Dissertation Proposal

Examination of Housing Price Impacts on Residential Properties before and after Brownfields Remediation Using Spatial Hedonic Modeling

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Introduction

The Environmental Protection Agency defines brownfields as “abandoned, idled, or underused industrial and commercial facilities or properties, expansion or redevelopment is complicated by real or perceived contamination” (USEPA 1995). According to a survey by U.S. Conference of Mayors (2000) conducted in 231 major U.S. cities, there are over 21,000 brownfields covering more than 81,000 acres spread over the nation; the Government Accounting Office (2004) has estimated that there are 450,000 to 1,000,000 brownfields sites across the United States. Contamination of land, along with suburbanization and deindustrialization, is cited as one of the primary causes of vacant urban land in the past few decades (Pagano and Bowman 2000). Change in industrial, transportation, and manufacturing technology and the subsequent shift in economy from manufacturing to service-oriented industries apart from land-use decisions, racial-economic discrimination, suburban sprawl, and global capitalism has exacerbated the growth of brownfields sites (Ellis, Mason Jr. et al. 2002).

Increasing cost of transportation and energy, and changing preferences of consumers regarding urban living has led to resurgence in central city revitalization. This renewed demand for housing in addition to concerns about environmental contamination in certain city neighborhoods has led to the remediation and redevelopment of brownfields. Urban redevelopment policy has in recent years focused on brownfields redevelopment to generate jobs, raise tax revenues, revitalize inner-city neighborhoods, and control suburban sprawl (Bartsch and Collaton 1997; Davis and Margolis 1997; Simons 1998) as opposed to examining micro-impacts on the proximate neighborhood. The typical public sector responses for brownfields redevelopment have focused either on restoring the contaminated land to its original state on public health and environmental impact grounds or on generating economic development activities by seeking to increase the tax base or creating employment opportunities on the site itself while ignoring the consequential effects on the proximate neighborhood (Kirkwood 2001).

In addition, public sector response to brownfields redevelopment is typically characterized by economic efficiency, with a focus on redevelopment of individual properties, as opposed to the positive spillovers of such remediation and redevelopment on surrounding property values and overall economic revitalization. Even the U.S. Conference of Mayors surveys (2000; 2003) evaluate the success of brownfields redevelopment more in terms of newly-created jobs and cumulative gains in tax revenue and less in terms of neighborhood impact.

Recent brownfields redevelopment research using theories of real estate appraisal and property valuation using cross-sectional data have indicated a detrimental price effect of contaminated land on surrounding residential properties, indicating that effects of contaminated brownfields may affect more than the property labeled as such (Brisson and Pearce 1995; Farber 1998; Boyle and Kiel 2001; Jackson 2001; Simons and Saginor 2006). But little research has examined similar price effects after remediation. This study uses a longitudinal model to analyze housing prices around the brownfields both before and after remediation, permitting an assessment of the impact of environmental disamenities on property value.

Brownfields remediation, either though public sector initiative or private sector development, is considered a contributing factor to neighborhood change. However, the effect of such remediation in terms of their economic impacts measured through housing prices is not completely known. Most research in real estate valuation and brownfields has been restricted to cross-sectional examination of negative impacts of brownfields on neighboring properties, while few studies examine positive price rebounds post-remediation (Kiel 1995; Dale, Murdoch et al. 1999; Kiel and Williams 2005; Leigh and Coffin 2005). Further, due to methodological limitations such as ignoring spatial aspects of housing transactions and omission of vital influencing factors, the findings in these studies are inconsistent. Although remediation of brownfields is generally considered beneficial for the economic and social health of the neighborhood, the extent and size of this effect on proximate properties is not clear.

Since sales price of properties largely affects prices of neighboring properties (spatial dependence), exclusion of spatial aspects of the data has impacted the validity of such studies. This study utilizes a comprehensive dataset that includes property-level data and corresponding sales prices of housing transactions and appraised values over a ten year period. Complemented with locational data on surrounding brownfields, this study allows for a more accurate spatial analysis of housing prices with respect to proximity to surrounding environmental disamenities. By including structural and neighborhood characteristics, this study addresses the gap in most housing valuation studies by controlling for traditionally influencing factors in determining housing values thus strengthening the causal impact of brownfield contamination and subsequent remediation across time. Since collecting detailed housing and socioeconomic factors that fully explain most housing valuation is difficult and time-consuming, the use of spatial hedonic modeling also helps mitigate such shortcomings by overcoming omitted variable bias in addition to eliminating issues of spatial autocorrelation among housing prices. Difference in risk perception toward surrounding contamination is accounted for by examining differences of impact in sales prices and appraised value of proximate residential properties.

Other factors that might explain differences in housing prices due to proximate brownfields like role of submarkets, tax rate, and presence of other minor contamination are incorporated in this study and thus will allow for examination of differences in economic benefits post-remediation across housing submarkets for contemporaneous sociodemographic changes indications of environmental justice and gentrification. Examination of economic impacts of brownfield remediation on surrounding properties highlight revealed preferences of housing market consumers and help inform policymakers and researchers on the role of environmental disamenities on residential housing transactions.

Justification for Research

Contribution to Policy

Urban renewal and development policies have recently been influenced by sustainable growth models and trends in redevelopment of inner-city vacant and abandoned lands have gained prominence. Government agencies like the Environmental Protection Agency (EPA), Department of Housing and Urban Development (HUD), Department of Transportation, (DOT), Economic Development Administration (EDA), and other related agencies in state and local governments have increasingly relied on brownfields remediation and subsequent redevelopment as a starting point for improving neighborhood quality and revitalizing inner city cores where brownfields are typically located. Brownfield remediation and subsequent redevelopment have mostly focused on the economic feasibility and imminent environmental danger to the community. Additionally, it has been observed that choosing sites for remediation has been largely arbitrary or has at times even depended on political factors like voter awareness and environmental group membership in the area (Viscusi and Hamilton 1999). This study will address an important gap in brownfields redevelopment literature by examining the impact on proximate property prices and provide an argument to policy makers for brownfields development that extends beyond economic viability and environmental concerns. Such an examination will help place brownfields redevelopment in the context of its surroundings by first identifying the negative impact of environmental disamenities and second by assessing the positive impact of its remediation in terms of household wealth generated through increase in property value and relate such changes for its effect on neighborhood quality.

Brownfields are typically found in older neighborhoods with a history of commercial and industrial operations that have caused real or perceived contamination. In the past, due to lack of government support in providing remediation costs and protection from legal liability, these brownfields remained unused leading to increased greenfields development especially in the suburban fringes of the city. Increased support for brownfields redevelopment through legislative action such as Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA/Superfund 1980), Risk-Based Corrective Action (RBCA), amendment policies to CERCLA like Small Business Liability Relief and Brownfields Revitalization Act (2002), EPA's Pilot Brownfields Program, and state Voluntary Cleanup Program (VCP) have made brownfields redevelopment competitive with comparative greenfields projects that add to suburban sprawl. The National Governor's Association (2000) finds higher state spending for brownfields remediation and redevelopment to be economically beneficial and considers increased involvement of state agencies in addition to environmental regulatory agencies pivotal in the success of brownfield programs. This study will examine the impact of property prices around brownfield sites remedied with the help of the Superfund program, providing economic justification not only in terms of infill development of an erstwhile contaminated and abandoned property but also in generating tax revenue through increased property value of the surrounding neighborhood. Policy makers and home buyers would be greatly benefited by being better informed of this positive economic effect thus making future remediation of brownfields politically feasible and justifiable.

Brownfields located in low-income and minority neighborhoods are less likely to be remedied and have a longer period between identification and cleanup due to pervasive discrimination, and lack of civic involvement and environmental awareness (Bullard and Johnson 2000). Even when remedied, properties in premier housing markets appreciate at higher rate than properties in below-average housing markets (Michaels and Smith 1990). Given this public sector emphasis on focusing solely on the individual brownfields sites instead of the surrounding neighborhood, it is highly likely that certain brownfields may be overlooked for redevelopment due to their location, size, and level of contamination. Such a redevelopment strategy is likely to ignore the effects of brownfields on the proximate neighborhood and may in fact be undermining economic and social consequences of such redevelopment in already-disadvantaged neighborhoods. Several factors have contributed to the creation of brownfields along with subsequent negative economic, social, and cultural impacts leading us to believe that such contaminated sites may be likely to be located in low-income and minority neighborhoods raising questions of environmental and social justice.

This study will examine the differences in economic benefits post-remediation across housing submarkets in order to examine indications of environment justice and help policy makers ensure that choice for brownfield remediation is equitable. The extent and size of the impact of proximity to contaminated brownfields especially in vulnerable and distressed neighborhoods might help policy makers redirect cleanup and redevelopment efforts in those neighborhoods first instead of other neighborhoods where the economic impact post-remediation is not pronounced. Also, understanding the characteristics of the contaminated properties and the neighborhood they are located in should assist the formation of governmental economic development strategies to stimulate redevelopment of those contaminated properties and subsequently the neighborhoods in which they are located.

Contribution to Theory

In the real estate literature, residential property values are estimated from a function of structural variables i.e. physical characteristics and neighborhood variables i.e. surrounding amenities. In addition, environmental factors or disamenities although intangible in terms of measurement are also considered to influence the property values in its vicinity. Brownfields or contaminated properties are perceived to have a detrimental effect on the values of the surrounding properties (Jackson 2001). Most of the studies in the research literature for influences of environmental disamenities on property value have shown inconsistent results in terms of extent and size of impact and have either examined the influence using cross-sectional models neglecting the potential of price rebound post-remediation (Brisson and Pearce 1995; Farber 1998; Simons and Saginor 2006). Few studies that have attempted to examine post-remediation impacts of brownfields on housing price have found little and inconsistent evidence. This study examines the price effect of such brownfields before and after remediation on proximate properties in the neighborhood while controlling for traditional factors such as structural and neighborhood variables that influence residential property value. Assessing the influence of environmental impact using proximity of and characteristics of brownfields through a longitudinal model across time provides a more complete understanding of the economic impact in disparate neighborhoods.

Environmental disamenities are known to have a negative influence on surrounding property values but the tenure of disamenities can determine if the price effect is temporary or permanent (Simons, Bowen et al. 1999). Also, negative influences from being proximate to brownfields arise from the perceived risk of contamination. Almost two-thirds of Americans polled by Gallup were "very concerned" about hazardous wastes (Masterson-Allen and Brown 1990), and concern for protecting the environment as well as regulating possible contamination has been high since early 1970s following the Clean Air Act, Clean Water Act and other related legislation. Although investors are concerned with existence of specific contaminants, they may not be entirely averse to buying cleaned up properties. However, there is concern that not many people are aware or made aware of contamination before purchasing property (Winson-Geideman 2005). This study will examine the impact on sales transactions, which is likely to embody the perceived risk of contamination, and compare it to appraised property value, which is likely to present a better understanding of the actual risk of contamination in proximate brownfields. Understanding the role of risk perception through different valuation methods helps in determining the extent and size of impact of proximate contaminated properties without being subjected to disclosure [to property owners] dilemmas for researchers.

