Modeling the Relationship among Brownfields, Property Values, and Community Revitalization

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Abstract

The main focus in redeveloping brownfields is on the most marketable properties, typically found in the healthiest urban neighborhoods. As evidenced by the rapid redevelopment that many communities are experiencing, this approach is helping to return brownfields to productive use. Yet not all brownfields are being cleaned up, nor are there enough resources to do so soon. Thus, from the perspective of community revitalization and of economic justice, we need to ask whether it matters which properties in which neighborhoods are receiving these scarce funds. That is, does the existence of brownfields in a neighborhood affect residential property values and capacity for revitalization?

To answer these questions, we use hedonic modeling to determine the impact of brownfields on property values in Atlanta and Cleveland. Our results suggest that short-term economic efficiency is neither the most appropriate nor the only criterion on which to base public investment decisions for remediation.

Keywords: Brownfields; Community development and revitalization; Urban policy

Introduction

It is not known exactly how many brownfields there are nationwide or how many have been cleaned up and remediated. Consequently, we also cannot know the extent to which the potential for economic development stemming from their redevelopment is not being met in communities across the nation. A comprehensive study of the effects of brownfields in 231 major U.S. cities (U.S. Conference of Mayors 2000) estimated that

1. They had more than 21,000 brownfields encompassing more than 81,000 acres[1]
2. If these brownfields were fully redeveloped, the cities would realize cumulative gains of $878 million in tax revenues

In 1995, the public sector at all levels of government became proactive in seeking to solve the brownfield problems found in communities across the nation. In January of that year, the U.S. Environmental Protection Agency (EPA) published its Brownfield Action Agenda, which included pilot grants to communities; clarification of liability issues for owners of brownfield properties; partnerships among federal, state, and local agencies to promote redevelopment; and job development and training for remediation. The rationale was to encourage a cooperative approach by EPA, lenders, and prospective purchasers to ease fears of financial liability and the regulatory burdens associated with redevelopment. Subsequently, a number of EPA and other federal initiatives have attempted to further increase brownfield redevelopment.

This public sector response, however, is predominantly characterized by a focus on the economic efficiency of the cleanup and redevelopment of individual properties, as opposed to how remediation and redevelopment affect neighborhood property values and correspondingly contribute to overall economic revitalization (Black 1995; Iannone 1996; Meyer 1999; Simons, Bowen, and Sementelli 1997). Brownfields can be large or small properties, and they can be located in depressed as well as healthy areas of our cities and states. But given the public sector emphasis on allocating scarce redevelopment resources to the properties that will realize the greatest market returns (Argonne National Laboratories 1998; Simons and Iannone 1997; Smart Growth Network 1996), properties that are small or located in depressed neighborhoods are more likely to be overlooked. Missing from the national dialogue is the issue of whether brownfield status affects more than the property labeled as such. That is, does the label also stigmatize and devalue surrounding nonbrownfield properties? And if so, by how much?

The work of Patchin (1988, 1991), Mundy (1992a, 1992b), and Chalmers and Roehr (1993) has shown that the stigma of contamination can negatively affect housing prices. Survey research on brownfields that Greenburg et al. label TOADS (Temporarily Obsolete Abandoned Derelict Sites) also suggests that these sites

[1] This study follows the 1996 initial study on brownfields by the U.S. Conference of Mayors. The 1996 study surveyed only 39 cities, and the results were less comprehensive but similar.

> can ruin the surrounding neighborhood by polluting the local environment, by giving the impression to businesses and residents that the local environment is dangerous, and by not being secured so that illegal activities (e.g., dumping, illegal drug sales, and other dangerous activities) occur on the site and in other ways stigmatize the neighborhood so that no one wants to invest in it, and those who live or work in it want to leave it. (2000, 719)

In this article, we report findings from a research project that analyzes the incidence and redevelopment pattern of brownfields in two cities to determine the impact on neighborhood residential property values. We use hedonic modeling and a unique database that we created and that takes a comprehensive approach to systematically identifying known and potential brownfields. Our research extends the literature examining the impact on property values[2] by capturing the neighborhood effects of brownfields via a threshold modeling strategy. Our results confirm that brownfields have a negative impact on surrounding properties and neighborhoods, an impact that varies with proximity. The negative externality that brownfields create is a barrier to community revitalization.

