EXAMINATION OF HOUSING PRICE IMPACTS ON RESIDENTIAL PROPERTIES BEFORE AND AFTER SUPERFUND REMEDIATION USING SPATIAL HEDONIC MODELING

A Dissertation

by

PRATIK CHANDRASHEKHAR MHATRE

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

August 2009

Major Subject: Urban and Regional Sciences

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ABSTRACT

Examination of Housing Price Impacts on Residential Properties Before and After Superfund Remediation Using Spatial Hedonic Modeling. (August 2009)

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Although recent brownfields redevelopment research using theories of real estate valuation and neighborhood change have indicated negative effects on surrounding residential housing, little evidence exists to show price impacts and sociodemographic change after remediation. This study examines the extent and size of the economic impact of Superfund sites on surrounding single-family residential properties before and after remediation in Miami-Dade County and examines trends for contemporaneous sociodemographic changes. The study combines the economic impact from changes in environmental quality with contemporaneous sociodemographic changes within the purview of environmental and social justice. This study uses spatial hedonic price modeling on a comprehensive dataset of property-level data, with corresponding sales prices of housing transactions while controlling for other structural, neighborhood, and submarkets characteristics for assessing economic impact.

Findings revealed that housing sales prices for single-family residential properties significantly increases as distance to the nearest contaminated Superfund increases. Following remediation, this negative impact declined and housing values increased significantly in neighborhoods with remedied Superfund sites albeit more so in low housing submarkets than premium submarkets. Spatial hedonic models outperformed traditional OLS models in presenting unbiased efficient parameter estimates, correcting for spatial dependence. Although no evidence for gentrification was observed, there existed significant differences between certain sociodemographic characteristics of neighborhoods around contaminated Superfund sites and those of properties located elsewhere leading to concerns of environmental and social justice. Findings suggest that low-income minority populations are more likely to be living in neighborhoods around contaminated Superfund sites and experience a greater negative effect on housing sales prices; these sites are also less likely to be remedied as compared to sites located elsewhere.

The findings highlight not only the revealed preferences of homeowners with respect to environmental disamenities, but also help inform policymakers and researchers of the impact of brownfields redevelopment on economic and sociodemographic characteristics of a growing urban region with evolving cultural and social diversity. Incorporating influences of housing submarkets, neighborhood amenities, and spatial dependence help provide a holistic and comprehensive model for examining environmental disamenities and provide a better understanding for neighborhood change.

DEDICATION

This dissertation is dedicated to my wife, Ashweeta, who has supported me with love, patience, and care through one of the arduous stages of my life.

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This dissertation is by no means the result of my individual effort and I wish to express my sincere acknowledgements to those who made it possible. First, I would like to thank my dissertation co-chairs, Dr. Shannon Van Zandt and Dr. Walt Peacock for their confidence and belief in my abilities. Dr. Van Zandt's continual guidance and support and Dr. Peacock's insightful opinions during the course of this research made all the difference. I would also like to thank my committee members, Dr. Jesse Saginor and Dr. Cristine Morgan for their invaluable inputs and time.

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Many thanks also to the staff at the Department of Landscape Architecture and Urban Planning and my friends, colleagues, and acquaintances at Texas A&M University who made my time in graduate school and College Station an enjoyable and learning experience.

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CHAPTER I

INTRODUCTION

Background

The United States Environmental Protection Agency (USEPA) 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 (USCM, 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 (USGAO, 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 & 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., Shamasunder, & Garzon, 2002). Brownfields are ranked by the level of contamination present on the site and highly hazardous brownfields are designated as Superfund sites. Brownfields are mostly found in urban

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areas and the USEPA estimates that one in four Americans live within four miles of a Superfund site making them a pertinent issue in urban planning. According to USEPA 1995 data, there were 1479 Superfund sites in the United States out of which 56.7 percent have no cleanup plan yet.

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. Redevelopment concerns have risen from a real or perceived perception of risk toward health and social problems. Sites targeted for development with a history of contamination due to industrial activities or storage or disposal of hazardous substances pose not only an environmental risk but also a consequential risk, perceived or otherwise toward enhancing quality of life to potential residents. However, 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 & Collaton, 1997; Davis & Margolis, 1997; R. 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 (USCM, 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. The sociodemographic impact of brownfields on surrounding communities often provides little incentive toward redevelopment. Communities located around such contaminated properties exhibit higher incidences of crime, poverty, and dereliction which in turn lead to a lower economic base making the examination beyond economic indicators even more important. Neighborhood changes following brownfields remediation in terms of demographics and other social indicators such as poverty, unemployment, crime, and job type distribution may indicate displacement of lower income populations by higher income population, a trend commonly referred to as gentrification. In addition to an economic impact on surrounding residential properties, brownfields remediation is expected to also influence contemporaneous sociodemographic changes in the proximate neighborhood.

Problem Statement

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 (Boyle & Kiel, 2001; Brisson & Pearce, 1995; Farber, 1998; Jackson, 2001; R. A. Simons & Saginor, 2006). But little research has examined similar price effects after remediation. 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 well understood. Most research in real estate valuation and brownfields has been restricted to the cross-sectional examination of negative impacts of brownfields on neighboring properties, while few studies examine positive price rebounds post-remediation (Dale, Murdoch, Thayer, & Waddell, 1999; K. A. Kiel, 1995; K. A. Kiel & Williams, 2005; Leigh & Coffin, 2005). Further, due at least in part 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.

In addition to the impact on property values and housing sales transactions due to proximate brownfields, there has been little effort in analyzing contemporaneous sociodemographic change in such neighborhoods. Communities with brownfields are more likely to be afflicted with higher levels of crime, poverty, and dereliction, in addition to being predominantly minority neighborhoods, raising environmental justice concerns (Bullard & Johnson, 2000). Additionally, redeveloping neighborhoods in urban areas have exhibited trends toward gentrification due to changing consumer preferences and shifting demographics. Such movement toward gentrification particularly in low socioeconomic neighborhoods following brownfield remediation may elicit social justice concerns due to unfair distribution of benefits in housing appreciation and subsequent social benefits. In fact, remediation decisions may be based on the socioeconomic characteristics of the neighborhood (Viscusi & Hamilton, 1999) and the impact of brownfield remediation may be significantly higher in neighborhoods with higher socioeconomic indicators. Similarly economic impact on residential properties may differ in neighborhoods with varying sociodemographic characteristics resulting in an imbalance of distribution of benefits post-remediation raising issues of environmental justice and social equity.

Research Purpose and Objectives

The overall purpose of this study is to determine the extent and size of impact of Superfund sites on surrounding single-family residential properties and examine trends for gentrification resulting from changes in sociodemographic characteristics of the proximate neighborhood in the Miami-Dade County region of Florida. Based on the rational economic model of hedonic price theory, homeowners are expected to maximize their utility by trading off their revealed preferences with respect to distance from environmental disamenities; Superfund NPL site in this case. The main objective of this study is to add to the current body of knowledge that examines the relationship of environmental disamenities and economic impact in terms of property value while looking for contemporaneous change in sociodemographic indicators.

This study uses a longitudinal hedonic price 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. Additionally, this study utilizes a comprehensive dataset that includes property-level data and corresponding sales prices of housing transactions over a ten year period. 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 previous studies. 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 brownfields 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.

Other factors that might explain differences in housing prices due to nearby brownfields like the role of submarkets, tax rates, and the 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 brownfields 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. The specific objectives of this study are:

- 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 surrounding neighborhood?
- Do properties in proximity to remedied brownfields experience positive price rebounds?
    - Do other brownfields characteristics like type of contamination, and 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.

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 (Hamilton & Viscusi, 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), Risk-Based Corrective Action (RBCA), amendment policies to CERCLA like Small Business Liability Relief and Brownfields Revitalization Act, 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 (NGA, 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 brownfields sites remedied with the help of the Superfund program, providing economic justification not only in terms of infill development of previously contaminated and abandoned property but also in generating tax revenue through increased property value of the surrounding neighborhood. Policy makers and home buyers will greatly benefit 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 & Johnson, 2000). Even when remedied, properties in premier housing markets appreciate at higher rate than properties in below-average housing markets (Michaels & 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 examines 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 brownfields remediation is equitable. The extent and size of the impact of proximity to contaminated brownfields especially in vulnerable and distressed neighborhoods will 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. These studies have focused on examining the influence using cross-sectional models neglecting the potential of price rebound post-remediation (Brisson & Pearce, 1995; Farber, 1998; R. A. Simons & 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 (R. A. Simons, Bowen, & Sementelli, 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 & 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).

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 (Adair, Berry, & McGreal, 1996; Bourassa, Hamelink, Hoesli, & MacGregor, 1999; Harsman & Quigley, 1995). 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, brownfields 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, brownfields 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

This dissertation analyzes and examines the housing price impact of the proximity of contaminated properties otherwise termed as Superfund NPL sites (brownfields). The research focuses not only on the housing price effects of such sites before remediation but also examines the impact of remediation of Superfund sites on the surrounding properties in the proximate neighborhood. For purposes of this research, dependent variables capturing the housing price impact of the brownfields are represented by sales prices of housing transactions. This proximity effect of the brownfields is controlled with other factors like structural and neighborhood variables that traditionally influence property value (see Figure 1.1).

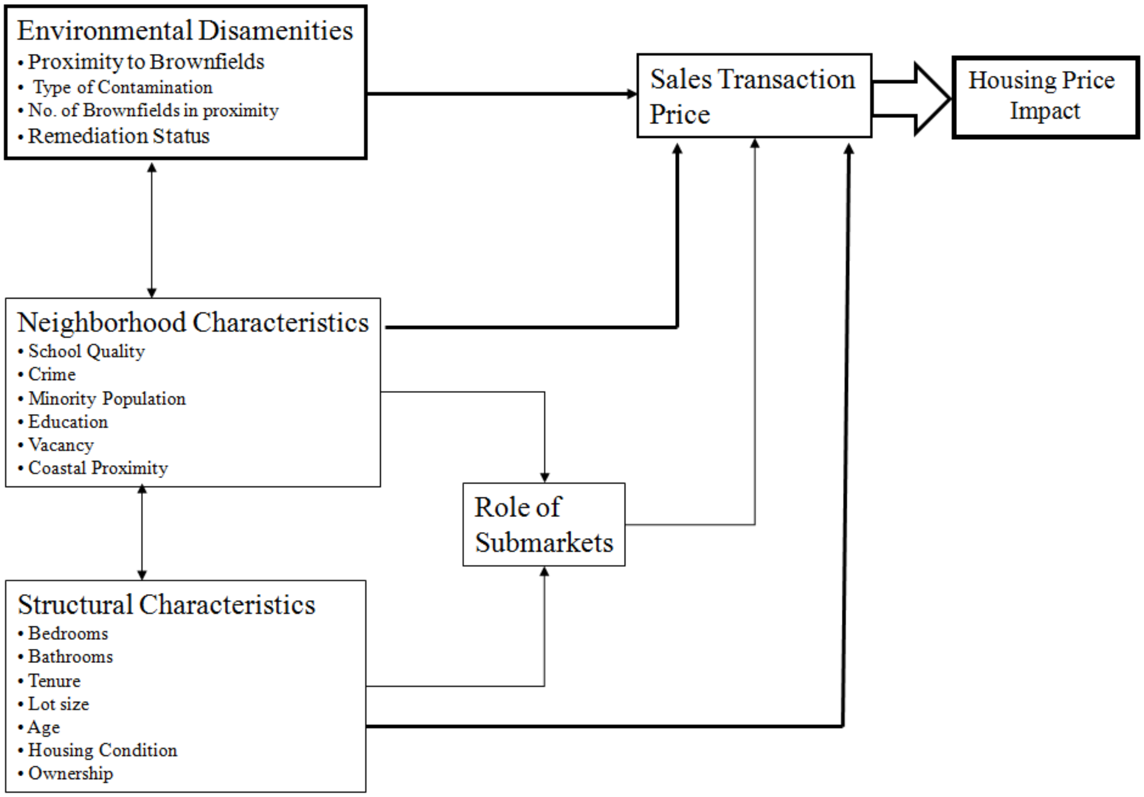


Figure 1.1 Factors Influencing Housing Price Impact

Additionally, this housing price effect of brownfields is examined at 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 is tested through econometric models that account for spatial dependence providing more accurate estimates for predicted property values as well as correcting for omitted variable bias. By analyzing the values of the properties over a ten-year period i.e. before and after remediation, it is possible to measure the extent and level of housing price effect borne out through the proximity to brownfields and to examine if such effects differ over submarket segmentations in order to understand differential impacts for various sociodemographic groups.

By understanding the extent, nature, size, and level of property value change in neighborhoods undergoing brownfields remediation, this dissertation attempts to bring together seemingly disparate threads of real estate valuation, neighborhood change, and environmental justice. The impact of brownfields 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 brownfields remediation.

Dissertation Outline

This chapter provides background information on the topic and elaborates on the problem statement under examination for this dissertation. It states the research purpose, lists the research objectives, and clarifies the research hypotheses & predicted outcomes. It lays down the justification for this research on policy and theory and describes the conceptual framework of the dissertation within the parameters of housing valuation, neighborhood change, and environment justice. Finally, in this section it lists the general organizational outline of the dissertation.

Chapter II examines the literature on the incidence of brownfields within the changing urban landscape and looks at the trends in redevelopment aimed at revitalizing previously neglected and dilapidated sections of the city. The chapter will focus on the Superfund sites or brownfields that are considered extremely hazardous and placed on the National Priorities List (NPL) for redevelopment with special emphasis on the role of the federal and state government in classifying and redeveloping brownfields. Finally, a conceptual framework outlining the three core areas of research defining this study is presented.

Chapter III examines the literature for environmental disamenities and housing valuation. The housing valuation literature is examined from the perspective of the impact of environmental disamenities on surrounding properties arising from health concerns and risk perceptions. The chapter looks at the gap in the post-remediation impact of such disamenities which this study will address.

Chapter IV takes a look at the literature in neighborhood change examining it under the lens of gentrification and within the purview of contemporaneous change following brownfields remediation. The chapter also analyzes the location and subsequent impact of contaminated sites from the perspective of environment justice and social equity and if subsequent remediation of such disamenities has a differential impact if any on proximate populations. The impact of such redevelopment post-remediation is also examined by controlling for housing market segmentation.

Chapter V explains the sociodemographic profile of the target region and describes the data sources and subsequent methods of data preparation and validation.

The chapter also describes the data and variables at the regional level as well as at the submarket level.

Chapter VI describes the variables used in the study with an exploratory descriptive analysis including spatial examination of the data. The chapter concludes with the selection of variables in the model and specification of the analytical model.

Chapter VII describes the research methodology and analyses used in this study. Following the definitions and operationalization of various tests and analyses used in this study, the research model is developed using theories of hedonic price modeling and spatial statistics. Methods of spatial analysis are examined by describing various spatial weight schemes. The chapter concludes with a look into common threats of validity associated with such a study and how this study overcomes such threats.

Chapter VIII discusses the results of the analysis following the hypotheses tests and comparison of estimation methods namely, the OLS, Spatial Lag, or the Spatial Error models. Test statistics examining the spatial dependence of the data are used to justify the choice of the model. This chapter also examines the change in the sociodemographic characteristics of the neighborhoods affected by environmental disamenities and if any significant changes occur post-remediation using T-Tests data analysis methods.

The final chapter summarizes the important findings of the study and provides the broad implications of the conclusions for redevelopment policy and brownfields remediation. After listing the limitations of the study, the chapter concludes by examining the contribution of this study toward addressing the gap in property valuation in environmental distressed neighborhoods and subsequent contemporaneous sociodemographic change with respect to environmental justice and social equity.

CHAPTER II

BROWNFIELDS REDEVELOPMENT AND FLORIDA BROWNFIELDS INITIATIVES

Emergence of Brownfields

Defined as "abandoned, idled, or underused industrial and commercial facilities or properties, expansion or redevelopment is complicated by real or perceived contamination", there are nearly a million brownfields with varying levels of contamination and acreage (USEPA, 1995). Although most of these sites are located in previously industrial cities like Detroit, Pittsburgh, New York, etc., several brownfields are also found in rural parts of the country. Historically, cities were built around employment centers and the traditional mode of employment was in industrial and manufacturing units located in the inner core of the urban settlement. Due to less advanced transportation systems, the working class lived close to the industries. However, as economies changed and became gradually globalized, industries moved away from the inner cities as the nature of the economic base in the United States moved from manufacturing to service-oriented industry. These changes in industrial, transportation, and manufacturing technology and the subsequent shift in economy from manufacturing to service-oriented industries exacerbated the growth of brownfield sites leaving large tracts of contaminated lands abandoned in inner-city neighborhoods. Subsequently, the inner city suffered due to changes in the economy and job loss as industries moved out of the cities, leaving behind their contaminated sites. These brownfields account for a large proportion of vacant and abandoned land in inner cities and have had a detrimental effect on the health of the neighborhood – economically and physically. These brownfields are not only marked by heavy contamination causing severe environmental harm but are also accompanied by social prejudices that cause economic and environmental inequities leading to instability in the social fabric of urban settlement.

The Need for Redevelopment

Health Concerns

Unfettered use of toxic chemicals in industries often located on urban land prior to the introduction of the environmental laws in 1970s damaged the environment via air, water, and soil pollution. 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. These neighborhoods also account for higher incidences of depression, asthma, diabetes, and heart disease (Cohen et al., 2003). Presence of such contaminated sites increased the health risks of the affected population in addition to making them susceptible to economic downturns. Although brownfields alone need not directly cause these illnesses, the correlation between living in a deprived neighborhood and low health is high enough to warrant further enquiry. Brownfield redevelopment thus can be completely justifiable under the health of the community alone, irrespective of other reasons.

Eliminating Negative Externalities

Vacant and abandoned land especially that which was previously contaminated or still is not only proves to be an aesthetic eyesore on the state of the neighborhood but also implies a social stigma on the health of the community. Properties that are neglected or abandoned imply declining interest in the willingness on part of the residents to invest in the neighborhood and are symptomatic of decreasing market demand. Abandoned properties similarly impose a negative externality on the neighborhood by lowering the market value of the surrounding properties (Accordino & Johnson, 2000). Greenberg, Popper et al. (1992) in a survey of 15 largest cities in the United States identify fire hazard, shelter for homeless, toxic waste, drug problems, and dumping of trash and rodent infestation as some of the problems that arise from such abandoned properties. Skogan (1986) argues that abandoned buildings can not only harbor and imply social and physical decay but also provide refuge to trash, rats or other stray animals, squatters or even criminals. Such properties often serve as drug dens and used by predatory criminals who may attack neighborhood residents. Theft from abandoned properties is also less likely to be reported and neighbors are not emotionally invested in the affairs of neglected properties. These problems often act as magnets to crime and signify physical and social disorder and undermine the ways in which communities maintain control. Remedying and redeveloping abandoned brownfields seeks to eliminate such societal negative externalities that can have ill effects on not only the social fabric of the community but also lead to economic distress.

Environmental Injustice and Social Inequity

The negative social, economical, and cultural impacts of the presence of brownfields especially in inner cities that served as industrial and manufacturing locations have contributed to the lower-income and racial segregation trends that every city is plagued with. These contaminated sites located in mostly low-income and minority neighborhoods due to suburbanization, also receive little or no attention regards cleanup and decontamination measures due to pervasive discrimination (Bullard & Johnson, 2000). Redlining and discriminatory practices by real estate agents have further diminished the efforts for redeveloping such contaminated sites. Developers, industry, and other service industry interests have followed the middle-income and higher-income 'flight to the suburbs' thus rendering inner-city areas abandoned, derelict, and underutilized due to fears of contamination. This caused heavy concentration of brownfields within a specific area of a city, notably closer to the less-empowered population i.e. minorities and low-income population of a region.

These factors combine to make the environmental health hazards more concentrated in low-income and minority neighborhoods and subsequently the chances of the resident community rallying around for cleanup of such properties can be hampered by the low level of social networking among residents and lack of adequate community cohesiveness. Such neglect and discrimination also led to the rise of other social negative externalities such as dereliction and abandonment that encouraged crime and drug use in the neighborhood which further made the neighborhoods unfit places to live and invest in. The increasing suburbanization of the cities has depleted resources from the city and driven businesses from the core. This has rendered communities helpless and without assistance to redevelop their neighborhoods.

Targeted brownfields redevelopment seeks to resolve sociodemographic inequities by encouraging identification and cleanup in disadvantaged neighborhoods. Such redevelopment is aimed at spreading the benefits of brownfields redevelopment to those that are most vulnerable to social and economic ill-effects and least likely to remedy this problem on their own.

Untapped Potential for Urban Redevelopment

Given the nature and the location of brownfields, they have now provided an opportunity in urban redevelopment policy to revitalize shaping the form and structure of the city. Brownfields provide an untapped potential in redevelopment opportunity for disadvantaged neighborhoods and although interest in such regeneration is reaching a critical point, some issues remain to be addressed in terms of environmental liability and stigma of risk perception. Shifting population trends and changing consumer preferences have rekindled the interest in central city revitalization and land resources provided by previously abandoned brownfields have made their environmental remediation economically feasible. Although suburbanization has continued in almost all parts of the country, (Clay, 1978) found trends of revitalization in more than 100 neighborhoods some of which can be traced back to the Life Cycle Model (Hoover & Vernon, 1959). The Life Cycle model elaborates the typical process that certain areas within an urban region go through over time. The changes are – development, transition, downgrading, thinning out, and renewal. These changes are then reflected not only in the physical structure of the neighborhoods but also in the social status, racial and age composition of the population, quality of housing, and intensity of land and dwelling use. More often than not, availability of previously contaminated lands within declining neighborhoods provides the impetus for revitalization in growing central cities.

Decreasing availability of suburban land, inflation of suburban housing costs, rising transportation costs, and relative low-cost of inner-city neighborhoods provide a tipping point for the markets to reinvest in revitalization of brownfields. The changing consumer preferences of a ‘new middle class’ is served by developers who can offer them downtown living in neighborhoods that were previously affected by brownfields (Samuel, 1982). This heightened demand makes cleanup and remediation economically feasible. This new middle-class not only demands housing but also other ancillary facilities such as coffee shops, neighborhood shopping, night clubs, bars, restaurants, local parks which end up revitalizing the surrounding neighborhood. Thus brownfield revitalization is not only driven by need to clean up contaminated brownfields that pose as health hazards or are social problem incubators but also by the need to fulfill a market demand to generate additional housing and promote business.

Government Support in Redevelopment

The government has been active in promoting brownfields cleanup and in turn fostering redevelopment of neighborhoods through mitigation of contamination and social stigma. The social consequences of abandonment and dereliction not only lead to social problems like crime and drug use but also result in reduction of tax revenue. Abandoned and contaminated brownfields within the city core are aesthetic eyesores that make the city seem less appealing for investors and business owners thus depressing job creation and driving away investment.

The EPA administers the Superfund program under the auspices of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) that was passed in 1980 to create a regulatory mechanism for investigation, cleanup, and recovery of contaminated sites. However, this Act proved to be counter-productive to the aims of brownfields redevelopment and instead made developers fear liability as they could be held accountable even if they were not responsible for the contamination post-sale. To counter this and to make the process of redevelopment more streamlined, the EPA introduced the Brownfields Action Agenda in 1995 to help states and localities to work with economic development agencies to prevent, assess, safely cleanup, and sustainably reuse brownfields in order to explore the economic and social potential (USEPA, 1995). This Pilot Program clarified the liability issues and encouraged partnerships and outreach programs. The implementation of the Brownfields Action Agenda at the local level has been effectively matched with the grants and revolving loans given by the Department of Housing and Urban Development for redevelopment of brownfields.

Additionally, the Superfund program created by the CERCLA, amended by the Superfund Amendments and Reauthorization Act (SARA) also segregated brownfields by the level of contamination. Ranked on a scale of 0 to 100 for assessing extent of contamination using Hazard Ranking System (HRS), the EPA placed brownfields with a rating of 28.5 on the National Priorities List (NPL) and terms such brownfields as Superfund sites. Using a structured analysis approach, the HRS-assigned numerical values relate to the risk from contamination based on the conditions at the site and not used to determine the priority in funding EPA remedial response actions. Such Superfund sites prioritized remediation action that entails a detailed and complex cleanup process. This process implements removal action where immediate action is necessary while holding responsible parties liable for the contamination. The cleanup process is paid for through a tax on petroleum and chemical industries which in turn seeks to provide incentives to use less toxic substances. Such a process involves cooperation from state agencies as well as community involvement for long-term protectiveness. The Superfund Program is overseen by EPA's Office of Solid Waste and Emergency Response (OSWER) through the ten regional offices around the nation; Florida’s Miami-Dade County lies in Region 4. There are currently 1,240 sites listed on the Superfund National Priority List, an additional 317 have been delisted, and 61 new sites have been proposed. There are 13 Superfund sites in Miami-Dade County and are described in detail in Appendix B (USEPA, 2008).

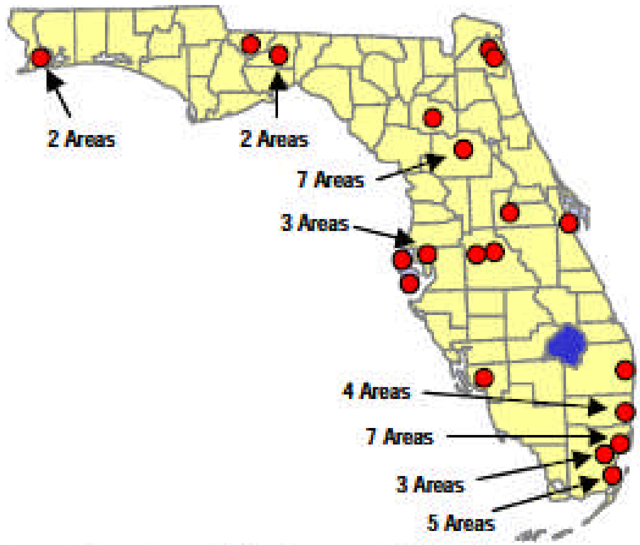
The U.S. Department of Transportation also incorporate brownfields in their planning activities for the regional transportation network projects. The Community Reinvestment Act (CRA), Community Development Block Grant (CDBG), and HOME Investment Partnerships provide federal support for state and local urban revitalization efforts and have special clauses for neighborhoods with brownfields. These laws seek to overcome market failures and discriminatory practices like predatory lending or even redlining by providing financial capital to disadvantaged neighborhoods with brownfields. In addition, Congress passed the Small Business Liability Relief and Brownfields Revitalization Act (Public Law 107-118 [H.R. 2869]) in 2002 that sought to exempt small volume contributors from Superfund liability, provide legislative authority for brownfields programs to include grants for cleanup and assessment, and even shift court costs and attorney fees to a private party if the party loses a Superfund contribution action against another exempt party.

In addition to federal involvement, states have instituted the Voluntary Cleanup Program (VCP) to provide oversight to motivated parties to assess and cleanup low-priority sites. Other practices that are expected to provide incentives to private parties to engage in brownfields redevelopment are termed as “risk-based corrective action” (RBCA). State-level initiatives implemented by Florida are described in the following section.

Thus, supported by brownfields legislation and voluntary cleanup efforts in more than 29 states, brownfields redevelopment has received a boost through standardized cleanup measures, protection from legal liability, public participation in the review process, advances in remediation technology, and greater awareness of environmental protection through information dissemination. Local and state efforts are supported by federal initiatives that provide assurances for assimilation of previously contaminated lands aided by pilot demonstration projects, showcase revitalized communities, and innovative technologies for less expensive, more efficient, and quicker site assessment and subsequent cleanup.

State Initiatives for Brownfield Redevelopment in Florida

In addition to national initiative for brownfields remediation and redevelopment, the state of Florida has taken active steps to resolve problems of environmental contamination. The Florida legislature created the Brownfields Redevelopment Program in 1997 to achieve goals such as "reducing public health and environmental hazards on existing commercial and industrial sites, preventing premature development of farmland, open space areas, and natural areas, reducing public costs for installing new water, sewer, and public infrastructure, and addressing environmental and health consequences of contamination on minority and poverty populations" (FDEP, 2008). This program was a voluntary cleanup program targeted at landowners and developers instead of enforcing a regulatory government action agenda. In collaboration with local governments, the state of Florida identified 45 brownfields areas encompassing 66,959 acres (FDEP, 2008). As opposed to identifying specific sites, this program demarcated brownfields areas of varying acreage as shown in Figure 2.1.



Source: Department of Environmental Protection.

Figure 2.1 Superfund Sites in Florida

Number of specific contaminated sites within brownfields areas is unknown since they are defined only by the execution of a Brownfields Rehabilitation Agreement. This agreement is negotiated between the developer of the site and the Department of Environmental Protection and as of December 31, 2001 14 such agreements have been reached from 13 brownfields areas; only two of which lie in the Miami-Dade County. There were an additional seven agreements made up until 2007 (FDEP, 2008). These agreements are for sites designated as brownfields by the state environmental protection department and not the federal EPA and thus are not covered by federal grants. At the state level, three entities are primarily responsible for brownfields redevelopment – the Department of Environmental Protection, the Governor's Office of Tourism, Trade, and Economic Development (OTTED), and Enterprise Florida, Inc. (EFI). Enterprise

Florida, Inc. is a public-private partnership created by the Legislature to serve as the state's principal economic development organization and this association is borne out from the state's goals of job creation and business growth through brownfields redevelopment. The following table delineates the basic functions of the three entities involved in brownfields redevelopment:

Table 2.1 Organizations and Stakeholders Involved in the Brownfields Program

Local Governments	**Department of Environmental Protection**	**Office of Tourism, Trade, and Economic Development**	**Enterprise Florida, Inc.**	**Private Businesses**
Designate brownfield areas	Using RBCA, DEP develops cleanup schedule and task to be performed	Administers Brownfield Redevelopment Bonus Refund	Advertises and markets the brownfields program	Provides funds for cleanup and redevelopment
Offer local incentives	Executes cleanup agreement with responsible party	Director chairs loan guarantee council	Responsible for comprehensive marketing plan	Choose to rehabilitate brownfields
	Provides technical assistance to developers	Administers revolving loan fund	Assists companies that apply for incentives	Creates jobs and revitalize blighted communities
	Compile information about areas and sites			
	Issues "No Further Action" orders to signify completion of cleanup requirements			
	Administers voluntary tax credit			

Source: (OPPAGA, 2002)

In addition to the Brownfields Site Remediation Agreements, the department of environmental protection administers the voluntary tax credit for taxpayers who help clean up contaminated sites. This personal or property tax credit is valid for up to 35% of site rehabilitation cost not exceeding $250,000 per site per year. An additional 10% not exceeding $50,000 of the total cleanup costs may be claimed in tax credit in the final year of the site's cleanup. The OTTED offers refunds of $2500 per job created at the designated remedied site under the Brownfields Redevelopment Bonus Refunds program. In addition, the Brownfields Area Loan Guarantee Council guarantees up to 10% of the loan to brownfields developers and can also receive low-interest loans from the Brownfield Property Ownership Clearance Assistance Revolving Loan Trust Fund (OPPAGA, 2002).

In 2006, the Florida Legislature expanded benefits available to sites in the Brownfields Cleanup Program by authorizing changes to Voluntary Cleanup Tax Credit Program through House Bill 7131. The house bill expanded the program to include removal, transport, and disposal of solid waste from brownfields sites and it not only increased the previously available tax incentives but also provided a bonus incentive for sites redeveloped for affordable housing. The loan guarantees were increased from 10% to 50% and local governments were empowered to grant economic development *ad valorem* tax exemptions for certain businesses in designated brownfields areas and criteria of jobs created for exemptions were relaxed (FBA, 2008). The City of Miami and the Miami-Dade County also works in conjunction with the state departments in offering incentives for brownfields redevelopment and contamination remediation. See Appendix B for detailed profiles for Superfund sites under examination in Miami-Dade Country in Florida.

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 for 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 dissertation 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 brownfields 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 chapters, I examine the role of brownfields and their subsequent remediation through the different lens of real estate valuation, neighborhood change, and environmental justice (See Figure 2.2). 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.

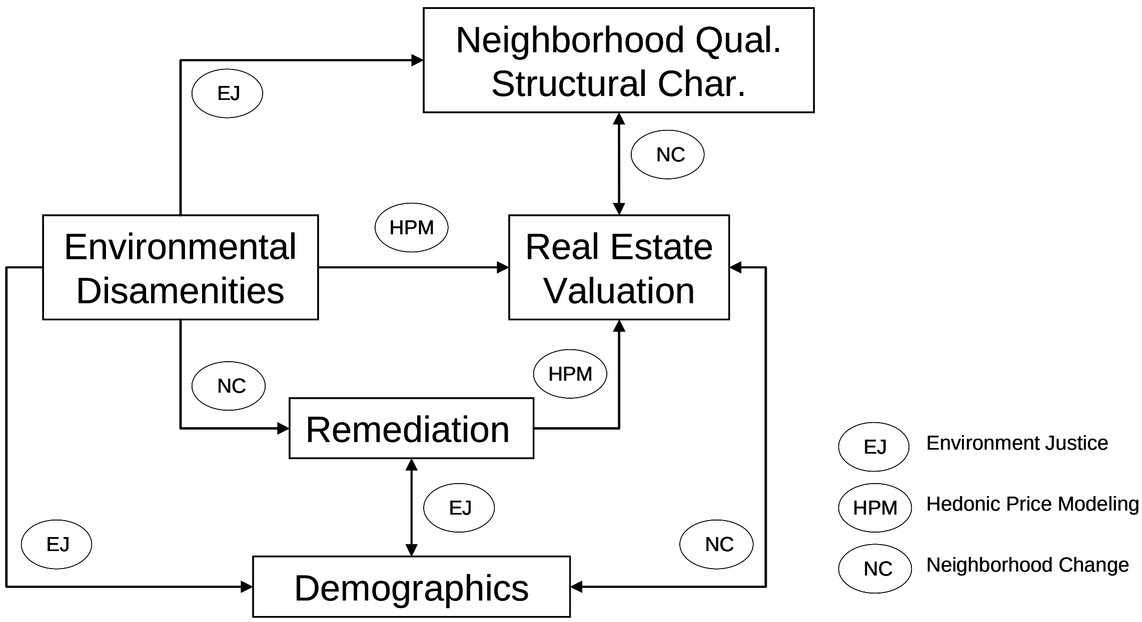


Figure 2.2 Relationship of Housing Valuation, Neighborhood Change, and Environment Justice

CHAPTER III

LITERATURE REVIEW: ENVIRONMENTAL DISAMENITIES AND HOUSING VALUATION

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). The theoretical foundations of the hedonic price model are rooted in willingness to pay for a bundle of interchangeable attributes within a good and these are elaborated upon in Chapter V and Appendix C.

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 & Pollakowski, 1977; Lansford Jr & Jones, 1995), or proximity to parks, green spaces, recreational areas, etc (Mahan, Polasky, & Adams, 2000; Vaughan, 1977). 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 & Huffman, 1996; Benson, Hansen, Schwartz, & Smersh, 1998; Grudnitski & Do, 1997). 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 measures the impact of environmental disamenities or brownfields on residential property values from the perspective of proximity, and type 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 1.1). For purposes of this dissertation, 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.

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; D. E. Clark & Nieves, 1991; Mendelsohn, Hellerstein, Huguenin, Unsworth, & Brazee, 1992; K. Nelson, 1981). Such undesirable land uses or disamenities might be perceived as dangerous to human health or a potential threat to safety.