In several real estate valuation and neighborhood studies, property prices are not considered to be uniform across the housing market even within a metropolitan region and researchers aggregate data either geographically or by property type to incorporate market segmentation in their analysis (Harsman and Quigley 1995; Adair, Berry et al. 1996; Bourassa, Hamelink et al. 1999). The fundamental characteristic of the housing market is variation in housing characteristics and prices by location (Straszheim 1987). Identifying the relevant submarket segregated by sociodemographic groups and including its influence in housing price models not only helps in improving the price prediction accuracy but also provides better assessment of household preferences, risk assessment, and behaviors of disparate populations located within a particular neighborhood (Bates 2006). This study thus controls for the influence of and examines the role of housing submarkets in the housing price models that estimate the influence of proximate brownfields. Further, it provides a basis for better understanding the differences between sociodemographic populations in terms of intra-urban price levels and changes within a major metropolitan region and allows for better price prediction accuracy, given the appropriate level of segmentation.

Traditionally brownfield redevelopment has been encapsulated in either scientific (environmental cleanup, public health, and healthy living) or economic development (increase local tax base and generate employment) frameworks (Kirkwood 2001). However, as Kirkwood (2001) mentions, brownfield redevelopment should be a part of an integrated planning framework that focuses on quality of life issues and creation of infill development in inner-city neighborhoods through informed decision-making. This study examines brownfield remediation and development from the perspective of wealth creation in terms of property value in the proximate neighborhood while taking into account other factors that traditionally influence property value and helps describe corresponding contemporaneous sociodemographic changes in the proximate neighborhoods of brownfields. In addition, incorporating influences of housing submarkets, neighborhood amenities and spatial dependence of properties help provide a holistic and comprehensive model for examining impacts of environmental disamenities and provide a better understanding for neighborhood change.

Traditionally, hedonic price modeling is the primary form of analysis for empirical research in real estate analysis. Such modeling often ignores the spatial aspects of the factors especially neighborhood characteristics that influence property value. Housing prices are highly likely to be spatially correlated i.e. houses located next to each other are more likely to be correlated in terms of attributes and prices than to houses located further away and can affect sales transactions or property value of properties in geographic proximity in a similar manner, thus causing spatial autocorrelation in the error term of the hedonic price modeling, leading to biased and inefficient estimates (Anselin 1988). This study addresses this problem by incorporating spatial econometric estimation methods and specification tests for examining spatial dependence instead of the commonly used OLS method. Adjusting the predicted property values using weighted average of the prediction errors obtained from nearby properties by assigning a function of proximity and degree of spatial dependence can lead to more accurate results. Using spatial techniques for price estimation also helps in overcoming the omitted variable bias that often plagues real estate valuation research due to data availability limitations.

Conceptual Framework

The proposed research will analyze and examine the housing price impact of the proximity of contaminated properties otherwise termed as brownfields. The research will focus not only on the housing price effects of such brownfields before remediation but will also examine the impact of remediation of brownfields on the surrounding properties in the proximate neighborhood. For purposes of this research, dependent variables capturing the housing price impact of the brownfields include sales prices of housing transactions and appraised property values. This proximity effect of the brownfields will be controlled with other factors like structural and neighborhood variables that traditionally influence property value. Additionally, this housing price effect of brownfields shall also be examined for different submarket levels for contemporaneous sociodemographic changes in terms of gentrification and environmental justice. Given the high probability of spatial autocorrelation among property values, the housing price effect shall be tested through econometric models that account for spatial dependence, provide more accurate estimates for predicted property values and correct for omitted variable bias.

By understanding the extent, nature, size, and level of property value change in neighborhoods undergoing brownfields remediation, this study attempts to bring together seemingly disparate threads of real estate valuation, neighborhood change, and environmental justice. The impact of brownfield remediation on housing value of surrounding properties can lead to consequential impacts on neighborhood change through incidence of gentrification and lead to serious implications for environmental justice and social equity. The effects of remediation of brownfields also can lead to varied results depending on the status of market conditions and segmentation of housing submarkets causing differential impacts of benefits accrued from brownfield remediation.

Research Objectives

The following research objectives shall form the primary focus of this study:

- Do properties closer to contaminated brownfields have lower property values than properties located further away?
    - What is the size (in dollars) and extent (in miles) of this negative effect in the proximate neighborhood?
    - Does this proximity to brownfields have a differential effect on sales transaction prices as compared to appraised property values?
- Do properties in proximity to remedied brownfields experience positive price rebounds?
    - Do other brownfield characteristics like size, type of contamination, number of other brownfields in close proximity also have a significant housing price effect on residential properties?
    - What is the extent and size of the impact of remedied brownfields on surrounding residential properties compared to the previously measured negative impact?
    - How much do prices rebound after remediation?
- Does the extent, size, and significance of the housing price effect of proximity to brownfields differ across different housing submarkets?
    - Do properties in higher socioeconomic submarkets experience greater positive price rebound post-remediation?
    - What are the sociodemographic characteristics of neighborhoods with brownfields and do these characteristics change as distance from brownfields increases?

- Do changes in property value with remedied brownfields show indications for potential gentrification in proximate neighborhoods?

By analyzing the values of the properties over a ten-year period i.e. before and after remediation, it will be possible to measure the extent and level of housing price effect borne out through the proximity to brownfields and if such effects differ over submarket segmentations in order to understand differential impacts for various sociodemographic groups.

For the purposes of this research, housing price effect is conceptualized using sales transaction prices and appraised values of residential properties. The study examines the economic impact of environmental disamenities, more specifically contaminated properties otherwise known as brownfields, on proximate residential properties in order to understand contemporaneous neighborhood change precipitated by brownfield remediation for different sociodemographic populations.

Analyzing Impact of Brownfields: Perspectives from Housing Valuation, Neighborhood Change, and Environmental Justice

The changing form of the urban region has largely depended on the mobility of capital and people which in turn is determined by the location choices and preferences of the housing market consumers. This mobility has been partly led by the change in economy from a primacy on manufacturing to a service-oriented focus which has affected the migration toward the suburbs. Such economic shifts and demographic changes have subsequently altered the social makeup of American cities. Evolving changes in economic trends, income levels, and consumer preferences eventually led to resurgence of central and inner city neighborhoods that had been earlier abandoned by the white middle-class due to massive suburbanization. Scarcity of suburban land, rising costs of transportation, advances in telecommunication technology, altering lifestyles of household living, diminishing dominance of familial lifestyles, and emergence of the new middle class has sped up redevelopment of the inner city neighborhoods.

Inner city neighborhood revitalization influenced either by public or private development has renewed interest in remediation of brownfields that have been previously cited as one of the reasons of depressing property value within central cities due to risk of real or perceived contamination. These environmental disamenities not only posed health hazards but also caused subsequent negative externalities like abandonment, dereliction, crime, and other socioeconomic problems that led to decline in neighborhood quality. Although the extent and size of this negative influence on surrounding property has not been consistent, remediation of such brownfields is perceived to bolster revitalization efforts through increased property values and subsequently lead to improvement in neighborhood quality by eliminating negative externalities. Although this study focuses primarily on measuring impact on housing values of surrounding properties before and after remediation, the consequences for neighborhood change through revitalization are intrinsic in our understanding of the implications of brownfield redevelopment.

Also, within this optimism of urban regeneration and revival of interest in the urban core, concepts of social and environmental justice remain unaddressed. Environmental disamenities that have long depressed prices in inner city neighborhoods have also disproportionately affected minority and low-income populations. Remediation of brownfields may have unintended consequences through gentrification which displace low-income and minority original residents with predominantly white middle- and upper-income gentrifiers. Planning for neighborhood change through brownfields remediation even if directly intended to remedy the environmental justice problems for the minorities and low-income residents may result in unintended consequences that ultimately do not benefit the residents.

In the following sections, I will examine the role of brownfields and their subsequent remediation through the different lens of real estate valuation, neighborhood change, and environmental justice (See Figure 1). Since the primary lens by which I measure effect of remediation on surrounding properties is housing valuation, I shall focus first on effect of environmental disamenities, risk perceptions that influence negative price effects, and extent of impact of such disamenities. The perspectives of neighborhood change through gentrification and environmental justice through social equity are subsequently examined in terms of brownfields contamination and post-remediation redevelopment impacts.

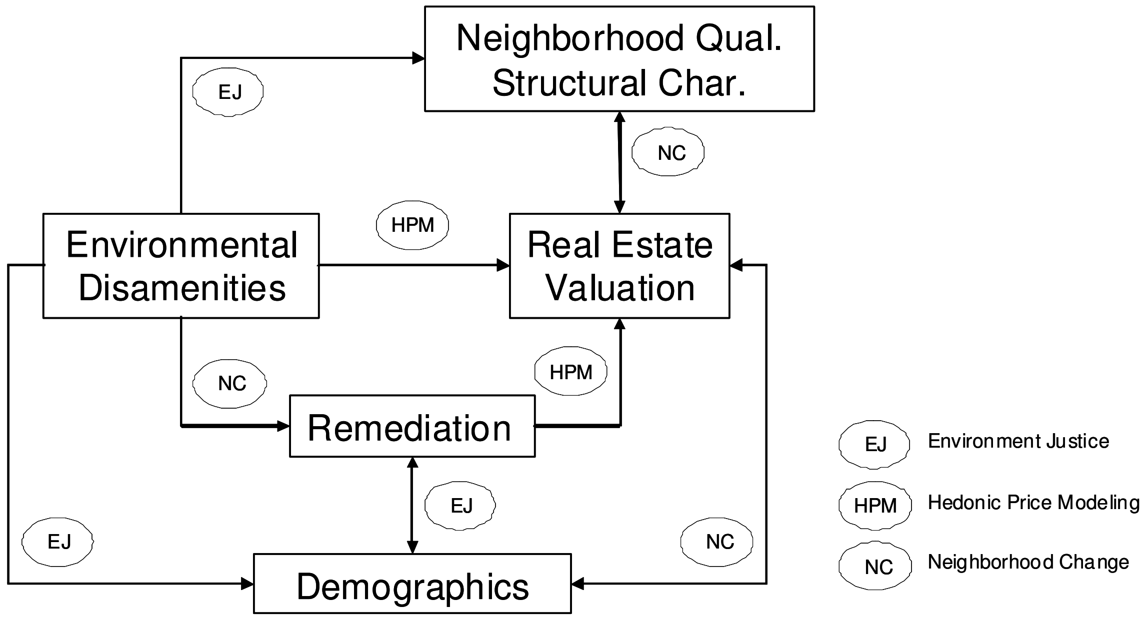

Figure 1: Relationship of Housing Valuation, Neighborhood Change, and Environment Justice

Housing Value from Proximate Environmental Factors

In traditional real estate valuation, residential property values are estimated from a function of structural variables (physical characteristics) and neighborhood variables (surrounding amenities.) These impacts are measured with a hedonic price model that distinguishes impact of specific variables on housing price while controlling for other influencing factors that allows for quantifying intangible measures like surrounding environmental amenities (Rosen 1974). Hedonic analysis of residential property values have included measurement of benefits from various environmental amenities such as proximity to the coast or a lake (Brown and Pollakowski 1977; Lansford Jr and Jones 1995), or proximity to parks, green spaces, recreational areas, etc (Vaughan 1977; Mahan, Polasky et al. 2000). Studies have largely shown a positive price impact due to proximity to scenic views of open space and from locating close to a golf course (Asabere and Huffman 1996; Grudnitski and Do 1997; Benson, Hansen et al. 1998). It is widely believed that in addition to structural and socio-economic neighborhood characteristics, property values are thus positively influenced by intangible benefits derived from passive recreational environmental amenities. Such environmental amenities offer intrinsic value to housing market consumers who prefer to pay a premium for enhancing their quality of life.