Research approach

Our research considers the effects of brownfields and their redevelopment on housing property values during the second half of the 1990s.[3] We use a pretest/posttest research design to model these effects, seeking to understand the impact of federal brownfield policies on neighborhoods via their housing markets. In doing so, we identify the difference in property values before and after 1995, the year when the EPA established its pilot brownfields program.

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[2] We reviewed the following journals for the 1990s: *Appraisal Journal, Housing Policy & Development, Journal of Housing Economics, Journal of Real Estate Research, Land Economics, Urban Affairs, Urban Economics*, and *Urban Studies*. In addition, academic search engines were accessed on the following keywords: brownfields and models, regression, property value, econometric, neighborhood, census tract, urban inequality, metropolitan inequality, gentrification, and urban or central city or metropolitan income distributions.

[3] The Brownfields Reform and Small Business Liability Relief Act (HR 2869) passed both the House and the Senate on December 21, 2001, and was signed into law on January 13, 2002. This legislation significantly changes the liability aspects of brownfield cleanup by providing solid liability relief for prospective redevelopers. These changes are expected to help revitalize aging urban areas by removing litigious barriers to redevelopment (EPA 2002).

Research questions and hypotheses

To measure impacts, we isolate the effect of brownfield cleanup and redevelopment through a cross-sectional analysis of neighborhoods containing brownfields that have been redeveloped and those that have not. A unique feature of our research is that we have built a database of what we label "known" and "potential" brownfields. Known brownfields are those that appear on an official list of contaminated properties. Potential brownfields are those that have had a history of previous use that gives them a high probability of being contaminated but are not on an official list (see Leigh and Coffin 2000).

In addition to testing whether brownfields have an impact on property values, we test whether this impact changed between the pre- and post-1995 periods. That is, we seek to determine whether market redevelopment activity since 1995 reflects greater awareness and stigmatization of brownfields in general and of potential brownfield properties in particular.

In our modeling effort, we test two hypotheses stated in null form:

1. Brownfields do not affect property values.
2. There is no difference in the strength of the effect of brownfields on property values as modeled before and after 1995, the pivotal policy year.

Selection of case study cities

While similar in population size, our two case study cities, Atlanta and Cleveland, differ on a number of fundamental economic development characteristics, as described in table 1. We deliberately chose these two cities for their dissimilarities and the insights that might be gained from studying brownfield redevelopment in two such different geographic areas and urban economies.

Atlanta is a fast-growing Sunbelt metropolitan area. Although the city was founded in 1847, its primary growth took place during the second half of the 20th century, with particular acceleration during the 1990s. Its landmass in 2000 was greater than that of Cleveland by more than 30,000 acres, or 60 percent, despite the fact that Cleveland's population is almost 15 percent larger.

The major event that stimulated strong growth in Atlanta during the 1990s was hosting the 1996 summer Olympic games, which spurred a number of redevelopment activities in the first half of the decade. The momentum did not slow when the Olympics were over, since the city added 781 jobs and 2,246 population annually throughout the decade (Atlanta Regional Commission 2004).

Table 1. Descriptive Characteristics

	Atlanta	Cleveland
Current population, 2000	416,474	478,403
Percent population change from 1990 to 2000	5.7	–5.4
Percentage of the population over 65, 2000	9.7	12.5
Percent change in the population over 65 from 1990 to 2000	–1.8	–1.9
Percent black, 2000	61.4	51.0
Percent change in the black population from 1990 to 2000	–5.9	4.2
Percentage of the population living below the poverty line, 1999	9.6	11.2
Percent change in the proportion of the population living in poverty from 1989 to 1999	–2.9	–2.4
Rate of change in the number of persons living in poverty from 1989 to 1999 (%)	–1.8	–4.0
Percent unemployment, November 2001	3.9	5.1
Mean age of the housing stock, 1998, 2000 (years)	53	78
Landmass (acres)	84,750	52,458

Sources: Unpublished data from the Cuyahoga County (OH) Property Tax Auditor and the Fulton County (GA) Property Tax Auditor; U.S. Bureau of the Census 1990, 2000.