The disamenities are usually also characterized by tenure i.e. whether the impact is short-term or long-term. Disamenities like contaminated lands are considered to have a relatively short tenure due to the possibility of a cleanup or remedial action in the future whereas other disamenities like an airport are considered long-term. The tenure of disamenities can determine if the price effect is temporary or permanent. Simons (R. A. Simons, 1999) examined the effects of a petroleum pipeline rupture on single-family house sale and townhouse sales in Fairfax County, Virginia and found a 5.5% and 2.6% reduction in sales prices for homes and townhouses respectively on the pipeline following the rupture. Such a price effect can be temporary as the prices are expected to rebound in due course of time after pipeline repair and subsequent cleanup of affected properties.

These are temporary shocks to the housing market and such negative effects are compounded by the immediate media attention that follows. But after corrective action either by the responsible private parties or the government, the negative economic impact lessens and often rebounds to pre-disaster levels. Carroll, Clauretie et al. (1996) studied three sub-samples of properties in the area of Henderson, Nevada, the location of the 1988 PEPCON explosion. They examined the price effect following the explosion and the subsequent announcement that the plant would be relocated to Utah. In one of their samples, initially before the explosion, prices increased at a rate of 4.6% at two miles from the plant signifying a negative price effect. The explosion caused a steep price drop by at least 17.6% but following the announcement regarding the relocation of the plant, prices rebounded by nearly 38%.

Although environmental disamenities range from quantifiable measures like air and water quality to intangible effects reflected by noise or visibility, this dissertation 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 Superfund sites and placed on the National Priorities List (NPL), as explained in Chapter II, are the focus of this dissertation. Threat from proximity to contaminated lands can be traced back to concerns for health leading to heightened risk perceptions among residents. These risk perceptions be it real or perceived lead people to lower their expectations for an optimized standard of living in the neighborhood due to other neighborhood factors such as abandonment and crime that often accompany such contaminated properties.

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 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 et al., 1995). Almost two-thirds of Americans polled by Gallup were “very concerned” about hazardous wastes (Masterson-Allen & Brown, 1990) and concern for protecting the environment as well as enforcing regulations on possible contamination has been high since early seventies. According to Gallup's annual Environment poll (2006) sixty percent of Americans think environmental quality today is "only fair" or "poor," and sixty-seven percent believe it is worsening, making it the highest negative rating when compared to the recent past.

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 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 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 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 can also 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. The role of transforming the perception of risk can be performed by the EPA notification proclaiming certain brownfields to be hazardous enough to be listed on the National Priorities List (NPL).

Effect of EPA Notification for NPL Superfunds

The federal government used the hazardous ranking system (HRS) established through CERCLA or the Superfund Act 1980 to evaluate the impact of the contaminated site on the environment and local resident and placed brownfields that scored above a certain threshold value (28.5) on the National Priorities List (NPL).

The negative impact of contaminated property placed on the NPL Superfund list on surrounding properties can be perceived to be greater as compared to other contaminated sites due to the heightened level of risk to health and environment. In fact, the effect on house prices may be significant as soon as the extent of contamination becomes known. Adler, Cook et al. (1982) examined the price effects of proximity to a hazardous waste site in Pleasant Plains, New Jersey that was later placed on the NPL list. They compared the sales prices before and after 1974 i.e. when the contamination became known. They observed a significant price effect of nearly $2700 per mile up to 2.25 miles from the contaminated site after the extent of contamination was known indicating the effect of confirmed information on presence of contaminated which otherwise might have just been perceived correctly or otherwise.

Similarly, Kohlhase (1991) examined the effect of EPA announcements and policy actions on local housing markets in Houston. Thus, homes close to the NPL toxic waste dumps experienced a significant downturn only after the sites had been identified and publicized by the EPA and this downturn reverses after EPA cleans up and deletes the site from the NPL list. This negative effect was attributed to the information obtained by consumers for the first time regarding the local contaminated site. Consumers use this information from the EPA announcements since they are unable to differentiate between the degrees of toxicity and relative harm of these sites. This information is translated into potentially depressed housing values. As Kohlhase (1991) notes, there was no significant perceivable impact on housing prices prior to the creation of Superfund although the contaminated sites had long existed in the neighborhood. This fact underlines our earlier assumption that specific knowledge about the level of contamination provided by credible authorities such as the environment protection agencies, federal or state, provides the tipping point for negatively influencing the surrounding property values. Skaburskis (1989) argues that an inactive site that existed before housing developed and did not generate a great deal of publicity had relatively little impact on sales prices more than 350 feet from the site. Reichert (1997) analyzes the impact of a Superfund toxic waste site in Uniontown, OH on surrounding property values. He observed a sharp downturn in values for surrounding properties following the period of peak publicity of the contamination. The effects were more pronounced in the immediate vicinity of the site than for properties further away.

However, regardless of the greater level of contamination on Superfund sites, the negative effects are not always consistent. Other intervening variables that influence housing price such as location of the community in a rural or urban locale or status of the real estate market have also shown to be influential. Michaels and Smith (1990) used a similar measure for the environmental variables – distance to nearest hazardous site and distance interacted with time of sale - with regards to hazardous waste sites as Nelson (1981) had for nuclear power plants. They studied the impact of the hazardous NPL-level waste sites in the Boston area using sales data while controlling for house and neighborhood characteristics and by also dividing their data according to various market categories i.e. Premier, Above Average, etc. and found a statistically significant impact for the time-distance interaction terms thus finding an early indicator of an environmental justice issue regarding differential effects of contaminated properties.

Greenberg and Hughes (1992) compared sales prices in communities in New Jersey with and without Superfund sites. However, they didn’t find significant differences between sites that qualified for NPL status and those that did not, but differences emerged after taking into account the location (rural vs. urban) and state of the real estate market (those experiencing rapid price increases vs. those that are not). This dissertation thus uses the sales price numbers from the time period after the EPA announcement proclaiming brownfields to be Superfund sites and before they are remedied conserving the stigma of contamination and maximizing the chances of measuring the negative impact on surrounding properties. Detailed histories of the Superfund sites under examination have been provided in Appendix B.

Transfer of Risk Perception to Economic Value

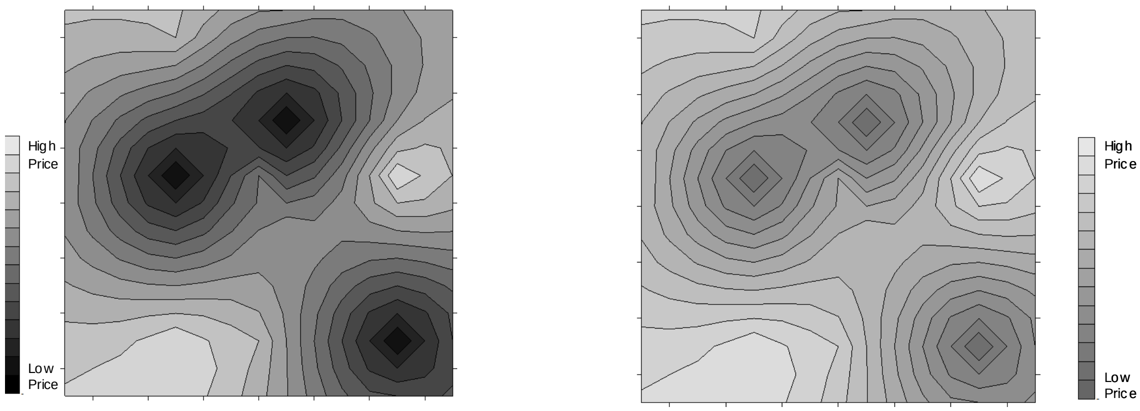
Localized contaminated lands like hazardous waste sites, landfills, and brownfields have a far greater impact on the neighborhood especially in the immediate vicinity, which reflects on the effect of perceived risks that are not only a function of statistical risk but also of other subjective risk factors such as dread, involuntariness, controllability, severity of consequences, etc (Slovic 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 (A. Freeman, 1979). This dissertation 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 this dissertation restricts itself 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 3.1).



Price Effect Before Remediation Price Effect After Remediation

Figure 3.1 Distance Decay Effects of Housing Price around Brownfields

There are several review studies that have documented examination of articles looking at effects of environmental disamenities. This dissertation on neighborhoods in close proximity to contaminated properties has been motivated from concerns of health as well as neighborhood quality that causes property values to decline. However, most studies analyzing the effect of undesirable land uses and activities focus on observing the price effect on residential properties. 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.

These studies often estimate the effect with respect to distance for micro scale impacts and property market effects for the larger regional macro scale studies (Farber, 1998). Boyle and Kiel (2001) analyze several local disamenities that have a negative impact on the surrounding property values. These disamenities include landfills, airports, and high-traffic roadways. Their study classifies environmental disamenities by air pollution, water quality, and undesirable land uses. The impact of undesirable land uses showed significant negative relationship on surrounding residential property value in most studies while also accounting for other factors like distance, information, neighborhood characteristics, and visibility. 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. Brisson and Pearce (1995) also review studies that estimate impact mostly from hazardous and municipal waste facilities thereby focusing on land uses that lead to unintentional contamination and mostly belong to the government. Such land contamination although equally hazardous is burdened by necessity of its presence in the urban region although choice of their location in particular neighborhoods can be a matter of debate.

Most studies rely on examining the effect of only one environmental aspect however some studies have included measures that have analyzed the impact of more than one environment factors (Blomquist, 1974; D. E. Clark & Nieves, 1991; Thayer, Albers, & Rahmatian, 1992) leading to a deeper understanding of the actual impact although the interaction of the contamination effects are likely to be highly correlated with each other.

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 (K. A. Kiel & 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 (V. K. Smith & Desvousges, 1986).

The effect of contaminated lands on surrounding housing is more pronounced in smaller communities. Smolen and Moore (1991) examined communities in suburban

Toledo, OH and found that property prices rose by almost 16-25% for each additional mile from an active hazardous waste landfill. This price effect was higher in the immediate proximity of the landfill and was not significant for homes more than 5.75 miles away. This pronounced effect was also noted by Greenberg and Hughes (1992) in their examination of impact of Superfund sites in 77 communities in New Jersey where they observed greater negative impacts on rural properties as compared to properties in urban communities.

Although proximity to brownfields 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. At the same time, the price effects are subject to rapid changes as the environmental harm is addressed. Kiel and McClain (1995)examined the price and distance effects of a municipal solid waste incinerator in Massachusetts. during different stages – prior to construction, during construction, and initial online and operations – of the siting process and found out that every additional mile from the site raised property values by $2671, $9497, and $7746 for each of the three phases respectively indicating proclivity toward increasing negative effects as the risk became more and more established.

Post-Remediation Impacts and Spatial Effects in Real Estate Valuation

After the CERCLA was amended in 1986 under the Superfund Amendments and Reauthorization Act (SARA), more than $2 billion had been spent by the federal government on Superfund assessment and cleanup grants (Hird, 1993). In addition to government appropriations, the Superfund enforcement program has received more than $24 billion in private party funding commitment. The decision to place any contaminated site on the NPL Superfund list is based on the HRS score that is largely related to health risk as opposed to economic loss. Similarly the cleanup decision is not related to the size of the impact population but rather is indirectly related to covert political factors like voter awareness and environmental group membership in the area (Viscusi & Hamilton, 1999). Gupta, Houtven and colleagues (1995) examine 110 Superfund sites to model the decision to clean up Superfund sites but find no significant relationship either to size of the site or to costs of excavating and treating contaminated soil. When the decision to cleanup a certain Superfund is taken, the level of cleanliness is predetermined and is expected to match the relevant state and federal standards. However, risk to the local affected population and the economic efficiency, two obvious factors were not incorporated in establishing the standards for the cleanup (Walker, Sadowitz, & Graham, 1995). Regardless of the reasons behind the choice of Superfund sites for cleanup, they inevitably have unintended yet significant effects on other aspects of the neighborhood such as property value, and demographics which is the objective of this dissertation.

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. Part of the reason for this shortcoming may be the lack of sufficient time between the cleanup and the measurement of impact. Kiel and Zabel (2001) examine the individual's implicit willingness-to-pay (WTP) to measure the effect of Superfund cleanup by using quantitative measures that cover primarily economic decision-making to examine the cost-benefit analyses of a Superfund cleanup. However, this study is restricted in its results since the positive impacts of remediation were measured just after the cleanup process had started. Reichert (1997) before cleanup had shown significant and negative impact on housing value due to the proximity of the Superfund site. The follow-up study (Reichert, 1999) failed to find any diminution of negative effect of the contaminated site in spite of the passage of time and introduction of city water thereby underscoring the heavy influence of the mere presence of a still-contaminated Superfund site. Another reason for the lack of price rebound might be because in some cases that stigma of being located near a Superfund site is likely to persist even after the cleanup is complete and often a lag period is lacking to measure price rebound. Both Kiel (K. Kiel & McClain, 1995) and Kiel and Williams (2005) indicate some signs of remnant stigma even after the cleanup had been completed.

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 (Boyle & Kiel, 2001; Farber, 1998;

Jackson, 2001; R. A. Simons & 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. (Schulze 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.

CHAPTER IV

LITERATURE REVIEW: NEIGHBORHOOD CHANGE AND ENVIRONMENTAL JUSTICE

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 (Dotzour, 1997; Kohlhase, 1991) 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 traditional grounds for justifying brownfields remediation has relied either on restoration of contaminated land from environmental and public health risks or on economic development concerns leading to creation of job opportunities (Kirkwood, 2001). Examination of the effects of brownfields redevelopment needs to extend beyond the technical and economic criteria and apply a holistic framework of analysis that includes sociodemographic changes in the proximate neighborhood. The housing price valuation literature fails to address the temporal effects for distance impacts of the brownfields and includes 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 structure 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 (Galster, 2001; Keller, 1968). The social scale of a neighborhood was historically defined by occupational and industrial differentiation, transportation network, and system of communication which in case of the United States was well developed and sharply defined (Greer & Orleans, 1962). The change in this social scale is often reflected by the urban land use and subsequently the social characteristics of the population within the neighborhood. A neighborhood defined by its population characteristics and bounded within certain geographic limits as specified reflects changes in observable indicators when certain pre-determined physical or social characteristics are altered. These characteristics or indicators can be organized around three dimensions: social status, familism, and ethnicity that include not only demographic factors like educational attainment, income, and occupational standing but also racial and ethnic identity that include individual familial traits like degree of fertility, female labor force participation, and housing choice (Schwirian, 1983).

Change in any of these defining attributes would subsequently alter other characteristics of the neighborhood and often highlight the relationships between those attributes. Focusing on community areas of Chicago from 1930-1960, Hunter (1971) and Hunter (1974) identified neighborhood change that involved change in social status and family characteristics and observed a relationship between spatial distributions of neighborhood change patterns and metropolitan population decentralization.

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. As with trends of decentralization, we can expect change in neighborhood patterns either physically or socially when such trends reverse in event of brownfields remediation. These changes in neighborhoods are reflected by other 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 causes depressed property values but also leads to social and physical decline of communities which further complicates potential redevelopment. Fear of crime in central cities through the mere presence of such abandoned and derelict properties can cause residents to withdraw physically and psychologically from community life thus adversely affecting the cohesive social fabric of the neighborhood. This results in a decline of organizational life and mobilization capacity of the neighborhood to ameliorate its social and physical problems leading to a downward spiral of decline (Skogan, 1986). This fear translates to degradation of business conditions and optimal standard of living for the residents leading to a vicious downward spiral of physical degradation and decline of neighborhood life in absence of any intervention by either the private sector or the government.

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 & 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, Galster, & Maclennan, 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. These models of neighborhood change are overarching and analyze change over prolonged periods of time. At the same time, it is worthwhile to understand the context of complex relationships between different dimensions of neighborhoods even if our focus remains on specific changes. For the purpose of this dissertation, I shall focus specifically on gentrification as a form of neighborhood change and examine causes of gentrification with respect to similar causes for overarching neighborhood change.

Incidence of Gentrification in Neighborhood Change

Largely understood initially as Hoover and Vernon's final step [renewal] in Neighborhood Life Cycle model, gentrification was first documented in 1970s (Clay, 1978; Lipton, 1977; Sumka, 1979) although the term 'gentrification' was first coined by Glass (1964) while observing the "invasion" of the members of the middle class and upgrading "shabby, modest mews and cottages" to "large Victorian lodging houses" and in turn, displacing the original "working-class occupiers." The initial understanding of gentrification was toward renewal of previous depressed inner-city neighborhoods by attracting middle-class residents, spurring investment, and raising local government revenue through increased property taxes. Given the changing preferences of the population, gentrification has saddled the middle-ground between reviving the decaying inner-city neighborhoods and causing the displacement of its original residents causing it to be subsequently referred to "as a 'chaotic concept' connoting many diverse if interrelated events and processes [that] have been aggregated under a single (ideological) label and have been assumed to require a single causal explanation" (Beauregard, 1986).

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, & Fleishman, 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, 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 (N. Smith, 1979, 1996) that gentrification is mainly driven by capital and land market. On the other hand, the demand-side perspective inspired by demographic/ecological perspective of neighborhood change relies mostly on change in factors like population, social organization, environment and technology (Hamnett, 1991, 2003; Ley, 1980, 1986).

These two competing perspectives are bounded by the socio-cultural realities that highlight the shifting trends in attitudes and values of the population that alter the social form of relationships and communications defining the character of the neighborhood. These changes reflect the changing demographics and cultural preferences of a 'new middle class' including societal trends like increasing feminization of the labor force, higher incidences of dual income professional and non-traditional households, and changing patterns of a population that redefine urban living.

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, E. 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 & 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 brownfields 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.

Gentrification as Neighborhood Change: The Post-Industrial City Hypothesis

With respect to gentrification as form of neighborhood change, the post-industrial hypothesis (Hamnett, 1991, 2003; Ley, 1980, 1986) focuses on the transformation of the economy and view neighborhood changes toward gentrification from the perspective of occupational class structure, nature and location of work, earnings and income, life styles, and finally the structure of the housing market. The emphasis of this perspective is less on the mechanisms of the market and movement of capital and more on the changing preferences of the population that make a deliberate choice to live in central city neighborhoods to make use of opportunities not easily available in the suburbs.

Compared to the capital and market-based perspective for neighborhood change and gentrification mentioned in the previous section, this perspective focuses on the transformation from an industrial manufacturing-based economy to a producer services-based economy resulting in change in population composition and demographic processes. This perspective hypothesizes that gentrification is caused by change in the industrial structure of major cities due to changes to producer service economy from a manufacturing one leading to demographic shifts from working-class blue collared population that inhabits central city neighborhoods to professional administrative white-collar class of population employed in the new economy. Concentration of these high-skill functions led to redefinition of economic structure by increasing occupation and income segregation that in turn affected the social segregation of residential space. Growing awareness and preference for urban lifestyle also gave increased importance to environmental and cultural amenities in decision-making for locating to revitalizing areas (Schaffer & Smith, 1986). Remediation of brownfields previously considered economically unfeasible became viable due to change in demand and previously disadvantaged neighborhoods with minority or vulnerable populations became desired locations for a growing class of population. Whether such transformation of the neighborhoods from lower-income populations to higher-income populations was deliberately coercive remains to be seen but the implications for environmental and social justice from changing preferences for urban living cannot be ignored.

Zukin (1987) and Hamnett (1991) argued that causes of gentrification lay in understanding of production of devalued neighborhoods that were eventually targeted for revitalization and consumption of the redeveloping neighborhoods based on their location and potential for growth. Such neighborhoods may have been host to previously contaminated brownfields that were targeted for remediation thus exposing the proximate neighborhood to gentrification. Displacement of residents that were subject to living in previously disadvantaged neighborhood hampered by the presence of contaminated brownfields by incoming residents who chose to relocate following remediation raises questions of unfair distribution of benefits in terms of environmental access.

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 transcend into related theories of power structure, political economy, and even participation democracy. Bullard and Johnson (2000) expand the environment definition in terms of “where people live, work, and play.” Thus, the concept of the neighborhood and surroundings in influencing opportunities and subsequently 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 as covert discrimination. 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 & McCarthy, 2001) especially when it comes to dealing with environmental contamination and subsequent decisions for remediation.

Although environmental justice goals have been mandated in the federal and state governmental mission statements, measures and processes of ensuring such outcomes has not been universally enforced either due to lack of established and conclusive empirical research or due to lack of political will at the state or local level. In spite of the overwhelming quantitative evidence of disproportionate exposure of environmental risk and disamenities to disadvantaged and vulnerable populations, several studies fail to account for spatial effects or do not include appropriate comparative regions against which to base conclusion of environmental injustice (Bowen, 2002). One of the earlier studies in environmental justice, Freeman (1979) proposed improvement of distribution of wealth as a way to improve the distribution of environmental quality since the two are highly correlated but at the same time lack any causation value. Similarly, Asch and Seneca (1978) showed high negative correlation between poor environmental quality (exposure to particulate matter in air) and socioeconomic variables in urban regions indicating concerns for environmental justice however evidence on strictly racial discrimination was inconclusive. The United States Governmental Accountability Office study also showed higher proportion of minorities living within four miles of large offsite hazardous waste landfills (USGAO, 1983).

Discrimination or Personal Choice?

In recent environment justice literature, there has been a constant discussion regarding reasons to locate near environmental disamenities. Are hazardous land uses deliberately sited 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 & Ulen, 2000). The inequitable exposure to contamination may amount to a form of racism and depends on the interaction of race and income variables and if this interaction holds true even after including other independent variables such as education, transportation, and industrial location (Kriesel, Centner, & Keeler, 1996). In spite of seemingly inconclusive evidences of racial discrimination regarding environmental access, the south Atlantic region especially

Florida (EPA Region IV) showed significantly more blacks located near hazardous sites (Stretesky & Hogan, 1998).

According to Rawls' Theory of Justice (1971), 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 for determining locational choices. 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. So in a sense, the issues of neighborhood change and contamination proximity indicates affinity for critical theory implications in a way that it seeks to emancipate the stakeholders from the circumstances that enslave them. It tries to also find a middle ground between brute quantitative theoretic results that seem to emerge from the free market mechanisms and normative constraints of social networking that define a community. As Horkheimer and Adorno (2002) defined such theoretical approach in a way that it is “adequate only if it meets three criteria: it must be explanatory, practical, and normative, all at the same time.”

However, the moral imperative of equitable environmental access may not be determined solely by outright discrimination on racial or economic grounds but also on the subsequent differential remediation decisions of contaminated properties located in disparate neighborhoods especially in the context of state-sponsored remediation. Although *Executive Order 12898* signed by President Clinton on February 11, 1994 calls upon the seventeen relevant federal agencies to develop strategic plans to specifically address environmental justice problems, it is pertinent to examine the social and environmental justice concepts within the purview of brownfields remediation and resulting sociodemographic change that might occur within the neighborhood and if they affect different neighborhoods differently.

Different Demographics form Different Submarkets

Submarkets are effectively delineated by neighborhood socioeconomic characteristics rather than individual properties under the assumption that people would prefer to live in neighborhoods that resemble their set of preferences and offer commensurable amenities that they directly relate with(Bourassa, Hoesli, & Peng, 2003). The primary factor in determining a housing submarket is obviously the housing price. Adair, Berry and colleagues (1996) use the house pricing structure to identify and differentiate housing submarkets. Other factors in delineating a housing submarket also can be wealth, ethnic makeup, suburban land use patterns, and the presence of young professionals (Day, 2003). In addition other factors such as demographics, crime, education level, professionalization, and type of housing may also determine housing submarkets and thus experience differential effects.

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. The effect on such submarkets can be reflected in the housing prices as sales or property prices are often reflective of structural, neighborhood, and environmental characteristics of the property and consequently that of the neighborhood (Bates, 2006). 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 et al., 1999; Bourassa & 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.

Differential Impacts Post-Remediation

Directly addressing problems of environmental justice in light of revitalization of previously disadvantaged neighborhoods specifically those with brownfields can 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.

Neighborhood revitalization is often directed at specific afflicted areas with the express intention of revising the targeted communities only at the cost of ignoring other regions. Such opportunity cost is often justified by revitalization planners by emphasizing the overall public and economic good for the rest of the urban region. However, by focusing the revitalization efforts on geographically delineated neighborhoods, the authorities ignore the common preferences and needs of the resident population as defined by the spatially incongruous housing submarket. Revitalization efforts are often most likely to impact property prices and thus affect other related characteristics of the neighborhood. Since the submarket is defined by the common factors and characteristics, any change in the neighborhood, be it by externally influenced revitalization efforts or market-driven forces of economic change, are likely to percolate throughout the affected submarkets through those factors. Considering that housing prices are a function of the structural, neighborhood, and environmental characteristics, they can be more closely predicted by the aggregated preferences and economic choices of individual submarkets instead of being applicable to dissonant residents who happen to live in proximate neighborhoods.

The valuation literature helps in stratifying the housing markets into submarkets based on certain environmental or locational characteristics (Bourassa, Hoesli, & Peng, 2002). Changes in these characteristics either by private-market intervention or government policies can therefore impact the housing prices in those submarkets. However, impact of such environmental characteristics may be exaggerated and also influenced by superfluous geographic boundaries and political limits. These limits also at times determine the differential impact of housing quality and prices and thus any redevelopment measures are also likely to have a discernible impact on the underlying property prices of each individual submarket due to those boundaries rather than the environmental characteristics.

Policy- or market-driven signals in form of revitalization efforts, or even revelation of a contaminated site similarly impacts properties in an associated submarket. Any change in one submarket such as shift in housing prices is also likely to affect other submarkets due to capital and labor mobility effects. These affected submarkets are likely to be proximately close to the submarkets where the change is being effected. This change in neighborhood structure within a submarket can also alter composition of the neighborhood depending on the elasticity of the preferences and economic choices of the constituents of the submarket.

Thus, in slight contrast to the Alonso-Muth model, price determination in submarkets is not only dependent on distance but also on a number of attributes such as housing quality, cost of living, neighborhood amenities, and demographic composition. These housing units may in turn be occupied by a certain class of population that may be demographically different. Thus, any changes to these characteristics of the submarket such as upgrading the housing stock or providing additional amenities such as schools or parks can have a positive impact on the housing prices of that submarket and in turn, move that particular community to a different submarket bracket since it falls beyond their means. On the other hand, such rise in housing prices due to positive influences will negatively impact the economic choices that certain section of residents can afford to make and will force them to move out to other neighborhoods or rather, other submarkets where they are better able to fit to their optimization gradient.

Negative influences such as revelation of a contaminated site are more likely to depress neighborhood prices and force residents who value those amenities more to move out to other submarkets where they are better able to optimize those preferences. They would be then replaced by residents who do not emphasize those preferences and may value the drop in the prices more than those who have moved out. Watkins (2001) defines effects on submarkets on structural dimension, spatial dimensions, demander characteristics, and joint influence of spatial and structural factors. Housing prices in submarkets can be influenced by ‘consumer groups’ who are formed on the basis of such joint characteristics in terms of how they value specific attributes. Thus, housing in submarkets can be segmented to cater to different kinds of consumer groups that are willing to pay for different attributes in different market segments (Watkins, 2001). In specific terms of environmental disamenities, Michaels and Smith (1990) found a significant difference across submarkets post-remediation with the greatest benefit accruing in the high-income neighborhoods, thus leading to questions of environment justice.

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 & 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. Although contamination proximity or brownfields 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, brownfields remediation was observed to have a greater positive impact in premium housing markets as opposed to other submarket types (Michaels & 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 (K. A. Kiel & Williams, 2005).

This dissertation 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.

CHAPTER V

DATA PREPARATION AND DESCRIPTION

Target Study Area

This section describes the geographical study area and its pertinent characteristics with a detailed look at the target population for this study. The section also examines the socio-economic and demographic characteristics of Miami-Dade County with a special emphasis on housing information.

Miami-Dade County (formerly known as Dade County), located in the southeast part of Florida, is the state's second-largest county in terms of land-area with 1,946 square miles. According to the 2000 Census, there were nearly 2, 253,485 people (2,402,208 as per 2006 project estimate), making it Florida's most populous county, divided into 776,774 households, and 548,402 families with a population density of 1,158 people per square mile. The high population density makes Miami-Dade county heavily urbanized. The county has 35 incorporated areas (up from 27 in 1990) along with many other unincorporated areas, most of which are considered as Census-designated places. Being a coastal county, most of these regions lie on the eastern coastline with the western portion extending into the Everglades National Park (see figure 5.1).

Figure 5.1 Miami-Dade County, Florida

Demographics and Economics

One of Miami-Dade's unique demographic characteristics is the high proportion of people of Hispanic ethnicity (57.32 percent) and high percentage of foreign-born population (50.9 percent). The county's racial demographic includes 69.70 percent White (20.7 percent Non-Hispanic White), 20.29 percent Non-Hispanic Black, 0.19 percent Native American, 1.41 percent Asian, 0.04 percent Pacific Islander, 4.58 percent from other races, and 3.79 percent from two or more races. Although the percentage of foreign-born population in Miami-Dade is high, 47 percent are naturalized U.S. citizens and countries of those foreign-born residents include Cuba (46 percent), Nicaragua (8 percent), Colombia (7 percent), Haiti (6 percent), Dominican Republic (3 percent), Honduras (3 percent), and Jamaica (3 percent) (Miami-Dade, 2008).

The median age in the county is 36 years with 24.80 percent under the age of 18, 9.10 percent from 18 to 24, 31 percent from 25 to 44, 21.70 percent from 45 to 64, and 13.30 percent who are 65 years of age or older. The average household size is 2.84 and average family size is 3.35, well above the national average. The median income for a household in the county is $35,966, and the median income for a family is $40,260 with 14.50 percent of families below poverty level.

Housing

According to the 2000 Census, there were 852,278 housing units in Miami-Dade County, up from 771,288 units in 1990, an increase of nearly 8,000 units per year or 10.5 percent. This growth was impeded by Hurricane Andrew in 1992 when thousands of homes were destroyed, not all of which were rebuilt. The housing units are distributed near-equally within incorporated and unincorporated areas of the county with 382,482 units or 45 percent lying in the unincorporated areas, up slightly from 44 percent in 1990 (Miami-Dade, 2005). The City of Miami predictably accounts for 148,388 units or 17.4 percent with Hialeah second with 72,142 units (8.5 percent), Miami Beach third with 59,723 (7.0 percent), and the City of Islandia having the least with just 5 housing units. The largest increases came from unincorporated areas which added 53,000 units or 65 percent of the total gain. If the seven incorporations within the same time period are ignored, then unincorporated areas as of 1990 would have added nearly 72,000 units or 90 percent of the total growth (Miami-Dade, 2005).

The percentage of owner-occupied units in Miami-Dade County is 57.9 percent, up from 54.2 percent in 1990, with 68.8 percent of all housing units lying in the unincorporated areas being designated as owner-occupied. There are nearly 335,815 single-family owner-occupied housing units with a median value of $124,000.

The Miami-Dade region is considered one of the fastest growing regions in the nation so homeowner vacancy rates of 2.1 percent and 5.6 percent for rental units are lower than the national average. However there are a significant number of overcrowded housing units in 2000 – 13.3 percent for owner-occupied and 29.2 percent for renter-occupied – up significantly 35.3 percent for owner-occupied and 17.1 percent for renter-occupied from 1990 (Miami-Dade, 2005). These high levels can be attributed to continued and increasing levels of immigration with a tendency for shared housing among recent immigrants. But contrary to expectations, housing without adequate plumbing facilities are low at 0.61 percent for owner-occupied and 1.59 percent for renter-occupied. These low numbers can be attributed to recency of housing stock built after 1970. Finally, the median housing values for owner-occupied housing increased from $86,500 to $113,200 and median contract rents increased from $422 to $572 from 1990 to 2000. However, there is great disparity in these values across the region.

Data Preparation

This section describes the data sources used in this study and the formats they were available in. It also explains the data validation and preparation techniques highlighting sources of error and steps taken to account for such errors. Finally, it lists and describes the variables included in the study.

Data Sources

This study is based on secondary data collected from a variety of sources. The property data for this study is drawn from Miami-Dade County, Florida. The original dataset consists of sales transactions of properties from this market and were obtained from the Miami-Dade County Property Appraisers office. 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 at regular intervals by the researchers at The Hazard Reduction & Recovery Center at Texas A&M University by merging annual datasets.

This dataset is stratified by County Land Use Code (CLUC), State Land Use Code (SLUC) description, municipality, district, and neighborhood to denote the various jurisdictions that the properties are located within. This study focuses primarily on the nearly 270,000 single-family residential properties denoted by CLUC 0001. Other types of housing units like condominiums, multi-family, cluster housing, cooperative housing, mobile homes, etc. are excluded from this study. Property characteristics for two time periods, 1992 and 2001, are selected and saved in separate datasets.

The brownfields data for this study in the Miami-Dade Country region is 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 brownfields is obtained from Enterprise Technology Services Department (ETSD) located in the County offices of Miami-Dade and Florida Geographic Data Library (FGDL) at the University of Florida's GeoPlan Center. This GIS dataset contains information on thirteen NPL sites such as facility name, address, and spatial location in terms of latitude-longitude. Additionally, the dataset also differentiates the brownfields by their status (active or delisted), type of operation (level of contamination) and size (in acres).

Other neighborhood and socioeconomic data like poverty rates, race demographics, income levels etc. are obtained from the 1990 and 2000 Census databases. For analyzing contemporaneous neighborhood change around the Superfund sites, Neighborhood Change Database from Geolytics at Texas A&M Libraries is used to obtain Census data at Census Tract level. Crime data are obtained from the FBI's Uniform Crime Reports. Crime data by jurisdiction for 2001 and 1996 (earliest available) are obtained from Florida Department of Crime and Law Enforcement. School quality data for 2001 is obtained from Florida Department of Education's School Indicators report website. Due to non-availability on the website, corresponding school quality data for 1993 is obtained in hard copy format through correspondence with Assessment, Research and Data Analysis Department, Dade Schools.

Data Validation

This section describes data validation and preparation techniques employed to customize the relevant variables for analysis in this study. These customizations were done to ensure precision, uniformity, and relevance for accurate measurement of the theoretical data constructs. Due to the large number of variables used, differential scales of data aggregation, and the variety of explanatory characteristics in accounting for variance in the dependent variable, effort is taken to ensure compatibility among different measures as evinced in the literature.

Dependent Variables

The dependent variables for this study are sales transaction prices of the single-family residential properties in the dataset. In the original dataset, the sales prices were expressed in US dollars and listed on an annual basis. If the property was sold more than once in a year, all sales price values were listed with a maximum of three sales price values per year. For this study, the sales price values for a particular year are abstracted by averaging the multiple sales prices in the year. Properties which did not experience any sale are assigned missing values. In order to maximize the number of properties with relevant sale price values, average values for 1993 and 2000 are calculated along with the study periods of 1992 and 2001. The maximum value between average sales price in 1992 and 1993 is considered as the average sales price for 1992 and similarly the maximum value between average sales price in 2000 and 2001 is considered as the average sales price for 2001. These values are matched to individual properties based on folio numbers for the periods 1992 and 2001respectively and adjust for inflation by using the Consumer Price Index.

Independent Variables

The independent variables for this study are divided into four distinct groups – structural variables, neighborhood variables, environmental disamenities variables, and submarket variables. While individual properties in the dataset are associated with their corresponding structural variables, neighborhood, brownfields, and submarket variables are assigned to individual properties based on the jurisdiction they lie in. The jurisdiction for each group of variables depends upon the availability of the data. For e.g. most socio-economic neighborhood variables like race, income, poverty, etc. are available at census tract level whereas school quality and crime data are available at school district level and municipality jurisdiction level respectively.

Structural Variables

Structural variables such as number of bedrooms, bathrooms, half-bathrooms, living area, lot size, year built, and tenancy length were already associated with individual properties in the dataset. The age of the structure on the property is calculated by subtracting the year built from 1992 and 2001 respectively and likewise for tenancy length.