In contrast, this study attempts to measure the impact of environmental disamenities or brownfields on residential property values from the perspective of proximity, type and size of contaminated properties, and number of such contaminated properties within the immediate vicinity of individual properties while controlling for other influencing factors like structural characteristics and neighborhood amenities (See Figure 2). For purposes of this study, it is hypothesized that environmental disamenities pose a substantial risk in terms of assessing quality of life, and preferences for living close to such contaminated properties are reflected through lower property prices.

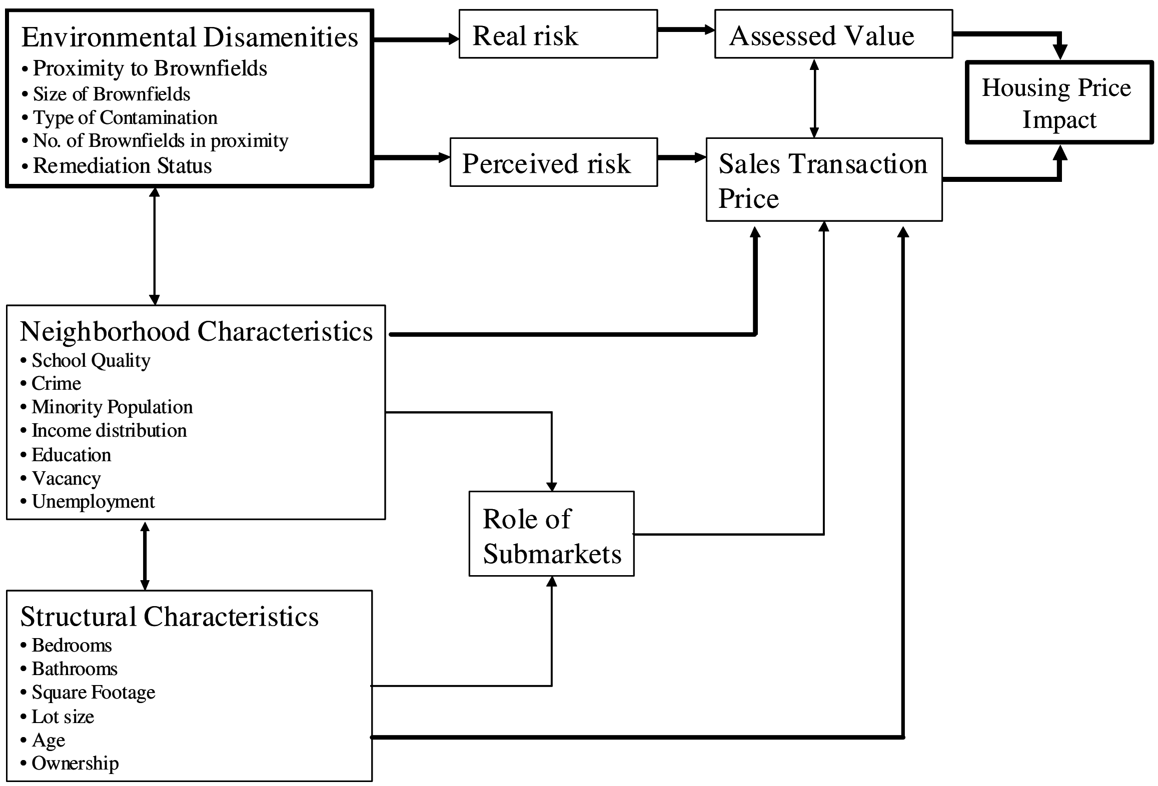

Figure 2: Hedonic Model for Housing Valuation

Type of Environmental Disamenities

Disamenities include various land uses that are associated with noise, congestion, odors, dilapidation, or contamination. The literature points to many facilities such as power lines, power plants, hazardous waste dumps, nuclear power plants, refineries, airports, trailer parks, reservoirs, beltways, traffic flow, highway noise and others that are considered as disamenities (Blomquist 1974; Nelson 1981; Clark and Nieves 1991; Mendelsohn, Hellerstein et al. 1992). Such undesirable land uses or disamenities might be perceived as dangerous to human health or a potential threat to safety. Although environmental disamenities range from quantifiable measures like air and water quality to intangible effects reflected by noise or visibility, this study is restricted to examining effects of hazardous land uses and more specifically contaminated lands known as brownfields. Brownfields with severe contamination and prioritized for remediation termed as Superfunds are the focus of this study.

Health Concerns leading to Heightened Risk

Due to opening up of trade barriers, manufacturing industries were able to move their labor-intensive industries from central cities to rural parts or even outside the country, leaving behind contaminated sites that were unfit for either commercial or residential use. Owing to the lack of environmental awareness and environmental protection laws prior to 1970s, such contamination remained unchecked and the consequences were directly borne by the neighborhood in which such brownfields were located. Initially, the primary concern was health leading to several concerns like rising incidences of cancer, birth defects, etc. that could be directly or indirectly attributed to the surrounding contamination be it in land, air, or water. Such undesirable land uses or disamenities are perceived as dangerous to human health or a potential threat to safety. Neighborhoods with incidences of contamination also account for higher incidences of depression, asthma, diabetes, and heart disease (Cohen, Mason et al. 2003). Such health risks lead to adverse risk perception of residents and potential homebuyers from locating closer to contaminated sites which in turn influences the housing values of properties located near contaminated sites.

Role of Risk Perception in Determining Lower Valuation

Risk perception by the proximate community and potential homebuyers is considered to be the primary factor in determining preferences to locate near contaminated sites. These perceptions affect choices buyers make and reveal preferences through changes in demand for housing near contaminated properties. It is generally believed that holding all other factors constant, buyers have a lower willingness to pay for housing if they perceive a health risk due to contaminated lands (Schulze, McClelland et al. 1995). Almost two-thirds of Americans polled by Gallup were “very concerned” about hazardous wastes (Masterson-Allen and Brown 1990) and concern for protecting the environment as well as enforcing regulations on possible contamination has been high since early 70s. According to Gallup's annual Environment poll (2006) sixty percent of Americans think environmental quality today is "only fair" or "poor," and 67 percent believe it is worsening, making it the highest negative rating when compared to recent previous years.

Residents in the neighborhood around contaminated properties reveal their preferences through risk beliefs that are perpetuated through information dissemination from either the authorities or the media. Such risk beliefs can also be determined through perpetual cues that are found in the neighborhood. These perpetual cues are either physical in the form of dilapidated and abandoned structures, odors, visible air or water pollution, heavy traffic, or more subtle long-term cues like health risk, crime or stigma associated with living in a neighborhood with contaminated sites (Schulze, McClelland et al. 1995). Consumers reveal their preferences to protect themselves and their properties from such obvious perpetual cues like presence of brownfields by choosing to locate as further away as possible and may be willing to pay more for this perception of safety and well-being. The role of perceptual cues in identifying proximate and visible brownfields can be compared with other risks of hazards without strong perceptual cues such as risk of radon gas in homes or the water supply, which though equally or even more harmful to the health or economic situation of the residents are underestimated (Doyle, Elliott et al. 1989). Without the effect of perpetual cues of specific location and visibility, such risk can be expected to have little or no susceptible impact on desirability as compared to effect of brownfields.

This perception of risk may be real or exaggerated and sometimes depends on the nature of the contaminated land in close proximity. Perceptual cues and visibility of contamination in the form of odors emanating from the site, unusual soil or water discoloration, or heavy volume of truck traffic carrying hazardous cargo can significantly influence such perceptions (Schulze, McClelland et al. 1995). On the other hand, the passive cues in form of abandonment or dereliction without any sign of potential activity on sites suspected of contamination due to previous usage influence risk perception. In such cases, the time lag between site abandonment and subsequent neglect either intentional or otherwise reinforces perceptions of risk and hazard. No sales activity leads to long-term vacancy and dereliction of the site which tends to increase such risk perception even when there is no real danger due to contamination.

Transfer of Risk Perception to Economic Value

Localized contaminated lands like hazardous waste sites, landfills, and brownfields have a far greater impact on the neighborhood especially in the immediate vicinity, which reflects on the effect of perceived risks that are not only a function of statistical risk but also other subjective risk factors such as dread, involuntariness, controllability, severity of consequences, etc (Slovic, Layman et al. 1991). The preferences of residents in such neighborhoods are derived from their willingness to pay or in more measurable terms, what individuals really pay in order to locate in affected neighborhoods based on their internal tradeoff decisions depending on income limitation and differential preferences for neighborhood amenities. These risk perceptions regarding living closer to contaminated sites are manifested through differential property values. In case of localized land use, adjacent property values are reflective of the disamenities in the neighborhood, the impact of which is not always easily measured. The primary reason for negative price effects is attributed to uncertain information pertaining to real or perceived risk arising from proximate contamination. This perceived risk stemmed from adverse risk beliefs in being close to the contaminated sites and such risks are perceived to dissipate with distance from those sites. Quantifying impact of environmental disamenities has primarily relied on measuring proximity from such sources of contamination to individual residential properties and associating it with economic value.

Impact of Contamination on Property Value

The real estate literature approaches examination of impacts of contamination on property value from two distinct perspectives (Jackson 2001). The first focuses on the valuation of contaminated property itself and addresses notions of stigma, risk, and market value of property suffering from contamination without necessarily addressing any effects on the surrounding neighborhood (Mundy 1992). The second looks at the impact of such contamination on the surrounding properties that are not the source of contamination (Freeman III 1979). This study is concerned with the latter perspective and examines the extent and size of the impact of contamination on surrounding properties specifically residential. The scope of the research restricts on examining the specific role of the proximate contamination on the economic value of surrounding properties while controlling for other traditionally influencing factors.