In contrast to Atlanta, Cleveland's major growth coincided with the age of industrialization and occurred over the first three decades of the 20th century. Consequently, the mean age of Cleveland's housing stock is 25 years older than Atlanta's. Between 1950 and 1990, the city of Cleveland lost close to 45 percent of its population even though the population in the region remained fairly stable (Krumholz 1999). The latest figures from the 2000 census reveal that the depopulation of the central city continues, with a loss of 5.4 percent during the 1990s (U.S. Bureau of the Census 2000). This trend is typical of the early industrialized cities, although recent revitalization appears to indicate that the trend might be slowing. Cleveland's November 2001 unemployment rate was 1.2 percent higher than Atlanta's. The proportion of Cleveland's population living below the poverty line fell 2.4 percent, or from 28.7 percent in 1989 to 26.3 percent in 1999. Yet the actual number of people living below the poverty line declined by 19,738 or 4 percent. This suggests that absolute poverty there is decreasing somewhat, perhaps reflecting the overall resurgence in the city's economy.

In Atlanta, the proportion of the population living below the poverty line fell 2.9 percent (from 27.3 percent to 24.4 percent), but the actual number dropped by only 6,621 people or 1.8 percent. Thus, Atlanta's dramatic economic and population growth over the past two decades appears not to have lifted as many households out of poverty as Cleveland's economic resurgence has.

In 2000, 61 percent of the population of Atlanta was black, compared with 51 percent in Cleveland. However, between 1990 and 2000, the black population of Atlanta actually decreased by 5.9 percent, while it increased by 4.2 percent in Cleveland. Blacks moving to the suburbs and whites moving back to the city are two trends that may be contributing to the recent drop in the proportion of Atlanta's population that is black.

Major growth in Cleveland coincided with precisely the kinds of economic activities that generate brownfields. As a consequence, its total incidence of brownfields is more than two and a half times greater than Atlanta's (tables 2 and 3). In fact, there was no census tract in Cleveland that did not have a brownfield (see figures 1 and 2 for the distribution of brownfields by city). In the U.S. Conference of Mayors report (2000), Cleveland officials estimated that there were approximately 350 brownfields on around 6,000 acres scattered throughout the city. Further, if these properties were fully developed, they would generate between $225 million and $500 million in tax revenue, as well as an additional 100,000 jobs.

Cleveland's urban renewal activities in the 1960s and 1970s, compounded by the economic woes of the 1970s energy crisis and significant inner-city

Table 2. Potential Brownfield Acreage

	Atlanta	Cleveland
Mean acreage	0.755	0.376
Median acreage	0.302	0.143
Total acreage	2,936	3,336
Counts	3,890	10,234

Sources: Based on authors' calculations derived from county parcel files developed by Fulton County in Atlanta and Cleveland State University in Cleveland. Brownfield information was derived from federal, state, and local data sets as described.

Table 3. Listed Brownfield Acreage

	Atlanta	Cleveland
Mean acreage	1.383	0.432
Median acreage	0.529	0.142
Total acreage	308	365
Counts	264	713

Sources: Based on authors' calculations derived from county parcel files developed by Fulton County in Atlanta and Cleveland State University in Cleveland. Brownfield information was derived from federal, state, and local data sets as described.