Neighborhood Variables

Neighborhood variables such as proportion of people living under poverty, proportion of minority population, median household income, proportion of population with college education, proportion of vacant properties, proportion of owner-occupied houses, and rate of unemployment are measured at census tract level and are available from Census data (SF1 and SF3). Values for such variables are tabulated at census tract level for 1990 and 2000. Using GIS tools, individual properties in 1992 and 2001 are assigned census tract IDs corresponding to 1990 and 2000 census data respectively. Thus values for neighborhood variables measured at census tract level are assigned to individual properties according to the census tract that they lie in.

Due to Miami-Dade County's unique ethnic mix, the proportion of minority population variable is divided into three separate variables – proportion of non-Cuban Hispanics, proportion of non-Hispanic Blacks, and proportion of non-Hispanic (all) minorities. This differentiation is due to the high prevalence of Hispanics and more specifically Cubans within Miami-Dade region. Cubans are traditionally economically better-off than other Hispanic groups (Perez, 1986) and in turn Hispanics are traditionally economically better-off than non-Hispanic blacks (African-Americans). Minorities other than Hispanics and African-Americans are present in much less numbers proportionally as compared to other regions in the nation; they are subsumed in the non-Hispanic (all) minorities variable that also includes African-Americans. These variables are obtained from the race demographics table and the Hispanic or Latino Origin by Specific Origin table in the Census datasets. Additionally, the Neighborhood

Change database from Geolytics data is used for comparing neighborhood change. The Geolytics data contains all census information with matched geographies for 1970, 1980, 1990, and 2000 such that all data is normalized to 2000 tract boundaries making it easier for comparison in such longitudinal studies.

The tax rate variable was present in the original dataset and associated with individual properties. This variable is measured in mills or millage rate (amount of tax per thousand currency units of property value) which is used as a base factor for calculating property tax. To calculate the property tax, the appraisal office multiplies the assessed value of the property by the mill rate and then divides by 1,000. Proportion of housing in bad condition is measured by calculating percentage of housing units without adequate kitchen and plumbing facilities at census tract level and assigned to properties that lie in the census tract. For calculating other neighborhood variables such as distance from the coast and distance to the central business district (Flager St. and 1st Avenue), Euclidean straight-line distance measurement (in feet) is used with the help of GIS tools.

Crime Index Variables

The crime index variable measures the number of property and violent crime incidences per 1,000 people. Violent crimes include murder, forcible rape, robbery, and aggravated assault and property crimes include burglary, larceny, and motor vehicle theft. Crime data is available through FBI’s Uniform Crime Reports (UCR) database at municipality or incorporated area jurisdictional level. These jurisdictions voluntarily report crime incidences to the FBI annually. Properties lying in incorporated areas that have voluntarily reported crime incidences to the FBI are assigned corresponding crime index rates in 1990 and 2000. For properties lying in unincorporated areas and in areas that had not reported crime incidences, GIS tools are used to identify the nearest jurisdiction for which crime data was available and the crime index value of this nearest jurisdiction is then assigned to these properties. For properties in jurisdictions not reporting crime incidences, this assigned crime index is also weighted by the population of the jurisdiction they actually lie in.

School Quality Index Variable

The school quality index measures the relative quality of high schools located near individual properties. For each high school, the school quality index is created by combining six variables – number of students taking Advanced Placement (AP) exams, mean Scholastic Aptitude Test (SAT) score, mean American College Testing Program (ACT) score, mean Florida Comprehensive Assessment Test (FCAT) score, Student-Teacher ratio, and per pupil expenditure. For 1992, mean Reading/Math Grade 10 Assessment score is used instead of FCAT score because FCAT was not uniformly administered. Using GIS tools, residential properties are assigned school quality index values according to the school attendance district they lay in. School attendance district boundaries were only available for 2007. Hence online resources from Miami-Dade County Public Schools are used to identify school attendance districts that the properties belonged to in 2000, and the corresponding school index values are assigned to those properties. A similar determination and assignment is done for 1990.

Environmental Disamenities

The primary independent variables for this study relate to proximity and nature of environmental disamenities. Using GIS tools, the Euclidean straight-line distance from each property to each of the NPL sites is calculated. Using these distances, the distance to the nearest NPL site is assigned to individual properties including other characteristics of the NPL site like remediation status, size, and nature of contamination present on the site. For 2000, the remediation status variable denotes the status of contamination – remedied or not (delisted or active) – of the nearest NPL site whereas for 1990, all NPL sites are considered contaminated or listed as active. Dichotomous variables are created to encapsulate the nature of contamination present on the nearest NPL site. The types of contamination included electroplater, chemical manufacturer /processor, industrial solvent disposal, landfill/dump, pesticide/insecticide/herbicide, and military base. To calculate the proximity of other NPL-level disamenities, the distances calculated earlier are used to count the number of NPL sites within a two-mile buffer of each property.

The land use mix variable is calculated to measure the number of commercial and industrial properties within the census block group in which a specific property lay. Using GIS tools, the number of all geocoded properties is calculated at the census block group level and compared to the number of commercial and industrial properties in the same census block group. The commercial and industrial properties were demarcated by the following CLUC codes 0011 (Retail Outlet), 0012 (Repairs), 0013 (Office), 0014 (Wholesale), 0015 (Entertainment), 0019 (Automotive Marine), 0021 (Hotel), 0022

(Motel), 0026 (Service Station), 0029 (Mixed Commercial), 0031 (Mineral Processing), 0032 (Light MFG Food Processing), 0034 (Canneries), 0037 (Warehouse), and 0039 (Mixed – Industrial). The proportion of such commercial and industrial properties is calculated for each census block group and assigned to individual properties that lay in the corresponding census block group.

Housing Submarket

High school quality using quartile frequency distribution method is used to demarcate housing submarkets. Four dichotomous variables were created to denote the submarkets. To assign properties to these specific housing markets, properties that lay in regions with similar school quality values were assigned corresponding values in dichotomous form using GIS tools. E.g. submarket 1 represented census block groups with values in the 25 percent quartile for school quality and assigned a value of 1 and zero for other submarket (2-4) variables. School quality, as opposed to housing structural characteristics is considered to be a better indicator of neighborhood quality and is used as a proxy to reflect differences in socioeconomic characteristics. As tables on pages 104 and 106 indicate, submarket 4 is considered to be socioeconomically better-off when compared to other submarkets and likewise submarket 1 is socioeconomically worse-off than other submarkets. Higher school quality is expected to be positively correlated to socioeconomic characteristics as measured by crime rate, education level, median household income, housing condition, including sales price. Such submarket segmentation results in non-contiguous housing submarkets as shown in Figure 5.1 and is considered a better indicator for price differentiation. School attendance districts in Miami-Dade County have been previously observed to be appropriate proxies for housing submarkets in order to reflect variance in housing prices (Hollans & Munneke, 2003).

Census Block Group Aggregation

The unit of analysis for this study is the Census Block Group (CBG). All data assigned to individual properties as described above is abstracted to the census block group that they lie in. Except for remediation status, NPL proximity, nature of contamination, and school region variables, mean values of property characteristics are used to aggregate values to the CBG level. For the rest, median values are used. Using GIS tools, x-coordinates and y-coordinates of centroids based on the NAD 83 State Plane Florida East coordinate system are calculated for each census block group for spatial analysis.

Table 5.1 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 5.1 Variables and Indicators with Level of Measurement and Data Source

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
Independent Variables				
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 Superfund sites within two-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 individual properties	Census Block Group	Continuous	Florida PAO
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	Continuous	Census 1990/2000

Table 5.1 continued

Factor	Indicators	Level of Measurement	Variable Type	Source
Neighborhood Characteristics				
Homeownership	Proportion of homes owner-occupied	Census Block Group	Continuous	Florida PAO
Poverty	Proportion of people living under poverty	Census Tract/ Block Group	Continuous	Census 1990/2000
Minority	Proportion of minority population within census tract	Census Tract/ Block Group	Continuous	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	Continuous	Census 1990/2000
Vacancy	Proportion of vacant properties within census tract/block group	Census Tract/ Block Group	Continuous	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	Continuous	Census 1990/2000
Tax Rate	Average Tax Rate; measured in mills	Census Block Group	Continuous	Florida PAO
Land Use Mix	Proportion of commercial and industrial land uses	Census Block Group	Continuous	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	Census Block Group	Dichotomous	Florida PAO; ETSD/ FDGL

Descriptive Statistics

This study uses nearly 270,000 single-family residential properties in the Miami-Dade County aggregated at CBG level. The cross-sectional datasets are constructed for two time periods, 1992 and 2001. There are 955 CBGs in the 1992 dataset and 1076 CBGs in the 2001 dataset. Each dataset consists of structural, neighborhood and environmental disamenities variables associated to individual census block groups that are aggregated from the individual property dataset as described earlier.

Data is aggregated to CBG level to account for sample selection issues in the dependent variable (sales price) since 197,505 properties in 1992-93 and 216,672 properties in 2000-01 experienced sales transactions. Also, data is aggregated to the census block group to correct for clustering of standard errors due to spatial dependence of sales price transactions.

All Properties

The number of properties range from one to 2375 with an average of 282 properties per CBG. Census Block Groups with fewer than 10 properties (7%) are excluded from the analysis. There are 888 Census Block Groups in the 1992-93 dataset and 1000 Census Block Groups in 2000-01 dataset with more than ten properties per CBG. Environmental disamenities (except remediation status) and distance variables remain constant in both time periods and hence are listed only once. Tables 5.2 and 5.3 present the descriptive statistics of the targeted data at CBG level in 1992-93 and 2000-01 respectively:

Table 5.2 Descriptive Statistics 1992-93

Variables	Minimum	Maximum	Mean	Std. Deviation
Dependent Variables				
Average Sales Price (year 2000 dollars; $)	$13,876	$1,557,614	$88,852	$90,627
Structural Variables				
No. of bedrooms	1.70	5.16	2.86	0.398
No. of bathrooms	1.00	4.84	1.66	0.453
No. of half-baths	0.00	.56	.043	0.056
Age of structure (years)	2.95	69.09	37.62	11.19
Living area (sq. ft.)	832.44	7862.36	1660.44	582.75
Lot Size (sq. ft.)	2070.00	370961.65	12101.37	21725.69
Tenancy Length (years)	15.74	78.00	29.91	9.15
Property Tax Millage (mills)	100.00	3005.00	1582.53	1343.58
Environmental Disamenities				
Distance to nearest NPL (miles)	0.11	9.05	2.91	1.70565
No. of NPL sites in 2-mile radius	0.00	5.00	.50	.89594
Area of NPL site (acres)	0.77	3373.94	219.78	741.50
Percent of Commercial & Industrial land use	0.00	56.07	4.80	6.36
Neighborhood Variables				
School Quality Index (1993-94)	16.97	83.85	38.56	11.63
Mean Crime Rate - Violent & Property	7.78	104.38	64.93	25.25
Percent Non-Cuban Hispanic	0.42	57.57	17.13	9.98
Percent Non-Hispanic Blacks	0.03	98.93	26.47	33.38
Percent College Educated	3.61	68.89	25.11	13.98
Percent Unemployed	0.00	14.53	5.7907	2.25
Median Household income ($)	$6,221	$101,019	$28,220	$14,172
Percent Below Poverty	2.09	68.01	20.15	13.57
Percent Vacant	1.44	31.26	7.43	5.27
Percent Owner-occupied	4.40	91.71	53.35	21.94
Percent Housing in Poor Condition	0.00	15.70	1.9116	2.01
Distance to CBD (miles)	0.71	30.79	8.7226	5.76
Distance to Intl Airport (miles)	1.13	28.83	7.7481	5.18
Distance to coast (miles)	0.01	9.54	1.93	1.75

Table 5.3 Descriptive Statistics 2000-01

Variables	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Dependent Variables				
Average Sales Value 2000-01 ($)	$21,422	$1,637,521	$96,526	$97,196
Structural Variables				
No of Bedrooms	1.52	5.26	2.94	0.413
No of Bathroom	1.00	4.96	1.73	0.46
No of Half Baths	0.00	0.71	0.0502	0.07
Age of Structure (years)	10.39	80.07	44.24	12.71
Living Area (sq. ft.)	768.54	7298.83	1744.07	588.60
Tenancy Length (years)	4.54	22.20	12.73	2.68
Lot Size (sq. ft.)	3274.03	370961.65	12101.34	22081.48
Property Tax Millage (mills)	100.00	3000.00	1693.03	1318.98
Neighborhood Variables				
Mean Crime Rate - Violent & Property	9.79	132.06	42.66	19.21
School Quality Index	27.58	79.59	37.52	8.31
Percent Non-Cuban Hispanic	1.29	68.22	23.96	12.90
Percent Non-Hispanic Blacks	0.00	96.99	25.77	32.31
Percent below Poverty	0.00	65.17	20.24	12.54
Percent unemployed	0.00	34.34	10.02	5.49
Percent College	11.44	91.04	41.35	18.99
Median household income ($)	$8,853	$133,073	$38,096	$19,581
Percent Vacant	0.00	34.64	6.4184	5.55
Percent Owner Occupied	0.00	90.07	47.93	23.97
Percent Housing in poor condition	0.00	27.14	3.01	3.37

As seen in tables 5.2 and 5.3, the average sales price (inflation-adjusted) at the CBG level rose from $88,852 to $96,526; an increase of 8.3 percent. In the structural characteristics, the average number of bedrooms, bathrooms, half-baths, and living area increased on the same property lots. These changes may be attributed to new construction, structural modifications, or subdivision of larger lots into smaller ones to build more units. The average tenancy length measured at the CBG level decreased by more than 60 percent indicating higher turnover in properties over the time period.

In the neighborhood characteristics, mean crime rate at CBG level decreased drastically by nearly 35 percent while school quality decreased slightly by less than 3 percent. The proportion of non-Cuban Hispanics increased by 40 percent and proportion of non-Hispanic blacks increased by 2.5 percent, indicating an increasing diversification of an already-cosmopolitan metropolis. The growth of the local economy and increasing property prices attracted people with higher education and household income. The average proportion of people with college education increased by over 65 percent between 1992 and 2001, and average household income also increased by 35 percent in the same time period. Surprisingly, the average proportion of people living below poverty and proportion of unemployed people remained the same or increased slightly indicating greater segregation within the population.

The proportion of vacant housing also remained more or less the same but considering that this region experiences higher level of property transactions for investment purposes, the average proportion of vacancy at 6-7 percent is not too high. This may also explain the 10 percent drop in proportion of owner-occupied housing over the same time period. Due to high turnover rate and continuous upgrading of the housing stock, the average proportion of properties at the CBG level with housing in poor condition is low. However, the highest value of proportion of low quality housing increased from 15 percent to 27 percent indicating aging housing stock and lack of maintenance in certain sections of the region.

Regarding the environmental disamenities variables, the average distance to the nearest NPL site is nearly 2.91 miles. However according to the figure B.1 showing the location of NPL sites in the region, most of the sites are located in the northern region. Some NPL sites near the center of the region are also clustered indicated by the high value of NPL sites within a two-mile radius. Nearly 280 CBGs have one or more NPL sites in a two-mile radius although the majority of properties in the region are more than two miles away from the nearest NPL site. The average size of the NPL sites is skewed by the presence of a large NPL site in the southern portion of the region. The average proportion of industrial and commercial properties within CBGs included to account for other possible brownfields is relatively low with only 12 percent of CBGs having more than 10 percent of commercial or industrial land uses within the CBG indicating distinctly zoned neighborhoods for disparate land uses within the region. Among other distance variables, the average distance to the coast is less than 2 miles which is not surprising considering that Miami is a coastal city and bordered on the western front by the Everglades National Park thus clustering most residential properties closer to the coast. The average distance to the airport and CBD is less than 10 miles with the maximum distance being not more than 30 miles indicating a highly dense region for single-family residential homes.

By Submarkets

The Miami-Dade County is divided into submarkets based on the high school quality using quartile frequency distribution method and are depicted in Figure 5.2 for 1992 and 2001. The CBGs in individual submarkets are not necessarily contiguous.

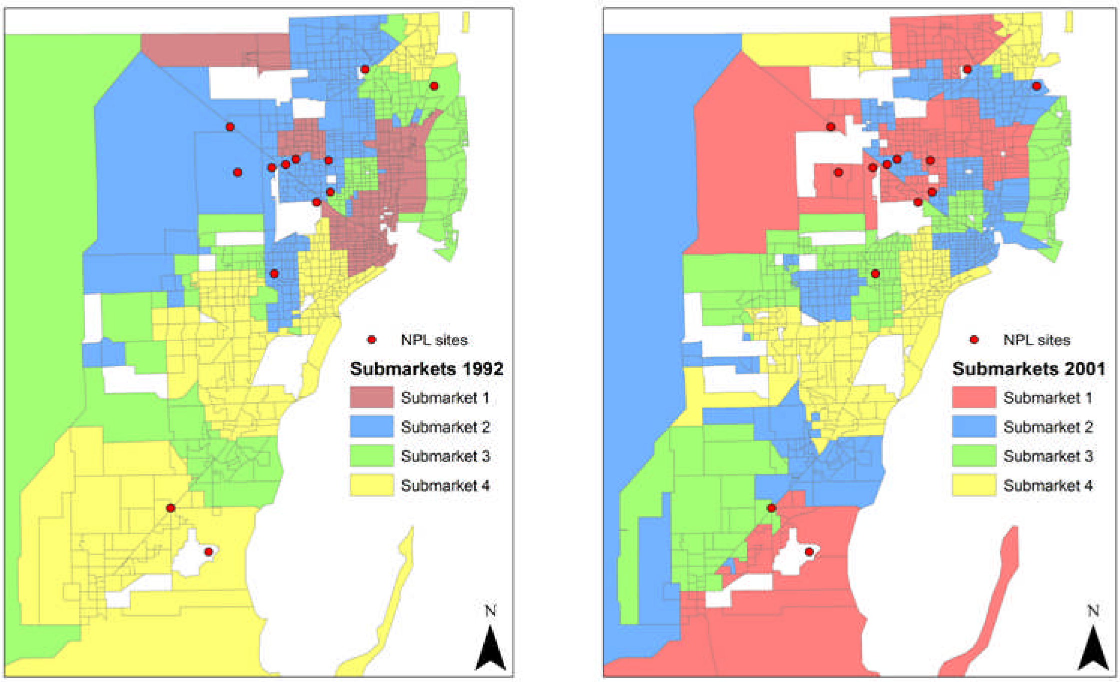


Figure 5.2 Submarkets Segmentation by High School Quality

As seen in Tables 5.4 and 5.5, there is much variation across submarkets in terms of sales price, structural characteristics, and neighborhood characteristics. The environmental disamenities and distance variables are displayed only for 1990 since they do not change in 2000 except for remediation status. Submarket 1 is expected to represent the lower socioeconomic CBGs and subsequently submarkets 2, 3, and 4 represent increasing levels of socioeconomic status. However, in 1992 submarket 2 has a higher number of NPL sites and the lowest average distance to the nearest NPL site. Additionally, it also has the lowest average sales price but on other neighborhood factors like crime rate and demographic factors like non-Cuban Hispanics, non-Hispanic blacks, median household income, percentage college educated, percentage below poverty, and percentage of poor housing conditions, it ranks lower on the socioeconomic scale as compared to submarket 1. Submarkets 3 and 4 display consistent and uniform indicators including average sales price, and other neighborhood characteristics pertaining to their higher socioeconomic status. Additionally these submarkets are also located closest to the coastline.

For the submarket segmentation in 2001, submarkets 1 through 4 display a more uniform increase in socioeconomic indicators with increasingly levels of average sales price. Submarkets displaying lower socioeconomic indicators also show higher crime rates and higher percentage of poor and unemployed populations. Median household income is lower in submarkets 1 & 2 as compared to submarkets 3 & 4 and there is a higher percentage of non-Hispanic blacks in submarkets 1 & 2 although the percentage of non-Cuban Hispanics is similar.

Table 5.4 Descriptive Statistics by Submarket 1992-93

Variables	**Submarket 1 (n=216)**	**Submarket 2 (n=242)**	**Submarket 3 (n=185)**	**Submarket 4 (n=247)**
Dependent Variables				
Average Sales Price (2000 dollars; $)				
Mean	$69,100	$62,055	$101,741	$123,079
Std. Deviation	$57,938	$32,639	$136,738	$97,424
Structural Characteristics				
No. of bedrooms				
Mean	2.70	2.79	2.92	3.03
Std. Deviation	0.30	0.33	0.47	0.41
No. of bathrooms				
Mean	1.52	1.51	1.77	1.85
Std. Deviation	0.29	0.29	0.61	0.47
No. of half-baths				
Mean	0.04	0.03	0.04	0.06
Std. Deviation	0.05	0.04	0.06	0.07
Age of structure (years)				
Mean	46.81	35.77	37.28	32.01
Std. Deviation	10.57	7.83	10.45	10.35
Living area (sq. ft)				
Mean	1533.70	1433.79	1750.45	1930.50
Std. Deviation	323.42	314.33	792.02	663.52
Lot Size (sq.ft.)				
Mean	7120.44	8461.50	9611.69	14085.42
Std. Deviation	1825.15	3309.09	6910.38	12703.56
Tenancy Length				
Mean	33.01	29.51	30.99	27.04
Std. Deviation	11.78	7.12	9.93	7.01
Property Tax Millage (mill)				
Mean	476.62	2064.62	1840.74	1858.55
Std. Deviation	839.24	1228.53	1309.82	1309.65
Environmental Disamenities				
Distance to nearest NPL (miles)				
Mean	3.12	1.84	2.99	3.71
Std. Deviation	1.16	1.09	1.90	1.88

Table 5.4 continued

Variables	**Submarket 1 (n=216)**	**Submarket 2 (n=242)**	**Submarket 3 (n=185)**	**Submarket 4 (n=247)**
Area of NPL site (acres)				
Mean	34.76	17.12	210.52	571.53
Std. Deviation	51.48	68.02	644.18	1196.04
No. of NPL sites in 2-mile radius				
Mean	0.38	1.02	0.42	0.15
Std. Deviation	0.88	1.19	0.63	0.37
Percent of Commercial & Industrial Land use				
Mean	7.37	4.32	4.63	3.30
Std. Deviation	7.53	6.20	6.01	4.92
Neighborhood Characteristics				
School Quality Index				
Mean	25.87	33.66	39.88	53.33
Std. Deviation	4.69	2.64	2.18	8.57
Mean Crime Rate - Violent & Property				
Mean	81.11	58.57	60.92	59.97
Std. Deviation	22.58	20.14	25.91	25.81
Percent Non-Cuban Hispanic				
Mean	22.28	15.75	14.20	16.46
Std. Deviation	12.67	8.11	9.38	7.98
Percent Non-Hispanic Blacks				
Mean	22.01	36.15	36.91	12.89
Std. Deviation	30.92	35.62	38.48	21.41
Percent College Educated				
Mean	18.38	20.59	26.17	34.53
Std. Deviation	10.46	9.56	13.36	15.40
Percent unemployed				
Mean	7.18	6.16	5.85	4.22
Std. Deviation	2.38	1.58	2.23	1.70
Median household income				
Mean	$20,669	$26,443	$25,842	$38,055
Std. Deviation	$8,860	$7,419	$13,530	$17,698

Table 5.4 continued

Variables	**Submarket 1 (n=216)**	**Submarket 2 (n=242)**	**Submarket 3 (n=185)**	**Submarket 4 (n=247)**
Percent Below Poverty				
Mean	27.31	18.14	24.23	13.14
Std. Deviation	12.98	8.01	17.92	10.40
Percent Vacant				
Mean	6.98	5.46	10.72	7.31
Std. Deviation	5.21	3.46	6.38	4.74
Percent Owner-occupied				
Mean	40.84	60.09	48.02	61.06
Std. Deviation	23.78	17.98	20.10	19.40
Percent Housing Poor Condition				
Mean	2.96	1.83	1.69	1.27
Std. Deviation	1.98	1.80	1.80	1.93
Distance to CBD (miles)				
Mean	4.47	8.55	8.54	12.52
Std. Deviation	3.05	2.58	4.64	7.48
Distance to Intl Airport (miles)				
Mean	5.26	6.00	8.54	10.89
Std. Deviation	1.64	3.14	4.02	7.17
Distance to coast (miles)				
Mean	1.38	2.52	1.48	2.11
Std. Deviation	1.60	1.55	1.74	1.80

Table 5.5 Descriptive Statistics by Submarket 2000-01

Variables	**Submarket 1 (n=256)**	**Submarket 2 (n=325)**	**Submarket 3 (n=215)**	**Submarket 4 (n=204)**
Dependent Variables				
Average Sales Price (2000 dollars; $)				
Mean	$65,287	$71,186	$117,653	$153,829
Std. Deviation	$44,247	$58,621	$136,769	$113,120

Table 5.5 continued

Variables	Submarket 1 (n=256)	Submarket 2 (n=325)	Submarket 3 (n=215)	Submarket 4 (n=204)
Structural Characteristics				
No. of bedrooms				
Mean	2.83	2.86	2.98	3.15
Std. Deviation	0.34	0.35	0.47	0.44
No. of bathrooms				
Mean	1.56	1.60	1.86	1.99
Std. Deviation	0.31	0.32	0.59	0.49
No. of half-baths				
Mean	0.04	0.03	0.06	0.08
Std. Deviation	0.05	0.05	0.09	0.09
Age of structure (years)				
Mean	44.98	47.64	43.23	38.97
Std. Deviation	10.29	13.17	13.44	12.13
Living area (sq. ft.)				
Mean	1502.81	1596.88	1916.60	2099.49
Std. Deviation	330.83	377.56	740.76	703.50
Lot Size (sq. ft.)				
Mean	8563.15	8740.28	12646.83	11388.41
Std. Deviation	4316.49	6105.85	13723.93	7511.53
Tenancy Length (years)				
Mean	13.06	13.22	12.65	11.62
Std. Deviation	2.67	2.83	2.44	2.35
Property Tax Millage (mills)				
Mean	1798.51	1579.61	1720.82	1712.05
Std. Deviation	1260.67	1353.94	1316.65	1332.65
Neighborhood Characteristics				
School Quality Index				
Mean	28.93	35.69	38.91	49.75
Std. Deviation	1.28	1.05	1.45	9.08
Mean Crime Rate - Violent & Property				
Mean	47.12	42.64	45.55	34.06
Std. Deviation	19.31	18.28	21.05	15.44
Percent Non-Cuban Hispanic				
Mean	20.45	24.31	27.73	23.83
Std. Deviation	10.92	15.44	11.80	10.54

Table 5.5 continued

Variables	**Submarket 1 (n=256)**	**Submarket 2 (n=325)**	**Submarket 3 (n=215)**	**Submarket 4 (n=204)**
Percent Non-Hispanic Blacks				
Mean	41.45	31.40	9.64	14.13
Std. Deviation	32.51	36.16	19.70	23.24
Percent College Educated				
Mean	33.15	33.88	43.62	61.18
Std. Deviation	13.70	13.49	17.33	18.89
Percent unemployed				
Mean	11.71	11.94	8.51	6.45
Std. Deviation	5.29	5.56	4.78	3.87
Median household income ($)				
Mean	$32,952	$30,212	$39,531	$55,599
Std. Deviation	$10,185	$12,636	$18,097	$26,712
Percent Below Poverty				
Mean	22.76	25.32	17.46	11.89
Std. Deviation	10.79	13.97	10.93	7.88
Percent Vacant				
Mean	6.35	6.56	7.19	5.46
Std. Deviation	4.57	5.62	7.46	3.85
Percent Owner-occupied				
Mean	51.75	41.37	47.89	53.61
Std. Deviation	21.74	24.18	24.74	23.13
Percent Housing Poor Condition				
Mean	3.04	4.29	2.64	1.34
Std. Deviation	2.67	4.55	2.54	1.20

CHAPTER VI

EXPLORATORY DATA ANALYSIS AND MODEL SPECIFICATION

This chapter examines the association between variables aggregated at the CBG level and checks for normality. Variables with non-normal distribution are transformed for further analysis. Scatterplots are used to plot the relationship between variables of interest and tests for kurtosis are used to check for normality.

In addition, cartograms in which spatial values are depicted by circles of varying sizes are used to highlight proportional values of variables on a map. The circles are aligned closely to their original spatial location with the help of nonlinear optimization routine employed by GeoDa. The dependent variable (sales price) is examined for spatial autocorrelation using Global and Local Moran's I tests.

Natural Log Transformations

Natural log transformation is useful when the range of a variable is very broad and has extreme outliers. The natural log transformation (to the base *e*) is used to stabilize the variance of the variable if the variance increases markedly as value of the variable increases. In this study, $\log_e(x)$ is the natural log of x. Natural log transformations are used mostly for continuous positive variables. Using algebraic and logarithmic functions, the percent change in the predicted value of dependent variable *y* in case of a unit change in the independent variable *x* is expressed as:

$$\%\Delta y = 100 \cdot [\exp(\beta_1 \Delta x) - 1]$$

Where $\beta_1 \Delta x$ is the coefficient representing expected change in the value of the independent variable x (Wooldridge, 2003).

In case of proportional variables such as those expressing values in terms of percentages, arcsine transformations are used to stabilize the variance. Additionally, a box-cox transformation for the dependent variable sales price is used to determine whether a linear or semi-log specification is appropriate. Using an iterative maximum-likelihood algorithm in SPSS, lambda, a Box-Cox parameter used to determine the exact power transformation is computed (Box & Cox, 1964). By rule of thumb, if lambda is 1.0 no transformation is needed and a lambda of 0 requires a natural log-transformation. For sales prices, the lowest root mean squared error (RMSE) corresponds to a lambda of -0.3 and; thus a natural log transformation is preferred for the dependent variable. Upon examination of all the other variables in the dataset for normality using tests for kurtosis, the following variables including the dependent variables are transformed (see Table 6.1) using either natural log transformation or arc-sine transformation:

Table 6.1 Variable Transformations

Variable	**Transformation**	**Variable**	**Transformation**
1992-93		***2000-01***	
Average Sales Price	Log_e	Average Sales Price	Log_e
Number of Bathrooms	Log_e	Number of Bathrooms	Log_e
Living Area	Log_e	Living Area	Log_e
Lot Size	Log_e	Lot Size	Log_e
Land Use Mix	Arcsine	Average Household Income	Log_e

Table 6.1 continued

Variable	Transformation	Variable	Transformation
1992-93		***2000-01***	
Housing Condition	Arcsine	Vacant Housing	Arcsine
		Land Use Mix	Arcsine
		Housing Condition	Arcsine

Other Transformations

Variables representing certain structural characteristics like average number of bedrooms and average lot size are also natural-log transformed to adjust their non-normal distribution.

Lot sizes are capped at 88,000 square feet or 2 acres and all lot sizes exceeding 88,000 square feet with less than 3000 square feet living area are assigned the maximum value. Properties more than 88,000 square feet and more than 3000 square feet living area (less than 0.5%) are excluded from the analysis. This is done to eliminate extreme outliers.

Spatial Distribution of Dependent Variables

Figure 6.1 shows the spatial distribution of the sales prices of single-family residential homes in 1992-93and 2000-01. Homes with high sales prices are located in the north-east region of the county and along the coast for both time periods.

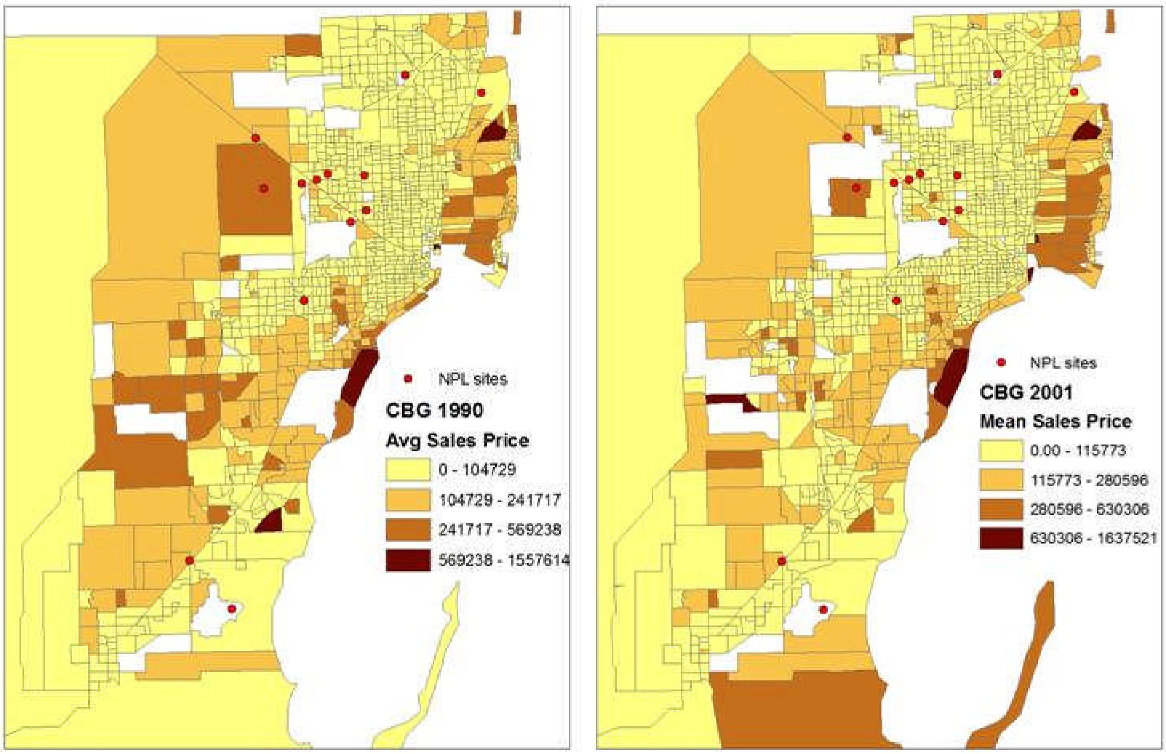


Figure 6.1 Spatial Distribution Sales Price 1992-93

Figure 6.2 displays the corresponding cartograms for the dependent variables. The size of the circles in the cartograms indicate the value of the variables; larger the circle, greater the value. The circles in red indicate the upper outliers.