Contaminated sites are perceived to have a negative price effect on surrounding residential properties and this effect decreases as distance from contaminated sites increases. Following remediation, these contaminated sites are expected to have a lesser impact on the housing prices of surrounding properties and similarly the decreasing effect with increasing distance is also likely to subside (See Figure 3). Havlicek Jr., Richardson and colleagues (1971) was one of the first studies to examine the impact of locating near an undesirable and perceived contaminated land use observing an increase of $3200 for every additional mile from the municipal solid waste landfill. Simons and Saginor (2006) use meta-analysis to address the effects on surrounding residential property values owing to environmental contamination caused by leaking underground storage tanks, superfund sites, landfills, water and air pollution, power lines, pipeline ruptures, nuclear power plants, animal feedlots and several other urban nuisance uses. Modeling effect of proximity, type of contamination, location, market conditions on loss of property value, they traced the impact of proximate contamination across several studies and estimated a mean loss of around $6000 in property value. Jackson (2001) examined the effects of environmental contamination from the perspective of real estate appraisal theory and sales price analysis. His analysis included research studies looking at residential and commercial property that were negatively impacted by landfills, petroleum, superfund sites, and other such disamenities and counted 15 studies with negative effects and 4 with no effects while listing negative price effects on residential, commercial, and industrial properties over time, distance variables, context of different markets, and stigma.

Extent of Impact of Contamination

The proximity of the contaminated site to the housing unit has been shown to be a determining factor in assessing property value impacts. However, the extent of that impact is not yet confirmed and tends not only to be localized and different for individual regions, cities, or even types of Superfund sites (Kiel and Williams 2005) but also varies with the characteristics of the neighborhood and the housing markets that the properties are located in. Studies by Kohlhase (1991) and Smolen and Moore (1991) indicated a negative price effect of the contaminated sites up to a distance of almost 6 miles. Measured in terms of willingness to pay, respondents were willing to pay almost $330-$495 per year more for housing located one additional mile away from the contaminated site (Smith and Desvousges 1986).

Although proximity to the brownfield is a typical indicator of economic impact of contamination, the effect is not always linear. Kohlhase (1991) discovered a declining impact with the greatest impact (decrease of $17,740) within one mile from the contaminated site and less than $790 for 5-6 miles. Schulze, McClelland et al. (1995) mentions that the average reduction in market value for properties located within one mile of a hazardous waste site was approximately $10,000.

Sales Prices and Appraised Values

The literature recommends using sales prices of the properties to analyze the price effect of environmental disamenities typically hazardous and contaminated properties (Harrison and Stock 1984; Michaels and Smith 1990; Kohlhase 1991; Schulze, McClelland et al. 1995; Kaufman and Cloutier 2006). The sales prices are expected to reflect the revealed preferences of the consumers in the real estate market and their proclivity for living close to environmental disamenities through diminished returns in property transactions. In absence of availability of sales prices data, other studies have relied on appraised property values obtained from the local government (Hite, Chern et al. 2001; Paterson and Boyle 2002; Leigh and Coffin 2005).

Analyses of tax appraisal processes pertaining to contamination have been restricted to examining valuation of contaminated properties and offer little information on incorporating information for contamination in the valuation of surrounding properties (Rinaldi 1991). The appraisers may choose to bolster their evaluation estimates by seeking opinion from qualified professionals in the environmental sciences (Dorchester Jr 1991) and thus may adjust their capitalization rate to account for the perception of increased risks due to contamination (Kinnard and Worzala 1999). This may lead to such tax appraisers who assess property value in residential neighborhoods to have better and more informed knowledge of the status of contamination and lead to lower appraisal estimates of surrounding properties.

However, since appraised values are based on the history of sales transactions in recent past, changes in neighborhood quality such as brownfield remediation may not be reflected in the recent sales history of the neighborhood and may be effectively captured through actual sales prices in housing transactions. In absences of recent sales transactions due to presence of contamination, appraised values might be lower than potential sales prices provided the contamination is remedied. Higher number of turnovers indicates greater demand and desirability for properties especially after remediation. Increasing sales prices during such transactions offer a better indicator of price impacts than appraised values which are calculated on annual basis (in Florida). Generally, tax appraised property values are lower than market sales prices due to differential preferences of consumers. Individuals prefer to trade off access to environmental disamenities for lower housing prices especially in housing markets with high demand. This difference between appraised value and sales prices is likely to shrink after remediation that removes a potential price-depressing factor.

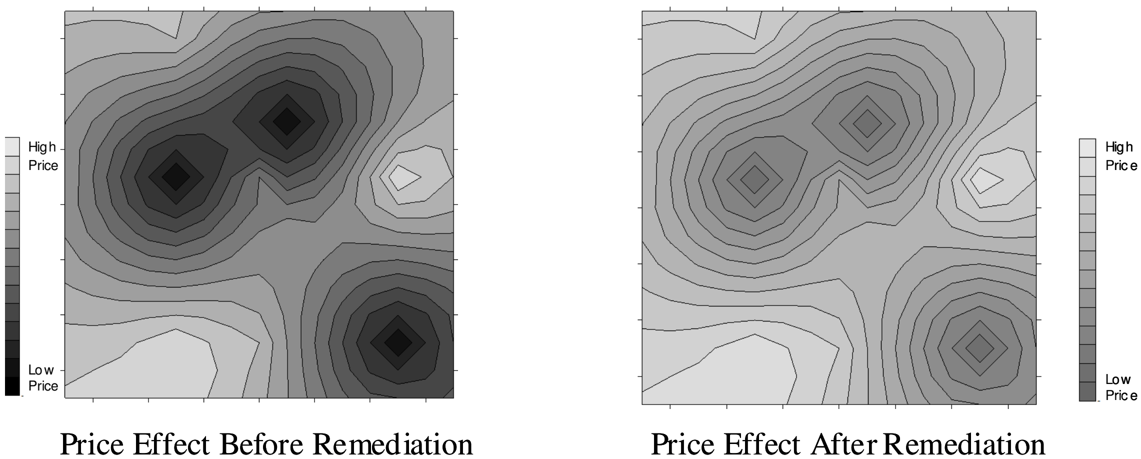

Figure 3: Spatial Effects of Housing Price around Brownfields

Post-Remediation Impacts and Spatial Effects in Real Estate Valuation

Although there is significant literature the on impact of contaminated and undesirable land uses on surrounding property values, there is little evidence or studies analyzing effects of remediation or cleanup efforts. Additionally, other review studies examining the extent of impact of contamination on surrounding properties have reached inconsistent conclusions and are unclear on the size and nature of such impacts (Farber 1998; Boyle and Kiel 2001; Jackson 2001; Simons and Saginor 2006). Although these studies present a comprehensive literature review of negative impacts of contaminated sites on surrounding properties, there is little mention of spatial relationships between properties under examination which may underestimate the prediction accuracy of the impacts. Also, few studies examine the incidence of price rebounds post-remediation of contaminated properties that have been depressing property values in the first place and those that do find inconsistent evidence.

Schulze, McClelland et al. (1995) mentions "the distance (or market size) over which property values may be affected by a disamenity such as a hazardous waste facility is one of the largely unresolved issues in property value studies." Although Dale and colleagues (1999) find some evidence of market rebound post-remediation, they emphasize that "a continuous price/distance relationship fails to capture the entire effect of proximity to the smelter (disamenity)". Although the reviewed studies indicate that the contamination effect is temporary, there is limited amount of evidence showing positive rebound in property value following remediation and this limitation was attributed to nature of contamination, extent of information available, or other unmeasured intervening variables. Additionally, such post-remediation measurement is either conducted too soon before the stigma effects have declined or remediation efforts have not been completed causing the brownfields to be still listed as active.

Contemporaneous Neighborhood Change Following Changes in Housing Valuation

Brownfields redevelopment research focuses primarily on the restoration of economic value of the contaminated site and studies focusing on negative impacts from such proximate contamination do not always account for intervening market conditions or role of information dissemination that influences perception of risk. Other studies have focused on notification of contamination and its perceived negative impact on surrounding properties (Kohlhase 1991; Dotzour 1997) and reached conflicting conclusions but very few studies have followed up this examination by looking at price impacts post-remediation. Land valuation studies examining impact of contamination restrict themselves to purely economic impacts in terms of property value without consideration of consequential impacts on neighborhood change either in terms of gentrification or issues of environment justice. In terms of promoting brownfields revitalization from a policy standpoint, it might be pertinent to examine the impacts for long-term neighborhood change and social consequences of government-supported remediation to see if the benefits of brownfields remediation are accrued by the original residents of the neighborhood. The housing price valuation literature fails to address the temporal effects for distance impacts of the brownfields and include limited control of other contemporaneous changes in the socioeconomic characteristics of the proximate neighborhood during or after the remediation process.

The housing price valuation literature fails to consider the neighborhood dynamics that may accompany changes in the status of the disamenities over time. Although redevelopment and remediation of brownfields has a direct measurable impact on the proximate neighborhood's property values, this change can lead to significant changes in not only the physical makeup of the community but also lead to socioeconomic changes in the resident population. Cleanup of brownfields often makes neighborhoods more desirable leading to higher property values thus increasing causing a potential change in the average income in communities around remedied brownfields. This rise in average income can lead to other sociodemographic changes like decline in crime and increase in physical upgrades to the housing stock. The following section discusses how change in the economic value of the properties due to brownfield remediation can lead to physical and demographic changes in the neighborhood.

Neighborhood Change

Neighborhoods are traditionally defined by physical and social components and structure of any change affecting the neighborhoods directly influence environmental, infrastructural, social, demographical, and locational characteristics (Keller 1968; Galster 2001). Change in any of these defining attributes would subsequently alter other characteristics of the neighborhood and often highlight the relationships between those attributes. Although neighborhood change is largely perceived to be gradual and dependent on a host of factors, the trajectory of such changes may often be traced back to certain tipping points such as remediation of contaminated sites. This change in neighborhoods defined either by its population or structural characteristics and bounded within geographic limits are reflected by changes in observable indicators like property value when certain pre-determined physical changes like remediation of proximate brownfields or social characteristics like population shifts occur.

Decline of Neighborhoods in Central Cities

The literature over the past half-century has been largely focused on examining the decline and revival of interest of the central cities. Aided by the favorable mortgage terms offered by the Federal Housing Administration and Veterans Administration programs post-war, many families sought to move out of the central cities and buy homes in the suburbs (Sumka 1979). The shift in the economy from primacy in manufacturing to services in addition to drastic reduction in transportation costs due to the construction of interstate highways altered the structure of the urban form. Availability of cheap housing in the suburbs and relatively cheap and efficient transportation systems helped people live away from the place of their work and commute daily. This not only expanded the cities outward but also led to the abandonment of central city neighborhoods which soon led to concentration of people that could not move out due to income limitations and exclusionary discrimination.

