	0.0	2.0	0.9	2.0	0.0
Min	(4.0)	0.0	0.0	(15.0)	(9.5)	0.0	0.0	(15.0)	(4.0)	0.0	0.0	(15.0)
Max	15.0	10.0	13.0	10.0	15.0	10.0	13.0	2.0	15.0	20.0	15.0	5.0

Differentials for Secondary Property Type (question 15)

	Differentials between GASOLINE and CLEAN				Differentials between DRY CLEANING and CLEAN				Differentials between SOLVENT and CLEAN			
	Overall Cap Rate	Reversion cap rate	Discount Rate	Holding Period	Overall Cap Rate	Reversion cap rate	Discount Rate	Holding Period	Overall Cap Rate	Reversion cap rate	Discount Rate	Holding Period
Mean	2.0	2.3	2.4	(1.0)	2.2	2.5	3.2	(1.3)	2.4	2.6	3.6	(0.9)
Median	1.8	1.0	1.0	0.0	2.0	0.8	1.5	0.0	2.0	1.0	1.5	0.0
Min	(4.0)	0.0	0.0	(10.0)	(4.0)	(2.0)	0.0	(10.0)	(4.0)	0.0	0.0	(10.0)
Max	11.5	10.0	13.0	5.0	11.5	10.0	13.0	2.0	11.5	10.0	15.0	8.0

Appendix 3.B3

Tests of Difference in Means among Respondent Groups by *Development Type* for *overall capitalization rate*

P-value Results of significance	Broker vs. Non-Broker	Developer vs. Non-Developer	Financier vs. Non-Financier	Investor vs. Non-Investor	Broker Only vs. All Others
Clean	0.6204	0.3603	0.9033	0.5372	0.9968
Test of Difference in Means by Contaminant Differential					
Gasoline	0.0286	0.1480	0.3165	0.0187	0.0018
Dry Cleaning	0.3030	0.0956	0.8535	0.0440	0.0013
Solvent	0.0836	0.1577	0.4537	0.0457	0.0014

Appendix 3.B4 – Cluster Analysis Findings

	Cluster of Responses of Differentials on Overall Cap Rate				Cluster of Responses of Differentials on Reversion/Terminal Cap Rate			Cluster of Responses of Differentials on Discount Rate	
	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 1	Cluster 2	Cluster 3	Cluster 1	Cluster 2
Number of Respondents in each Cluster	11	25	2	6	7	2	23	11	7
Percentage of Respondents by Role Characteristics *									
Broker	72.73%	72.00%	100.00%	100.00%	85.71%	50.00%	60.87%	72.73%	100.00%
Developer	63.64%	52.00%	50.00%	50.00%	85.71%	50.00%	69.57%	72.73%	71.43%
Financier	9.09%	8.00%	0.00%	16.67%	0.00%	0.00%	13.04%	18.18%	14.29%
Investor	54.55%	32.00%	0.00%	66.67%	85.71%	0.00%	34.78%	36.36%	42.86%
Percentage of Respondents by Role Characteristics (Complete Categorization) **									
B		37.50%	50.00%	16.67%		50.00%	18.18%	27.27%	14.29%
D	27.27%	20.83%			14.29%	50.00%	31.82%	27.27%	
F									
I		4.17%							
B+D	9.09%	8.33%	50.00%	16.67%			9.09%	9.09%	28.57%
B+F	9.09%						4.55%		14.29%
B+I	27.27%	4.17%		16.67%	14.29%		4.55%		
D+I							4.55%		
B+D+F							4.55%		
B+F+I				16.67%					
D+F+I							4.55%		
B+D+I	27.27%	16.67%		33.33%	71.43%		13.64%	18.18%	42.86%
B+D+F+I		8.33%					4.55%	18.18%	
Percentage of Favorable Responses to Investment in Contaminated Property ****									
Question 4	54.55%	40.00%	50.00%	33.33%	57.14%	50.00%	59.09%	63.64%	57.14%
Question 5	54.55%	20.00%	50.00%	16.67%	14.29%	50.00%	31.82%	18.18%	14.29%
Question 6	18.18%	8.00%	50.00%	0.00%	14.29%	0.00%	13.64%	9.09%	0.00%
Question 7	36.36%	36.00%	0.00%	16.67%	28.57%	50.00%	45.45%	18.18%	28.57%
Question 8	54.55%	56.00%	0.00%	16.67%	42.86%	100.00%	63.64%	45.45%	71.43%
average	*43.64%*	*32.00%*	*30.00%*	*16.67%*	*31.43%*	*50.00%*	*42.73%*	*30.91%*	*34.29%*

Average Differential Rates Specified *****

Overall Cap Rate

Gasoline	2.909	0.630	-3.000	6.167	4.714	2.000	1.330	0.750	3.000
Dry Cleaning	3.227	0.730	-3.000	6.333	5.714	3.000	1.560	0.795	3.429
Solvent	3.818	0.790	-3.000	6.333	5.000	3.000	1.538	0.886	4.643
average	*3.318*	*0.717*	*-3.000*	*6.278*	*5.143*	*2.667*	*1.476*	*0.811*	*3.690*

Reversion/Terminal Cap Rate

Gasoline	2.063	0.662		6.000	5.000	2.500	0.467	0.675	3.500
Dry Cleaning	2.813	0.662		6.000	5.286	4.500	0.467	0.675	4.214
Solvent	2.813	0.721		6.000	5.286	4.500	0.511	0.775	5.643
average	*2.563*	*0.681*	*n/a*	*6.000*	*5.190*	*3.833*	*0.482*	*0.708*	*4.452*