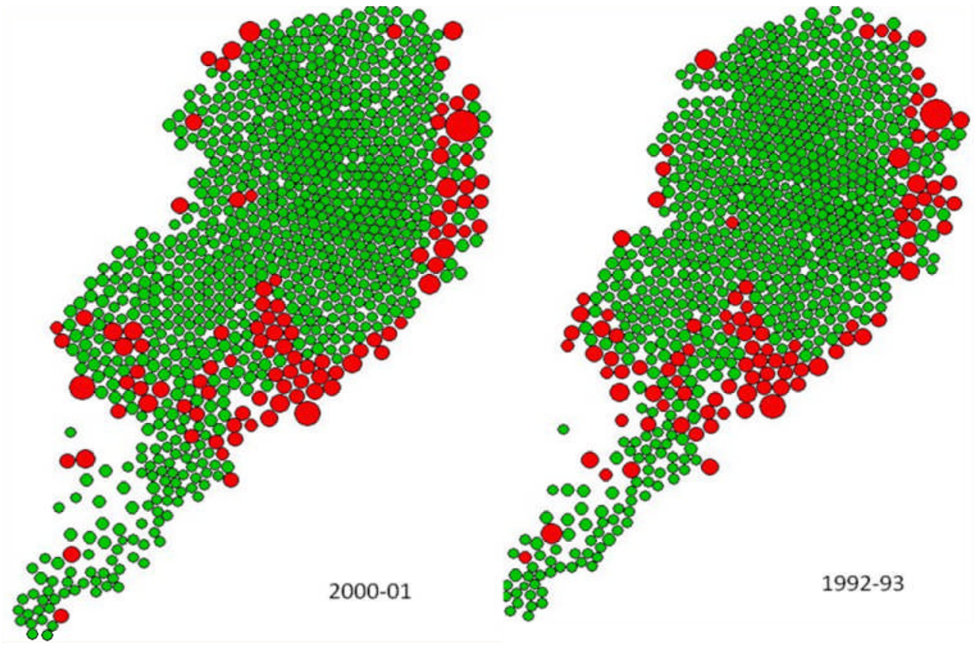


Figure 6.2 Cartogram - Sales Price

Multicollinearity

There is a greater chance of multicollinearity (correlation between independent variables) in a hedonic price function is higher than other regression models due to the inherent nature of variables involved in predicting sales price of single-family residential homes. For example, among structural characteristics, it is natural to expect a high positive correlation between number of bedrooms and bathrooms and living area and similarly among neighborhood characteristics, there exists a strong positive correlation between college education populations and median household income or rate of unemployment. There is a tradeoff involved in including highly correlated variables that inject multicollinearity bias and excluding such variables leading in biased estimates especially if the variables are considered important in determining sales price. The higher the correlation between X_k and other independent variables, the bigger the standard error will be leading to multicollinearity. The tolerance of X_k is represented by $(1- R_i^2)$ and the reciprocal of tolerance is known as the Variance Inflation Factor (VIF). The VIF shows how much of the variance of the coefficient estimate is being inflated by multicollinearity. The Variance Inflation Factors (VIF) for a regression coefficient β_i for independent variables X_k is expressed as:

$$\text{VIF}(\overline{\beta}_i) = \frac{1}{1 - R_i^2}$$

where R_i^2 is the coefficient of multiple determination when X_k is regressed on other X variables in the model and *k* is the set of all the X variables and *i* is the set of all observations. These factors measure the extent of the inflation of variance of estimated regression coefficient as compared to when such variables are not linearly related. Generally, VIF values greater than 10 are considered to be indicative of severe multicollinearity and such variables can be dropped provided they are not theoretically important in the prediction model and are not likely to bias the specification of the model. It is assumed that multicollinearity will exist to some extent in a hedonic price function predicting house values.

For purposes of this study, the effect of multicollinearity will be reduced either by choosing among the most influential variable from a set of highly correlated variables using Pearsons' coefficients and by judging the impact on R^2 upon exclusion in the OLS models or by using the test of VIF as described above. See Appendix D for the list of Variance Inflation Factors for selected variables in 1992-93 and 2001-01 regression models.

Correlational Data Analysis

Scatter plots were used to determine preliminary association between primary variables like average sales price, average assessed value, and distance to the nearest NPL site. Pearson correlation was also used to examine association between the dependent variables and the independent variables.

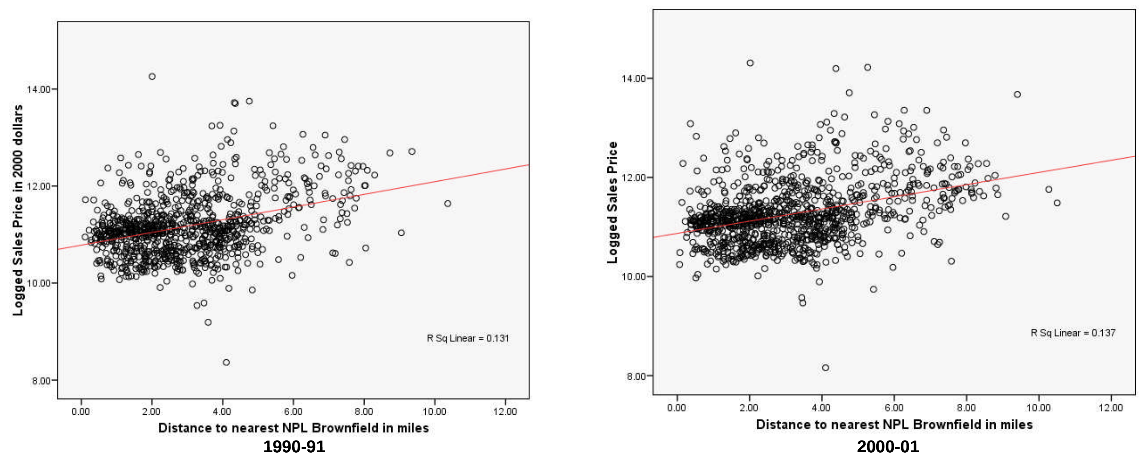


Figure 6.3 Average Sales Price and Distance to Nearest NPL site

As seen in Figure 6.3, average sales price ($\log_e$) has a weak although positive association with distance from nearest NPL site in both time periods indicating increasing values with increasing distance. The regression analyses will test this relationship for magnitude and significance.

Table 6.2 Pearsons Correlations

Variables	Logged Sales Price 1992-93	Logged Sales Price 2000-01
Log_e Sales Price	1	1
Structural Characteristics		
Number of Bedrooms	0.596(**)	0.557(**)
Number of Bedrooms - Dichotomous	0.482(**)	0.427(**)
Number of Bathrooms	0.762(**)	0.747(**)
Logged Number of Baths	0.755(**)	0.740(**)
Number of Half-Baths	0.468(**)	0.426(**)
Age of Structure	-0.376(**)	-0.310(**)
Age of Structure Squared	-0.322(**)	-0.260(**)
Living Area in Sq Ft	0.768(**)	0.732(**)
Logged Living Area	0.789(**)	0.737(**)
Number of Floors	0.459(**)	0.409(**)
Lot Size	0.234(**)	0.131(**)
Log_e Lot Size	0.465(**)	0.389(**)
Tenancy Length	-0.312(**)	-0.012
Property Tax Millage	0.019	0.370(**)
Environmental Disamenities		
Distance to Nearest NPL Brownfield in Miles	0.362(**)	0.101(**)
Area of Brownfield in Sq Ft	0.022	0.015
Log_e Brownfield Area in Sq Ft	0.160(**)	0.102(**)
Percent of Commercial Industrial Land Use	-0.195(**)	-0.189(**)
Arcsin-Root Landuse Mix	-0.270(**)	-0.249(**)
Number of NPL sites in 2-mile radius	-0.151(**)	-0.131(**)
Neighborhood Characteristics		
School Quality Index	0.380(**)	0.390(**)
Log_e School Quality Index	NA	0.415(**)
Mean Crime Rate - Violent & Property	-0.230(**)	-0.163(**)
Percent Non-Cuban Hispanic	0.022	0.127(**)
Percent Non-Hispanic Blacks	-0.542(**)	-0.528(**)
Percent College Educated	0.745(**)	0.733(**)

Table 6.2 continued

Variables	Logged Sales Price 1992-93	Logged Sales Price 2000-01
Percent Unemployed	-0.528(**)	-0.621(**)
Median household income	0.619(**)	0.614(**)
Log_e Median household income	NA	0.620(**)
Percent Below Poverty	-0.575(**)	-0.594(**)
Percent Vacant	-0.017	-0.040
Arcsin Percent Vacant	NA	-0.062(*)
Percent Owner-occupied	0.282(**)	0.146(**)
Percent Housing Poor Condition	-0.288(**)	-0.422(**)
Arcsin-Root Housing Poor Condition	-0.384(**)	-0.471(**)
Distance to CBD in miles	0.138(**)	0.090(**)
Distance to Intl Airport in miles	0.133(**)	0.101(**)
Distance to Coast in miles	-0.037	-0.137(**)

** Correlation is significant at the 00.01 level (2-tailed)
* Correlation is significant at the 00.05 level (2-tailed)

As seen in table 6.2, most structural characteristics are positively and significantly correlated to the sales prices in 1992-93 and 2000-01. The transformed variables with the exception of number of bedrooms show a significant increase in correlation with the dependent variables. The distance to the nearest Superfund NPL site variable although significantly and positively correlated to the dependent variables in both time periods, it falls drastically in 2000-01 indicating a possible weakening influence. Influence of other environmental disamenities variables however remain the same over the two time periods.

The neighborhood variables have a mixed albeit significant influence on the dependent variable with percentage of college educated population, proportion of non-Hispanic Blacks, and median household income accounting for the largest correlations in the expected direction. Other variables like school quality, crime rate, housing condition, home ownership, and poverty rate are observed to have a moderate to weak albeit significant correlation with the dependent variables. The distance variables that is, to central business district, international airport, and the coast have a weak but significant influence.

Table 6.3 Pearsons Correlations for Select Neighborhood Variables 1992-93

Variables	Percent College Educated	Percent Unemployed	Percent Below Poverty	Median household income
Percent College Educated				
Percent unemployed	-0.656(**)			
Percent Below Poverty	-0.699(**)	0.720(**)		
Median household income	0.783(**)	-0.720(**)	-0.765(**)	

** Correlation is significant at the 0.01 level (2-tailed).

Additionally, among the neighborhood variables Percent College Educated is positively correlated with Mean Household Income (0.78) since higher educated people are expected to earn higher incomes. Similarly, Percent College Educated is negatively correlated with Percent Unemployed (-0.66) and Percent below Poverty (-0.70) since in CBGs with higher education levels, the level of unemployment and poverty is expected to be lower (see Table 6.3). Values are similar for 2000-01. Therefore, to correct for multicollinearity, only Percent College Educated variable is included in the final models since it has the highest correlational association with the dependent variable and would account for most of the variance arising from the effect of all four variables.

Exploratory Spatial Data Analysis

Global Spatial Autocorrelation

Assuming homogeneity, the global spatial autocorrelation analyses offers a single Moran's I statistic to summarize spatial dependence and identify clustering in a given region. A Moran scatter plot for the variable of interest on the x-axis and the spatial lag on the y-axis is used to evaluate the Moran's I statistic. A positive and significant z-value for Moran's I indicates positive spatial autocorrelation signifying that census block groups with higher sales prices are spatially clustered in the region. The closer that a Moran's I value is to +1, the greater the indication that the data values are spatially clustered. This study uses the queen-based contiguity criterion to create the spatial weights matrix (row-standardized) and define neighbors for each observation. The queen criterion determines neighboring units as those that have common boundaries or common corners. The Moran's I values for the average sales price both time periods are given below:

Table 6.4 Global Spatial Autocorrelation - Sales Price

Variables	Moran's I Value	p-value
1992-93		
Logged Sales Price	0.69	0.00
2000-01		
Logged Sales Price	0.71	0.00

As seen in Table 6.4, the Moran's I tests show high incidence of spatial dependence in both time periods. The Moran's I values are based on a random permutation procedure that recalculates the statistic 999 times to generate a reference distribution that gives us the mean and standard deviation for that distribution. The obtained statistic is compared to this reference distribution to compute a pseudo significance level (0.001 for 999 permutations). The p-values observed in Table 6.4 indicate a high level of significance for presence of spatial dependence or clustering of the dependent variable values in the datasets.

Local Spatial Autocorrelation

Compared to global spatial autocorrelation that indicates presence of clustering in the given region, local spatial autocorrelation identifies significant local clusters within the region in form of hot or cold spots. Local indicators for Spatial Autocorrelation (LISA) analyses indicates not only clusters of locations with high values (hot spots) and low values (cold spots) but also other significant local outliers (high values surrounded by low and vice versa). The LISA analyses also calculates the local Moran's I statistic and the associated significance map for the clusters identified. The

LISA analyses uses the queen-based spatial neighborhood with row-standardized weights matrix as specified above and seeks local clusters based on the average sales price of single-family residential properties for the two time periods.

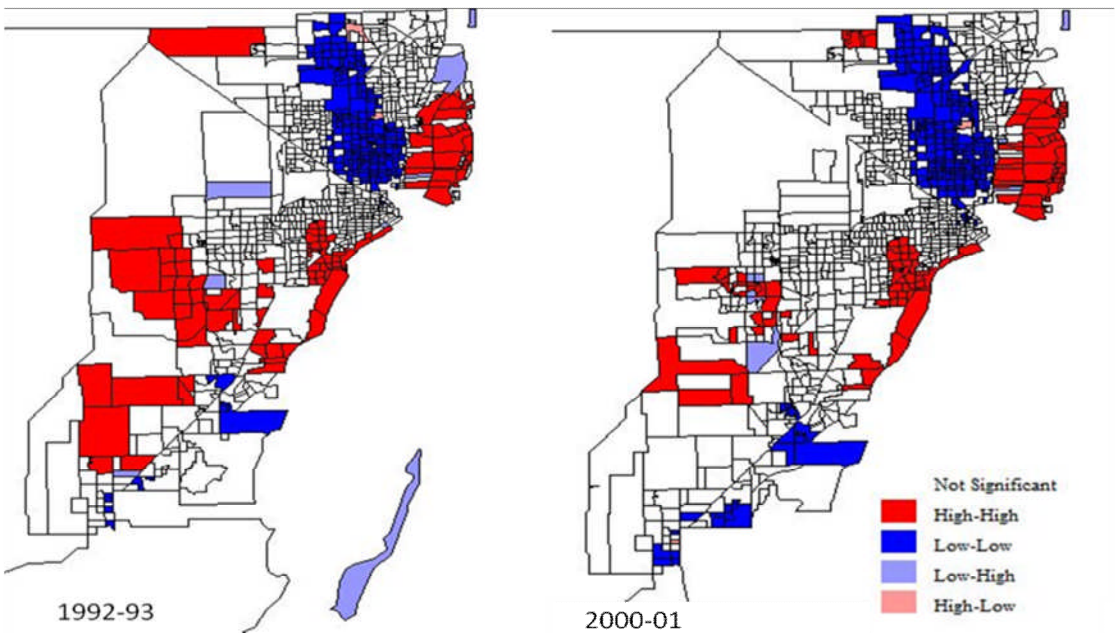


Figure 6.4 Local Clusters Showing Spatial Autocorrelation for Sale Prices

As seen in Figure 6.4, the census block groups colored in red or blue represent spatial clusters where the value at a location either high or low is more similar to its neighbors using the weighted average of the neighboring values, the spatial lag. These high-high and low-low clusters indicate positive local spatial autocorrelation. Thus the red and blue regions denote clusters of CBGs with high and low values, respectively. On the other hand, the spatial outliers i.e. regions high-low and low-high correspond to CBGs with high values surrounded by CBGs with low values and vice versa, respectively. These spatial outliers indicate negative positive local spatial autocorrelation. The clusters in the above figure are analyzed at 0.05 significance level.

As seen in the figures 6.4, sale prices display significant positive clusters with high values clustering near the coast and near the mid-western and south-western region of the county. The clusters with low values are located primarily in the mid-northern region of the county.

Model Building

The research methodology for this study is based on a longitudinal structure that compares cross-sectional regression coefficients and their significance levels over two time periods to determine the effect of NPL sites, before and after remediation, on the property values of surrounding single-family residential homes. The research models used in this study are constructed separately and compared for differences across the two time periods 1992-93 and 2000-01. Spatial analysis used in both models for 1992 and 2001 will factor in the influence of spatial dependence and examine the extent and size of the economic impact of environmental disamenities while controlling for other factors that influence housing price across regional submarkets.

For comparing contemporaneous sociodemographic changes, remediation of Superfund sites is considered to be the intervening condition to define pre-test and post-test groups. Using the Neighborhood Change Database from Geolytics, census tracts around delisted Superfund sites in 2001 are considered as the test group and those around still-active sites are deemed as control group. A two-mile radius around

Superfund sites is defined as an immediate neighborhood for comparison of sociodemographic changes since the impact of environmental disamenities is observed to be highest in this vicinity. Also, to observe pre-existing differences, sociodemographic characteristics including trends for gentrification are compared between census tracts within the 2-mile radius around Superfund sites and other census tracts in Miami-Dade County beyond the 2-mile radius. To check for effects of remediation on sociodemographic composition and change therein, census tracts in a 2-mile radius around remedied Superfund sites are compared to census tracts in a 2-mile radius around still-active Superfund sites. These changes are tested for significance using Independent Groups T-Tests for Means.

Variable Selection

Apart from the housing valuation literature and research in hedonic price modeling, there is little theoretical foundation regarding the relationship between various independent variables and housing price (Thayer et al., 1992). For this study, previous hedonic price studies are used in considering the possible factors influential in determining housing price. Housing price, as noted earlier in the hedonic price theory, is considered to be a function of structural, neighborhood, and locational characteristics. Structural characteristics consist of physical attributes of the property such as number of bedrooms, baths, living area, lot size, age, housing condition, property tax rate, and duration of ownership. Houses with more number of bedrooms and bathrooms and larger living area and lot size are expected to be priced higher whereas older houses and those in poor condition are expected to be priced lower. Property tax rate, or millage, is considered as a cost in home ownership and is considered to lower housing prices. Longer the duration of the home ownership, the lower the sales price is expected to be. Based on VIF analysis, this study excludes living area while including half bathrooms under the assumption that houses with more number of bedrooms, bathrooms, and half-bathrooms will have corresponding larger living area. Including both factors can produce biased estimates in the regression analyses.

Neighborhood characteristics and locational attributes are represented by sociodemographic indicators and distance to amenities that might influence housing price respectively. Upon examination of neighborhood characteristics, it is determined that percentage of college-educated is highly correlated with percent unemployed, median household income, and percent poverty since higher the education of population within a census block group, the lower the poverty and unemployment rate and higher the median household income (see Table 6.3). Since percent college-educated has the highest correlation coefficient with the dependent variables (see Table 6.2), it is included in the model in lieu of the other factors. Other neighborhood characteristics included in the model are school quality, crime rate, percent non-Cuban Hispanics, percent non-Hispanic blacks, proportion of vacant homes, and proportion of owner-occupied homes. Variables pertaining to distance to central business district and distance to airport are excluded due to high VIF values but distance to coast is included in the model.

With respect to environmental disamenities, the primary variable of interest, distance to the nearest NPL site is included in the model along with contamination type, number of NPL sites in a one-mile proximity, and land use mix indicating proportion of commercial and industrial activities. The influence of the different types of contamination is factored in by considering contamination by industrial solvents as the reference group. In the 2001 model, status of the NPL i.e. whether it is delisted or still active is included to model the influence of remediation. The variable denoting the size of the NPL site is excluded from the analysis due to the disproportionately large size of NPL site #13 (3,374 acres) in comparison to other NPL sites.

Additionally, the influence of the housing market segmentation is controlled by considering Submarket I, as the reference group. All the variables in the model have a VIF of less than 10 (See Appendix D); thus there is no evidence of strong multicollinearity with the model.

Model Specification

To account for the influence of inflation from 1992 to 2001, the dependent variables nominal sales price were adjusted using the general Consumer Price Index (CPI). Some of the independent variables were also transformed as described above. The functional form of the model can be specified as:

$$\text{Log}_e\,\text{Price} = \beta_0 + \beta_1\text{Bedrooms} + \beta_2\text{Bathrooms} + \beta_3\text{Half-Bathrooms} + \beta_4\text{Lot Size} + \beta_5\text{Age} + \beta_6\text{Millage} + \beta_7\text{Tenure} + \beta_8\text{Distance to NPL Site} + (\beta_9\text{Status}) + \beta_{10}\text{Distance to Coast} + \beta_{11}\text{School Quality} + \beta_{12}\text{Crime Rate} + \beta_{13}\text{Percent Non-Cuban Hispanics} + \beta_{14}\text{Percent Non-}$$

Hispanic Blacks + β_{15}Percent College-Educated + β_{16}Percent Vacant + β_{17}Percent Owner-Occupied + β_{18}Percent Poor Housing Condition + β_{19}Percent Land Use Mix + β_{20}Number of NPL Sites in Proximity + β_{21-27}Contamination Type + β_{28-30}Submarket + ε

where: Log_e Price represents natural log of sales price in 1992 and 2001

ε represents a random error term.

Variable descriptions and descriptives are provided in Table 5.2 & 5.3. The variable, *Status* is included only in the year 2001 model.

Pooled Model Specification

In order to test significance between estimators from the two cross-sectional models, the independent observations from the two time periods are pooled together. The observations may have different distributions in the two time periods and to allow the intercept to differ across the two years this model includes a variable *yr2001*. This variable *yr2001* is a dummy variable equal to one for properties in census block groups around the Superfund sites that were remediated and delisted from the NPL by 2001 and zero for those properties around the Superfund site that are still considered active. Additionally, the variable *nearbwn* represents the proximity of the Superfund site to the residential properties. This variable *nearbwn* is a dummy variable equal to one if the properties in the census block group are within a 2-mile radius of the Superfund site and zero if they lie beyond. Finally, the variable *y01nearbwn* represents the interaction of the year dummy variable with the Superfund proximity variable to see if the effect of the latter variable has changed over the two time periods.

The expected value for the parameter of this interaction term is often referred to as “the difference-in-differences estimator” and represents the average difference over time of housing prices in the two locations i.e. near Superfund sites and away from them (Wooldridge, 2000). The variable *y01nearbwn* will thus examine if there are any significant differences between the sales price of properties around Superfund sites before and after remediation in the two time periods. The following model will help test whether “the difference-in-differences estimator” is statistically different from zero and can be represented as follows:

$$\text{Price} = \beta_0 + \beta_n X + \beta_{(n+1)} \textit{yr2001} + \beta_{(n+2)} \textit{nearbwn} + \beta_{(n+3)}(\textit{yr2001*nearbwn} \text{ or } \textit{y01nearbwn}) + \varepsilon$$

Where the intercept β_0 is the average price of properties in the CBG not within a 2-mile radius of the Superfund site in 1992, β_n are the coefficients for the other structural and neighborhood variables listed previously, $\beta_{(n+1)}$ is the coefficient parameter that captures changes in all housing price or values from 1992 to 2001, $\beta_{(n+2)}$ is the coefficient that measures the location effect that is *not* due to the presence of the Superfund site, and $\beta_{(n+3)}$ measures the increase or decrease in housing price or values due to the change in status of the Superfund site controlling for other factors that might explain the change in price or value. Even if most of the housing and neighborhood characteristics remain the same over the two time period, including them in the above model reduces the error variance which in turn shrinks the standard error of expected value of the interaction coefficient (Wooldridge, 2003).

CHAPTER VII

RESEARCH METHODOLOGY

Testable Hypotheses

This study focuses on the economic impact of housing prices on surrounding single-family residential properties before and after remediation of the nearest NPL Superfund site, while controlling for structural, neighborhood, and submarket factors that typically influence housing price. In addition, contemporaneous change in the sociodemographic characteristics of the proximate neighborhood where such contaminated sites exists is also examined under the purview of gentrification. Based on the goal and research objectives stated above, the research hypotheses for this study can be described as follows:

Hypothesis 1: Sales price for single-family residential properties will significantly increase with increasing distance from the nearest contaminated Superfund site.

$$H_0 \quad : \beta_{\text{distance to nearest remedied Superfund NPL site}} = 0$$

$$H_{1a} \quad : \beta_{\text{distance to nearest remedied Superfund NPL site}} < 0$$

$$H_{1b} \quad : \beta_{\text{distance to nearest remedied Superfund NPL site}} > 0$$

where $\beta_{\text{distance to nearest remedied Superfund NPL site}}$ indicates the coefficient of impact on housing price (sales price) from distance to nearest remedied Superfund NPL site. The alternate hypotheses will further examine if the effect of distance from the nearest contaminated Superfund site, if any, is increasing or decreasing.

Hypothesis 2: Sales price for single-family residential properties will significantly increase after remediation of the nearest contaminated Superfund site.

$$H_0 \quad : \beta_{D1} = \beta_{D2}$$

$$H_{2a} \quad : \beta_{D1} \neq \beta_{D2}$$

where β_{D1} is the coefficient of impact on housing price (sales price) from the distance to the nearest contaminated Superfund site in 1992 and β_{D2} is the coefficient of impact on housing price (sales price) from the distance to the nearest remedied Superfund site in 2001.

Hypothesis 3: Neighborhoods located around contaminated Superfund sites will exhibit lower socioeconomic characteristics and will have higher percentage of minority households than neighborhoods located elsewhere in the region.

$$H_0 \quad : TS_{\text{Properties around contaminated sites}} = TS_{\text{Other properties}}$$

$$H_{3a} \quad : TS_{\text{Properties around contaminated sites}} \neq TS_{\text{Other properties}}$$

where $TS_{\text{Properties around contaminated sites}}$ and $TS_{\text{Other properties}}$ indicates test statistics for comparing means of sociodemographic characteristics (education level, median income, poverty, unemployment, job type, etc) within two miles around contaminated properties and other properties. Independent Groups T-Test for Means is used to test for significance between differences.

Hypothesis 4: Neighborhoods around remedied Superfund sites will exhibit higher socioeconomic characteristics and will have lower percentage of minority households than neighborhoods around active Superfund sites.

$$H_0 \quad : TS_{D1} = TS_{D2}$$

$$H_{4a} \quad : TS_{D1} \neq TS_{D2}$$

where TS_{D1} and TS_{D2} indicates test statistics for comparing means of sociodemographic characteristics (education level, median income, poverty, unemployment, job type, etc) within two miles around contaminated properties in 1992 versus 2001. Independent Groups T-Test for Means is used to test for significance between differences.

Hedonic Price Theory

Residential housing price is calculated by assessing the influence of structural characteristics, neighborhood attributes, and locational features. Structural characteristics include physical attributes of housing units like number of bedrooms, number of bathrooms, age of the structure, size of the living area, lot size area, and quality of housing condition which in turn may determine other aspects like property tax millage rates. Neighborhood characteristics include quality of school district, crime rate, level of education, poverty, unemployment, and vacancy rates. Locational features measure the proximity to amenities like shopping centers, central business district, and coastline. Similarly proximity to environmental disamenities like brownfields and NPL sites are perceived to have a detrimental effect on surrounding residential housing properties under the assumption that prospective home buyers are concerned with potential adverse health effects or negative neighborhood effects associated with disamenities. If prospective home owners choose such a location they expect to be compensated in the form of lower housing prices that captures the negative impact of the location.

The decisions of potential home buyers are determined by revelation of their preferences and their willingness to pay for housing with levels of structural, neighborhood, and locational attributes that they are comfortable with. If for any reason they choose housing with seemingly undesirable attributes, they seek to compensate that shortcoming with an advantage in other attributes. For example, individuals may choose to pay more for homes with more bedrooms, larger lot sizes, and desirable neighborhoods if they are located further away from a contaminated NPL site whereas another set of individuals might prefer housing that is located closer to such environmental disamenities in exchange for lower property prices. Thus each homeowner enjoys an economic relationship between the housing market price and the quality and quantity of attributes that any given house provides.

The housing market maintains equilibrium through price differentials based upon locations and attributes ranked by potential homeowners in terms of their preferences and desirability. Similarly for environmental disamenities, locations closer to contaminated NPL sites are expected to be priced lower than those located further away for all identical properties. This difference in price seeks to compensate potential buyers for the undesirable effects of the environmental disamenities and consumers preferring to live away from environmental disamenities are better off living away from disamenities if the price differential is not adequate for their optimal living conditions. This price differential due to differences in attributes of housing units is measured using hedonic price methods, mostly to quantify intangible aspects like locational attributes.

The hedonic price model was developed by Ridker and Henning (1967) and refined by Rosen (1974), and subsequently applied to housing valuation studies by Freeman (1979), Nelson (1981), and others. Through this perspective, housing is not considered as a homogeneous good but in fact as vector of attributes comprising of the structure's physical, neighborhood, and locational characteristics. According to Rosen's (1974) economic framework for heterogeneous goods, the price of any unit of a quality-differentiated good is a function of the characteristics embedded in the good or unit and such characteristics cannot be separated and sold separately from other characteristics of the good. Hedonic pricing methods are used to deduce the level of satisfaction to a consumer from various attributes or characteristics from the consumption of the entire product due to inseparability of those attributes. Given enough combinations of characteristics and attributes in a particular product, it may be possible to estimate the implicit price of such attributes and thus the market price of the product may be considered as the function of the various components and attributes that make up the product even though they are inseparable from the product itself. These implicit prices of individual attributes can be measured as marginal values and determined by the revealed preferences and interaction of consumer valuation and producer evaluation through mechanisms of the free market economy.

Applied to the single-family residential housing market, the attributes of houses cannot be separated and sold separately and are purchased as part of a housing unit. Bedrooms and bathrooms cannot be purchased separately and are bundled within the housing unit being purchased. But these components of housing units exert an individual influence on the total price through differing quantity and are traded in the open market. E.g. homes with more number of bedrooms command a higher price than those with less number of bedrooms for identical units although you cannot purchase bedrooms separately to bundle them with other properties. See Appendix C for detailed functional form.

Assumptions and Limitations

Although inherently logical, the hedonic price model is bound by certain assumptions and is marked by limitations that deserve mention. The hedonic price model based on an economic model assumes perfect information between a buyer and seller in order to achieve a price equilibrium that is optimal to both parties. But as we know, such a condition rarely exists in reality and often buyers will be misinformed of the properties negative aspects especially dealing with externalities. For example, the status of the neighboring brownfields may neither be easily available nor be evident to the untrained eye or even the presence of a brownfield may not be disclosed if it isn't visible from the property. Also, the hedonic price model assumes that there are no interrelationships between the implicit prices of attributes in order to work toward market equilibrium. However, in reality it is erroneous to assume that implicit price of the attributes does not vary throughout other submarkets and property types and also, the buyers will have reduced marginal benefit and lower level of utility for additional units of housing attributes i.e. the marginal benefit of a sixth bathroom is much lower than that of the second one. In addition, all attributes do not display similar level of utility for all buyers and thus may differ according to the unstated preferences of the buyers (Chin, 2003).

The final limitation of hedonic price model as in any housing pricing study is that of market segmentation. It is erroneous to treat the housing market in any geographical location as a single entity as effects across submarkets might be significantly different. The structure of demand and/or supply might be different across all submarkets and societal, cultural, or even legal entry barriers might exist for consumers across submarkets. In place of locational or political delineation, as is used in several hedonic studies, it might be useful to sub-divide the region according to the status of the housing market or on role of submarkets, as this study does, or even to estimate separate hedonic price functions for each submarket. Increased mobility, enhanced information provision, and greater integration across sociodemographic groups may reduce influence of implicit prices for any characteristics across submarkets.

In spite of these limitations, the hedonic price method remains highly influential in assessing implicit prices especially for intangible characteristics like proximity to environmental amenities or disamenities in the housing price market. Given the right model specification and accounting for all factors that might explain the variance in sales price, the hedonic price method is far more accurate than sales comparison approach, contingent valuation, or traditional appraisal techniques especially with the availability of a large sample size and actual transactions data (Dubin, Pace, & Thibodeau, 1999; Pace, Barry, Gilley, & Sirmans, 2000; Pace, Barry, & Sirmans, 1998).

Spatial Dependence

Hedonic price modeling is the primary form of analysis for empirical research in real estate analysis. Hedonic models also have to deal with limited data due to time and financial constraints so the specification of all the possible positive and negative influences on each observation may not be possible. Additionally, such modeling often ignores the spatial aspects of the factors especially neighborhood characteristics that influence property value. Tobler’s first law of geography indicates, "everything is related to everything else, but near things are more related than distant things" (Tobler, 1970) thus 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. When each residential property affects the sales price of neighboring residential properties, spatial autocorrelation may exist (LeSage, 1997). Sales prices in a neighborhood inherently are determined by previous sales transaction prices of housing in the neighborhood. The housing market is largely influenced by sales transactions of surrounding homes underscoring the spatial dependence among residential single-family housing properties.

Problems with OLS Estimation

Typically ordinary least squares (OLS) is the most common technique in the traditional hedonic price methods under the condition of independence of the error term with the independent variables and assumes that errors are independent, homoskedastic, and normally distributed (Ridker & Henning, 1967). Since the dependent variable in one location is not only influenced by the independent variables in that location but also by the dependent and/or independent variables in another location, such a relationship violates the independence assumption. This correlation can in turn affect sales transactions or property value of properties in geographic proximity in a similar manner also causing spatial autocorrelation in the error term of the hedonic price modeling, leading to biased and inefficient estimates in the traditional methods that employ OLS (Anselin, 1988). Additionally, tests used to determine statistical significance of structural and neighborhood attributes assume uncorrelated residuals and positively spatially autocorrelated hedonic residuals will underestimate the population residual variance and bias the resulting t-statistics upward (Basu & Thibodeau, 1998).

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.

Spatial Weights Matrices

To correct for spatial autocorrelation, this study utilizes spatial models 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. This spatial matrix specifies the degree of independence of observations and assumes declining influence with increasing distance. The spatial model also helps capture the influence of omitted variables that may vary across space.

In this study, the weight given to census block groups depends on their proximity as measured by the latitude and longitude of their centroids for each observation relative to all other census block groups. Depending on the type of matrix employed, the influence of each census block group on another will differ. The traditional form of the weights structure is an ‘n x n’ matrix with ‘n’ being the number of observations or locations in the dataset. Each geographic object is indicated by a row and a column corresponding to the value depending whether the location in the column header is a neighbor of the row location. As shown in Figure 7.1, the weight matrix contains a ‘d’ term for every combination of observations in the dataset and may be represented by the inverse distance between observations or 0,1 if they share a border and/or vertex depending on the selection of the weights matrix scheme (Anselin, 1988).

$$\begin{bmatrix} 0 & d_{12} & d_{13} \\ d_{21} & 0 & d_{23} \\ d_{31} & d_{32} & 0 \end{bmatrix}$$

Figure 7.1 Spatial Weights Matrix Form

Additionally, these weight sets can be symmetric and can be standardized. Symmetric weight sets have same weights in each row for locations that are considered neighbors and standardization of spatial weights which is generally expected to produce more accurate results normalizes the weights for each location by its neighbor count by making the sum of the weights of each location equal to one. Spatial weights are standardized by row by dividing each weight by its row sum. Row standardization does not change the relative dependence among neighbors but changes the total impact across observations. For regression analyses using spatial econometric estimation methods, weights for this study will be symmetric and row-standardized.

There are three basic types of weighting matrices – contiguity, distance, and k-nearest neighbors. First, the contiguity-based spatial weights are divided into rook-based contiguity or regions with common boundaries that are considered neighbors and queen-based contiguity or regions with common boundaries and vertices that are considered neighbors. These weight matrix form produces an ‘n x n’ matrix where $w_{ij} = 1$ when i and j are neighbors and zero when they are not. This produces a sparse matrix and is row-standardized so that all rows sum to one. Second, distance-based spatial weights matrix is created by using a minimum threshold (Euclidean) distance such that all observations within that distance exert an influence on other observations (Anselin, 2001). This influence declines as distance increases therefore closer observations exert a greater influence than those located further away. All observations outside the threshold distance are excluded. The minimum threshold distance is determined such that each observation has at least one neighbor. For this study, distance between the centroids of census block groups is used. Also used primarily in distance-based weights matrices, row standardization makes the distances relative rather than absolute, by scaling all the distances to a scale of 0 to 1 thus nearer features are given relatively greater weight. Finally, spatial weight matrices built using k-nearest neighbor method uses a pre-determined number (k) of neighbors and models their influence on observations. The k-nearest neighbor criterion ensures that each observation has exactly the same number (k) of neighbors.

In spatial econometrics, the choice of spatial weights matrix is made *a priori* and based on theoretical considerations (Anselin, 2001). For this study, regression analyses will be run using all three spatial weights matrices but queen-based contiguity criterion will be considered the default method since the influence of properties immediately adjacent to each single-family residential home is the highest as compared to those located further away.

Detecting Spatial Autocorrelation

One of the preliminary steps in estimating accurate and unbiased influence of factors including impact of proximate environmental disamenities in hedonic price modeling is detecting the presence and extent of spatial dependence between sales price values of properties in close proximity in order to justify the use of spatial econometric estimation methods. This study uses three asymptotic statistics and methods namely Moran's I and Lagrange Multiplier (LM), complemented by Likelihood Ratio (LR) to check for spatial autocorrelation in the OLS errors where the null hypothesis indicates no presence of spatial autocorrelation.