Additionally, neighborhoods with obsolete industrial and commercial units within inner cities that led to the formation of brownfields collapsed due to the migration of the middle-class leaving behind lower-income people with limited employment opportunities, degrading housing, and declining public services leading to dilapidation, neglect, rise in crime, and decline of school quality. Additionally due to strict legal liability issues that were further compounded by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) legislation that created Superfund sites, redevelopment of brownfields was considered economically unfeasible. Left undeveloped, brownfields remain unproductive, generate little or no economic benefits, and are not only environmentally hazardous but also social detrimental to the proximate communities. The negative consequences not only depressed property values but also led to social and physical decline of communities which further complicated potential redevelopment.

Rise in Neighborhood Revitalization

Although suburban growth is still increasing, there has been a revival in interest in relocating to central cities. Aided by the government's efforts in trying to revive the city cores in order to reduce related social problems, the 'back to the city' movement has been largely driven by massive investments in infrastructure and financial assistance such as investments in brownfield remediation. Clay (1978) found evidence of revitalization in more than 100 neighborhoods regardless of city size or geographic location.

Among theories of neighborhood change, the Neighborhood Life Cycle model focuses on the life-cycle changes – development, transition, downgrading, thinning out, and renewal – that certain areas within a city undergo (Hoover and Vernon 1959). Although not all neighborhoods go through all stages in succession, the basic premise is based on following the neighborhood evolution by observing the change in several components of the neighborhood that include social status, racial and age composition of the population, quality and condition of housing, and intensity of land and dwelling use. In case of this study, brownfield remediation can highlight renewal and signify removal of a potential value-depressing influence thereby modifying neighborhood amenities positively to signal the shift from one stage of the life-cycle to another.

Additionally, the economic approach to neighborhood change assumes the geographic separation of households according to income level differences. The classic stage model of neighborhood succession causes affluent residents to seek cheaper land and better housing on the urban fringe leading to disinvestment and neglect of maintenance of the aging inner city housing stock (Muth 1969). This aging and often deteriorating housing stock filters down the status and income hierarchy to less affluent and often minority households leading to depreciation of housing prices and rents to reflect changes in the income profile of residents and neighborhood desirability (Grigsby, Baratz et al. 1987). Presence of brownfields due to abandonment of commercial and industrial uses arising from population migration and economic changes further depresses housing prices in the neighborhood. Remediation of such brownfields can send a signal to the market regarding the growing potential of the neighborhoods. Coupled with increasing interest in central city neighborhoods, the decaying and aging housing may be purchased and upgraded by pioneers who chose to invest not only their economic resources but also their social capital and sweat equity in rebuilding housing in erstwhile dilapidated and disadvantaged neighborhoods.

Incidence of Gentrification in Neighborhood Change

Current gentrification research broadened the analytic framework beyond demographic factors and neoclassical land-use theory to include alternative conceptions and research methodologies to include cultural and economic trends (Zukin 1987). Gentrification is placed within a framework of urban restructuring and considered as one of the theories of community change and provides the most relevant perspectives on neighborhood change dynamics by integrating both economic and cultural analyses. While themes of incoming well-off residents moving into to replace original residents have been the central theme, the physical upgrading of the neighborhood is an oft neglected characteristic of gentrification. Clay (1978) suggests two distinct processes – incumbent upgrading and gentrification. Incumbent upgrading involves reinvestment in moderate-income neighborhoods by their original long-time residents due to presence of a strong neighborhood organization, high percentage of home owners, strong sense of identification, or basically a housing stock that is sound although in decline. Gentrification, on the other hand is defined by a similar upgrading process done by incoming middle-class people when they move into old, low-income neighborhoods that are in decline either economically or socially. As the age of housing stock increases, it becomes less desirable leading to filtering down to lower socioeconomic populations that are willing to occupy such housing in lieu of reduced costs. At a certain tipping point when housing ages significantly and neighboring brownfields are remedied, it becomes increasingly economically feasible to redevelop the physical structures thus leading to housing price appreciation (Helms 2003). In fact, there is a significant relationship between environmental conditions and housing modifications that lead to rise in property values (Portnov, Odish et al. 2006). This change in property value may attract higher socioeconomic groups causing potential gentrification. However, not all neighborhoods experience such change and the gentrified neighborhoods in several anecdotal studies in the literature have been described as emergence of "islands of renewal" as the outcome of metropolitan housing construction and filtering processes that produced vast "seas of decay" (Berry 1980; Berry 1985) in the urban core. Skepticism notwithstanding, interest in examining trends of gentrification has remained steady especially in neighborhoods that are experiencing revitalization either due to upgrading of housing stock or enhancing of environmental amenities. While the underlying causes of gentrification are still being debated in the literature, the emergence of political-economy perspective in neighborhood research that examines community change in terms of relationships between economic and political institutions is quite similar to Smith's rent gap hypothesis (Smith 1979; Smith 1996) that gentrification is mainly driven by capital and land market.

Gentrification as Neighborhood Change: The Rent Gap Hypothesis

Focusing purely on gentrification as form of neighborhood change, Smith (1979) in his seminal essay attributed the growing gap between property values and underlying land values in the inner city to this redevelopment change. Breaking away from the traditional viewpoint that looked at demographic change, Smith highlighted the importance of land values within the mechanisms of the housing and real estate market for properties within the inner-city neighborhoods that stood a high chance for being gentrified. Smith (1979) used concepts of "capitalized land rent" and "potential land rent" to define a potential cap in the utilization of the property in terms of the rent that is actually appropriated by the landowner and the actual value of the land if it was put to its highest and best use.

The rent gap can increase over time when the physical environment of the neighborhood deteriorates either due to disinvestment or due to presence of undesirable environmental amenities such as brownfields. This potential land rent of a property thus in the proximity of a contaminated property, according to Smith can be depressed and thus subjected to the current capitalized rent. This rent gap is prone to increase as knowledge about the contamination becomes known. However, this rent gap can also spur investment thus signifying a potential for profit in redeveloping such depressed neighborhoods. This rent gap exists in most major cities in the United States due to the suburbanization of industries and population leaving inner-cities depressed and leaving behind abandoned properties with suspected contamination. This devalorization of inner-city neighborhoods compounded by presence of contaminated lands, made reinvestment and potential remediation a profitable venture which led to redevelopment and demographic changes trending toward gentrification.

Gentrification according to Smith, is simply explained by the resurgence of the inner-city locations due to depressed potential of land values which is eventually realized to bring the market back to equilibrium. This resurgence for redevelopment may be triggered by remediation of brownfields in certain housing markets that have previously depressed property values and made such redevelopment infeasible. Remediation of environmental disamenities like brownfields can address this rent gap by leading to positive price rebounds in properties surrounding the brownfields. The extent and rate of change of properties around brownfields compared before and after remediation can provide indications of gentrification.

Testing the rent-gap hypothesis in revitalizing neighborhoods, Clark (1988) observed high sales price/tax assessment ratios as the neighborhoods approached redevelopment. One of the hallmark features of impending gentrification are rising property values and rental costs leading to either new construction, renovation upgrading of the housing stock, on conversion from rental to owner-occupied housing. These physical changes may be subsequently followed by change in local population by bringing in residents with higher socioeconomic status (Levy and Comey 2006). In a study comparing gentrifying neighborhoods from non-gentrifying ones, Freeman (2005) uses measures pertaining to age of housing, education attainment, and housing prices. Housing prices in particular were observed to have increased more steeply in neighborhoods classified as gentrifying especially owner-occupied housing. Melchert (1987) describe the progress of gentrification in the neighborhood in four distinct stages: pioneer, early settlers, mainstream, and stragglers. These groups of consumers indicate a progression of decreasing risk and increasing property values, while gradually experiencing conversion to residential in revitalizing neighborhoods. Thus although gentrification as form of neighborhood change has been seen through trends in demographic change, the underlying triggering indicators arising from property value has been significant.

However, rationally speaking, households may be motivated by the rent gap that allows them a low-cost opportunity to be involved in the restructuring of a potentially redeveloping neighborhood; other socioeconomic factors are likely also to play a significant role in the location decision-making and thus may explain differences in rate of change in property values in neighborhoods experiencing brownfield remediation. The chances for remediation of brownfields and subsequent redevelopment and revitalization of proximate neighborhoods may not be uniform across all submarkets and can lead to environmental justice and social equity issues which shall be dealt with in the following section.

Environmental Justice and Social Equity

Poverty and race have often been intertwined in the United States and thus access to environmental amenities have similarly been dictated on economic grounds thus have remained restricted from minorities and low-income populations (Bowen 2002). Environmental justice problems are not a direct consequence of surroundings but rather a reflection of "social problems, problems of people, their history, their living conditions, their relation to the world and reality, their social, cultural and political situations" (Beck 1992). Theories of environmental justice thus transcend into other related theories of power structure, political economy, and even participation democracy. Bullard and Johnson (2000) expands the environment definition in terms of "where people live, work, and play." Thus, the concept of your neighborhood and surroundings in influencing your opportunities and subsequently your life outcomes is strong. Further, Bullard and Johnson (2000) related environmental justice with social equity and justice by emphasizing the value-driven analysis of environmental decision-making that exists on three fronts – "procedural (government), geographic (hazard proximity), and social (use of sociological indices)." Theories of environmental justice are struggling between defining itself as a "right-based" theory on the lines of Rawls' theory of justice that "seeks to promote social justice due to distributional equities via environmental policy" (Rios 2000) or in terms of "environmental racism" to focus on the disproportionate impact of environmental hazards on minorities and low-income populations. But the occasional combination of the two strands have given the environmental justice movement strength by involving both minorities as well as low-income populations and facilitated community and citizen participation by focusing on advocacy theories (Faber and McCarthy 2001) especially when it comes to dealing with environmental contamination and subsequent decisions for remediation.

Discrimination or Personal Choice?

In environment justice literature, there has been a constant discussion regarding reasons to locate near environmental disamenities. Are hazardous land uses deliberately located in neighborhoods with low income or minority populations or do such populations choose to live near disamenities due to cheaper housing? Such behavior – "coming to nuisance" – to locate near disamenities may be prompted by adequate compensation in form of lower property values for the disutility they experience by living closer to the contamination (Cooter and Ulen 2000). According to Rawls' Theory of Justice (1974), the political and social system is particularly responsible for ensuring equitable rights and liberties in the form of access to unfettered environmental protection to those that live close to the environmental disamenities. This is especially pronounced if the environmental disamenities such as a functional industrial unit degrades the living experience of those in close proximity but provides more benefits in terms of jobs and power to those living further away. Thus, Rawls' Theory of Justice grants special protection to those directly affected by it. This theory of justice is rooted in the denial of economic opportunities of the disadvantaged that would prevent them from effectively pursuing their conception of the good. Environmental contamination, according to Rawls' theory, imposes undue burdens on those living in close proximity by limiting their economic opportunities due to depressed property prices, increased crime due to dilapidation and poverty thus preventing them from optimizing their well being.