Discount Rate

Gasoline	1.333	0.833		6.000	5.800	2.000	0.857	0.091	2.571
Dry Cleaning	3.333	1.250		6.000	5.800	2.000	2.071	0.091	2.857
Solvent	4.500	0.833		6.000	5.800	2.000	2.214	0.091	3.143
average	*3.056*	*0.972*	*n/a*	*6.000*	*5.800*	*2.000*	*1.714*	*0.091*	*2.857*

Investment Holding Period

Gasoline	-0.333	-1.042	-6.500	-2.400	-2.000	0.000	-0.857	0.000	-0.714
Dry Cleaning	-0.333	-0.833	-6.500	-2.400	-2.000	0.000	-0.619	0.000	-0.714
Solvent	0.000	-0.833	-6.500	-2.400	-2.000	0.000	-0.476	0.000	-0.714
average	*-0.222*	*-0.903*	*-6.500*	*-2.400*	*-2.000*	*0.000*	*-0.651*	*0.000*	*-0.714*

Notes:

* This is a broad cataloging of whether the respondents in each cluster identified themselves as a broker, developer, financier, or investor.
Each respondent may have identified themselves as being in one or more of these roles.

** This provides a complete break down as to the exact role(s) of each respondent.
Retail, Office, and Industrial).

*** This is a summary of each cluster of respondents identifying how favorable/unfavorable there attitude is toward investment in contaminated property.
Questions 4, 5, 6, 7, and 8 of the survey were intended to measure the tolerance of the respondent to contaminated property investment.
The percentages indicate the amount of favorable/tolerant answers provided by each cluster.

**** These are the average differential rates by contaminant type specified by each cluster of respondents.

Appendix 3.B5: Probit Regression Findings

Q4 – ***Have you ever purchased a property with environmental contamination issues?***

$Y_{Q4} = \beta_0 + \beta_1(\text{broker}) + \beta_2(\text{developer}) + \beta_3(\text{financier}) + \beta_4(\text{investor})$

	Broker	Developer	Financier	Investor
z-value	-3.20	2.87	0.92	0.91

Broker – coefficient is negative indicating "No"

Developer – coefficient is positive indicating "Yes" (either bought unknowingly or intentionally)

Q5 – ***Which best describes you?***

$Y_{Q5} = \beta_0 + \beta_1(\text{broker}) + \beta_2(\text{developer}) + \beta_3(\text{financier}) + \beta_4(\text{investor})$

	Broker	Developer	Financier	Investor
z-value	-2.17	0.61	-0.12	0.73

Broker – coefficient is negative indicating "will not ever buy contaminated property" or "try to avoid, but invest if makes sense"

Q6 – ***Do you intentionally seek contaminated property as an investment?***

$Y_{Q6} = \beta_0 + \beta_1(\text{broker}) + \beta_2(\text{developer}) + \beta_3(\text{financier}) + \beta_4(\text{investor})$

	Broker	Developer	Financier	Investor
z-value	-1.03	-0.70	---	-0.57

Q7 – ***Have you ever walked away from a potential deal solely because environmental contamination was present?***

$Y_{Q7} = \beta_0 + \beta_1(\text{broker}) + \beta_2(\text{developer}) + \beta_3(\text{financier}) + \beta_4(\text{investor})$

	Broker	Developer	Financier	Investor
z-value	-0.42	3.28	-0.02	-0.18

Developer – coefficient is positive indicating "not always, but will gladly evaluate the potential cost of remediation" or "yes, after further investigating the extent of environmental problems" or "yes, but only after I determine that remediation cost made the deal infeasible"

Q8 – ***Have you ever dealt with a property that had a "No Further Action" letter form a state Voluntary Cleanup program?***

$Y_{Q8} = \beta_0 + \beta_1(\text{broker}) + \beta_2(\text{developer}) + \beta_3(\text{financier}) + \beta_4(\text{investor})$

	Broker	Developer	Financier	Investor
z-value	-1.58	0.67	0.71	0.46

Q14 – ***If there is a GASOLINE contamination problem: Would you still consider investing?***

$Y_{Q14g} = \beta_0 + \beta_1(\text{broker}) + \beta_2(\text{developer}) + \beta_3(\text{financier}) + \beta_4(\text{investor})$

	Broker	Developer	Financier	Investor
z-value	-0.50	1.21	-0.41	0.67

Q14 – ***If there is a DRY CLEANING contamination problem: Would you still consider investing?***

$Y_{Q14d} = \beta_0 + \beta_1(\text{broker}) + \beta_2(\text{developer}) + \beta_3(\text{financier}) + \beta_4(\text{investor})$

	Broker	Developer	Financier	Investor
z-value	-0.83	-0.08	0.58	0.56

Q14 – ***If there is a SOLVENT contamination problem: Would you still consider investing?***

$Y_{Q14s} = \beta_0 + \beta_1(\text{broker}) + \beta_2(\text{developer}) + \beta_3(\text{financier}) + \beta_4(\text{investor})$

	Broker	Developer	Financier	Investor
z-value	-1.30	-0.22	0.29	0.73

Appendix 3.C1

	Clean	*Contaminated /Cleaned*
Capitalization Rates*:		
	10.23%	12.84%
This implies the value, or market purchase price is**:		
	$58.65 PSF	$46.73 PSF
Given an average Net Rent of:		
	$6.00 PSF	$6.00 PSF

* Capitalization Rates are taken from survey response data.

** Purchase Price (VALUE) = NOI (NET RENT) / Capitalization Rate