Moran's I

The Moran's I statistic is commonly used to detect the presence of spatial autocorrelation within locational data. Moran's I is a weighted correlation coefficient used to detect departures from spatial randomness and indicative of spatial patterns such as clustering within the target study area (Moran, 1950). Moran's I for 'N' observations on a variable X_i & X_j indicative of observations X at location i and location j respectively is expressed as:

$$I = \frac{N \sum_i \sum_j}{\sum_i \sum_j w_{ij}} \; \frac{(X_i - \bar{X})(X_j - \bar{X})}{\sum_i (X_i - \bar{X})^2}$$

where w_{ij} is the spatial weights matrix and $\bar{X}$ is the mean of X.

Positive values indicate positive spatial autocorrelation and vice versa for negative values. Closer the Moran's I values are to +1 or -1 greater the indication that such groups are clustered and values closer to zero indicate random spatial distribution. Under the null hypothesis of randomization, a z-value is calculated to test for significance.

Similarly using Local Moran's I values, clusters of high values (hot spots) and low values (cold spots) can be identified and tested for significance to examine presence of spatial clusters within the target region. These local indicators for spatial autocorrelation can also be used to detect other significant outliers indicative of locations with high values surrounded by those with low values or vice versa.

Lagrange Multiplier (LM) Tests

In addition to using Moran's I test, other focused tests are used to select spatial model specifications. Similarly to the Moran's I and based on the OLS residuals, Lagrange Multiplier (LM) uses additional matrix trace operators to achieve an asymptotic distribution as χ^2 under the null hypothesis of no spatial dependence. The LM statistics measure extent of spatial dependence arising from either spatial error autocorrelation or spatial lag autocorrelation. The functional form of the LM error statistic is expressed as:

$$LM_\lambda = \frac{[e'\mathbf{W}e/(e'e/N)]^2}{tr[\mathbf{W}'\mathbf{W} + \mathbf{W}\mathbf{W}]'}$$

where LM_λ is the LM error statistic, e is a 'n x 1' vector of regression residuals, **W** is the spatial weights matrix, and *tr* is the trace operator or sum of the diagonal elements of the matrix (Anselin, 1988). Excluding the scaling factor in the denominator, this statistic is virtually the square of Moran's I. Similarly, the functional form of the LM lag statistic is expressed as:

$$LM_{\rho} = \frac{[e'\mathbf{W}y/(e'e/N)]^2}{\mathbf{D}}$$

with *e* as the OLS residuals and the denominator **D** is expressed to represent:

$$\mathbf{D} = [(\mathbf{WX}\overline{\beta})'[\mathbf{I} - \mathbf{X}(\mathbf{X}'\mathbf{X})^{-1}\mathbf{X}'](\mathbf{WX}\overline{\beta} / \overline{\sigma}^{2}] + tr(\mathbf{W}'\mathbf{W} + \mathbf{WW})$$

where β and σ^2 are from OLS. The test statistics is asymptotically distributed as χ^2.

Robust versions of the LR statistics are calculated to overcome bias borne from either spatial lag dependence or error correlation and generally preferred in the selection of appropriate spatial models. Additionally, the LM-SARMA test is the higher order alternative with both spatial lag and spatial error terms (Anselin 1988). This test is bi-directional and is distributed as χ^2 with two degrees of freedom and tends to be significant when either the error or the lag model are proper alternatives hence it is not that useful in practice.

For the selection of the spatial econometric models in this study, the significance of the robust versions of the LM statistics is considered only when the standard versions of the test are found to be insignificant. Anselin and Rey (1991) indicate that LM_{λ} or LM_{ρ} can be used to decide between alternative model specifications. When both LM_{λ} and LM_{ρ} are significant, the one with the largest value is chosen to select the alternative; for example $LM_{\lambda} > LM_{\rho}$ = spatial error model and $LM_{\lambda} < LM_{\rho}$ = spatial lag model, and when only one is significant, the significant specification is used to select the corresponding model specification.

Likelihood Ratio (LR) Tests

The LR test is used to make a decision between two models based on the value of the ratio. In this study it is used to estimate the difference between the log-likelihood of the spatial error model (described below) and the log-likelihood for OLS regression distributed as χ^2 with one degree of freedom in order to select the appropriate model. Similarly, the LR test is also used to compare OLS regression models and the spatial models; higher the log-likelihood value is, the better the fit of the model. Thus the model with the higher log-likelihood value would be preferred compared to the model with a lower value.

Spatial Regression Models

As noted earlier, traditional OLS models are likely to produce biased and inefficient estimates for explaining variance in the dependent variables sales price due to presence of spatial dependence. After confirming detection of spatial dependence, spatial regression models are used. As mentioned earlier, the traditional form of an hedonic price regression is expressed as $Y = X\beta + \varepsilon$ where Y is a 1 x n vector of observations of the dependent variable; in this case sales price, β is a k x 1 vector of parameters associated with independent variables X, which is a n x k matrix and ε is the stochastic error term assumed to have a constant variance and a normal distribution. As per Rosen's (1974) theory β is interpreted as the willingness to pay for or the implicit value of housing attributes under examination in the model.

Spatial dependence between OLS residuals or in some cases, spatial autocorrelation among errors render any estimates thus obtained biased and inefficient making inclusion of a spatial structure important for accurate parameter estimates and inference. Spatial dependence can be incorporated in two distinct ways – as an additional regressor in form of a spatially lagged dependent variable or in the error structure (Anselin, 1988). The first method is termed as a spatial lag model and the second is called a spatial error model. Depending on the results of the LM and LR tests, this study will employ either model to correct for spatial dependence.

Spatial Lag Model

The spatial lag model or as it is sometimes referred to as spatial autoregressive model (SAR) assumes that the dependent variable in one location is affected by the values of not only the dependent variables in other proximate locations but also by the other independent variables i.e. events in one place predict an increased likelihood of similar events in neighboring places (Brueckner, 2003).

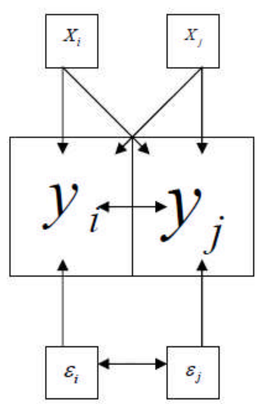


Figure 7.2 Assumptions of Spatial Lag Model

Due to the presence of spatial lag in OLS regression, the assumption of uncorrelated error terms as well as the assumption of independence of observations is violated rendering the estimates inefficient and biased (see Figure 7.2). To correct this anomaly, a function of the dependent variable observed at other locations in form of a spatially lagged independent variable is added to the regression model using the structure of a spatial matrix (Anselin, 1988). The structure of the spatial weight matrix is determined a priori and models the extent of the influence of nearby observations. As described earlier, the weights can take different forms, for example contiguity based weights, distance based weights, and K-nearest neighbor weights. The spatial lag model is expressed as:

$$\mathbf{y} = \rho \mathbf{W}\mathbf{y} + \mathbf{X}\boldsymbol{\beta} + \varepsilon$$

$$\mathbf{y} = (\mathbf{I} - \rho \mathrm{W})^{-1}\mathbf{X}\boldsymbol{\beta} + (\mathbf{I} - \rho \mathbf{W})^{-1}\varepsilon$$

where y is 1 x n vector of observations of the dependent variable, β is a k x 1 vector of parameters associated with independent variables X, which is a n x k matrix, ε is the vector of random error terms, ρ is the spatial autoregressive coefficient reflecting the strength of the spatial dependence, and W is the N x N spatial weights matrix with the elements w_{ij} indicating the relative connectivity from i to j. Wy is the spatial lag variable for each observation that provides the weighted sum of y_i with weights w_{ij}. The spatial lag model controls against bias parameter estimate and if the ρWy term is significant and if it were omitted as in a traditional hedonic OLS model, the matrix of the parameter estimates represented by β would be biased and render any conclusions invalid (Anselin, 2001).

Spatial Error Model

In addition to controlling for effect from dependent and independent variables in other locations, it is important to consider the effect of correlation of error terms across different spatial units. In such case, the assumption of uncorrelated error terms (E [ϵ_i, ϵ_j] = 0 for $i \neq j$) is violated rendering the resulting estimate inefficient. Spatial error is indicative of omitted covariates that are spatially correlated which if neglected would lead to erroneous conclusions (Anselin, 1988).

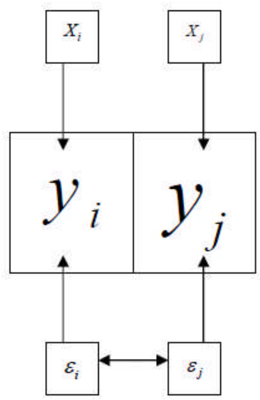


Figure 7.3 Assumptions of Spatial Error Model

Observations through unmeasured variables might be interdependent thus rendering measurement errors from correlated errors through space. This can arise from missing influencing factors or geographic boundaries that are not perfect measures. This spatial correlation between the errors renders estimates inefficient and is corrected by use of a spatial error model (see Figure 7.3). The spatial error model includes a modified non-spherical error covariance matrix in which all the off-diagonal elements are non-zero (Anselin, 2001). The spatial error model is expressed as:

$$\mathbf{y} = \mathbf{X}\beta + \varepsilon$$

$$\varepsilon = \lambda\mathbf{W}\varepsilon + \boldsymbol{u}$$

$$\mathbf{y} = \mathbf{X}\beta + (I - \lambda W)^{-1}\boldsymbol{u}$$

where ε is a spatial autoregressive error term that implies that the error term for each observation is related to the error terms of the neighboring observations. As in the spatial lag model, W is a spatial weights matrix that summarizes the spatial layout of the given data, λ is the spatial autoregressive parameter to be estimated that tells us the degree to which the error terms of the observations and its neighbors are related, and *u* is a white noise error term (Anselin, 2001). The expanded characterization of the error term in the equations above helps correct for heteroskedasticity and outliers (LeSage, 1997). Thus the spatial error model allows the spatial autoregressive term to capture any influences of the omitted variables and any such influence that vary across space will be subsumed by the error term.

Maximum Likelihood Estimation

Unlike traditional OLS regression, the joint log-likelihood for a spatial regression is not equal to the sum of the log-likelihood of individual observations due to be bi-directional nature of spatial dependence (Ord, 1975). For datasets reliant on spatial observations, extent of distances between observations is critical. A distance matrix is constructed with the distances between each observation with respect to another with the main diagonal consisting of zeros (distance between an observation and itself is zero) and off-diagonals showing distance separating the *i*th and *j*th observation. Additionally, the matrix is symmetrical since the distance between observation *i* and *j* is same as the distance between *j* and *i*. The distance matrix is used to construct estimated functions of the variance – covariance matrix and with a Gaussian correlogram, the correlation between observation *i* and observation *j* is:

$$\boldsymbol{K}_{ij} = \mathbf{b}_1 \exp - \left(\frac{\mathbf{D}_{ij}}{\mathbf{b}_2} \right)^2$$

where b_1 and b_2 are parameters to be estimated. These parameters are estimated with the regression coefficients by choosing the values of the unknowns (b_1, b_2, β, σ^2) that maximize the log-likelihood function, ln(L) expressed as (Dubin et al., 1999):

$$ln(L) = - \frac{N}{2} \ln \sigma^2 - \frac{1}{2} \ln |K| - \frac{1}{2\sigma^2} (V - X\beta)' K^{-1} (V - X\beta)$$

The use of the spatial lag term in the spatial models rules out OLS as errors cannot be assumed to be independent of the lag term. Thus maximum likelihood estimation that involves maximization of log-likelihood functions of the spatial lag models relying on nonlinear optimization techniques is used for spatial models (Anselin, 1988). However, maximum likelihood estimation is based on infinite sample sizes and do not work well with small samples. Further, such estimates are also based on the assumption of violation of normality. Traditional measures of goodness of fit like R^2 may not be valid and hence maximum likelihood measures of log-likelihood must be used to compare models (Anselin, 1988).

Test for Heteroskedasticity

This study examines three diagnostic statistics to detect heteroskedasticity or a non-constant error variance. Breusch-Pagan and Koenker-Bassett tests are used as tests on random coefficients that assume a specific functional form for heteroskedasticity and differ only in the fact that residuals in the Koenker-Bassett test are studentized i.e. made robust to non-normality (Anselin, 1990). The White's general test is used to test for the null hypothesis of homoskedasticity producing a statistic distributed as χ^2 with n-1 degrees of freedom with n is the number of parameters without the constant term. Presence of heteroskedasticity is confirmed when the test statistics are significant.

Comparing Sociodemographic Characteristics

In order to examine differences in sociodemographic characteristics between the two time periods, this study will compare differences if any in racial composition, school quality, crime rate, proportion of college-educated, rate of unemployment, poverty rate, proportion of population with white collar jobs, and median household income. These sociodemographic characteristics will indicate any move toward gentrification following NPL site remediation.

Census block groups within a two-mile radius of NPL sites are compared to other census block groups to examine any impact of environmental disamenities before and after remediation. Census block groups around NPL sites are compared across the two time periods to determine any possible relationship with remedial measures made on NPL sites. Finally, neighborhoods around the remedied NPL sites and non-remedied

NPL sites are compared in the year 2001 to look for differences on basis of environmental justice and social equity. Any differences in such comparisons are tested for significance using independent groups t-tests for means using corresponding sample sizes, group means, and standard deviation wherein the null hypothesis posits that no differences in sociodemographic characteristics exist between comparison groups.

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 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 brownfields 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. The dataset is complemented 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 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 are 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. The two Census Block Groups on the western and southern boundary are also excluded from the analyses due to disproportionately large geographic size since it would skew the spatial analyses.

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 allows 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 is 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. As mentioned earlier, 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. 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 specified 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.

CHAPTER VIII

FINDINGS

This chapter presents the hedonic estimations of housing prices controlling for structural and neighborhood characteristics, and submarket segmentation in order to examine the impact of proximate Superfund sites. First, hedonic estimations using ordinary least squares are displayed and tested for spatial autocorrelation. Second, the appropriate spatial model is used to account for spatial dependence in the data and corrected for biased and inefficient parameter estimates in the OLS estimation. Third, regression analysis is conducted for pooled observations from the two time periods in order to test for significance of difference between the impact of Superfund proximity before and after remediation. Fourth, both OLS and spatial hedonic estimations are conducted for individual submarkets in order to assess the differential impact of environmental disamenities and other housing price influencing characteristics. Finally, Independent Groups T-Tests for Means are used to estimate changes, if any, in the sociodemographic characteristics of the neighborhood surrounding the Superfund sites before and after remediation.

Since the structural and neighborhood characteristics in the hedonic estimations are not the focus of this research and primarily serve as controlling variables, the discussion of their results is kept to a minimum. The impact and changes in sociodemographic characteristics in the affected neighborhoods is addressed separately from the perspective of gentrification and are not expected to be a causal factor. Both sales price from the housing transactions are used as dependent variables in the OLS and spatial hedonic estimations but the focus of this research is on the sales transaction prices. The environmental disamenities & other controlling variables are prepared and validated for these analyses as explained in Chapter V.

Traditional OLS Hedonic Regression Models

Before Remediation (1992)

The results of the OLS hedonic model for sales price including the coefficient estimates and summary statistics in 1992, i.e. before remediation for all properties at the Census Block Group level are shown in Table 8.1. This table shows the estimations of the natural log of housing sales prices regressed on the environmental disamenities variables and controlled by structural & neighborhood characteristics and submarket segmentation for 889 census block groups. The primary variable of interest is the proximity of Superfund site followed by other environmental characteristics such as nature of contamination and number of other Superfund sites in the vicinity. The model fits the data well and the variables included explain nearly 82% of the variance in the property sales price based on the adjusted R-square values. For sales price, the model produced expected coefficient signs for all structural variables with the exception of number of bedrooms. Based on the descriptive statistics for the data in 1992 and 2001, the mean number of bedrooms is approximately three which implies that the sample used in this study has homes with predominantly three or more bedrooms. Such a distribution of the data lacks adequate variation that is needed to explain the effect of this variable.

Homes with more bathrooms, more half-bathrooms, larger lot sizes, and longer residency tenure received significant higher sales prices. Older homes and homes with higher millage rates sold for significantly less than newer homes and those with lower millage rates respectively. Fourteen out of all twenty nine variables are significant either at the 0.05 or 0.1 level. Among the neighborhood variables, only percentage of non-Hispanic blacks, percentage of college educated population, and distance to the coast had the expected significant influence on the sales prices. For every mile away from the coast, housing sales prices dropped by 2.37% and given the mean sales prices in 1992 (~$88,852) for the region, that amounts to nearly $2,105. Although percentage of vacant homes, percentage of homes in poor housing condition, and percentage of commercial and industrial land uses within the census tract produced expected coefficient signs, they were not significant even at 0.1 level leading to inconclusive results for their interpretation.

Table 8.1 Ordinary Least Squares (OLS) Hedonic Model 1992

Variables	**Sales Price**
Structural Characteristics	
No. of Bedrooms	-0.012 (0.80)
Log_e (No. of Bathrooms)	0.998 *** (0.00)
No. of Half-Baths	1.384 *** (0.00)
Age of Structure	-0.013 *** (0.00)
Log_e (Lot Size)	0.059 *** (0.00)
Resident Tenure Length	0.005 *** (0.00)
Millage Rate	-5.84e-005 *** (0.00)

Table 8.1 continued

Variables	**Sales Price**
Neighborhood Characteristics	
School Quality	-0.003
	(0.16)
Mean Crime Rate	0.000
	(0.75)
Percent Non-Cuban Hispanic	0.002
	(0.24)
Percent Non-Hispanic Black	-0.003 ***
	(0.00)
Percent College-educated	0.012 ***
	(0.00)
Percent Vacancy Rate	-0.004
	(0.17)
Percent Owner-Occupied	-0.00
	(0.61)
Arcsine (Percent Poor Housing Condition)	-0.14
	(0.44)
Distance to Coastline	-0.024 ***
	(0.00)
Environmental Proximity	
Distance to Nearest Superfund	0.022 ***
	(0.00)
Proximity of other Superfund sites	0.025 *
	(0.09)
Arcsine (Percent Land Use Mix)	-0.128
	(0.15)
Environmental Contamination	
Electroplater	-0.10 ***
	(0.00)
Chemical Manufacturing/ Processing	-0.08
	(0.37)
Landfill/ Dumpsite	-0.04
	(0.36)
Pesticide/ Herbicide/ Insecticide	-0.13 **
	(0.03)
Military Base	-0.18 ***
	(0.00)
Steel Manufacturing	0.03
	(0.74)
Other Contamination	0.02
	(0.63)
Housing Submarket	
Submarket 2	0.016
	(0.67)
Submarket 3	0.06
	(0.18)
Submarket 4	0.06
	(0.38)

Table 8.1 continued

Variables	Sales Price
Summary Statistics	
Constant	10.50 ***
	(0.00)
N	889
Adjusted R-Squared	0.82
F-Statistic	141.782 ***
	(0.00)
Log-likelihood	-37.277

*** significant at 0.01 level ** significant at 0.05 level * significant at 0.1 level (p-value)
Dependent variable: Log_e Sales Price
Contamination Reference Group: Industrial Solvent Disposal.
Housing Submarket reference group: Submarket 1

Regarding the primary variables of interest namely, proximity of Superfund sites to surrounding single-family residential homes and type of contamination, the distance to Superfund variable was significant at 0.01 level; so were the variables for electroplating, pesticide/herbicide/insecticide, and military base contamination. For every mile away from the Superfund site, the housing sales prices increased by 2.17% or $1,928. The reference contamination in the model was industrial solvent thus sites with electroplating contamination decreased surrounding housing prices by nearly 9.5%, military base contamination at Homestead Air Reserve Base decreased prices by 16.5%, and pesticide/ herbicide/ insecticide contamination at Woodbury Chemicals decreased prices by 12.2% as compared to homes surrounding Superfund sites with industrial solvent contamination at Gold Coast Oil (See *Appendix B* for profiles of Superfund sites in Miami-Dade County). Other types of contamination with the exception of steel plating at Pepper's Steel and Alloys and other contamination at Biscayne Aquifer from the Varsol spill also decreased surrounding housing prices when compared to industrial solvent contamination at Gold Coast Oil but were not significant at 0.1 level and hence results are considered inconclusive. For housing submarket segmentation, none of the variables were significant although every submarket showed an increase up to nearly 6% in housing price when compared to the reference Submarket 1.

After Remediation (2001)

The results of the OLS hedonic model for sales price including the coefficient estimates and summary statistics in 2001 i.e. after remediation for all properties at the Census Block Group level are shown in Table 8.2. Six of the 13 Superfund sites in 1992 were remediated and delisted from the National Priorities List before 2001. This table measures the overall impact of this remediation and will be later examined with reference to immediate vicinity of the remediated and still-contaminated Superfund sites. This table, like that for 1992, shows the estimations of the natural log of housing sales prices regressed on the environmental disamenities variables and controlled by structural & neighborhood characteristics and submarket segmentation for 997 census block groups. As with the data in 1992, this model also fits the data well and the variables included explain nearly 82% of the variance in the property sales price based on the adjusted R-square values.

Table 8.2 Ordinary Least Squares (OLS) Hedonic Model 2001

Variables	**Sales Price**
Structural Characteristics	
No. of Bedrooms	0.096 **
	(0.03)
Log_e (No. of Bathrooms)	0.877 ***
	(0.00)
No. of Half-Baths	1.168 ***
	(0.00)
Age of Structure	-0.003 **
	(0.03)
Log_e (Lot Size)	0.025
	(0.12)
Resident Tenure Length	-0.039 ***
	(0.00)
Millage Rate	-5.51e-005 ***
	(0.00)
Neighborhood Characteristics	
School Quality	-0.0003
	(0.87)
Mean Crime Rate	0.002 ***
	(0.00)
Percent Non-Cuban Hispanic	-0.001
	(0.45)
Percent Non-Hispanic Black	-0.002 ***
	(0.00)
Percent College-educated	0.007 ***
	(0.00)
Arcsine (Percent Vacancy Rate)	0.055
	(0.70)
Percent Owner-Occupied	-0.001 **
	(0.01)
Arcsine (Percent Poor Housing Condition)	-0.231 *
	(0.09)
Distance to Coastline	0.001
	(0.90)
Environmental Proximity	
Status of Superfund	-0.098 ***
	(0.00)
Distance to Nearest Superfund	0.014
	(0.052)
Proximity of other Superfund sites	0.068 ***
	(0.00)
Arcsine (Percent Land Use Mix)	-0.078
	(0.34)

Table 8.2 continued

Variables	**Sales Price**
Environmental Contamination	
Electroplater	0.003
	(0.95)
Chemical Manufacturing/ Processing	0.013
	(0.87)
Landfill/ Dumpsite	-0.112 ***
	(0.00)
Pesticide/ Herbicide/ Insecticide	-0.123 ***
	(0.00)
Military Base	-0.124 **
	(0.04)
Steel Manufacturing	0.142 **
	(0.045)
Other Contamination	0.079 **
	(0.03)
Housing Submarket	
Submarket 2	0.038
	(0.16)
Submarket 3	0.114 ***
	(0.00)
Submarket 4	0.125 **
	(0.01)
Summary Statistics	
Constant	10.681 ***
	(0.00)
N	997
Adjusted R-Squared	0.83
F-Statistic	160.176 ***
	(0.00)
Log-likelihood	-17.95

*** significant at 0.01 level ** significant at 0.05 level * significant at 0.1 level (p-value)
Dependent variable: Log_e Sales Price
Contamination Reference Group: Industrial Solvent Disposal.
Housing Submarket reference group: Submarket 1

The structural variables (with the exception of the lot size in sales price model) are significant and display the expected signs for their respective coefficients for both sales price. Among the neighborhood characteristics, with the exception of school quality, almost all of the variables are significant and display the expected sign. The mean crime rate variable although significant shows the opposite sign that what was expected but again, the size of the coefficient is small hence negligible.

In terms of the primary variable of interest i.e. the environmental disamenities, the impact of the distance to the nearest Superfund on sales price of surrounding residential homes is relatively lower at 1.4% increase for every mile away and is barely significant as compared to the impact in 1992 indicating a declining effect of the presence of contamination. Given the mean sales price in 2001, that translates to approximately $1350; a drop of nearly $600. Strangely, the proximity of more significant environmental disamenities has an impact of increase of 6.6% in sales price and for every additional Superfund site within a two-mile radius of the residential property. However, it is not clear if these sites are remedied or not and that impact is measured by the status of the Superfund variable. The impact of the status of the nearest Superfund is highly significant for sales price. In terms of sales prices, every active Superfund site leads surrounding residential properties to sell for 9.3% lower than those surrounding a remedied Superfund site thus indicating the positive effect of remediation on surrounding housing values at least in terms of sales price. In terms of other variables measuring impact of contamination, landfill contamination at Munisport Landfill and NW 58th Street Landfill, military base at Homestead Air Reserve Base, and pesticide/herbicide/insecticide contamination at Woodbury Chemicals indicate a significant negative impact of 10.59%, 11.66%, and 11.57% respectively in sales prices compared to the reference group, industrial solvent at Gold Coast Oil. Residential homes surrounding Superfund sites with above mentioned contamination sell for lower than those surrounding sites with industrial solvents indicating a greater risk perception from those contaminants. Similarly, contamination from steel metal plating at Pepper's Steel and Alloys and other contamination at Biscayne Aquifer from the Varsol spill have a significant but positive impact of 15.23% and 8.22% respectively on surrounding home values when compared to properties surrounding contamination from industrial solvents thereby indicating lower risk perception from those contaminants when compared to industrial solvents.

Diagnostics for Detecting Spatial Dependence

The dataset for this study was tested for spatial dependence using Global and Local Moran's I Tests especially pertaining to the dependent variables, sales price. High incidence of spatial dependence was found for both variables in both time periods justifying the need to use spatial models in lieu of traditional OLS models. The tests for local indicators for spatial autocorrelation also indicate presence of significant clusters with high and low values for sales price. In addition to Moran's I test, this study uses Lagrange Multiplier (LM) tests to not only detect spatial dependence but also help decide between using the spatial error or spatial lag models. Table 8.3 displays the values for LM tests for sales price in 1992 and 2001:

Table 8.3 Spatial Diagnostic Tests for 1992 & 2001

Spatial Diagnostic Tests (Lagrange Multiplier)	Sales Price	
	1992	**2001**
Lagrange Multiplier (lag)	33.694 *** (0.00)	64.757 *** (0.00)
Robust LM (lag)	5.503 ** (0.02)	20.923 *** (0.00)
Lagrange Multiplier (error)	37.698 *** (0.00)	49.203 *** (0.00)
Robust LM (error)	9.507 *** (0.00)	5.369 *** (0.00)

*** significant at 0.01 level
** significant at 0.05 level
* significant at 0.1 level (p-value)

As explained in Chapter VII, robust versions of the LM tests are used when the standard versions of the test do not produce significant statistics. The justification of using spatial error or spatial lag model depends on the significance level and size of the value of the LM test statistics. From the above table, it can be safely concluded that the spatial error model should be used both for the sales price model for 1992, and spatial lag model should be used for sales price model in 2001. Although results for only the selected spatial models are presented in this study, their corresponding likelihood ratio test statistics, Akaike info criterion value, and Schwarz criterion value are also presented in order to confirm the choice of the spatial model.

Goodness of Fit and Spatial Model Selection Diagnostics

Based on the global and local Moran's I tests, spatial hedonic models were considered in favor of traditional OLS models and LM test statistics were used to choose between the two spatial models. Table 8.4 & Table 8.5 presents other goodness of fit diagnostics for 1992 and 2001 that provide information on the strength of the models used above and to reinforce the choice of spatial models over OLS and choice between the spatial models. Larger the values for R-squared or adjusted R-squared, the better it explains the variance in the dependent variable. Similarly, larger the values for the log-likelihood test or likelihood ration test, the better the fit for the model whereas smaller the values for Akaike info criterion (AIC) or Schwarz criterion, the better the fit for the model. The Lagrange Multiplier test statistics are used to decide between which spatial models to use to account for spatial dependence. First, the standard values of the LM test are considered and if both are significant then the robust versions are used. If both robust versions are significant, then the ones with the higher value are used.

Table 8.4 Goodness of Fit Diagnostics for 1992

	Sales Price		
Diagnostic Tests	**OLS Model**	**Spatial Error Model**	**Spatial Lag Model**
R-squared/ Adjusted R-squared	0.821	0.838	0.835
Log-likelihood	-37.277	-17.742	-20.535
Akaike info criterion	134.554	95.484	101.069
Schwarz criterion	278.257	239.187	244.772
Lagrange Multiplier (lag)	33.694 (0.00)	-	-
Robust LM (lag)	5.503 (0.02)	-	-
Lagrange Multiplier (error)	37.698 (0.00)	-	-
Robust LM (error)	9.507 (0.00)	-	-
Likelihood Ratio Test	-	39.067 (0.00)	33.756 (0.00)

As seen in Table 8.4, for sales price in 1992, the spatial error model is clearly the preferred model due to higher values for the log-likelihood/ likelihood ratio test, R-squared, and robust LM tests; and lower values for Akaike info criterion (AIC) and Schwarz criterion values.

Table 8.5 Goodness of Fit Diagnostics for 2001

		Sales Price	
Diagnostic Tests	**OLS Model**	**Spatial Error Model**	**Spatial Lag Model**
R-squared/ Adjusted R-squared	0.833	0.843	0.845
Log-likelihood	-17.949	1.7261	13.5759
Akaike info criterion	97.899	56.548	36.848
Schwarz criterion	249.947	203.690	193.80
Lagrange Multiplier (lag)	64.757 (0.00)	-	-
Robust LM (lag)	20.923 (0.00)	-	-
Lagrange Multiplier (error)	49.203 (0.00)	-	-
Robust LM (error)	5.369 (0.02)	-	-
Likelihood Ratio Test	-	46.227 (0.00)	63.051 (0.00)

Similarly, as seen in Table 8.5, for sales price in 2001, the spatial lag model is clearly the preferred model due to higher values for the log-likelihood/ likelihood ratio test, R-squared, and robust LM tests; and lower values for Akaike info criterion (AIC) and Schwarz criterion values.

Spatial Hedonic Regression Model

Before Remediation (1992)

This section presents and interprets the results of the spatial hedonic model chosen according to the LM test statistics displayed in Table 8.6. Barring the inclusion of the spatial autoregressive parameter that tests the extent of spatial dependence and justifies the use of spatial modeling, the interpretation of the other variables in the spatial hedonic model is similar to the traditional OLS models. Table 8.6 also uses the natural log of housing sales prices for hedonic estimations for analyzing the influence of the environmental disamenities variables in 1992. These estimations are controlled by structural & neighborhood characteristics and submarket segmentation for 889 census block groups. The spatial models use the maximum likelihood estimation methods as opposed to ordinary least squares as explained in Chapter VII.

The lambda is the estimated spatial autoregressive parameter and tells the degree to which the error terms of our observation and its neighbors are related. This parameter is addressed by the spatial weights matrix that summarizes the spatial layout of the data on a map; in this case we use the queen matrix that effectively models the influence of its neighbors with which it shares its borders and vertices, as explained in Chapter VII. The spatial error model also captures the influence of the omitted variables that vary across space and are captured by the spatial autoregressive term. The spatial weights matrix examines the neighboring census block groups around each census block group and models its influence through the spatial autoregressive parameter depicted by lambda. In this case, the spatial error lag has a parameter estimate of 0.35 and is significant at 0.01 level in the sales price model. This estimate not only implies that the use of spatial statistics is warranted, but the error terms on average have a 0.35 spatial correlation with each other in the hedonic model for sales price i.e. the unmeasured influences in our model are somewhat similar to the unmeasured influences of its neighbors. The R-squared statistics of 0.84 for the sales price model is a slight improvement over the traditional OLS model indicating a better fit of the spatial models.

Table 8.6 Spatial Error Hedonic Model 1992

Variables	**Sales Price**
Structural Characteristics	
No. of Bedrooms	0.019 (0.68)
Log_e (No. of Bathrooms)	0.987 *** (0.00)
No. of Half-Baths	1.364 *** (0.00)
Age of Structure	-0.013 *** (0.00)
Log_e (Lot Size)	0.043 ** (0.01)
Resident Tenure Length	0.005 *** (0.00)
Millage Rate	-5.039e-005 *** (0.00)
Neighborhood Characteristics	
School Quality	-0.003 (0.22)
Mean Crime Rate	0.0004 (0.50)
Percent Non-Cuban Hispanic	0.001 (0.50)
Percent Non-Hispanic Black	-0.003 *** (0.00)
Percent College-educated	0.010 *** (0.00)
Percent Vacancy Rate	-0.006 * (0.052)
Percent Owner-Occupied	-0.0007 (0.38)
Arcsine (Percent Poor Housing Condition)	-0.299 (0.11)

Table 8.6 continued

Variables	**Sales Price**
Distance to Coastline	-0.024 **
	(0.018)
Environmental Proximity	
Distance to Nearest Superfund	0.022 **
	(0.037)
Proximity of other Superfund sites	0.023
	(0.20)
Arcsine (Percent Land Use Mix)	-0.093
	(0.29)
Environmental Contamination	
Electroplater	-0.105 **
	(0.02)
Chemical Manufacturing/ Processing	-0.064
	(0.51)
Landfill/ Dumpsite	-0.024
	(0.64)
Pesticide/ Herbicide/ Insecticide	-0.157 **
	(0.014)
Military Base	-0.189 ***
	(0.00)
Steel Manufacturing	-0.032
	(0.77)
Other Contamination	0.019
	(0.71)
Housing Submarket	
Submarket 2	-0.004
	(0.93)
Submarket 3	0.066
	(0.46)
Submarket 4	0.347
	(0.46)
Summary Statistics	
Constant	10.656 ***
	(0.00)
Lambda	0.347 ***
	(0.00)
N	889
R-Squared	0.84
Log-likelihood	-17.752
Likelihood Ratio Test	39.069 ***
	(0.00)

*** significant at 0.01 level ** significant at 0.05 level * significant at 0.1 level (p-value)
Dependent variable: Log_e Sales Price
Contamination Reference Group: Industrial Solvent Disposal.
Housing Submarket reference group: Submarket 1

As in the OLS model for sales price, all structural variables with the exception of number of bedrooms are significant and display the expected sign for their coefficients. Among the neighborhood variables, distance to the coast, percentage of non-Hispanic blacks, percentage of college educated, and percentage of vacant homes are significant either at the 0.1 or 0.05 level and display expected signs. The size of the coefficients is not much different from the OLS models but the inclusion of the spatial factors makes these parameters more reliable. None of the submarket variables, as in the OLS model are significant although Submarket 3 & 4 variables indicate a net advantage of 6.82% and 41.5% difference with the reference group, Submarket 1.

Regarding the primary variables of interest i.e. the environmental disamenities, the proximity of the nearest Superfund site is significant and for every additional mile from the contaminated site, the sales price increases by 2.17% or $1928 with every additional mile away from the Superfund site, a slight drop from the OLS model. However, the influence of electroplating contamination (-9.96%), military base at Homestead Air Reserve Base (-17.22%), and pesticide/ herbicide/ insecticide contamination at Woodbury Chemicals (-14.53%) registers a net negative impact in the sale price model compared to its reference group, industrial solvent contamination at Gold Coast Oil and is significant at 0.05 or 0.01 level.

After Remediation (2001)

The results of the spatial hedonic model for sales price including the coefficient estimates and summary statistics in 2001 i.e. after remediation for all properties at the

Census Block Group level are shown in Table 8.7. Judging from the diagnostic statistics for LM tests as seen in Table 8.3, spatial lag model is used for the sales price. Table 8.7 shows the estimations of the natural log of housing sales prices regressed on the environmental disamenities variables and controlled by structural & neighborhood characteristics and submarket segmentation for 997 census block groups while using spatial estimating methods.