Contrastingly, Nozick (1974) relies on the free market mechanisms. Locating near a contaminated site, for example, might be a conscious choice of an individual who is constrained by income and thus is exercising personal discretion in trading off other amenities in exchange for the low price of the property. If the individuals were to value environmental amenities higher than other amenities that they enjoy in their current location, they would relocate elsewhere where they can do so. Thus, even in case of gentrification, individuals are making a conscious and voluntary choice after property prices increase to relocate to neighborhoods that they can afford.

Differential Impacts Post-Remediation

To examine the social and environmental justice concepts within the purview of brownfield remediation, planning problems will generate waves of consequences whose traces mostly cannot be reversed. Changing neighborhoods through brownfields remediation, even those directly intended to remedy the environmental justice problems for the minorities and low-income residents, can result in unintended consequences, such as gentrification, that ultimately do not benefit the residents.

While contamination proximity is clearly a social construct complicated by systemic inequities due to income limitations, remediation and subsequent redevelopment has a strong economic component that sometimes makes race a correlational factor (Bostic and Martin 2003). The primary causes of neighborhood change through gentrification lie in the mechanisms of market change and revival of previously disadvantaged neighborhoods that are now attractive to middle-income populations that also happen to be predominantly white. However, contamination proximity or brownfield remediation may seem to have economic underpinnings but the decisions may also be largely political. Viscusi and Hamilton (1999) find that such cleanup decisions are heavily based on extraneous political factors like voter awareness and environmental group membership in the area. Also, when analyzed at a submarket level, brownfield remediation was observed to have a greater positive impact in premium housing markets as opposed to other submarket types (Michaels and Smith 1990). While plenty of studies highlight the economic impact of the contaminated sites on the surrounding neighborhood, there is little agreement on the extent of that impact and various studies have shown the extent of economic impact of contamination in terms of appraised price or sales price tends to be different for individual regions, cities, or even types of Superfund sites (Kiel and Williams 2005).

Different Demographics form Different Submarkets

On the demand side of housing, consumers can be grouped on the basis of household's housing preferences and tastes, stage in life cycle, lifestyle, size and composition, school quality preference, and socioeconomic status (MacLennan 1992) although this consumer grouping is also constrained by search and information costs. This leads into the segmentation of the housing market into distinct 'product groups' (MacLennan 1992) within a larger metropolitan region. These 'product groups' are perceived to be composed of relatively homogenous housing units that contain characteristics or relatively close substitutes to demanders of housing. This might lead to different housing submarkets and thus cause differential prices between submarkets for a given set of attributes (Watkins 2001).

The demander-based segmentation of housing markets relies on consumer preferences for housing stock quality or neighborhood amenities. Such segmentation is not necessarily spatially congruous although neighborhood quality may definitely influence housing quality which in turn may depend on the socioeconomic characteristics of the residents. Socioeconomic conditions, physical conditions of nearby housing and access to the central business district are considered the major characteristics defining housing quality and hence may also be factors for segmenting housing submarkets (Bourassa, Hamelink et al. 1999; Bourassa and Hoesli 1999).

Housing submarkets are deemed to exist within a larger metropolitan region if housing units within a submarket are relatively close substitutes and differential prices exist between segments. In such a case, the market is divided into distinct groups which generally exhibit independent behavior in terms of levels of supply and demand for determination of housing prices (Watkins 2001). Given the variability on housing markets within any major metropolitan region, few studies have included the role of submarket segmentation in explaining differences of housing price impacts on properties surrounding contaminated properties either before or after remediation. Although couple of studies have indicated role of differences in submarkets for determining whether a contaminated site get remedied or not, there has been little evidence of including variability of housing submarkets in examining differences between housing price impacts.

This study not only examines the variation and differences in housing price impact over time as contamination status changes but also looks at systematic shifts in the spatial distribution of sociodemographic groups relative to the environmental disamenities. This study attempts to construct a model of housing prices and associated neighborhood change related to the contemporaneous change in the status of brownfields and examines sociodemographic processes that may accompany changes in property value leading to environmental justice and social equity concerns.

Predicted Outcomes

Based on the conceptual framework illustrated in Figure 1, this study expects the following outcomes:

1. Contaminated lands (brownfields) have a negative impact on the sales prices of the residential properties surrounding the brownfields (perceived risk).
    a. Contaminated lands (brownfields) have a negative impact on the appraised value of the residential properties surrounding the brownfields (actual risk).
    b. Sales prices and appraised value of residential properties surrounding brownfield sites will increase as distance to the nearest brownfield increases.

2. Remediation of brownfields will lead to higher sales prices of the residential properties surrounding the brownfields as compared to sales prices before remediation.
    a. Remediation of brownfields will lead to higher appraised values of the residential properties surrounding the brownfields as compared to appraised values before remediation.
    b. Sales prices of residential properties surrounding brownfield sites will increase as distance to the nearest brownfield increases.
3. Large sized brownfields will lead to lower sales prices of the surrounding residential properties than smaller sized brownfields.
4. Brownfields with different types of contamination will have different economic impact on sales prices of the surrounding residential properties.
    a. Brownfields with hazardous chemical contamination will cause greater negative price effect on surrounding properties than land-fill brownfields.
5. Residential properties with higher number of brownfields in close proximity will have lower sales prices than those with lower number of brownfields.
6. Sales prices of residential properties surrounding brownfield sites will be different across housing submarkets in the region.
    a. Submarkets with contaminated brownfields will have higher proportion of lower socioeconomic populations and lower property values.
    b. Properties in higher socioeconomic submarkets will experience greater positive price rebound post-remediation of proximate brownfields.
    c. Magnitude and rate of changes in property value in neighborhoods before and after brownfields remediation will indicate potential gentrification.

Research Design

The research design is based on a longitudinal structure that examines the effect of brownfields before and after remediation on surrounding residential properties over time. This study will examine the economic impact on residential properties located around remedied brownfields and compare them to properties located around contaminated brownfields. Additionally, spatial analysis employed in this study will examine the extent and size of the economic impact brownfields have on sales prices and appraised value of properties surrounding them. Incorporation of housing submarket segmentation in the study allows for examination of differential price impacts of brownfields and their subsequent remediation. Finally, including structural and neighborhood characteristics in the hedonic price models allows controlling for structural and locational quality thus enabling better analysis of causal impacts of presence of brownfields on the economic value of properties.

This research design allows for comparison of housing price impact across time i.e. before and after remediation of proximate brownfields thus compensating for shortcomings in previous studies that examine the price impact at a given point in time. Additionally, the comprehensive dataset used in this study contains individual property-level data for structural characteristics and sales prices from housing transactions as opposed to median sales and structural data in other studies that results in more efficient and accurate predictions for examining housing price impact from proximity to brownfields. Spatial analysis, not used in most studies, allows enhanced prediction accuracy by accounting for spatial dependence among individual properties and correcting for omitted variable bias. Lastly, most studies in brownfield remediation literature fail to control for submarket segmentation in the housing market thus examining differences in price impacts over submarkets will greatly improve the research model.

Data Sources

This study is based on secondary data collected from a variety of sources. The data are drawn from Miami-Dade County, Florida, and consist of sales transactions of residential dwellings from this market and were obtained from the Miami-Dade County Property Appraisers office. This study shall focus primarily on single-family residential properties. These data are a subset of a larger dataset from the Property Appraisers Office (PAO) that catalogs all properties for tax assessment purposes. The data set includes property-specific characteristics as well as recent transaction prices of each property. The data set consists of transactions taking place between 1992 and 2001 and includes repeat sales if any. The properties were geocoded originally by Florida Power and Light for the Property Appraisers Office in the aftermath of Hurricane Andrew and updated on regular intervals by The Hazard Reduction & Recovery Center at Texas A&M University by merging annual datasets.

The brownfields data in the Miami-Dade Country region shall be obtained from the United States Environmental Protection Agency (USEPA), Florida Department of Environmental Protection (Brownfields Initiative Program), and Miami-Dade County and City of Miami offices. The spatial data for the location, size, and nature of brownfields shall be obtained from Enterprise Technology Services Department (ETSD) located in the County offices of Miami-Dade and Florida Geographic Data Library (FGDL) located at University of Florida's GeoPlan Center.

Other neighborhood and socioeconomic data, like poverty rates, race demographics, income levels, etc., shall be obtained from the 1990 and 2000 Census, America Housing Survey (AHS), and Home Mortgage Disclosure Act (HDMA). Crime data shall be obtained from FBI's Uniform Crime Reports (UCR), and school quality data shall be obtained from Florida Department of Education. See Table 1 on the following page for details.

Target Population

The target population is single-family residential properties that are located around brownfields. Properties that are in close proximity to the brownfields are the primary interest because of an expected declining relationship between presence of contamination and distance of properties from the contamination. However, since the extent of this relationship is largely unknown and is one of the research objectives of the study, this study shall consider all single-family residential properties within the study area. Although structural and neighborhood characteristics of the properties are also important factors in determining the economic value, this study shall be using these variables as controlling factors to focus on the environment disamenities factors.

The sample, as mentioned above, consists of single-family residential properties located in Miami-Dade County, Florida. This sample is a subset of a larger dataset that comprises of properties in the region and is selected to restrict the analyses to residential properties. This larger dataset is stratified by County Land Use Code (CLUC), State Land Use Code (SLUC) description, municipality, district, neighborhood, and millage to denote the various different jurisdictions that the properties are located under.