As explained in the previous section, the spatial error model uses lambda, an estimated spatial autoregressive parameter to address the spatial correlation between the error terms and to justify the use of spatial models in lieu of traditional OLS models. On the other hand, the spatial lag model uses a similar autoregressive lag term to guard against biased parameter estimates. This spatial lag term models the influences of the neighbor's independent variables on the dependent variables of each census block group i.e. how much do the structural, neighborhood, and environmental characteristics of its surrounding census block groups affect the sales prices in each census block group?

Table 8.7 Spatial Lag Hedonic Model 2001

Variables	**Sales Price (spatial lag)**
Structural Characteristics	
No. of Bedrooms	0.103 ** (0.02)
Log_e (No. of Bathrooms)	0.738 *** (0.00)
No. of Half-Baths	1.160 *** (0.00)
Age of Structure	-0.003 ** (0.02)
Log_e (Lot Size)	0.027 * (0.07)

Table 8.7 continued

Variables	**Sales Price (spatial lag)**
Resident Tenure Length	-0.034 *** (0.00)
Millage Rate	-4.738e-005 *** (0.00)
Neighborhood Characteristics	
School Quality	-0.0006 (0.74)
Mean Crime Rate	0.0014 *** (0.00)
Percent Non-Cuban Hispanic	-0.0004 (0.71)
Percent Non-Hispanic Black	-0.0012 ** (0.02)
Percent College-educated	0.005 *** (0.00)
Arcsine (Percent Vacancy Rate)	-0.085 (0.52)
Percent Owner-Occupied	-0.001 * (0.057)
Arcsine (Percent Poor Housing Condition)	-0.085 (0.52)
Distance to Coastline	0.0027 (0.69)
Environmental Proximity	
Status of the Superfund	-0.108 *** (0.000
Distance to Nearest Superfund	0.002 (0.77)
Proximity of other Superfund sites	0.052 *** (0.00)
Arcsine (Percent Land Use Mix)	-0.029 (0.70)
Environmental Contamination	
Electroplater	0.048 (0.25)
Chemical Manufacturing/ Processing	0.060 (0.45)
Landfill/ Dumpsite	-0.114 *** (0.00)
Pesticide/ Herbicide/ Insecticide	-0.097 ** (0.015)
Military Base	-0.062 (0.27)
Steel Manufacturing	0.110 (0.10)
Other Contamination	0.099 *** (0.00)

Table 8.7 continued

Variables	**Sales Price (spatial lag)**
Housing Submarket	
Submarket 2	0.046 *
	(0.07)
Submarket 3	0.094 ***
	(0.00)
Submarket 4	0.118 **
	(0.01)
Summary Statistics	
Constant	7.764 ***
	(0.00)
Lag Coefficient/ Lambda	0.262 ***
	(0.00)
N	997
R-Squared	0.84
Log-likelihood	13.575
Likelihood Ratio Test	63.051 ***
	(0.00)

*** significant at 0.01 level ** significant at 0.05 level * significant at 0.1 level (p-value)
Dependent variable: Log_e Sales Price
Contamination Reference Group: Industrial Solvent Disposal.
Housing Submarket reference group: Submarket 1

As seen in Table 8.7, the spatial lag autoregressive parameter in the sales price model is 0.26 and is significant at the 0.01 level. The size and significance of this estimate justifies the use of spatial statistics over the traditional OLS model and indicates that average correlation between one census block group's sales price and its neighbor's sales price is 0.26. The R-squared value of 0.84 for sales price is a slight improvement over the corresponding values in the OLS model thereby strengthening the case for using spatial models. All the structural characteristics variables are significant in the sales price either at the 0.05 or 0.1 level. The lot size variable in the sales price model (p-value = .074) is the only structural characteristics that are weak in significance. Every additional bedroom increases the sales price by 10.8%; every additional year in a structure's age decreases its sales price by 0.3%; and every additional year in resident's tenure decreases sales price by 3.34%. Only percentage of non-Hispanic black and percentage of college educated are significant and display the expected sign for their coefficients. Although the sign for the mean crime rate coefficient is opposite of what we expect and significant, the size of the coefficient is small enough to be considered negligible.

For the submarket segmentation variables, almost all variables are significant either at 0.05 or 0.1 level and display expected signs and size of the coefficients. Homes in Submarket 2 have 4.49% higher sales prices; homes in Submarket 3 have 8.97% higher sales prices; and home in Submarket 4 have 12.5% higher sales prices than Submarket 1 when controlled for other structural, neighborhood, and environmental characteristics. The submarket segmentation variables are not significant in the 1992 model and this change in significance indicates stronger and positive impacts of brownfields remediation for premium housing markets.

Regarding the primary variable of interest i.e. the environmental disamenities, the impact of the distance to the nearest Superfund on sales price of surrounding residential homes is much lower at 0.2% increase for every mile away and is highly insignificant (p-value = 0.77) as compared to the impact in 1992 indicating a declining or almost no effect of the presence of contamination. In fact, the variable indicating proximity of other Superfund sites within a two-mile radius show a positive impact of nearly 5.33% in sales price with every additional mile. However, since not all Superfund sites were remedied by 2001, there might be mixed remnant effects of impact of contaminated and remedied sites. The impact of the remedied sites is measured by the Status variable that indicates whether the Superfund was remedied and delisted from the NPL by 2001. The impact of the status of the nearest Superfund is highly significant for sales price. Every active Superfund site leads surrounding residential properties to sell for nearly 10.23% lower, a slightly larger value than that indicated in the OLS model, than those surrounding a remedied Superfund site thus indicating the positive effect of remediation on surrounding housing values at least in terms of sales price. The distance to nearest Superfund site thus loses significance in the spatial model as compared to the OLS model and has a much lower value for its coefficient indicating the incorporation of the spatial dependence and inclusion of omitted variables effect. In terms of the type of contamination, only landfill contamination at Munisport Landfill and NW 58th Street Landfill (-10.77%), pesticide/herbicide/insecticide contamination at Woodbury Chemicals (-9.24%), and other types of contamination at the Biscayne Aquifer from the Varsol spill (+10.4%) have significantly different impacts than industrial solvent contamination found at Gold Coast Oil.

Testing for Heteroskedasticity

Cross-sectional data that uses housing transaction data tends to be heteroskedastic in nature and can be tested using the Breusch-Pagan and Koenker-Bassett tests, as is done in this study. In order to account for heteroskedasticity issues and sample selection problems, the regressions are estimated by clustering them at Census Block Group level instead of using individual observations of housing locations.

This lets the subsequent observations at CBG level to be independent across the census block groups but in turn allows for those observations to lack independence within the census block groups. Additionally, the data are also analyzed at submarket level that helps in reducing the correlation between standard errors and the type of submarket although the intention of this analysis was to examine the differences in impact of environment disamenities in different submarkets.

Table 8.8 Diagnostics for Heteroskedasticity

Diagnostic Tests	Sales Price		
	OLS Model	**Spatial Error Model**	**Spatial Lag Model**
Breusch-Pagan			
1992	581.504**	581.684**	598.602**
2001	723.332**	739.793**	722.298**
Koenker-Bassett			
1992	120.103**	-	-
2001	102.768**		

** significant at 0.01 level, * significant at 0.05 level

However based on the tests, as seen in Table 8.8, there is still some evidence of presence of heteroskedasticity in the data. The existence of heteroskedasticity points to the presence of an unequal variance within the residuals. Expectedly, there is relatively weaker evidence at the submarket level but based on the diagnostics from the three tests used especially in the OLS models, the conclusion that there is little or no heteroskedasticity is at best mixed based on the results of the corresponding spatial models. However, since it would be extremely difficult to obtain a random sample of single-family residential homes that are truly homogeneous especially in a diverse and dense city like Miami, this evidence of heterogeneity within the sample data is expected and acceptable and is expected to be compensated for by the use of spatial models.

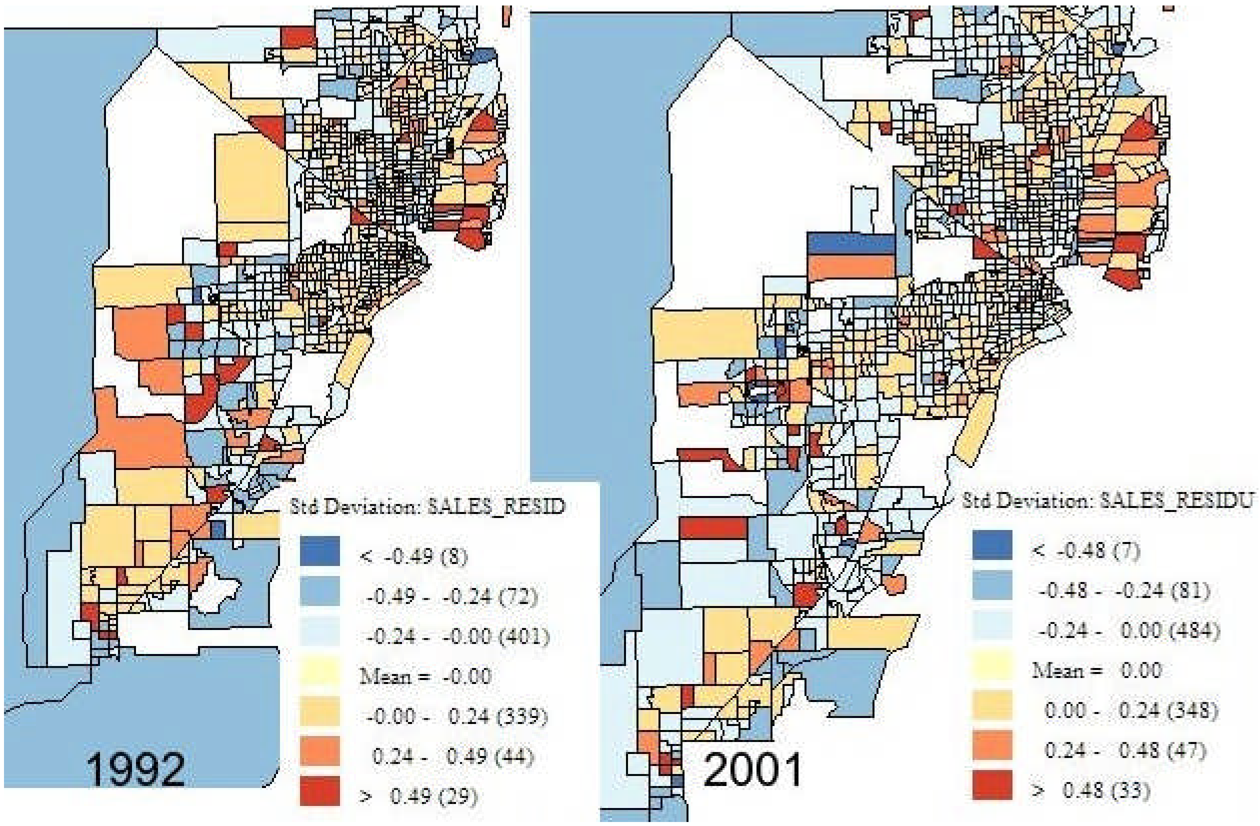


Figure 8.1 Sales Price Residuals Distribution: 1992 - 2001

Figure 8.1 shows the geographical distribution of the residuals produced by the basic hedonic model for sales price in both time periods. The clustering of residual values of similar color, either positive or negative, is indicative of the existence of spatial autocorrelation in the given geographical region. Since most of the residual clusters are positive residuals, especially along the coast and the central region and more so in 1992 than in 2001, it is indicative of the fact that the econometric model is underestimating residential property sales prices and spatial characteristics need to be incorporated to correct for this anomaly, as this study does.

Testing Significance of Differences

As seen in previous tables for hedonic models before and after remediation of the nearest Superfund site, there exists a difference between the impact of the Superfund site on housing sales price. However those models, although tested for significance at the cross-sectional level are not tested for significance between the two time periods. In order to achieve that, the independent observations from the two time periods are pooled together along with addition of certain variables that will assist in the testing for significance between differences.

Table 8.9 Pooled Observations Regression Model

Independent Variable	**Sales Price**
constant	10.06 ***
yr2001	-0.158 ***
nearbwn	-0.091 ***
y01nearbwn	0.101 ***
Observations	1171
R-Squared	0.828

*** significant at 0.01 level

Table 8.9 shows the results of this model with 1171 pooled observations representing properties in census block groups with respect to remedied Superfund sites from the two time periods. The model incorporates the new variables in addition to the structural and neighborhood variables included in previous model with the exception of the redundant distance to the nearest Superfund variable and the housing submarket variables. The coefficients for the controlling variables are not shown for the sake of brevity but display expected signs for their coefficients, as in the previous models. The *R*-Squared values for both models are high and explain nearly 82% of the variation in sales price. According to the results displayed in Table 8.9, the interaction variables *y01nearbwn* are highly significant for sales price. The coefficient on the interaction terms implies that properties in census block groups located near the Superfund sites gained nearly 10.62% in sales price value due to remediation. These values are close or near identical to the values obtained in individual cross-sectional hedonic models; spatial or otherwise, run previously for the two time periods. This analysis leads us to conclude that the difference in the differences in sales price over the two time periods is significant.

Submarket Segmentation Analysis Findings

As mentioned in Chapter V, the census block group observations are segregated into four primary housing submarkets based on the school quality index. The housing submarkets thus segmented are not necessarily contiguous as shown in Chapter VI (Figure 6.2) and vary in geographic size and number of census block groups contained. Although the school quality index is not significantly influential on the housing sales price at the regional level as seen in the hedonic models earlier in this chapter, the descriptive statistics for individual submarkets for 1992-93 and 2000-01 as shown in Chapter VI (Tables 8.4 & 8.5) are indicative of the sociodemographic characteristics that make such submarkets distinct from each other. The sales price within each submarket vary significantly and generally tend to increase from Submarket 1 to Submarket 4 implying that the latter submarket can be considered as a premier housing market and the former as a below-average housing submarket with the other two lying in the middle. The structural characteristics across the submarkets in both time periods further indicate that as we go from Submarket 1 to Submarket 4, there is an increasing tendency for rise in such characteristics. Submarket 4 has more bedrooms, bathrooms, half-bathrooms, living area, lot size, and has generally newer structures than other submarkets. Similarly, Submarket 3 has better structural characteristics than the lower two submarkets and so on. Other neighborhood characteristics like demographic distribution, household income, poverty level, housing condition, crime, and location from the coast, also indicate similar trends across the submarkets further reinforcing the belief regarding the nature and quality of the housing markets. This section examines the influence of the distance to the nearest Superfund site on the sales prices in both time periods using OLS and spatial hedonic models in each submarket.

Table 8.10 displays the diagnostics for spatial dependence obtained from the ordinary least squares model (not shown) for submarkets. According to the justification for model selection explained earlier, spatial lag model is used for Submarket 1 and spatial error model is used for the other submarkets spatial hedonic models. The diagnostics for heteroskedasticity as measured by the White's General test indicate that the four submarket samples are homoskedastic in nature thus justifying segmentation based on school quality. The high value of R-Squared statistic in the range of 0.7 – 0.9 in all four models is indicative of the high percentage of explained variance in the sales price variable even at the submarket level.

Table 8.10 Diagnostics for Spatial Dependence & Heteroskedasticity for Submarkets 1992

Diagnostic Tests	**Submarket 1**	**Submarket 2**	**Submarket 3**	**Submarket 4**
Adjusted R-squared	0.704	0.811	0.908	0.794
Log-likelihood	0.283	79.944	26.043	-25.266
Lagrange Multiplier (lag)	6.968 *** (0.01)	0.101 (0.75)	1.247 (0.26)	1.331 (0.25)
Robust LM (lag)	8.976 *** (0.00)	0.00 (0.98)	1.892 (0.16)	0.685 (0.40)
Lagrange Multiplier (error)	0.770 (0.38)	8.436 *** (0.00)	3.611 * (0.06)	3.981 ** (0.04)
Robust LM (error)	2.778 * (0.09)	8.335 *** (0.00)	4.257 ** (0.04)	3.336 * (0.07)
White's General	215.36 (0.37)	217.93 * (0.07)	177.83 (0.70)	222.45 (0.24)

*** significant at 0.01 level ** significant at 0.05 level * significant at 0.1 level (p-value)

Table 8.11 displays the respective spatial models for the four submarkets for 1992. The submarket data samples represent 216 census block groups with 38,647 properties in Submarket 1 (low), 242 census block groups with 82,660 properties in Submarket 2 (low-middle), 185 census block groups with 54,796 properties in Submarket 3 (high-middle), and 246 census block groups with 92,210 properties in Submarket 4 (high).

Table 8.11 Spatial Hedonic Models 1992 for Submarkets

Variables	**Submarket 1 (spatial lag)**	**Submarket 2 (spatial error)**	**Submarket 3 (spatial error)**	**Submarket 4 (spatial error)**
Structural Characteristics				
No. of Bedrooms	0.216 *	-0.110 *	0.095	0.007
	(0.06)	(0.09)	(0.28)	(0.95)
No. of Bathrooms	0.307 **	0.450 ***	0.473 ***	0.614 ***
	(0.03)	(0.00)	(0.00)	(0.00)
No. of Half-Baths	1.164 ***	-	-	0.574
	(0.00)			(0.15)
Age of Structure	-0.011 ***	-0.014 ***	-0.022 ***	-0.011 ***
	(0.00)	(0.00)	(0.00)	(0.00)
Log_e (Lot Size)	0.025 **	0.023 *	0.257 ***	0.154 ***
	(0.03)	(0.09)	(0.00)	(0.00)
Resident Tenure Length	0.003	-0.004 *	0.006 ***	0.007
	(0.30)	(0.09)	(0.00)	(0.10)
Millage Rate	5.117e-05	-5.1e-05 ***	-3.94e-05 **	-6.5e-05 ***
	(0.13)	(0.00)	(0.02)	(0.00)
Neighborhood Characteristics				
School Quality	-0.002	-0.003	-0.072 ***	-0.004
	(0.77)	(0.74)	(0.00)	(0.29)
Mean Crime Rate	0.003 **	-0.002 **	0.001 *	0.001
	(0.03)	(0.01)	(0.07)	(0.30)
Percent Non-Cuban Hispanic	-0.002	0.005 *	0.026 ***	-0.001
	(0.25)	(0.09)	(0.00)	(0.72)
Percent Non-Hispanic Black	-0.003 **	-0.003 ***	0.005 ***	-0.001
	(0.02)	(0.00)	(0.00)	(0.56)
Percent College-educated	0.003	0.014 ***	0.028 ***	0.014 ***
	(0.37)	(0.00)	(0.00)	(0.00)
Percent Vacancy Rate	-0.015 ***	0.007	0.005	-0.025 ***
	(0.00)	(0.14)	(0.13)	(0.00)
Percent Owner-Occupied	-0.0009	0.0005	0.004 ***	-0.003 *
	(0.47)	(0.59)	(0.00)	(0.08)
Arcsine (Percent Poor Housing Condition)	-0.024 **	0.058	0.213	-0.506
	(0.04)	(0.83)	(0.44)	(0.17)
Distance to Coastline	-0.048 **	-0.002	-0.028 **	-0.016
	(0.02)	(0.93)	(0.02)	(0.49)
Environmental Proximity				
Distance to Nearest Superfund	0.078 ***	-0.027	0.004	0.007
	(0.00)	(0.23)	(0.67)	(0.75)
Proximity of other Superfund sites	0.036	-0.010	0.015	-0.038
	(0.28)	(0.62)	(0.60)	(0.57)
Arcsine (Percent Land Use Mix)	-0.034	-0.167	0.069	-0.085
	(0.83)	(0.18)	(0.61)	(0.68)

Table 8.11 continued

Variables	**Submarket 1 (spatial lag)**	**Submarket 2 (spatial error)**	**Submarket 3 (spatial error)**	**Submarket 4 (spatial error)**
Summary Statistics				
Lambda/ Lag Coefficient	0.256 ***	0.447 ***	-0.634 ***	0.34 ***
	(0.00)	(0.00)	(0.00)	(0.00)
Constant	7.080	11.054	9.671	9.311
N	216	242	185	246
R-Squared	0.745	0.836	0.923	0.818
Log-likelihood	4.642	85.339	30.50	-22.280
Likelihood Ratio Test	8.717 ***	10.790 ***	8.914 ***	5.971 **
	(0.00)	(0.00)	(0.00)	(0.01)

*** significant at 0.01 level ** significant at 0.05 level * significant at 0.1 level (p-value)
Dependent variable: Log_e Sales Price

As seen in Table 8.11, all the spatial autoregressive parameters – the lag coefficient in the spatial lag model and lambda in the spatial error models – in the four hedonic models are highly significant justifying the use of spatial models instead of the traditional OLS models. The effect of the distance to the nearest Superfund declines as we proceed from Submarket 1 (low) to Submarket 4 (high). Housing sales prices increase by 8.11% with every additional mile away from the Superfund site in Submarket 1 whereas it declines by 2.66% in Submarket 2, increases by 0.4% in Submarket 3, and increases by 0.7% in Submarket 4. However, only the variable in submarket 1 is significant, implying the influence of environmental disamenities is most felt in low housing submarkets as compared to higher housing submarkets where other factors such as school quality, low crime rate, or proximity to the coast may compensate for the presence of a Superfund site.

Examining other factors such as structural characteristics, addition of a bathroom has a greater impact in higher submarkets than lower ones and age has an increasing negative impact in lower submarkets than higher ones with the exception of Submarket 4 (high) where it is as much as or lower than other submarkets. The effect of the lot size is the highest in Submarket 3 (high-middle) where every additional percent change causes a significant increase of 29.3% in housing sales price and correspondingly an additional percent change in lot size in Submarket 4 (high) also leads to a significant increase of 16.6% in sales price.

Given the homogeneity of the neighborhood characteristics within each submarket, it is not surprising that not many of them are significant. Percentage of vacancy within census block group has a negative and significant effect only in the two ends of the spectrum of the housing submarkets i.e. Submarket 1 & 4 but the impact is greater in the high submarket where every additional percent in vacancy rate leads to a decline of 2.5% in sales price whereas the corresponding influence in the low submarket is 1.5% indicating that vacancy has a greater impact in premium housing submarkets. However, the impact of poor housing conditions in the census block group is only significant in the low submarket. The other consistent variable that is significant across submarkets is percentage of college educated people in census block group. Due to lack of variation, this variable is not significant in the low submarket and the highest impact is felt in the high-middle submarket where an additional percent increase in college-educated people leads to an increase of 2.84% in sales prices; the corresponding number for the low-middle and high submarkets is an increase of 1.41%.

Table 8.12 displays the diagnostics for spatial dependence from the ordinary least squares models (not shown) for the submarkets. According to the justification for model selection, spatial error model is used for Submarket 1 & 2 and spatial lag model is used for the Submarket 4; since none of the statistics in the diagnostics for Submarket 3 were significant, the OLS model is retained. The high value of R-Squared statistic in the range of 0.73 – 0.83 in all four models is indicative of the high percentage of explained variance in the sales price variable even at the submarket level.

Table 8.12 Diagnostics for Spatial Dependence & Heteroskedasticity for Submarkets 2001

Diagnostic Tests	**Submarket 1**	**Submarket 2**	**Submarket 3**	**Submarket 4**
Adjusted R-squared	0.736	0.786	0.833	0.785
Log-likelihood	19.605	59.113	5.547	-19.715
Lagrange Multiplier (lag)	1.274 (0.25)	3.297 * (0.07)	0.028 (0.86)	5.693 ** (0.02)
Robust LM (lag)	0.185 (0.66)	1.315 (0.25)	0.125 (0.724)	5.508 ** (0.02)
Lagrange Multiplier (error)	10.448 *** (0.00)	17.789 *** (0.00)	0.717 (0.39)	0.808 (0.37)
Robust LM (error)	9.359 *** (0.000	15.807 *** (0.00)	0.814 (0.36)	0.623 (0.43)

*** significant at 0.01 level ** significant at 0.05 level * significant at 0.1 level (p-value)

Table 8.13 displays the respective spatial models for the four submarkets for 2001. The submarket data samples represent 255 census block groups with 71,726 properties in Submarket 1 (low), 324 census block groups with 74,428 properties in Submarket 2 (low-middle), 215 census block groups with 56,358 properties in Submarket 3 (high-middle), and 203 census block groups with 65,788 properties in Submarket 4 (high).

Table 8.13 Spatial Hedonic Models 2001 for Submarkets

Variables	**Submarket 1 (spatial error)**	**Submarket 2 (spatial error)**	**Submarket 3 (OLS)**	**Submarket 4 (spatial lag)**
Structural Characteristics				
No. of Bedrooms	-0.086	-0.016	0.037	-0.021
	(0.28)	(0.80)	(0.76)	(0.87)
No. of Bathrooms	0.623 ***	0.489 ***	0.489 ***	0.495 ***
	(0.00)	(0.00)	(0.00)	(0.00)
No. of Half-Baths	0.697 **	1.064 ***	1.256 ***	0.226
	(0.03)	(0.00)	(0.00)	(0.48)
Age of Structure	-0.007 **	0.002	-0.007 **	-0.014 ***
	(0.02)	(0.27)	(0.02)	(0.00)
Log_e (Lot Size)	0.003	0.180 ***	0.054	0.138 *
	(0.85)	(0.00)	(0.28)	(0.06)
Resident Tenure Length	-0.033 ***	-0.025 ***	-0.028 **	-0.041 ***
	(0.00)	(0.00)	(0.01)	(0.00)
Millage Rate	-9.3e-05 ***	-6.7e-05 ***	-1.8e-05	-9.9e-05 ***
	(0.00)	(0.00)	(0.48)	(0.00)
Neighborhood Characteristics				
School Quality	0.038 *	-0.001	0.031	0.003
	(0.07)	(0.93)	(0.13)	(0.31)
Mean Crime Rate	-0.0006	-0.001	0.0004	0.009 ***
	(0.55)	(0.26)	(0.78)	(0.00)
Percent Non-Cuban Hispanic	0.001	0.0006	-0.005 *	-0.001
	(0.62)	(0.79)	(0.07)	(0.81)
Percent Non-Hispanic Black	-0.0004	-0.0004	-0.004 ***	-0.002
	(0.73)	(0.67)	(0.00)	(0.27)
Percent College-educated	0.003 *	0.011 ***	0.004	0.007 ***
	(0.09)	(0.00)	(0.10)	(0.00)
Arcsine (Percent Vacancy Rate)	-0.662 *	-0.654 **	-0.070	0.385
	(0.07)	(0.02)	(0.79)	(0.30)
Percent Owner-Occupied	-0.0035 ***	-0.003 ***	-0.0007	0.0003
	(0.00)	(0.00)	(0.57)	(0.79)
Arcsine (Percent Poor Housing	-0.369	-0.117	0.249	0.092
Condition)	(0.28)	(0.58)	(0.44)	(0.83)
Distance to Coastline	0.011	0.029 **	-0.045 **	0.053 **
	(0.61)	(0.03)	(0.01)	(0.00)
Environmental Proximity				
Status of the Superfund	-0.175 ***	-0.082 **	0.004	-0.161 *
	(0.00)	(0.02)	(0.96)	(0.08)
Distance to Nearest Superfund	0.022	0.025	0.016	-0.004
	(0.39)	(0.11)	(0.28)	(0.83)
Proximity of other Superfund	0.069 **	0.056 **	-	-0.081
sites	(0.01)	(0.02)		(0.35)
Arcsine (Percent Land Use	-0.369	-0.149	0.172	0.209
Mix)	(0.28)	(0.24)	(0.31)	(0.34)

Table 8.13 continued

Variables	**Submarket 1 (spatial error)**	**Submarket 2 (spatial error)**	**Submarket 3 (OLS)**	**Submarket 4 (spatial lag)**
Summary Statistics				
Lambda/ Lag Coefficient	0.409 ***	0.336 ***	-	0.167 ***
	(0.00)	(0.00)		(0.00)
Constant	10.359***	8.919***	9.413***	7.715***
N	255	324	215	203
R-Squared	0.78	0.81	0.85	0.81
Log-likelihood	30.58	67.651	5.547	-16.68
Likelihood-Ratio Test	15.18***	17.08***	-	6.06**
	(0.00)	(0.00)		(0.01)

*** significant at 0.01 level ** significant at 0.05 level * significant at 0.1 level (p-value)
Dependent variable: Log_e Sales Price

As seen in Table 8.13, for Submarkets 1, 2, and 4, the spatial autoregressive parameter denoted by lambda and lag coefficient respectively are highly significant and have high enough values to justify the use of spatial models in lieu of traditional OLS models to account for spatial dependence even at the submarket level with the exception of Submarket 3. The primary variables of interest here are the distance to nearest Superfund site and the status of the Superfund whether it is remedied or still active. The distance to the nearest Superfund in all four submarket models are insignificant although they display the expected sign (except for Submarket 3) and are in the range of 1.5-2.5% change in sales price with each additional mile away from the Superfund. But as with the regional pooled model, the status variable measures the impact of the remediation since not all Superfund sites were delisted by 2001. This variable is highly significant only in the Submarket 1 & 2 models and barely significant at 0.1 level for Submarket 4. For Submarket 1, properties in census block groups surrounding still-active Superfund sites sell for 16.1% less than properties in census block groups surrounding Superfund sites that were remedied and delisted by 2001. Similarly, in Submarket 2, the influence of remediation is lower; properties in census block groups surrounding still-active Superfund sites sell for 7.9% less than properties in census block groups surrounding Superfund sites that were remedied and delisted by 2001. The corresponding influence in Submarket 4 is 14.9% but this impact is not significant at 0.05 level and hence inconclusive. These findings indicate that the impact of remediation is significantly higher in low and low-middle housing submarkets as compared to higher submarkets underlining the importance of remedying environmental disamenities in such neighborhoods in order to gain maximum societal benefit.

Housing Price Impact Relative to Distance

Although the distance to the nearest Superfund site variable measures the impact of the environmental disamenities on surrounding single-family residential housing, it does not offer comparisons across distances. Therefore, the proximity variable is divided into four variables to represent four concentric circles in 2-mile incremental distances from each Superfund site. The variables *< 2 miles, 2 – 4 miles, 4 – 6 miles,* and *> 6 miles* are dummy variables and equal to one if the properties in the census block group lie within 2 miles, 2-4 miles, 4-6 miles, and more than 6 miles from the Superfund site respectively and zero otherwise.

Table 8.14 Regression Model for Housing Price Impact Relative to Distance

Distance Variables	1992	2001 (all)	2001 (Active)	2001 (Remedied)
constant	9.819 ***	10.368 ***	10.635***	10.362***
	(0.00)	(0.00)	(0.00)	(0.00)
< 2 miles	-0.155 ***	-0.089 *	-0.129	-0.124**
	(0.00)	(0.05)	(0.27)	(0.03)
2 – 4 miles	-0.128 ***	-0.033	-0.137	-0.034
	(0.00)	(0.39)	(0.22)	(0.46)
4 -6 miles	-0.114 **	-0.035	-0.005	-0.065
	(0.01)	(0.35)	(0.96)	(0.14)
Observations	890	1000	371	629
R-Squared	0.83	0.83	0.78	0.84

*** significant at 0.01 level ** significant at 0.05 level * significant at 0.1 level (p-value)
Dependent variable: Log_e Sales Price. Distance Reference Group: > 6 miles

A simple regression model controlled by the structural, neighborhood, and other environmental factors (not shown) suggests that average sales prices for properties in census block groups within 2 miles are 14.4% lower than the reference group, properties in census block groups more than 6 miles away. Similarly, average sales prices for properties in census block groups within 2-4 miles and 4-6 miles are 12% and 10.8% lower respectively than the reference group (see Table 8.14). All coefficients are significant at least at 0.05 level. Hence properties within a 2-mile radius are most affected by the environmental disamenities and are considered for contemporaneous sociodemographic change following change in the status of the contamination. Similarly, in 2001 or post-remediation, the average sales prices for properties in census block groups within 2 miles are now 8.5% (12.1% and 11.7% for active and delisted sites respectively) lower than the reference group, properties in census block groups more than 6 miles away and average sales prices for properties in census block groups within 2-4 miles and 4-6 miles are 3.25% and 3.44% lower respectively than the reference group (see Table 8.14). Also, the average sales prices for properties in census block groups within 2 miles around remedied Superfund sites in 2001 are 12.9% (significant at 0.05 level) lower than properties in census block groups more than 6 miles away. The coefficient for properties in a 2-mile radius is barely significant at 0.05 level and the corresponding coefficients for properties in the 2-4 mile and 4-6 mile range is not significant even at the 0.1 level. However, the decline in the size of coefficients and change in the significance implies reduction in the impact of the environmental disamenities following remediation.

Contemporaneous Sociodemographic Change

This study, in addition to examining the economic impacts on surrounding single-family residential housing in terms of sales price due to environmental disamenities, also examines the contemporaneous sociodemographic change in the corresponding neighborhood. As mentioned above, this analysis of sociodemographic change is restricted to the 2-mile radius around the Superfund sites in order to examine the direct and maximal impact of change in status of the contamination. Data from the Neighborhood Change database from Geolytics at census tract level is used for this analysis in order to take advantage of the matched geographies for 1990 and 2000 for easier comparison. Census tracts around the Superfund sites are not only compared with the general region but also across time periods to account for impact of remediation. Demographic change will be measured using differences in racial composition represented by proportion of non-Cuban Hispanics and non-Hispanic blacks in addition to other neighborhood characteristics like proportion of college-educated, proportion of population with white-collared jobs, proportion below poverty level, average household income, and rate of unemployment. Similarly, change in the housing stock will be measured by proportion of vacant housing and proportion of housing with no kitchen, plumbing, or heating facilities (aggregated to represent proportion of housing in poor condition). These changes will be tested with Independent Groups T-Tests for Means by using corresponding sample sizes, group means, and standard deviations where the null hypothesis suggest no differences in characteristics across comparison groups.

On theoretical grounds using operational definitions of gentrification specified by Babbie (2001), household social status was defined using measures of education and occupation. A social status index is created using the average values of proportion of college-educated and proportion of population with white-collared jobs for comparison groups (Kim, 2006). White collar jobs, as defined previously, are those in the quaternary sector (professional, managerial, technical, and administrative jobs) and college-educated includes any university or college experience. For e.g. for 1992,

$$\text{Social Status Index}_{1990} = \frac{(\%\text{College-Educated}_{1990} + \%\text{White-Collar}_{1990})}{2}$$

Equivalent indices are created for 2001 including for properties in census block group in a 2-mile radius and outside it; remedied or otherwise in both time periods. The Gentrification Index is calculated as the difference of the Social Status Index between the comparison groups. For e.g. to test if the region is trending toward gentrification between years 1992 and 2001, the difference between social status index for 1992 and

2001 is obtained and if the difference is positive, the region is trending toward gentrification otherwise not (Kim, 2006).

$$\text{Gentrification Index} = \text{Social Status Index}_{2001} - \text{Social Status Index}_{1990}$$

For this study, remediation is considered to be the intervening condition to define test and control groups where census tracts around delisted sites in 2001 are considered part of the test group and those around still-active sites are deemed as control group. Observations in 1992 are considered pre-test because all Superfund sites are considered active in 1992 and observations for census tracts as specified are considered post-test or post-control depending on the remediation status of the Superfund sites around which they lie. For 1992, the sociodemographic characteristics including testing for trends toward gentrification are compared between census tracts within the 2-mile radius (sample group) around Superfund sites and other census tracts in Miami-Dade County region beyond the 2-mile radius (non-sample group). Similarly, for 2001, the sociodemographic characteristics are compared between the entire Miami-Dade region and census tracts within the 2-mile radius around Superfund sites. Additionally, census tracts in a 2-mile radius around remedied Superfund sites are compared to census tracts in a 2-mile radius around still-active Superfund sites to examine differences in demographics and other neighborhood characteristics.