Measurement

The table below lists each factor in the hedonic price model to be measured along with indicators for each factor including, type of variable, level of measurement, and data source:

Table 1: Factors and Indicators

Factor	Indicators	Level of Measurement	Variable Type	Source
Dependent Variable **Economic Impact**				
Sales Price	Mean house transaction price for 1992/2001 sales; inflation adjusted	Census Block Group	Continuous	Florida PAO
Appraised Value	Mean Appraised Property Value; inflation adjusted	Census Block Group	Continuous	Florida PAO
Independent Variable **Environmental Disamenities**				
Brownfield Proximity	Average distance from individual property to the nearest brownfield; measured in miles	Census Block Group	Continuous	Florida PAO; ETSD/ FDGL
Brownfield Size	Mean size of nearest brownfield; measured in square feet	Census Block Group	Continuous	Florida PAO; ETSD/ FDGL
Brownfield Contamination	Type of contamination on nearest brownfield	Census Block Group	Nominal	Florida PAO; ETSD/ FDGL
Brownfield Clustering	Mean number of other Superfunds within one-mile distance	Census Block Group	Continuous	Florida PAO; ETSD/ FDGL
Controlling Variables **Structural Characteristics**				
Lot Size	Mean lot size in thousands of square feet	Census Block Group	Continuous	Florida PAO
Bedrooms	Mean number of bedrooms on individual properties	Census Block Group	Continuous	Florida PAO
Bathrooms	Mean number of bathrooms on	Census Block Group	Continuous	Florida PAO

	individual properties			
Age	Mean structure age of individual properties	Census Block Group	Continuous	Florida PAO
Living Area	Mean living area in square feet	Census Block Group	Continuous	Florida PAO
Condition	Proportion of homes without plumbing and kitchen facilities	Census Block Group		Census 1990/2000
Homeownership	Proportion of homes owner-occupied	Census Block Group		Florida PAO
Neighborhood Characteristics				
Poverty	Proportion of people living under poverty	Census Tract/ Block Group		Census 1990/2000
Minority	Proportion of minority population within census tract	Census Tract/ Block Group		Census 1990/2000
Income	Median household income within census tract	Census Tract/ Block Group	Continuous	Census 1990/2000
Education	Proportion of population with college education	Census Tract/ Block Group		Census 1990/2000
Vacancy	Proportion of vacant properties within census tract/block grp	Census Tract/ Block Group		Census 1990/2000
Crime	Rate of crime within incorporated city jurisdiction	City	Index; crimes per 1000 people	FBI UCR
School	Quality of the high school that serves individual properties;	School district	Index of test scores, student-teacher ratio, and AP enrollment	FL DOE
Unemployment	Rate of unemployment within census tract	Census Tract/ Block Group		Census 1990/2000
Tax Rate	Average Tax Rate; measured in mills	Census Block Group		Florida PAO
Land Use Mix	Proportion of commercial and industrial land uses	Census Block Group		Florida PAO
Coast	Location of the CBG with respect to coast	Census Block Group	Dichotomous; if the CBG is located on the coast or not.	Florida PAO; ETSD/ FDGL

Distance to CBD	Average distance of properties to central business district; in miles	Census Block Group	Continuous	Florida PAO; ETSD/ FDGL
Mediating Variables				
Housing Submarket	School Attendance District Region	Census Block Group	Dichotomous	Florida PAO; ETSD/ FDGL

Housing Price Impact

The housing price impact of the proximate brownfields shall be measured in terms of differences in sales prices and appraised property value before and after remediation. Individual property-level data for sales prices and appraised value is available in the dataset, but to minimize sample selection bias (see *Selection Issues*), the economic impact will be aggregated to census block group (CBG) level. The average values of sales prices and appraised value for individual properties at CBG level shall be assigned to that CBG.

Since CBGs generally contain between 600 and 3,000 people and are relatively homogeneous in terms of population characteristics, economic status, and living conditions, property sales prices within CBGs are expected to be highly correlated and spatially dependent. Also, because census tracts consist of one or more block groups, smaller units of analysis (block groups) tend to be modestly more homogeneous than larger ones (census tracts), hence the decision to aggregate data at CBG level.

Environment Disamenities

Although the definition of brownfields includes any site with perceived or known contamination, this study considers Superfund sites located in the Miami-Dade region. The choice of using Superfund sites is dictated by widely disseminated information regarding contamination and subsequent remediation from the federal, state, and county offices of Environmental Protection for such sites. Superfund sites also have a documented history of known contamination and remediation efforts including dates for listing the site on the National Priorities List (NPL) and delisting it post-remediation. For the purposes of this study, a brownfield is considered remediated if it is delisted from the NPL. Miami-Dade County had 13 brownfield sites on the NPL in 1990 and had 6 sites delisted by 1997.

The effect of the proximate contaminated brownfields shall be measured by the Euclidean linear distance from individual properties to the nearest brownfield. For purposes of aggregation, this variable will be operationalized as average distance to nearest brownfield at the CBG level. Since the impact of the brownfield contamination may not always be linear in nature, a squared-term or logarithmic conversion might also be included. Also, number of brownfields located within a one-mile radius of individual residential properties will be included in measuring impact of environmental disamenities. Additionally, brownfield site characteristics like type of contamination and size of the lot will also be incorporated to operationalize the environmental disamenities variables. Presence of other disamenities with relatively low levels of contamination will be controlled by including the proportion of commercial and industrial land uses in the given census block group under the assumption that higher the proportion of commercial and industrial land uses, the lower the average housing price in the census block will be.

Structural and Neighborhood Factors

The structural and neighborhood factors help control for examining the extent of impact of environmental disamenities on property value. The structural variables as mentioned in the above table are available at an individual household level for the period between 1992 and 2000. However, due to sample selection bias (see *Selection Issues*) and need to include all properties in the analyses, variables will be aggregated at CBG level. The average measures for number of bedrooms, number of bathroom, square footage, lot size, and age of the structure shall be abstracted to the CBG level. Other structural variables like homeownership, structural condition, millage, and location to the coast shall be measured in terms of proportional representation in the given CBG.

Neighborhood variables by definition and availability are measured at the census tract level. Variables like poverty level, income level, minority population, education level, unemployment, and vacancy rate are measured at the census block group level or census tract level as available. Other neighborhood variables like school quality and crime rate are measured at their respective available scales (school quality is quantified from relevant measures at the school district level and crime rates are measured at the city-level jurisdiction and abstracted to the corresponding census block group level).

Housing Submarket Segmentation

Methods of segmenting submarkets depend on the size and complexity of individual housing markets for a metropolitan region. This study relies on the research by Hollans and Munneke (2003) who focus on intra-city analyses of the Miami housing market and determine school attendance districts to be superior as compared to political/municipal boundaries for segmenting housing submarkets. This study will divide the housing market according to segmentation of school attendance districts based on the 33 high schools serving the Miami-Dade County. School districts with high levels of homogeneity based on their test scores may be merged to increase degrees of freedom. These submarkets are represented by dichotomous independent variables with Miami Jackson Senior High district as the reference group. Given the spatial relationship of brownfields to the surrounding properties, geographically constrained submarket selection may be a better predictor for measuring price level and price prediction accuracy.

Analyses

The analytic approach used in this study uses a longitudinal structure that examines the economic impact of brownfields on surrounding residential properties before and after remediation. The design also compares these changes across housing submarkets within the metropolitan region. The study uses a hedonic price model to calculate the implicit value of environmental disamenities through sale prices of housing transactions in proximity of the brownfields. The inclusion of other variables like structural and neighborhood characteristics that traditionally determine housing value permit me to control for other explanatory factors and better isolate the causal impacts of brownfields. Finally, spatial models will be used to construct hedonic price models to account for spatial dependence in sales prices in housing transactions and to correct for omitted variable bias. I shall discuss the analysis processes for this study before briefly mentioning the justification for using hedonic price modeling and spatial statistics and conclude with pointing out threats of validity and limitations for this study.

Three levels of analysis will be conducted for this study. First, each dependent variable i.e. sales prices from housing transactions as a measure of economic impact to reflect perceived risk from proximate contamination, and appraised property values as a measure of economic impact to reflect real risk from proximate contamination will be examined for spatial dependence. This analysis will allow us to test for extent of spatial autocorrelation to justify use of spatial modeling instead of traditional ordinary least squares (OLS).

Second, bivariate analysis of each factor denoting economic impact will be used to examine differences for periods before and after remediation of brownfields in addition to the differences for different submarkets. This will allow us to examine differences between economic impacts depending upon the location of the properties within the metropolitan region as well as look at the impact of individual neighborhood and structural characteristics on the economic value of the properties. Also, these analyses will help determine whether properties in a neighborhood with high proportion of minority or low-income population are more likely to be located in close proximity to contaminated sites. Additionally, it also helps us in looking at the location of remedied brownfields and determines if such brownfields are likely to be located in submarkets with properties characterized by low minority, high-income, or higher level of education. These analyses will be supplemented with graphics using GIS mapping tools.

Third, for each time period i.e. before and after remediation, multivariate analysis will incorporate control variables to help isolate the influence of proximity of brownfields and other characteristics of environmental disamenities, as well as the influence of each of the controlling variables on the outcome variables denoting housing price impact. Although this analysis will allow us to examine the extent to which structural and neighborhood characteristics like size of living area, lot size, number of bedrooms and bathroom, income, education level, minority population, crime rate, or poverty influence the extent of economic impact, our primary focus will be on environmental disamenities factors like proximity, size and type of contamination site, and number of other such sites in the vicinity.

The objective of this stage of analysis will be to examine the impact of environmental disamenities on surrounding properties before remediation and compare it to the impact of the same after remediation. The spatial hedonic models used in this multivariate analysis will test for housing price impact on residential properties surrounding brownfields before remediation and a similar model after remediation will allow us to look for differences in housing price impact while controlling for other influencing factors. Comparison of the two models will help us in observing extent and size of price rebounds among properties around remedied brownfields.

Hedonic Price Modeling

Theoretically, the hedonic price model is based on Lancaster's (1966) consumer theory and Rosen's (1974) economic modeling. Both these approaches tend to calculate prices of certain attributes based on the observed prices of related products and the number of attributes related to those products. The goods in question, here the housing location, are said to possess certain bundle of characteristics that the consumer values such that those characteristics are considered to be measurable and utility-affecting. Rosen's theory which is more applicable to housing pricing assumes that consumers do not maximize their utility by purchasing a combination of good but rather do so by discretely consuming individual goods from a variety of sources thus forming their own bundle that maximizes their utility. This ability to untie goods from the bundle and purchase them separately allows the consumers a wider flexibility in exercising choice and thus allows them to pit one set of attributes against the other by reducing and increasing individual items in the bundle. For example, consumers may choose to live in a smaller house if they prefer better neighborhood amenities. Thus, we can deduce the willingness-to-pay for the goods in question by deriving the implicit price function obtained by analyzing the price of the good with its various attributes.

In this study, I will be looking to estimate the price consumers are willing to pay to locate away from a contaminated site i.e. brownfields or inversely, other attributes of a property that consumers are willing to trade in exchange for proximity to a contaminated site. In addition, I will be looking at the change in this price after the environmental attribute has been eliminated i.e. cleanup of the brownfields. Hedonic price modeling thus allows us to isolate impacts of otherwise intangible measures of environmental disamenities on property value while controlling for other tangible and measurable indictors in property value calculations.