Table 8.15 Comparing Sociodemographic Characteristics for Miami-Dade County Across Time Periods

Variables	Miami-Dade County Census Tracts 1992 (N=347) Mean	Std Dev	Miami-Dade County Census Tracts 2001 (N=347) Mean	Std Dev	Means Difference	T-value (sig.)
Racial Composition						
Percent Non-Cuban Hispanic	19.16	11.00	26.83	13.92	7.67	8.053***
Percent Non-Hispanic Black	19.73	29.24	22.06	30.79	2.33	1.022
Gentrification Index						
Percent College Educated	10.59	4.05	11.32	3.79	0.73	2.485**
Percent White-Collar	12.97	7.77	12.21	8.14	-0.76	1.258
Social Status Index	11.78	5.49	11.77	5.39	-0.01	0.024
Economic Characteristics						
Percent Unemployed	7.88	4.44	9.78	6.73	1.90	4.399***
Percent Below Poverty	17.96	13.62	18.76	12.60	0.80	0.803
Average household income	$38,126	$23,320	$52,496	$33,126	$14,370	6.61***
Housing Characteristics						
Percent Vacant	8.92	7.68	7.84	9.37	-1.08	1.661*
Percent with No Heating	4.24	3.33	4.90	3.46	0.66	2.560**
Percent with No Kitchen	0.87	1.31	1.50	2.09	0.63	4.758***
Percent with No Plumbing	0.82	1.04	1.15	1.45	0.33	3.445***
Percent Poor Housing Cond.	1.98	1.60	2.52	1.76	0.54	4.229***

*** significant at 0.01 level ** significant at 0.05 level * significant at 0.1 level

Table 8.15 displays the change in the sociodemographic characteristics for the Miami-Dade County in 1992 and 2001. Most of the significant sociodemographic changes from 1990 to 2001 in the county are marginal with less than one percentage point increase at least for housing characteristics. Proportion of non-Cuban Hispanic increases significantly by nearly 8 percentage points and average household income increases by $14,370 although the variance increases drastically as well implying increasing gap between income classes. Proportion of college-educated population increases by less than one percentage point and proportion of unemployed workers increases slightly by less than 2 percentage points. Both are significant. There is no significant change in proportion of non-Hispanic black population, proportion of white-collared workers, combined social status index, and proportion of people living below poverty level.

Table 8.16 Comparing Sociodemographic Characteristics Between Two-Mile Neighborhood and Other Tracts in 1992 (pre-sample v. pre-non-Sample)

Variables	**Non-2-mile buffer census tracts (N=208)**		**2-mile buffer neighborhood (N=139)**		**Means Difference**	**T-value (sig.)**
	Mean	**Std Dev**	**Mean**	**Std Dev**		
Racial Composition						
Percent Non-Cuban Hispanic	20.63	11.43	16.95	9.96	-3.68	3.133***
Percent Non-Hispanic Black	17.25	26.36	23.45	32.82	6.2	1.944*
Gentrification Index						
Percent College Educated	10.99	4.16	9.98	3.83	-1.01	2.287**
Percent White-Collar	14.67	8.45	10.40	5.75	-4.27	5.205***
Social Status Index	12.83	5.85	10.19	4.48	-2.64	4.509***
Economic Characteristics						
Percent Unemployed	7.56	4.77	8.37	3.85	0.81	1.671*
Percent Below Poverty	17.79	14.79	18.21	11.70	0.42	0.281
Average household income	$41,368	$27,244	$33,273	$14,512	$-8,095	3.211***
Housing Characteristics						
Percent Vacant	9.91	8.39	7.45	6.24	-2.46	2.953***
Percent with No Heating	4.40	3.81	3.99	2.41	-0.41	1.127
Percent with No Kitchen	0.96	1.51	0.75	6.24	-0.21	0.466
Percent with No Plumbing	0.79	1.18	0.88	0.81	0.09	0.784
Percent Poor Housing Cond.	2.05	1.90	1.87	1.02	-0.18	1.023

*** significant at 0.01 level ** significant at 0.05 level * significant at 0.1 level

Table 8.16 compares sociodemographic characteristics between the two-mile buffer neighborhood around Superfund sites before remediation and the rest of the census tracts in the Miami-Dade County in 1992. As seen in the table, proportion of non-Hispanic black population (6.2 percentage points) is significantly higher in the neighborhood around Superfund sites although the non-Cuban Hispanic populations is significantly lower (3.68 percentage points) in the same neighborhood. For proportion of college-educated population, white-collar employees and the combined social status index, there exists a significant difference of nearly 2.29 percentage points, 5.21 percentage points and 4.51 percentage points respectively implying that census tracts around Superfund sites are significantly more likely to be populated by non-college-educated blue-collared workers than the other parts of the county.

Similarly, the average household income in census tracts around Superfund sites is significantly lower by more than $8,000 when compared to the other parts of the county. Although a significant albeit small difference exists for proportion of unemployed populations between the two comparison groups, the difference between the proportions of people living below poverty level in the neighborhood around Superfund sites and the other parts of the county although in the expected direction is not significant. Similarly most of the housing characteristics with the exception of proportion of vacant housing are not significant although homes with poor housing conditions are (slightly) more likely to be present in the neighborhoods around Superfund sites. The difference in vacancy rates may be explained by the high tendency of purchasing homes for investment reasons in Miami-Dade County.

Table 8.17 Comparing Sociodemographic Characteristics Before and After Remediation in Two-Mile Neighborhood Around Superfund Sites (pre-test v. post-test)

Variables	**2-mile buffer neighborhood - 1992 Active (N=96)**		**2-mile buffer neighborhood – 2001 Delisted (N=96)**		**Means Difference**	**T-value (sig.)**
	Mean	**Std Dev**	**Mean**	**Std Dev**		
Racial Composition						
Percent Non-Cuban Hispanic	16.41	10.01	23.74	12.48	7.33	4.477***
Percent Non-Hispanic Black	19.19	30.21	22.02	31.76	2.83	0.630
Gentrification Index						
Percent College Educated	10.16	4.35	10.52	3.86	0.36	0.607
Percent White-Collar	10.70	6.64	9.69	7.31	-1.01	1.002
Social Status Index	10.43	5.14	10.10	5.15	-0.33	0.431
Economic Characteristics						
Percent Unemployed	8.19	4.18	10.47	8.54	2.28	2.341**
Percent Below Poverty	18.99	13.18	21.67	13.42	2.68	1.396
Average household income	$33,163	$16,304	$44,983	$21,362	$11,819	4.310***
Housing Characteristics						
Percent Vacant	7.78	7.02	8.33	11.97	0.55	0.389
Percent with No Heating	4.42	2.57	4.84	2.60	0.42	1.126
Percent with No Kitchen	0.87	1.03	1.72	1.67	0.85	4.209***
Percent with No Plumbing	0.96	0.89	1.46	1.94	0.5	2.272**
Percent Poor Housing Cond.	2.08	1.06	2.67	1.27	0.59	3.476***

*** significant at 0.01 level ** significant at 0.05 level * significant at 0.1 level

Table 8.17 compares sociodemographic characteristics between census tracts in the two-mile buffer neighborhood around Superfund sites in 1992 and the corresponding two-mile buffer neighborhood around the same Superfund sites after remediation in 2001. As seen in the table, none of the characteristics indicating gentrification show any significant difference before and after remediation in census tracts in a two-mile neighborhood around Superfund sites. However, there exists a significant difference in the expected direction for average household income. Census tracts around remedied or delisted Superfund site show an increase of nearly $12,000 in average household income post-remediation although the proportion of unemployed also rises by 2.3 percentage points in the same period. Additionally, the average household income in census tracts around remedied Superfund sites is also significantly lower than the average for the entire Miami-Dade county in 2001 ($52,496.84) and although the average household income increases by 35% in census tracts around remedied Superfund sites, it increased by 72% for the entire Miami-Dade region. Thus this difference is indicative that even after remediation, neighborhoods with Superfund sites are still home to low-income populations. This suggests that stigma effects may persist much longer after the sites have been remedied and delisted from the NPL. Also, there is a significant increase in proportion of housing with no kitchen or plumbing facilities including in the composite housing condition index in census tracts with remedied Superfund sites, the changes are less than one percentage point and this might be indicative of aging of the housing stock and lack of maintenance.

Table 8.18 Comparing Sociodemographic Characteristics Around Unremedied Superfund Sites Across Time (pre-control v. post-control)

Variables	**2-mile buffer neighborhood - 1992 Active (N=96)**		**2-mile buffer neighborhood – 2001 Active (N=84)**		**Means Difference**	**T-value (sig.)**
	Mean	**Std Dev**	**Mean**	**Std Dev**		
Racial Composition						
Percent Non-Cuban Hispanic	16.41	10.01	23.43	14.55	7.02	5.325***
Percent Non-Hispanic Black	19.19	30.21	32.18	37.81	12.99	3.544***

Table 8.18 continued

Variables	2-mile buffer neighborhood - 1992 Active (N=96) Mean	Std Dev	2-mile buffer neighborhood – 2001 Active (N=84) Mean	Std Dev	Means Difference	T-value (sig.)
Gentrification Index						
Percent College Educated	10.16	4.35	9.41	3.52	-0.75	1.695*
Percent White-Collar	10.70	6.64	6.98	4.24	-3.72	5.854***
Social Status Index	10.43	5.14	8.19	3.28	-2.24	4.554***
Economic Characteristics						
Percent Unemployed	8.19	4.18	12.12	8.68	3.93	5.628***
Percent Below Poverty	18.99	13.18	22.20	12.29	3.21	2.284**
Average household income	$33,163	$16,304	$40,160	$13,842	$6,996	4.156***
Housing Characteristics						
Percent Vacant	7.78	7.02	6.58	11.29	-1.2	1.220
Percent with No Heating	4.42	2.57	4.52	2.90	0.1	0.337
Percent with No Kitchen	0.87	1.03	1.48	1.47	0.61	4.545***
Percent with No Plumbing	0.96	0.89	1.37	2.02	0.41	2.578**
Percent Poor Housing Cond.	2.08	1.06	2.46	1.30	0.38	2.985***

*** significant at 0.01 level ** significant at 0.05 level * significant at 0.1 level

Table 8.18 compares sociodemographic characteristics of the control group across the two time periods. It compares census tracts in the two-mile buffer in 1992 and the corresponding two-mile buffer neighborhood in 2001 around Superfund sites that remained active over the time period. This table compares any changes in the sociodemographic characteristics without the intervention of remediation. In absence of remediation, the proportion of non-Cuban Hispanic and Non-Hispanic blacks significantly increase by nearly 7 percentage points and 13 percentage points respectively whereas the corresponding populations for non-Hispanic blacks did not change significantly and non-Cuban Hispanics increased by 8 percentage points for the overall Miami-Dade County. Thus the change in racial composition around still-active

Superfund sites was more pronounced than the rest of the county with increased minority representation indicating strengthening environmental justice issues in terms of vulnerability to environmental disamenities. The proportion of college-educated populations around still-active Superfund sites dropped marginally but significantly by less than one percentage point but the proportion of population with white-collared jobs decreased significantly by nearly 4 percentage points as compared to the previous time period. The combined social status index dropped by two and a quarter percentage points over the same time period indicating declining in neighborhood social characteristics due to continued presence of contamination. However, the proportion of college-educated population increased marginally albeit significantly by less than a percentage point and proportion of white-collared workers registered no significant change over the same time period for the entire county.

The proportion of unemployed and persons living below poverty increased significantly by three and four percentage points respectively in the targeted area whereas the proportion of unemployed increased by less than two percentage points and persons living below poverty did not register any change for the county. Average household income increased significantly by nearly $7,000 in the targeted region but the change in income for the overall country was more than double at more than $14,000 thus average household income increased albeit at a lower rate in census tracts around still-active Superfund sites compared to the region. There were marginal changes in the housing characteristics and housing condition deteriorated negligibly but significantly by nearly half a percentage point in the targeted region across the two time periods reflective of the changes in the overall county trends.

Table 8.19 Comparing Sociodemographic Characteristics Around Still-Active and Future-Remedied Superfund Sites in 1992 (pre-test v. pre-control)

Variables	**2-mile buffer neighborhood – Active in 1992 but Delisted in 2001 (N=96)**		**2-mile buffer neighborhood – Active in 1992 (N=84)**		**Means Difference**	**T-value (sig.)**
	Mean	**Std Dev**	**Mean**	**Std Dev**		
Racial Composition						
Percent Non-Cuban Hispanic	16.41	10.01	18.02	10.40	1.61	1.445
Percent Non-Hispanic Black	19.19	30.22	28.47	35.38	9.28	2.616***
Gentrification Index						
Percent College Educated	10.16	4.36	9.05	3.51	-1.11	2.507**
Percent White-Collar	10.70	6.64	8.75	4.65	-1.95	3.004***
Social Status Index	10.43	5.15	8.89	3.75	-1.54	3.029***
Economic Characteristics						
Percent Unemployed	8.19	4.19	8.92	3.74	0.73	1.659*
Percent Below Poverty	18.99	13.18	20.13	12.10	1.14	0.816
Average household income	$33,163	$16,304	$30,324	$10,380	$-2,839	1.821*
Housing Characteristics						
Percent Vacant	7.78	7.02	6.76	4.96	-1.02	1.483
Percent with No Heating	4.42	2.57	3.59	2.43	-0.83	3.013***
Percent with No Kitchen	0.88	1.04	0.82	1.04	-0.06	0.527
Percent with No Plumbing	0.96	0.89	0.99	0.89	0.03	0.308
Percent Poor Housing Cond.	2.09	1.06	1.80	1.04	-0.29	2.516**

*** significant at 0.01 level ** significant at 0.05 level * significant at 0.1 level

Table 8.19 compares sociodemographic characteristics of the test group (active in 1992 but delisted by 2001) and control group (active in 1992 and 2001) across the two time periods. It compares census tracts in the two-mile buffer in 1992 around Superfund sites that were remedied by 2001 and the corresponding two-mile buffer neighborhoods in 2001 around Superfund sites that remained active over the time period. This table provides the baseline for examining differences among comparison groups, if any, pre-exist. Table 8.19 will be compared with the next table, Table 8.20 to examine the size and significance of differences between sociodemographic characteristics post-remediation. According to Table 8.19, there is significant difference in proportion of non-Hispanic blacks and other marginal and significant differences in social status indices that include proportion of college-education population and white-collared workers. Census tracts around Superfund sites that were active in 1992 and have remained so have around 9 percentage points more non-Hispanic blacks than census tracts around Superfund sites that were delisted in 2001. Similarly, the average household income is around $2,839 lower in the census tracts around Superfund sites that were active in 1992 and have remained so compared to the ones that were remedied in 2001. Other characteristics including housing conditions have remained largely unchanged and any differences even if significant are negligible (less than one or half a percentage point).

Table 8.20 Comparing Sociodemographic Characteristics Around Active and Delisted Superfund Sites in 2001 (post-control v. post-test)

Variables	2-mile buffer neighborhood – 2001 Delisted (N=96)		2-mile buffer neighborhood - 2001 Active (N=84)		Means Difference	T-value (sig.)
	Mean	Std Dev	Mean	Std Dev		
Racial Composition						
Percent Non-Cuban Hispanic	23.72	12.48	23.43	14.56	-0.29	0.144
Percent Non-Hispanic Black	22.01	31.76	32.18	37.82	10.17	1.961**
Gentrification Index						
Percent College Educated	10.52	3.86	9.41	3.51	-1.11	2.008**
Percent White-Collar	9.69	7.31	6.98	4.23	-2.71	2.988***
Social Status Index	10.11	5.15	8.19	3.28	-1.92	2.935***
Economic Characteristics						
Percent Unemployed	10.47	8.58	9.41	3.51	1.65	1.280
Percent Below Poverty	21.67	13.43	6.98	4.23	0.53	0.275
Average household income	$44,893	$21,362	$40,160	$13,842	$-4,732	1.736*
Housing Characteristics						
Percent Vacant	8.33	11.97	6.58	11.29	-1.75	1.005
Percent with No Heating	4.84	2.60	4.52	2.89	-0.32	0.782
Percent with No Kitchen	1.72	1.67	1.48	1.47	-0.24	1.017
Percent with No Plumbing	1.46	1.94	1.37	2.02	-0.09	0.305
Percent Poor Housing Cond.	2.68	1.28	2.46	1.30	-0.22	1.142

*** significant at 0.01 level ** significant at 0.05 level * significant at 0.1 level

Table 8.20 compares sociodemographic characteristics between census tracts in the two-mile buffer neighborhood around active Superfund sites and the corresponding two-mile buffer neighborhood around delisted Superfund sites after remediation in 2001. As Table 20 indicates, neighborhoods with still-active Superfund sites are more likely to have a higher proportion of non-Hispanic black population with a significant difference of nearly 10 percentage points between neighborhoods with active and delisted Superfund sites. Similarly, neighborhoods with remedied Superfund sites are significantly more likely to have a higher proportion of college educated population and are employed in white-collared jobs, with a combined social-status index of nearly 2 percentage points higher than comparative neighborhoods around still-active Superfund sites. Also, neighborhoods with remedied Superfund sites have populations with significantly higher average household income to the tune of nearly $4,700 more than neighborhoods with active Superfund sites. However no significant difference exists among neighborhoods based on proportion of unemployed and below poverty populations. Also, there is little difference in housing conditions based on availability of heating, kitchen, and plumbing facilities between the neighborhoods with remedied and still-active Superfund sites.

These differences do not appear to be as large although the differences are slightly larger than the baseline figures displayed in Table 8.19. For example, the average household income between comparison groups increases from $2,839 to $4,732, a near doubling of difference. Similar increase in differences is observed in proportion of white-collared workers and the combined social status index while the housing characteristics remain significantly unchanged as before. However, the proportion of college-educated population although different when compared to the control group is exactly the same over the two time periods when remediation occurs indicating no change in demographics related to change in status of the Superfund contamination. Although these findings do not suggest any large significant changes in sociodemographic characteristics due to change in remediation status, it offers insights into nature of neighborhoods whose Superfund sites are targeted for remediation. These implications and insights will be discussed in detail from the perspective of environmental justice in the concluding chapter.

CHAPTER IX

DISCUSSION, IMPLICATIONS, AND CONCLUSION

The research presented here seeks to expand the existing literature on impact of environmental disamenities on housing property valuation and contemporaneous sociodemographic change. Using a comprehensive dataset of actual sales price from housing transactions collected over a period of ten years and supplemented with related structural, neighborhood, and environmental characteristics, this research with the help of several models tested the impact and trends in Miami-Dade County from the presence and subsequent remediation of Superfund sites on the National Priorities List. This study uses data from 1992 when all Superfund sites were considered active and compares it to the data from 2001 when a majority of the sites were remedied. This comparison allows for before-and-after comparison of not only the housing sales prices due to the change in remediation status but also the corresponding neighborhood characteristics from the perspective of gentrification and environmental justice. The cross-sectional hedonic models accounting for spatial dependence allow for analysis of comparable properties across space and the longitudinal analysis assists in demonstrating the effects of remediation over time. The hedonic models are also constructed for housing submarket segmentation based on school quality to reflect differences in socioeconomic characteristics across the region.

The purpose of this research was to understand and elaborate on the relationship between the proximity of environmental disamenities and the surrounding single-family residential properties in terms of housing price impact and sociodemographic change. First, this study indicated significant negative effects on housing sales price from proximity to active Superfund sites and found significant discernible effect of remediation on sales price of surrounding properties. Second, this research accounted for the effect of spatial dependence to enhance the accuracy of price prediction and eliminate bias due to omitted variables and found spatial models that fix biased and inefficient parameter estimates to be better predictors than traditional OLS models. Finally, this research examined the differences in sociodemographic characteristics of the neighborhoods where the Superfund sites are located and found no indication of gentrification in neighborhoods with remedied Superfund sites. However, neighborhoods with still-active Superfund sites were found to be characterized by low-income minority populations and experienced further decline in property values and neighborhood quality leading to concerns for environmental and social justice. Although the impact of remediation was significantly higher in low and low-middle housing submarkets, Superfund sites in higher submarkets were more likely to be remedied indicating concerns for environmental and social justice.

Discussion

Housing Price Impact

Based on the findings in the previous chapter, this study finds a significant negative impact of environmental disamenities, specifically Superfund sites, on surrounding single-family residential homes before remediation. According to the traditional OLS model, holding other structural, neighborhood, and submarket segmentation characteristics constant, sales prices increased significantly by 2.2 percent or $1,955 with every additional mile from the nearest Superfund site. Following remediation by 2001, this impact of the nearest Superfund site declines to near 1.4 percent or $1,351, a drop of nearly $600 with every additional mile from the environmental disamenities indicating a declining effect of the contamination on housing sales price. Since not all Superfund sites are remedied by 2001, the difference between the housing sales prices around remedied sites is 10 percent higher than around still-active sites thus rejecting the null hypothesis that supposes no difference. The diagnostic statistics for determining the validity of using spatial models in lieu of traditional OLS hedonic models as represented by the Moran's I tests and Lagrange Multiplier tests are highly significant indicating the presence of strong spatial autocorrelation among the average sales prices of residential properties at the census block group level. Other tests like likelihood ratio tests, Akaike info criterion, and Schwarz criterion also reinforce the rejection of the null hypothesis that there is no difference among parameter estimates in using OLS models and spatial models. Although the R-Squared and adjusted R-Squared statistic along with Mean Standard Error (MSE) and log-likelihood ratios suggest that the estimation with the spatial models outperform the OLS estimation, the values for the R-Squared and adjusted R-Squared statistic in the OLS models are assumed to be biased due to strong spatial autocorrelation.

The spatial models – lag or error – chosen based on the value and significance of their Lagrange Multiplier test statistics provide a better hedonic model for estimating impact on housing sales price due to surrounding environmental disamenities while controlling for other price-influencing factors like structural and neighborhood characteristics. In the pre-remediation model, the primary independent variable – proximity of the nearest Superfund site – is highly significant and for every additional mile away from the contaminated site, the sales price of the surrounding residential properties increases by 2.15 percent, a slight drop from the OLS model. The type of contamination also makes a significant difference in estimating the effect on sales prices of surrounding properties with contamination from electroplating, pesticide/ herbicide/ insecticide, and military base contamination being nearly 7.9, 2.2, and 1.4 percent respectively lower than the reference contamination of industrial solvent disposal.

In the post-remediation model, the effect of the nearest Superfund site is highly insignificant implying reduction or near-elimination of the impact of contamination on surrounding residential properties. But since not all sites were remedied in the interim time period, the price effect for properties around remedied sites and still-active Superfund sites was compared. As in the OLS model, the difference between the housing sales prices around remedied sites is 10.9 percent higher than around still-active sites thus implying that although the effect from proximity to environmental disamenities diminished over the entire region, significant differences still persisted among neighborhoods with Superfund sites having different remediation status. In terms of contamination types, landfill contamination (-11.4 percent), pesticide/ herbicide/ insecticide contamination (-9.7 percent) and other forms of contamination (+9.9 percent) have significantly different impacts on surrounding residential properties when compared to industrial solvent contamination. However, it should be noted that due to lack of variance in contamination types, any conclusions regarding price impacts from types of contamination may be restricted to the Miami-Dade region. Types of contamination are at best nominal measures without any existing and predetermined ranking so as to suggest that some contaminations may be more harmful than others. Also, the military base contamination may not only have a detrimental effect from on-site land and water contamination but also other ancillary effects from noise and size of the site that depresses property values of surrounding housing. Additionally, the size of military base Superfund site (3,376 acres) is significantly higher than other contaminated sites which tend to skew the effect of size on price impacts.

These results underline the basic premise of this study that presence of environmental disamenities or as in this case, Superfund sites, have a significant detrimental impact on surrounding single-family residential housing properties. Remediation of such contamination reduces the negative impact. Certain types of contamination, presence of other Superfund sites, and higher proportion of commercial and industrial land uses are observed to be significantly more detrimental in terms of price impacts and can influence the effect of the proximity of the nearest Superfund site. Sales prices are considered to provide more an accurate and better reflection of housing values for measuring impacts of other exogenous factors like sociodemographic characteristics and presence of environmental disamenities. Markets typically react more quickly and more efficiently in adjusting values of properties in response to the change in status of contamination, if any, by incorporating the information disseminated in form of perceptual cues or government assessment of contaminated properties within the price model. Appraised values although considered appropriate for assessing property taxes, generally react more slowly to changes in neighborhood characteristics and due to their inherent connection to sales prices in determining its value is prone to time lag.

Additionally, the Homestead Act of Florida prevents appraised values from increasing more than 3 percent every year unless the property has experienced a sale. This legislation is intended to protect homeowners from losing their properties from drastic price increases that lead to higher property taxes. However in terms of measuring impact of proximity to Superfund sites, properties closer to the Superfund sites are less likely to be sold due to diminished marginal benefit accrued from environmental factors. This results in stagnancy of or less than optimal increase in appraised values over time leading to inaccurate estimation of price impacts from environmental disamenities.
The pooled observations regression model examines the significance of the differences of the sales price of properties around Superfund sites before and after remediation in 1992 and 2001. Remediation led to nearly 10.1 percent increase in value of sales price for properties in the immediate vicinity of the Superfund sites thus confirming the findings from separate cross-sectional models.

Other structural and neighborhood characteristics that act as controlling variables but are not the focus of this study, also exhibit expected results in both the OLS and spatial models. Among the neighborhood variables, distance to the coast, proportion of non-Hispanic blacks, and proportion of college-educated population, are highly significant. These variables typify the Miami-Dade region profile as it is a coastal city and home to a large population of Hispanics. Homes closer to the coast generate a higher price premium than those away from it and higher proportion of African-Americans particularly non-Hispanic as evidenced in contemporary neighborhood demographics literature tend to reflect lower home values. The proportion of college-educated population is negatively correlated (highly) to rate of poverty and unemployment rate, and positively correlated (highly) to average household income (See Table 6.3). Thus association between level of education and average housing value is reflective of other correlated neighborhood characteristics as well.

Housing Submarket Segmentation

The Miami-Dade region is segmented in this study into four housing submarkets based on school quality to act as a proxy for socioeconomic differences. The means of the sales price along with other neighborhood characteristics varied significantly across these submarkets (See Table 5.3 and 5.4). Such segmentation is not spatially contiguous and is thought to be better indicators of submarket definition as compared to the traditional segmentation based on structural characteristics. School quality is also indicative of neighborhood quality which in turn determines the sociodemographic mix. Submarkets with lower sales price also show higher incidences of crime rates, lower median household income, higher percentage of poor and unemployed populations, and higher percentage of non-Hispanic blacks reinforcing the relationship between socioeconomic health and submarket definition segmented on school quality. Based on the sociodemographic characteristics, Submarket 1 is considered as the low housing submarket and submarket 4 is considered as the high housing submarket with submarket 2 and submarket 3 considered as the low-middle and high-middle housing submarket respectively.

Findings based on spatial diagnostic statistics using Lagrange Multiplier tests and the size and significance of spatial autoregressive parameters justify the use of spatial hedonic models over the traditional OLS models. The effect of the proximity to the Superfund site on housing sales price is the highest in the lower submarkets as compared to the higher submarkets. The sales prices of properties around contaminated Superfund sites increases by 7.8 percent with every additional mile away from the contamination in the low housing submarket, and this proximity effect is insignificant for other submarkets. These findings indicate that contaminated Superfund sites are more likely to have a detrimental effect on housing sales prices in lower socioeconomic housing submarkets as compared to premium housing submarkets. This differential impact points to a greater adverse effect from environmental disamenities on neighborhoods with low-income minority populations leading to concerns for environmental justice at least in terms of disproportionate access to environmental factors. However, in premium housing submarkets, the presence of other positive factors that influence housing price such as school quality, low crime rate, or proximity to coast may compensate for the presence of Superfund sites. People are more likely to live closer to environmental disamenities if they perceive other neighborhood characteristics such as better school quality or lower crime rate and structural characteristics such bigger lot size or more bedrooms as more beneficial and optimal to their sense of quality of life in the neighborhood. Housing consumers in premier housing submarkets may tradeoff living close to environmental disamenities with other neighborhood characteristics that enhance the standard of living effectively undermining the presence of Superfund sites. However, in lower socioeconomic neighborhoods, the presence of such environmental disamenities seeks to add to the perception of lower standard of living that reinforces the negative impact from the proximity to Superfund sites as opposed to compensating for as is the case in premium housing submarkets. The presence of contaminated sites in premium housing submarkets may be compensated by the presence of other positive factors but in lower housing submarkets, the presence of Superfund sites in fact adds to the host of other negative factors that influence housing price. Presence of abandoned and contaminated sites adds to the perception of lower safety and diminished standard of living in the neighborhoods in form of physical perceptual cues that already have higher crime rate higher vacancy rates, and lower socioeconomic standards causing a multiplier effect. This presence of derelict, abandoned, and perceived contaminated sites adversely impact the perception of risk from health effects and related socioeconomic problems that are generally associated with the presence of such environmental disamenities.

Following remediation, the effect is consistent across all housing submarkets and impact of proximity to the Superfund sites is no longer significantly influential on surrounding housing properties. However due to the presence of still-active Superfund sites in the region, the difference in housing price impact between active and delisted sites across housing submarkets is examined. The effect of remediation is highest in the low housing submarket where properties in census block groups surrounding the still-active Superfund sites sell for 17.5 percent less than properties in census block groups surrounding Superfund sites that were remedied and delisted by 2001. This effect is lower in low-middle housing submarket where properties around still-active Superfund sites sell for 8.1 percent less than properties around remedied and delisted Superfund sites. Remediation has no discernible effect in high-middle or high housing submarkets. These findings indicate the importance of remedying environmental disamenities in lower socioeconomic neighborhoods. Not only from the perspective of addressing concerns of environmental justice arising from disproportionate access to contamination but also from the perspective of significantly increased benefits accrued from remedying Superfund sites in such neighborhoods.

Economically, it makes sense to remediate Superfund sites in lower socioeconomic neighborhoods because benefits in terms of housing price impact from such remediation are significant and measurable in such neighborhoods as compared to premium housing markets. Remediation of Superfund sites in economically depressed neighborhoods is also likely to have a multiplier effect for other neighborhood characteristics by attracting homebuyers that were previously hesitant due to presence of contamination. Generally, remediation and delisting of a Superfund site attracts significant media attention and tends to assuage public perceptions regarding contamination risk. Delisting Superfund sites not only sends a strong signal to the market of improved environmental conditions in a previously distressed neighborhood that is targeted for revitalization but also encourages redevelopment of an underutilized land resource. Remedied brownfields have often been targeted by public or private enterprises to boost economic development of the neighborhood and provide vitality to the health of the community. Lower socioeconomic submarkets are more likely to respond to such redevelopment efforts and present a potential for greater price impacts due to existing gaps in capitalized land rents and potential land rent. Remediation of a Superfund site serves as a trigger point for launching redevelopment efforts in a disadvantaged and vulnerable neighborhood and this confidence in future potential of redevelopment is often first reflected in the housing price impacts for residential properties in the immediate vicinity of the Superfund site.

Contemporaneous Sociodemographic Change

This study not only compares the housing price impact in terms of sales price but also examines the contemporaneous sociodemographic change before and after remediation in the immediate neighborhood surrounding the Superfund sites. This sociodemographic change is examined on basis of racial, economic, housing, and social status characteristics at the Census Tract level using the Geolytics Neighborhood Change database. The focus of this sociodemographic change examination is through the lens of environmental and social justice that seeks to address inequitable and unfair access to environmental disamenities. Further, the social status characteristics use education level and job classification to look for any incidences of gentrification that follow remediation in neighborhoods surrounding Superfund sites.

In order to examine sociodemographic change, it is important to define a targeted neighborhood area that is significantly impacted by the presence and subsequent remediation of Superfund sites instead of looking at demographic change for the entire region. Delineation of such neighborhood provides focused analysis of the direct impact of environmental disamenities and their contamination status. Comparing housing price impacts due to proximity to environmental disamenities relative to distance, properties in census block groups within a two-mile radius around Superfund sites experience significantly greater effects than properties located further away. Controlling for other structural and neighborhood characteristics, the average sales price for properties in census block groups located within a two-mile radius is 15.5 percent lower than properties located more than 6 miles away whereas properties in census block groups located within 2-4 miles and 4-6 miles sell for 12.8 percent and 11.4 percent less than properties in census block groups located more than 6 miles away (see Table 8.14). Post-remediation, the effect of the nearest Superfund site relative to distance declines by nearly half but is still significantly lower at 8.9 percent for properties within a two-mile radius as compared to properties located further away. The impact on average sales price of properties in census block groups beyond the two-mile radius are no longer significantly different from the average sales prices of properties located further away following remediation. This indicates a significantly higher impact on properties located in the close vicinity of the Superfund sites. Thus, this study uses properties in census tracts in this two-mile radius for defining a neighborhood in order to examine differences in sociodemographic characteristics before and after remediation.

Comparing the region between the two time periods (see Table 8.15), little change is observed in proportion of non-Hispanic blacks and in the combined social status index and any significant change in other economic and housing characteristics is negligible at best. The only significant and meaningful change in the racial composition has been the increase in non-Cuban Hispanics which can be attributed to the national trend of increased levels of migration. In order to examine the sociodemographic characteristics for populations living in close proximity to the environmental disamenities, the census tracts in the two-mile radius Superfund sites are compared to the tracts away from them before remediation (see Table 8.16). The neighborhoods around Superfund sites are significantly more likely to be populated with non-Hispanic blacks, have lower proportion of college-educated persons, have lower proportion of persons holding white-collared jobs, and lower average household income as compared to neighborhoods away from such environmental disamenities. These differences indicate obvious concerns for environmental and social justice as low-income minority populations are more likely to be found in neighborhoods closest to the Superfund sites and hence more are vulnerable to ill-effects from contamination and consequential lower housing prices.

The difference in average household income between neighborhoods around Superfund sites and those away is nearly $8,000 and the average household income for the neighborhood around Superfund sites is nearly $5,000 lower than the average household income for the entire region suggesting that such neighborhoods tend to house low-income populations that may or may not be living close to contaminated sites voluntarily. The social status index as measured by level of education and job classification also indicates that neighborhoods in close proximity to Superfund sites are more likely to be non-college educated blue-collared workers restricted by income limitations into living in such neighborhoods when compared to neighborhoods away from the contaminated sites. These neighborhoods also rank lower in terms of the social status index when compared to the entire region reinforcing the distressed and disadvantaged nature of neighborhoods that are located around Superfund sites. Interestingly, properties around Superfund sites are less likely to be vacant and are home to low proportions of non-Cuban Hispanics as compared to other parts of the region. The Miami-Dade region was at least during the 1990s the destination for investment properties due to the construction and housing boom. Premium housing submarkets or neighborhoods with higher socioeconomic characteristics are more likely to house vacant properties than neighborhoods with lower socioeconomic characteristics. This difference in vacancy rates can be attributed to Miami-Dade being a primary magnet metropolitan region for immigrants. Housing in lower socioeconomic neighborhoods is expected to be demand-oriented since many recent immigrants especially the working class chose to first live in neighborhoods with lower socioeconomic characteristics that provide affordable housing. Also, due to the unique ethnic mix and Hispanic-dominated population in the Miami-Dade county, traditional differences between Hispanic and non-Hispanic populations found elsewhere in the country are not significant with the exception of non-Hispanic blacks.

Effect of Remediation

Comparing neighborhoods before and after remediation of proximate Superfund sites, there exist no significant and discernible differences with respect to gentrification. None of the social status index variables were found to be significant implying no trends toward an in-migration of college-educated and white-collared workers in neighborhoods where Superfund sites had been remediated. Even after remediation, such neighborhoods with Superfund sites continued to be dominated with low-income minority populations. In fact, the proportion of non-Hispanic black population, and percentage of unemployed workers increased significantly. In the same period, significant increase in deterioration of housing conditions in terms of kitchen and plumbing facilities were also observed. Even the average household income increased less (+35%) than the overall increase for the county (+72%) indicating that although higher wage-earning populations moved into the region, the people that lived around Superfund sites even after remediation continued to earn less and experienced deteriorating housing conditions. The persistence of stigma associated with living closer to environmental disamenities and inadequate dissemination of information pertaining to remediation status and decreased risk might explain these results. Incoming gentrifiers that tend to be white, college-educated and are typically employed in white collared professions might still be considering such neighborhoods risky enough for raising their families given the increasing levels of minority population and declining housing quality. However, the deteriorating condition of housing might in fact portend the pioneer stage of gentrification that inspires people who renovate homes by investing in personal sweat equity. These neighborhoods, as Smith (1979) explains, may be at the threshold of addressing the rent gap through low capitalized rent due to poor housing conditions and provide an investment opportunity to smart investors who have recognized the potential and future impact of the elimination of potent price-depressing environmental disamenities. But under the current conditions either due to the persistent effect of stigma or lack of adequate passage of time, no gentrification trends seem to be emerging in neighborhoods where Superfund sites have been remediated.

On the other hand, comparison of neighborhoods over time with still-active Superfund sites presents a different picture. Without the effect of remediation, neighborhoods experience a significant increase in non-Cuban Hispanic and non-Hispanic black populations; much higher than the overall increase for the county. The social status index variables including proportion of college educated persons and white-collared workers also drop significantly along with a significant rise in poverty and unemployment rate indicating a decline in the socioeconomic characteristics for neighborhoods where environmental disamenities went unaddressed. Although gentrification trends are not observed in neighborhoods where Superfund sites were remedied, isolation of low-income minority populations is observed in neighborhoods where no remedial action was taken. These results reinforce the environmental justice concerns regarding vulnerability and unfair access to contaminated properties. Residential neighborhoods not only continued to suffer the ill-effects of the presence of contaminated Superfund sites but also gradually worsened in terms of housing condition and other sociodemographic characteristics. Failure to take remedial action for these

Superfund sites may have contributed to the ‘ghettoization’ of the neighborhoods by depressing housing values due to presence of contamination and proving to be the last refuge for affordable housing for low-income minority populations.

Compared to the baseline time period in 1992, the differences in the sociodemographic changes in the neighborhoods remain largely unchanged at least in terms of incidence of gentrification and racial composition. However differences exist between neighborhoods that experienced Superfund remediation and those that did not. Neighborhoods that were remedied had significantly lower proportion of non-Hispanic blacks and higher proportion of college-educated white-collared workers. Does this mean that Superfund sites in certain neighborhoods were selectively marked for remediation? How were these selections made? Although it might not seem causal, given the findings of this study it appears that Superfund sites in premium housing submarkets with lower percentage of non-Hispanic blacks and higher percentage of college-educated white-collared workers were remedied. The average household income in neighborhoods with Superfund sites selected for potential remediation by 2001 was also significantly higher than neighborhoods where Superfund sites remained contaminated. This selection of Superfund sites to be remedied associated with the sociodemographic characteristics enables the cloistering of low-income minority populations in those neighborhoods as described earlier. The unchanged status of the environmental contamination in the neighborhoods diminishes any geographic opportunities that vulnerable and disadvantaged populations might require to enhance their standard of living and boost their social status.

To conclude, the research hypotheses listed earlier were tested and based on the findings, conclusions can be summarized as follows:

1. Housing sales price for single-family residential properties significantly increases as distance to the nearest contaminated Superfund increases,
2. Superfund NPL sites with different types of contamination have a significantly different economic impact on the sales price of the surrounding single-family residential properties,
3. Post-remediation, housing sales prices for single-family residential properties had no significant relationship with distance to the nearest Superfund site,
4. Single-family residential properties surrounding a remedied and delisted Superfund site had a significantly higher sales prices than comparable single-family residential properties surrounding an still-active and contaminated Superfund site,
5. There was significant presence of spatial autocorrelation based on sales price for single-family residential properties in 1992 and 2001 as measured by global and local Moran's I tests thereby justifying the use of spatial hedonic models.
6. Based on the spatial diagnostic tools using Lagrange Multiplier tests, spatial error hedonic models were used for measuring impact on sales price in 1992, and spatial lag and spatial error hedonic models were used for measuring impact on sales price in 2001.

7. Based on the test statistics for model fit, spatial hedonic models outperformed traditional OLS models in parameter estimation for measuring housing price impact.
8. There existed significant differences between certain sociodemographic characteristics of census tracts around contaminated Superfund NPL sites and those of properties located elsewhere.
9. No trends or indications of gentrification were noticed in the neighborhoods in the period following remediation. Strong evidence in terms of environmental justice regarding disproportionate and unfair access to environmental disamenities and in the decision to remediate Superfund sites was observed.
10. Low-income minority populations are more likely to live in neighborhoods around contaminated Superfund sites. Superfund sites in low-income minority neighborhoods are less likely to be remedied as compared to Superfund sites located elsewhere.
11. Presence of contaminated Superfund sites has a significant and negative impact on single-family residential properties in low housing submarkets as compared to high housing submarkets. Remediation of Superfund sites in low housing submarkets have a significant positive impact on single-family residential housing as compared to that in high housing submarkets.

Implications

This study addresses an important gap in brownfields redevelopment and housing valuation by examining the economic and sociodemographic impact on single-family residential housing surrounding Superfund sites. As the findings show, presence of contamination not only has a detrimental impact on the sales price of surrounding properties but also the remediation of such contamination reverses any previous negative effects. Increased property value from the remediation of environmental disamenities not only boosts personal household wealth of individuals but also adds value to the neighborhood in terms of better services from increased property taxes and higher turnover rate. While increased property prices are not only the measure of a successful remediation and redevelopment project but also a strong indicator of neighborhood renewal. Remediation of Superfund sends a strong signal of impending revitalization of the neighborhood characteristics and seeks to attract potential homebuyers that might have been dissuaded earlier due to presence of contamination.

Departing from earlier justifications of economic feasibility and imminent environmental danger to the proximate community, this study examines brownfields or specifically Superfund remediation and subsequent redevelopment from the holistic framework of improving neighborhood quality and revitalizing previously disadvantaged and distressed communities. Starting from the economic impact in terms of change in housing sales prices and proceeding to analyzing contemporaneous sociodemographic changes emanating from changes in environmental quality, this study contributes to the field of sustainable growth models and trends in redevelopment of vacant and abandoned lands that have increasingly gained prominence in contemporary literature of urban planning. The results of this study add insights to the question of investment in brownfields redevelopment as a tool for influencing the nature and structure of the neighborhoods. While not revealing patterns of development, this study demonstrates the immediate economic profit from the declining effect of contamination that in turn boosts personal household wealth at least within the immediate proximity of the remedied site. Although demographic change is not yet apparent, the economic change leads us to believe that consumers will perceive optimization of their living conditions due to decreased risk from environmental disamenities. This increased potential for profit in terms of enhanced housing value will make the neighborhood more desirable for development. The act of remedying brownfields helps in moving the burden of redevelopment away from public initiatives to private investments by making the neighborhood more desirable for housing consumers and thus making the redevelopment of previously distressed neighborhoods more economically feasible.

The reasons for location of brownfields in older neighborhoods with a history of commercial and industrial operation that led to the contamination are obvious. However, the continued presence of contamination even after operations ceased undermined the health of the surrounding community and leading to related neighborhood effects of abandonment and dereliction. The physical effects of abandoned and contaminated sites suppressed property values and resulted in subjecting the largely low-income minority populations to an unfair and disproportionate share of access to environmental disamenities. The question of whether these brownfields were initially located before governmental intervention ceased operations in existing low-income minority neighborhoods is beyond the purview of this study. However, based on the federal and state environmental legislation and remediation programs, the criteria for making the decisions to remediate brownfields can be discussed from the perspective of environmental and social justice. This study reveals that continued contamination or failure to remediate Superfund sites result in intensification of the presence of low-income minority populations in such neighborhoods. Communities where Superfund sites have not yet been remedied have not only experienced an increase in low-income minority populations but also an increase in unemployment and poverty rates. Sharp differences also exists between neighborhoods where Superfund sites have been remedied and where they have not. These differences may not indicate overt discrimination or racism against low-income minority populations. Due to lack of civic involvement and environmental awareness reinforced by insufficient voter awareness regarding federal and state brownfields redevelopment in low-income minority neighborhoods may explain the differences in sociodemographic characteristics of neighborhood where remediation occurs although pervasive discrimination cannot be entirely ruled out. This study underscores the inequitable distribution of remedied Superfund sites and helps contextualize the nature and effects of environmental disamenities not only on the basis of their economic effects on housing price but also on the inherent structure of the neighborhood sociodemographic characteristics. Due to insufficient time lag post-remediation, this study fails to notice any sociodemographic change especially with respect to gentrification in the neighborhoods with remedied

Superfund sites but it highlights important differences in neighborhoods where such remediation occurs.

Considering the prevalence of Superfund sites in low-income minority neighborhoods, this study recommends that the choice of remediation of Superfund sites should not be based on the size and extent of contamination but rather on its location and sociodemographic characteristics of its surrounding neighborhood. Remediation of Superfund sites in predominantly low-income minority neighborhoods is likely to have greater and far-reaching implications in terms of impact on housing value and addressing concerns of environmental justice. To paraphrase Rawls, the greatest benefit of remediation accrues to the least advantaged populations. Although presence of contaminated sites in premium housing markets also negatively impacts housing value, the presence of other benefits like proximity to coast, higher quality of schools, lower crime rate, etc partly compensates for the negative effects of contamination whereas presence of contamination in low housing submarket adds to the existing negative externalities of the neighborhood. Consequentially, remediation has a far lesser effect in premium housing submarkets or neighborhoods with affluent populations than it would in low housing submarkets and neighborhoods with disadvantaged populations. Policy makers would be better advised of these differences in decisions to remediate and effects of remediation in order to redirect cleanup and redevelopment efforts to vulnerable neighborhoods where the economic impact post-remediation is most pronounced and the choice for remediation is equitable and fair from the perspective of environmental and social justice.

From the theoretical perspective, there was little evidence in the literature that presented examination of post-remediation impact although plenty of studies have documented the negative effects of presence of proximate contamination. The brownfields redevelopment literature has typically analyzed the specific contaminated site itself through the lens of environmental hazard and scope for reuse as well as impact of the brownfields on surrounding neighborhood. However, this impact on the surrounding community has always been primarily driven by economic impacts with a brief look at the structure and composition of the sociodemographic characteristics. Housing submarket segmentation in conjunction with brownfields impact has been driven by structural characteristics as opposed to neighborhood sociodemographic characteristics. This study assesses the influence of environmental disamenities before and after remediation across time to provide a more complete and comprehensive understanding of not only the economic impact but also the trends and patterns of sociodemographic characteristics that distinguish such neighborhoods. This economic effect is measured by using a comprehensive dataset that includes sales price values from housing transaction over the period of ten years and is expected to reflect the perceived risk of contamination as measured by the housing market and potential homebuyers.

The segregation of the region into distinct and non-spatially contiguous housing submarkets based on school quality to represent nature and quality of the neighborhoods resolves questions of measuring impact of contamination based on nature of the neighborhoods. Identifying and segregating the housing market into submarkets not only improves price prediction accuracy but also provides better assessment of housing preferences, risk assessment, and disparate behaviors of populations from different sociodemographic groups. Given the level of segmentation, housing submarkets also help control for state and nature of market mechanisms in determining housing values. This study thus not only includes submarkets as a controlling factor to isolate the effect of environmental disamenities but also uses segmentation to examine differential effects of subsequent remediation or decisions to remediate.

Finally, one of the important implications of this study is the accounting for spatial dependence in the hedonic modeling used to determine housing price impact. Most housing studies have ignored spatial aspects of the data that tend to influence property value and thus produce biased and inefficient parameter estimates for measuring influence of environmental disamenities. This study uses spatial econometric estimation methods and specification tests for hedonic modeling for examining spatial dependence in the data instead of the commonly used OLS methods. Adjustment of the property values by using weighted average of the prediction errors obtained from the adjoining properties by assigning a function of proximity and degree of spatial dependence leads to better and more accurate results. Using spatial hedonic modeling also compensates for omitted variable bias that most real estate valuation studies suffer from.

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. Brownfields 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 external validity of the research.

Additionally, this study restricts itself to measuring economic impacts in terms of changes to sales prices in housing transaction. Although this study allows for sufficient lag time between remediation and measurement of economic impacts, some neighborhoods undergoing brownfields remediation experience an extended period of stigma and 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. Additionally, this study limits itself to single-family residential housing properties and does not include other forms of housing like multi-family units, condominiums, cooperative housing, and public housing. This limitation is imposed due to particular characteristics of single-family housing such as proximity to nearest Superfund site that cannot be incorporated for multifamily or condominium housing. The distance to the environmental disamenities would be the same from all units in multifamily housing and yet have different prices due to floor levels, views, and other amenities not applicable to single-family housing.

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 not be generalizable to other 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.

Future Research

This study explores the relationship of environmental disamenities and the surrounding residential properties on the basis of economic and sociodemographic effects. Based on the limitations and preliminary findings from this study, there are several research avenues that can be explored in the future. This study uses Superfund sites as locations of environmental contamination due to better documentation of their contamination and subsequent remediation. The federal agencies involved provide not only widely disseminated results of the contamination and remediation process but also highlight the high levels of hazards that can significantly affect the neighborhood they are located in. However, there are other kinds of brownfield sites that are contaminated but have failed to meet the criteria for being classified as Superfund sites. The levels of contamination in such sites can equally affect the surrounding properties especially if the status of their contamination is known locally. Future studies can document such brownfields that have not been identified by the USEPA but still qualify as contaminated sites according to state and local standards. Potential sites such as abandoned gas stations or dry cleaning facilities that have not yet been classified as brownfields and might even be in operation right now can also be potential brownfields. Additionally, a detailed resident survey can also be carried out to help expanding the definition of environmental disamenities to account for any factors that have not been traditionally considered as such and yet are affecting housing prices.

Persistence of stigma from proximate contaminated sites within the neighborhood might after risk perceptions of potential homebuyers even after remediation has been successfully conducted. Since perception of risk plays a far greater role than actual risk in determining preferences among homebuyers, it might be necessary to allow for more lag time in order to look for any significant sociodemographic changes. This study has shown the remediation of proximate contamination has a positive effect on housing prices but this change has not adequately reflected in terms of demographic change. Neighborhood change even after an uptick in housing values can be gradual and slow. This study can be repeated in the future after allowing for sufficient lag time for demographic change to take effect. Additionally, a panel study can also be undertaken to determine trends in price changes at every stage of the remediation process. This can be supplemented by examining if rate of price increase changes as time from when it was remedied increases.

This study does not examine the reasons for selecting Superfund sites for remediation although it has been shown that contaminated sites in the low-income minority neighborhoods are less likely to be remedied than sites in the affluent neighborhoods. Future research can examine the mechanism and processes that lead to the selection of certain Superfund sites over others. The current model of selection unfortunately poses environmental and social justice concerns and need to be addressed by explicitly elaborating on the criteria and process of selection by the government. Previous research has shown factors like voter awareness and environmental group membership to be pivotal in choosing sites for remediation (Viscusi & Hamilton, 1999). Since brownfields remediations are primarily government-assisted initiatives and utilizes taxpayer money, the public interest in understanding the role of selection and remediation of contamination in light of environmental justice concerns is paramount. Although overt discrimination may not be the underlying reason, research in understanding role of group dynamics, political processes, community social networking, and environmental activism in largely political decisions of selecting brownfields for remediation will go a long way in assuaging environmental and social justice concerns. The extent of the role of the government in not only remediating contaminated sites but also assisting or fostering public-private partnerships for subsequent revitalization of the surrounding neighborhood is worth exploring. Existing research on environmental justice issues can be supplemented by assessing differences in affordability, migrations trends, and demographic change relative to type and source of contamination.

This study attempts to analyze trends for gentrification as form of sociodemographic change in neighborhoods with remedied Superfund sites but finds no such evidence. Future research can examine aspects and nature of sociodemographic change by looking at the previous and current housing locational decisions of residents. Detailed survey in determining housing preferences regarding relocating to revitalized neighborhoods will help in better understanding of why potential homebuyers move to previously disadvantaged neighborhoods. Is it the affordability factor that allows them to purchase homes or any other locational factor that determines their housing choice? Do people that choose to move to such neighborhoods display certain sociodemographic characteristics that distinguish them from other populations? Such research questions can only be answered through an in depth analysis of targeted neighborhoods where brownfields have been remedied and neighborhood change has been initiated. Risk perception toward proximate contamination can be analyzed using survey research to evaluate the awareness and perceptions of affected residents in the target areas, as well as the feasibility of development from the perspective of residential mortgage lenders.

Conclusion

The effects of brownfields 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 explores the spatial relationship of presence of Superfund sites 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 Miami-Dade County over the period of ten years. By using geographically relevant data on brownfields and census demographics, this study examines the housing price impact of Superfund 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 helps 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 examines 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 provides for introspection in achieving goals of environmental and social justice.

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APPENDIX A

OPERATIONAL DEFINITIONS

- Single-Family Residential Properties: These sites and properties are marked as single-family residential by the Miami-Dade County and accorded a County Land Use Code (CLUC) of 1.
- Superfund NPL Site: Contaminated properties designated as extremely hazardous by the USEPA and placed on the National Priority List (NPL) for priority in executing remediation measures.
- Remedied Superfund NPL site: Previously contaminated site that has been delisted from the National Priority List and is considered safe from environmental and health risks.
- Housing Price Impact: measured by changes in the sales price obtained from housing transactions in the given time period from the Miami-Dade Property Appraisal Office.
- Spatial Dependence/Autocorrelation: The extent of influence of geographic data with similar data situated at other locations with nearer locations having greater influence.
- Geographic Information Systems (GIS): Type of information system characterized by locational data with the help of spatial or geographic coordinates. GIS mapping provides graphic displays backed by inherent attribute information.

- Hedonic Price Modeling: Empirical analysis method used in real estate valuation for determining influence of individual bundles of housing typically measured by structural, neighborhood, and locational characteristics.
- Sociodemographic Characteristics: neighborhood characteristics measured at or aggregated to the Census Block Group level comprising of social and demographic factors like level of education, median household income, rate of poverty, school quality, crime rate, level of unemployment, and job type associated with the population within the Census Block Group.
- Gentrification: displacement of original lower income population by incoming higher income ‘gentrifiers’ due to shifting trends in social and economic characteristics of the neighborhood borne out by physical changes in the neighborhood and measured by indicators such as change in property price, demographics, and level of professionalization of the population.
- Superfund NPL Site Proximity: Euclidean distance measured from individual residential property to the nearest Superfund NPL site and averaged at the Census Block Group Level.

APPENDIX B

SUPERFUND SITES IN MIAMI-DADE COUNTY

This study focuses on Superfund sites placed on the National Priorities List in Miami-Dade County. There are 13 sites with varying degrees and types of contamination; six of which were delisted from the NPL. The following sections explore each of these sites in detail describing their location, type of contamination, and status of remediation and this information was obtained from EPA's Site Narratives (USEPA, 2008).

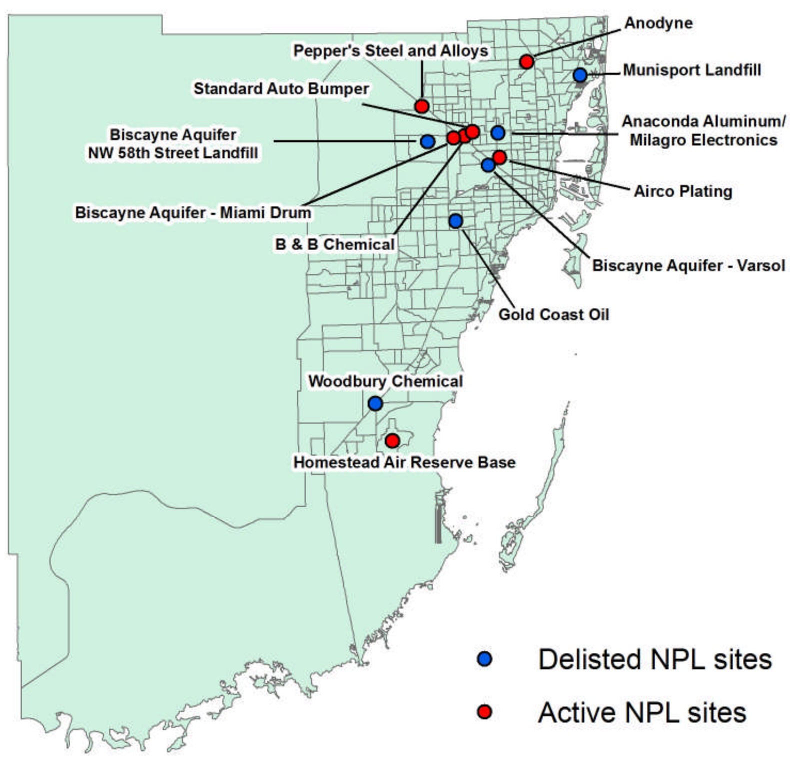

Figure B.1 Superfund Sites in Miami-Dade County, Florida

Airco Plating Co., Miami, FL

This 1.5 acre site is located at 3650 N.W. 46th Street, Miami, Dade County, Florida and had an operating electroplating shop since 1957 involving nickel, cadmium, chromium, copper, and zinc plating processes. Wastes from these industrial processes were disposed on three on-site seepage ponds and later released into the Miami municipal sewage system. EPA investigations discovered heavy concentrations of cadmium, chromium, copper, and nickel in surface and subsurface soil from near the ponds and the lawn area between the ponds and was listed on the NPL in February 1990 (EPA FLD004145140). Airco Plating Co. entered into a Consent Agreement with Miami-Dade County on May 18, 1989 outlining their plans for soil sampling and development of a remedial action plan. The site is still listed on the NPL and considered as an active Superfund site by the EPA.

Anaconda Aluminum Co./ Milgo Electronics Corp.

This 1.5 acre site consists of two areas located directly across from each other on N.W. 76th Street in Miami, Dade County, Florida. The sites hosted an industrial unit involving an electrochemical process using acids and an aluminum-containing base to produce a protective coating on aluminum on the Anaconda Aluminum Co. site and the Milgo Electronics Corp. site hosted operations involving chrome, nickel, and copper electroplating of data processing equipment and the manufacturing of cabinets for electronic components. The contaminants were disposed on-site using soakage pits and drainfields causing potential harm to the Biscayne Aquifer and the sites were listed on the NPL in August 1990 (EPA FLD020536538). EPA initiated remedial actions and removed contaminants in 1993 and environmental harm for humans was brought into control in 1994 leading to the site's deletion from the NPL in 1998.

Anodyne, Inc.

This 1 acre site is located in the Sunshine State Industrial Park in North Miami Beach, Dade County, Florida and divided into two sections occupied by a furniture manufacturer, Mt. Furniture and United Parcel Services (UPS). Until 1975, this site hosted Anodyne, Inc. that produced lithographs and silk screen prints and disposed of wastes in an injection well on the site that connected directly into the Myrtle Grove Sewerage System. EPA found high levels of chromium in on-site soil and ground water and PCB-1260 in on-site soil causing potential harm to not only the Biscayne Aquifer located directly beneath the site but also to the W. A. Oeffler and Westside Well Fields. The site was placed on the NPL in February 1990 (EPA FLD981014368). The EPA has sought to identify the parties responsible for the contamination and is currently working on a remedial investigation/feasibility study to determine the type and extent of contamination at the site and identify alternatives for remedial action. The site is still listed on the NPL and considered as an active Superfund site.

B&B Chemical Co., Inc.

This 5 acre site is located in an industrialized area in Hialeah, Dade County, Florida and has hosted operations by B&B Chemical Co., Inc. manufacturing industrial cleaning compounds. The company washes its mixing vats lined with chemical compounds in unlined lagoons before being discharged into the Hialeah sewer system. The EPA found solvents such as chlorobenzene, trans-1,2-dichloroethylene, 1,2-dichlorobenzene, and 1,4-dichlorobenzene in monitoring wells on and off the site and chromium in on-site wells causing potential harm to the Biscayne Aquifer and Four municipal well fields - the John E. Preston, the Hialeah, and the Upper and Lower Miami Springs. This site was listed on the NPL by the EPA in August 1990 (EPA FLD004574190). The company contractor has initiated remedial investigation/feasibility study to determine the type and extent of contamination at the site and identify alternatives for remedial action and have also installed an air stripper to remove volatile organic compounds from ground water. But as of now, the site is still listed on the NPL and is considered as an active Superfund site.

Gold Coast Oil Corp.

This 2-acre site is located at 2835 SW 71st Ave., Miami, Florida and has nearly 2,500 corroded and leaking drums containing sludge from the solvent distilling operation, contaminated soils, and paint wastes. The EPA detected lead, zinc, and various organic pollutants in shallow ground water at the site causing potential harm to the Biscayne Aquifer. The state evicted Gold Coast Oil Corp from the site in 1982 due to heavy contamination concerns and the site was listed on the NPL in September 1983 (EPA FLD071307680). The EPA proceeded to complete a Remedial Action Master Plan outlining the investigations needed to determine the full extent of cleanup required at the site and is conducting a search for all potential generators of wastes at the site. The site was delisted in October 1996 and has deemed that under current conditions potential or actual harm to humans from contamination is under control and no longer a threat to human health.

Homestead Military Base

This 2,916-acre site is located 25 miles southwest of Miami and 7 miles east of Homestead, Florida with additional easements of 429 acres. Operational since 1942, the base was turned over to Miami-Dade County in 1945 following extensive hurricane damage. During this tenure, electroplating operations were conducted on the site, and plating wastes containing heavy metals and cyanides were allegedly disposed of directly on the ground. The Air Force assumed control of the base in 1953 and attempted to remove hazardous substances leading to spillage of residual fluids, including one of PCBs from an electrical transformer. The EPA detected high concentrations of ethyl ether in ground water and listed the base on the NPL in August 1990 (EPA FL7570024039). The EPA, the Florida Department of Environmental Regulation, and the Air Force are currently negotiating an Interagency Agreement under CERCLA Section 120 to cover response activities at the base. However, the site continues to be listed as on the NPL and considered as an active Superfund site.

Miami Drum Services

This 1-acre site is located at 7049 NW 70th St. in a predominantly industrial area of Miami, Florida Dade County and hosted operations for recycling drums involving more than 5,000 drums of various chemical wastes (including corrosives, solvents, phenols, and toxic metals). The contamination on the site involved surface spills and saturation of soil through percolation of contaminated waste water along with various toxic organic solvents and heavy metals. Due to heavy environmental concerns, the Miami-Dade country obtained a court order to close the facility in 1981 the EPA listed the site on the NPL in September 1983 (EPA FLD076027820). Since then, the EPA recommended excavation and off-site disposal of contaminated soil that resulted in removal of 8,500 cubic yards of contaminated soil and treatment of 0.5 million gallons of ground water. However due to the nature and extent of contamination, the site is still listed on the NPL and considered an active Superfund site.

Munisport Landfill

This 291-acre landfill site is located in North Miami, Florida and operated as a sanitary landfill by a lessee of the City of North Miami. This led to contamination from hazardous wastes and the EPA found low concentrations of various organic pollutants in leachate from the site, and elevated levels of lead in several perimeter monitoring wells. Due to its proximity to two public well fields and to Biscayne Bay, the EPA listed the site on the NPL in September 1983 (EPA FLD084535442). The EPA initiated the first cleanup action in July 1994 and completed the remediation activities in September 1997.

The site was delisted from the NPL in September 1999 and is no longer considered a threat to human health and activities.

Northwest 58th Street Landfill

This 1-square mile site was a large, active municipal landfill located near Hialeah, Florida, along the east edge of the Everglades. In operation since 1952, the landfill site received nearly 3,000 tons per day of municipal solid waste leading to contaminated ground water with metals such as arsenic, cadmium, chromium, and lead, as well as phenols and halogenated organic compounds from leachate. Due to the threat to the regional water supply, the State sought a court order to cease operations by August 1981. The EPA listed the site on the NPL in September 1983 and completed a remedial investigation (EPA FLD980602643). The hazardous contaminants were removed by March 1995 and the site was delisted from the NPL in October 1996 and is no longer considered a threat to human health and activities.

Pepper Steel & Alloy, Inc.

This 10-acre site is located at 11100 NW S River Dr., Medley, Miami-Dade County, Florida and has hosted operations involving processing scrap metals since the early 1970s. The company is also involved in recycling of transformers and other electrical equipment and has reportedly disposed of transformer oil containing PCBs on the site and on two adjacent sites. County inspections revealed oily layer containing high concentrations of PCBs up to 6 inches deep in six pits, each 2 to 4 feet deep, on the site.

Soil sampling by the EPA revealed an additional two zones with PCB contamination and was listed on the NPL in September 1984 (EPA FLD032544587). The EPA is currently conducting a remedial investigation/feasibility study to determine the type and extent of contamination at the site and identify alternatives for remedial action. The site remains listed on the NPL and is considered as an active Superfund site.

Standard Auto Bumper Corp.

This 0.8-acre site is located at 2500 West 3rd Court, Hialeah, Florida and has hosted operations involving electroplated automobile bumpers, furniture, and other metal objects with chrome. Before 1970, waste water from the electroplating and stripping process was discharged into a ditch between the process building and railroad tracks resulting in percolation into the ground. After experimenting with a septic tank/percolator pit and drain field system, the company started discharging treated waste water into the Hialeah sewer system. The EPA detected cadmium, chromium, lead, and copper in surface soil, subsurface soil, and ground water on the site and was listed on the NPL in October 1989 (EPA FLD004126520). Remedial action was started in 1994 when Standard Auto Bumper started removing contaminated soil from the site and transporting it to an EPA-regulated facility. But the site was delisted from the NPL only in October 2007. Since this study examines price impacts in 2001, this site is considered as an active Superfund site for purposes of this research.

Varsol Spill

This site was created due to an underground pipeline leak resulting in the discharge of about 1.6 million gallons of Varsol (a petroleum solvent) at the Miami, Florida, International Airport in 1968. The EPA formally designated the site of this leak as a Superfund site in September 1983 and completed a remedial investigation at this site as part of the area-wide "Biscayne Aquifer" project (EPA FLD980602346). In consultation with the state of Florida, EPA determined that all appropriate Superfund-financed response under CERCLA had been implemented, and the site was delisted from the NPL in September 1988.

Woodbury Chemical Co.

This 3-acre site located along the west side of U.S. Route 1 in the southeast section of Miami-Dade County (13690 SW 248 St. Princeton, Florida) hosts operations involving blending technical-grade materials in 50-gallon vats to produce pesticides and fertilizers. Upon initial assessment, the EPA identified aldrin, dieldrin, toxaphene, and chlordane in four surficial soil samples from the site vicinity causing potential harm to the Biscayne Aquifer, three well fields - Elevated Tank Well Field, Naranja Well Field, and Homestead Air Force Base Well Field - and several private wells that are within 3 miles of the site. The EPA designated this site as a Superfund site and listed it on the NPL in August 1990 (EPA FLD004146346). Under direction of the EPA and the Miami-Dade County, Woodbury Chemical Co. removed toxaphene-contaminated soils from the southeast corner of the site that led to further remedial action. The EPA finally delisted the site from the NPL in November 1995 and the site is no longer considered a threat to human health and activities.

APPENDIX C

HEDONIC MODEL FUNCTIONAL FORM

According to Rosen's specification (1974), the heterogeneous product or as in this study, a single-family residential home, Z, is made up of attributes that provide a direct utility to potential homeowners and is expressed as:

$$Z = (Z_1, Z_2, Z_3, \ldots, Z_n)$$

Where 'n' is a vector of characteristics that describe the housing good and that each Z can be measured objectively and there exists a large number of differentiated products with varying combinations of 'n' characteristics such that an implicit value of Z can be estimated. The price of the product or the housing unit is a direct function of the characteristics and is expressed as:

$$P = P(Z) = P(Z_1, Z_2, Z_3, \ldots, Z_n)$$

This equation is referred to as the market hedonic price function which is the product of consumer preferences and comparison shopping for varying degrees of optimal homeowner satisfaction. This works under the assumption that when different products or housing units with same bundle of characteristics (Zs) are sold at different prices, the rational consumer will choose the product that is least expensive. The underlying theory of this function is that any product or in this case, housing unit can be segregated into a bundle of attributes that are priced separately and thus the implicit price of each of the attributes can be determined and compared across units.

Thus, according to the hedonic price model, let H represent the product or in this case, housing and any unit of H, say h_i is completely described by the vector of its characteristics including structural, neighborhood, and environmental. If S_j represents the vector of structural characteristics, N_k represents the vector of neighborhood attributes, and Q_m represents the vector of environmental quality, then the price of H is the function of the magnitude of those characteristics and expressed as:

$$P_{hi} = P_h\ (S_{i1},\ldots S_{ij},\ N_{i1},\ldots N_{ik},\ Q_{i1},\ldots Q_{im})$$

Where S_{i1} is the quantity of ith structural characteristic in h_i, N_{i1} reflects the k_{th} quality of neighborhood attributes, Q_{i1} represents the j_{th} environmental characteristic, and the function P_h is the implicit or hedonic price for H. The marginal implicit price of a particular characteristic is determined by differentiating the implicit price function with respect to that characteristic. For example, the marginal implicit price of the environmental characteristic is determined thus:

$$\frac{d\ (P_h)}{d\ (Q_m)} = P_{Qm}\ (Q_m)$$

This gives the increase in expenditure on H that is required to purchase a house with an additional unit of Q_m, everything held constant (*ceteris paribus*). Under the given budget constraint or income limitation, all rational consumers of housing units will choose an optimal bundle of attribute to maximize their utility and the marginal willingness to pay for any change in housing attribute is equal to the hedonic price.

APPENDIX D

VARIANCE INFLATION FACTORS

Table D.1 Multicollinearity Statistics for Selected Variables

Variables	1993-93		2000-01	
	Tolerance	VIF	Tolerance	VIF
No. of bedrooms	0.213	4.693	0.207	4.827
No. of bathrooms	0.147	6.810	0.160	6.263
No. of half-baths	0.565	1.771	0.274	3.649
Log_e Lot Size (sq. ft.)	0.494	2.024	0.632	1.583
Age of structure (years)	0.309	3.241	0.514	1.946
Tenancy Length (years)	0.374	2.671	0.408	2.449
Property Tax Millage (mills)	0.389	2.572	0.408	2.453
Distance to nearest NPL Superfund site (miles)	0.465	2.149	0.647	1.547
Distance to coast (miles)	0.464	2.157	0.550	1.820
No. of NPL sites in 2-mile radius	0.534	1.874	0.597	1.675
School Quality Index	0.592	1.689	0.647	1.545
Mean Crime Rate	0.480	2.082	0.560	1.785
Percent Non-Cuban Hispanic	0.385	2.597	0.312	3.204
Percent Non-Hispanic Blacks	0.256	3.903	0.234	4.268
Percent College Educated	0.253	3.951	0.228	4.383
Percent Vacant	0.509	1.967	0.358	2.792
Percent Owner-occupied	0.315	3.175	0.365	2.739
Arcsine Landuse Mix	0.567	1.765	0.519	1.928
Arcsine Housing Poor Condition	0.533	1.877	0.207	4.827

Note: Type of contamination and submarket variables are not shown

VITA

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