Use of Spatial Statistics

This study utilizes a linear multivariate equation that relates the economic value of a property to its important characteristics including proximity to brownfields through unknown coefficients and an error term. Typically OLS is the most common technique under the condition of independence of the error term with the independent variables and assumes that errors are independent, homoskedastic, and normally distributed. However, in examining property values, probability of the housing price of a particular property influencing the housing price of neighboring properties is high thus leading to spatial autocorrelation between residuals which may lead to biased, inefficient, and inconsistent estimators. To correct for this anomaly, this study will utilize a spatial model that includes a spatial weights matrix that summarizes the spatial layout of the observations. This spatial weights matrix is constructed by using the influence of the nearest neighbors of each observation. The spatial model also helps capture the influence of omitted variables that may vary across space.

This study will use the spatial lag model, spatial error model or Durbin model that includes a spatial lag of the dependent variable as well as spatial lags of the explanatory variables. The spatial lag model addresses the spillover effect of independent variables in one location on the dependent variable in adjacent location (Anselin 2001). This is done by adding an additional spatially lagged dependent variable to the hedonic price equation. This lag variable is calculated by taking weighted average of surrounding spatial units either by contiguity based weights, distance based weights, or K-nearest neighbor weights (Anselin 1988). The spatial error model uses a non-spherical error term that is the weighted average of the error terms in the adjacent areas. This is based on the assumption that the spillover effect occurs through spatial correlation in the error terms for adjacent properties and omitted factors are spatially correlated as well. The Durbin model or mixed regressive spatially autoregressive model also accounts for influences of nearest neighbors on the outcomes in the particular location. For example the presence of crime and poverty in a census block group not only influences outcomes within its boundaries but also partly influences the outcomes in the adjacent census block groups.

The use of spatial models thus accounts for spillover effects in housing value functions that have been largely ignored in previous hedonic estimations. Due to use of lag terms, the spatial models absorbs unobserved influences including presence of multiple environmental disamenities that may affect property value which otherwise may be subsumed by the error term. By allowing for the lagged spatial effects in the dependent or explanatory variables, the use of maximum likelihood on the overall model assumes the true errors are independently and normally distributed (Pace, Barry et al. 1998). This study will use the computation programs GeoDa 0.9.5-i designed by Luc Anselin (2001) and SpaceStatPack v2.0 designed by Pace, Barry et al. (2000) to specifically handle large datasets that is available for free at http://geoda.uiuc.edu/ and http://www.spatial-statistics.com respectively.

Threats to Validity

Research in brownfields remediation and redevelopment has traditionally been plagued with methodological limitations that have affected the ability to derive conclusions in general or specific to the impact of contamination in residential neighborhoods. The threats to validity discussed in this section primarily comprise of internal validity i.e. ability of the study to conclude that the relationship between the two given variables is causal. The primary threats to validity consist of three different types of threats; causal order effects, selection bias and attrition, and reliability of measures.

Research in housing valuation focused on neighborhoods with remedied and redeveloped brownfields fails to account for analyzing the pre-existing conditions of contamination and its impact on the surrounding properties. Only after the contamination is removed, are the economic effects realized in terms of increased revenue from restored tax base or improvement in neighborhood quality. Otherwise, most studies use cross-sectional analyses to examine the impact of the brownfields on the surrounding properties either before or after remediation. Also, due to the difficulty of collecting housing and socioeconomic data that explains most housing valuation, such studies often miss out on causal implications of brownfield remediation on housing price.

This study employs a longitudinal model that examines residential properties before and after remediation of contaminated sites. Additionally, this study uses a comprehensive dataset that contains detailed structural characteristics and sales prices information from housing transactions over the period of ten years. I complement this dataset with information on brownfields contamination and subsequent remediation within the same time period. Also, addition of neighborhood variables from the Census and other sources allows me to control for traditionally causal factors in determining housing values thus enabling separation of causal effects of brownfields contamination and remediation across time. Measuring outcomes at two different time intervals following change in contamination status while controlling for other influencing factors helps in determining the economic impact attributable to environmental disamenities and thus eliminating causal ordering bias.

Housing valuation studies that employ longitudinal models suffer from sample selection bias and attrition problems highlight the limitations of tracking housing transactions in the real world. Properties that were sold in one time period may not necessarily be sold in the comparison time period and vice versa thus resulting in attrition of cases that may skew the causal relationships between influencing factors and economic impact. Further, properties located around brownfields are less likely to be sold before remediation due to depressed property values and high perception of risk. Using transaction data of properties that were sold in both time periods i.e. before and after remediation might imply sample selection bias and greatly reduce the number of cases; resulting in diminishing the efficiency and robustness of the model.

Properties located in economically-growing neighborhoods are also more likely to experience higher turnover in property sales than those in disadvantaged neighborhoods. Although this study controls for neighborhood effects, lack of sales transactions in low-growth neighborhoods is likely to bias estimates of housing price effect of brownfields. To overcome this limitation, sales prices from individual properties are abstracted to the census block group. This study aggregates the sales prices of housing transactions at the census block group level and includes data from two years (1992-93 and 2000-01) before and after remediation in order to increase the number of viable cases and eliminate attrition bias. Using data at census block group level instead at individual property level enables us to better associate related neighborhood factors that are collected at the broader level. Census block groups with little or no housing transaction data will be eliminated instead of individual properties within all census block groups to prevent bias. Also, in metropolitan regions with dense populations like Miami, there might be little differences [for estimation] between collecting data at individual property level and aggregating at census block level especially spatial data due to smaller geographical units. In the absence of random assignment of properties to comparison groups due to locational attributes of brownfields, unpredictability of sales prices transaction data, and limitations of field studies in social research, this study includes all residential properties within the study area and controls for structural, neighborhood, and submarket differences that would typically account for disparate housing price effects. Further, comparing with baseline measures before remediation for all factors influential in determining housing price will allow for better estimation of economic impacts post remediation.

Contaminated brownfields are more likely to be located in erstwhile industrial and commercial zones of the metropolitan region thus may not have single-family residential properties in close proximity. The closest residential properties might be located at a distance beyond which the impact of the brownfields is negligible. Also, due to zoning regulations of such erstwhile industrial and commercial properties, contaminated brownfields may be clustered around in close proximity thus making it difficult to separate out the impact of one particular brownfield on the surrounding residential properties. To account for the presence of other types of relatively less contaminated sites, proportion of industrial or commercial land uses will be calculated for each census block group and included in the model to control for effect of other contaminated sites in addition to controlling for other Superfund sites in close proximity apart from the nearest one.

Most housing valuation studies examining impact of contamination employ hedonic price modeling to isolate effects of surrounding environmental disamenities. These studies fail to account for the spatial dependence between housing transactions which often can lead to biased and inefficient estimations. Also, some studies employ appraised property values due to lack of availability of sales prices from housing transactions. Depending on the jurisdiction, there are discernable differences in the way property values are appraised due to millage, legislations, and erroneous measurement calculations. Other studies that use a survey methodology to estimate perceptions of residents toward contamination often tend to either underestimate or overestimate the perception of risk depending upon the information available to them.

This study uses a spatial hedonic model to estimate effect of brownfields on surrounding residential properties and uses sales prices to measure economic impact. Additionally, this study also uses appraised property values as appraised by the local government to compare the perception of risk due to proximate contamination. The spatial model not only helps in eliminating issues of spatial dependence and autocorrelation but also accounts for any omitted measures that might have been missed in the constructed model.

Using data from the market transactions instead of respondent surveys captures consumer behavior in an efficient and unbiased manner eliminating respondent bias toward differential perception of risk from contamination. The housing market is considered to be better enabled to capture the housing price effects of contamination reflected through property values than individual consumers who might lack the information or inclination to do so.

Limitations

Studies examining the impact of contamination and other housing valuation research have differed regarding the extent and size of impact depending upon the jurisdiction and location of brownfields. Policies and legislation pertaining to brownfields remediation differ greatly from state to state and depend greatly on the priorities of the federal and local government in remedying and subsequently redeveloping contaminated properties. Brownfield remediation is primarily driven by expected increases in the tax base and improving neighborhood quality which makes it site-dependent instead of examining the role of its redevelopment in the larger context of its surrounding neighborhood. Although this study attempts to generalize economic impacts from remedying brownfields on individual residential properties, the results might be restricted to jurisdictions of similar size and characteristics and may limit the overall generalizability of the impact.

Additionally, this study restricts itself to measuring economic impacts in terms of changes to sales prices in housing transactions and appraised property values as appraised by the local government. Although this study allows for sufficient lag time between remediation and measurement of economic impacts, some neighborhoods undergoing brownfields remediation may experience an extended period of stigma and may continue to have depressed property values. Due to the varied definitions of brownfields due to size, contamination type, and jurisdiction they lie in, this study primarily focuses on assessing impacts of Superfund sites mostly due to better documentation of its contamination and remediation and wider dissemination of information pertaining to the risk and subsequent cleanup that enables better price prediction for surrounding properties.

Other impacts on neighborhood quality due to changes in the brownfields sites, although measurable through changes in socioeconomic characteristics of the neighborhoods, is not the primary focus of this study and may require a longer lag period to fully estimate.

This study restricts itself to a major metropolitan region with a higher concentration of Superfund sites than other urban areas in the nation and hence its results might be generalizable to comparable metropolitan regions. Although the study's results can be extended to other types of physical environmental disamenities, the extent and size of the impact may vary depending upon the type of disamenities.

Conclusion

The effects of brownfield remediation in terms of size and extent of housing price impact on proximate properties has given inconsistent results and specific economic impacts beyond the remedied brownfields are not completely known. This study seeks to explore the spatial relationship of presence of brownfields and the property value of surrounding residential properties by using a comprehensive and detailed dataset containing housing transactions and individual property-level data from the City of Miami over the period of ten years. By using geographically relevant data on brownfields and census demographics, this study will examine the housing price impact of brownfield cleanup by comparing the property value before and after remediation while controlling for other influencing factors like structural and neighborhood characteristics. Use of spatial models within a longitudinal structure instead of traditional cross-sectional hedonic models will help control for spatial dependence in housing transaction and account for any factors that are usually overlooked thus enabling increase in price prediction accuracy. The study also seeks to examine the differences across housing submarkets as defined in a metropolitan region thereby controlling for market conditions, differential preferences of consumers, and locational characteristics of intra-city neighborhoods. Policy makers, researchers, and consumers in the housing market would be greatly benefited by being informed of the economic effect of remedied brownfields on surrounding properties and thus provide an argument for remediation beyond mere economic viability and environmental concerns. By doing so, the study seeks to extend discussion beyond negative impacts of proximity to brownfields by focusing on the positive price rebounds post-remediation. Also, in conjunction with theories of neighborhood change, the difference in economic benefits measured through housing price impacts across not only different submarkets but also for distressed and vulnerable populations adversely affected by presence of contamination shall provide for introspection in achieving goals of environmental and social justice.

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