Figure 1. Distribution of Brownfields, by Type, in Atlanta

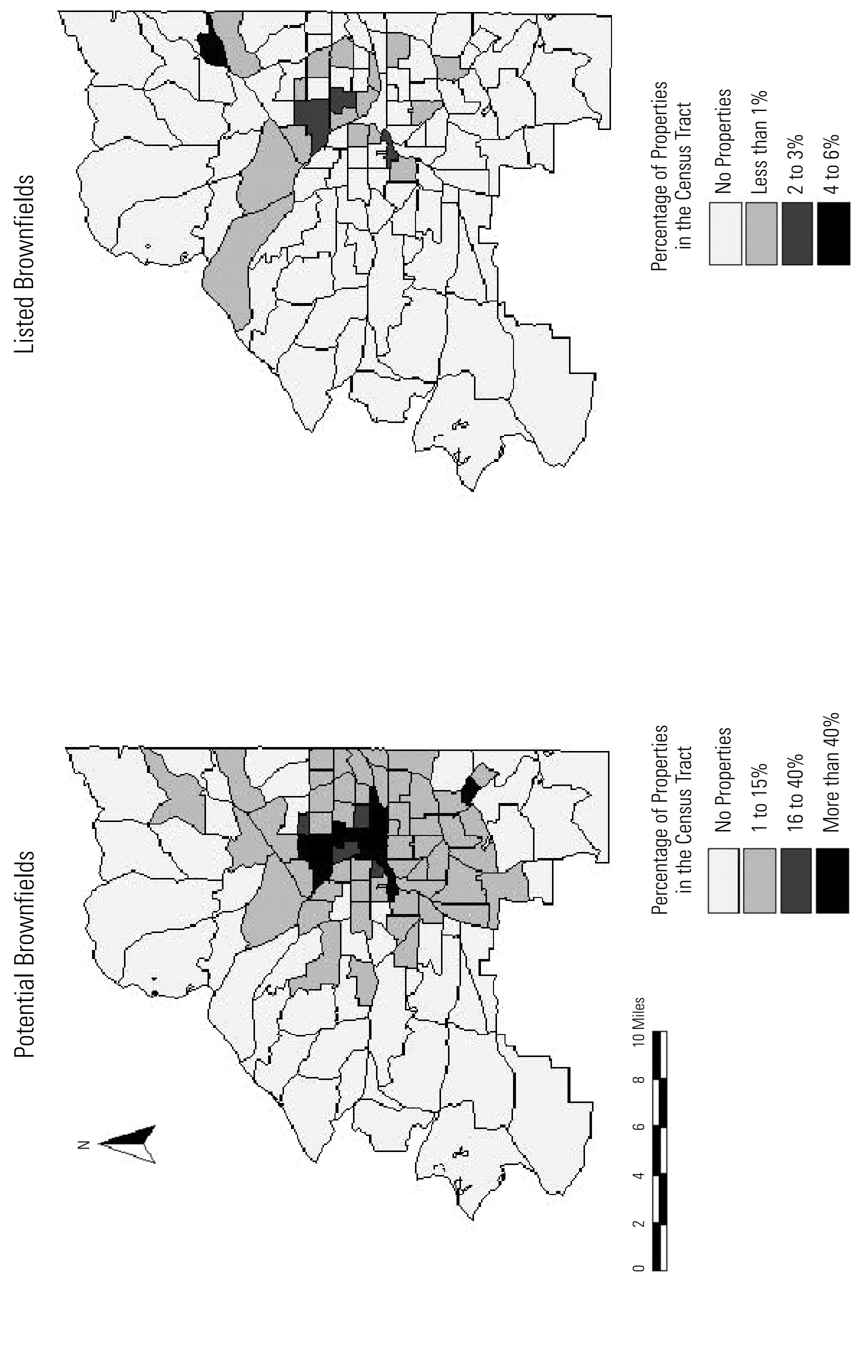
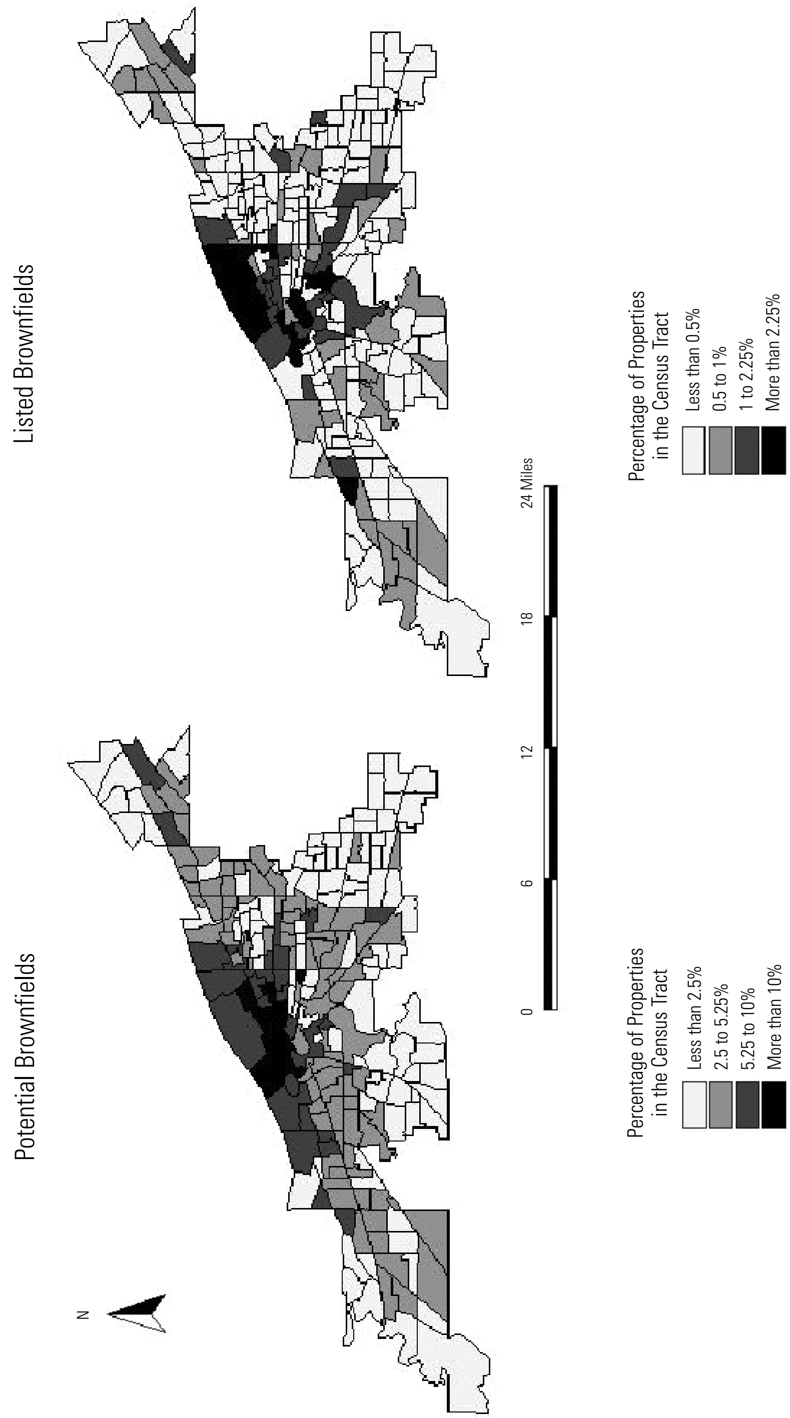


Figure 2. Distribution of Brownfields, by Type, in Cleveland



population loss from white flight, left behind entire neighborhoods of abandoned, vacant lots and substandard housing where only the poorest residents remained. Following the restructuring of the auto and steel industries in the 1970s and 1980s, the city experienced severe deindustrialization that left an even larger landscape of abandoned and underutilized properties.

Cleveland recognized before many other cities the need to redevelop the vacant and abandoned brownfields stemming from urban renewal and deindustrialization. The urban core of the city was hard hit by recent recessions, and it struggled to regain an economic foothold in the region. Early efforts to revitalize, however, were hampered by perceptions of contamination. Consequently, brownfield redevelopment was a high priority for Cleveland even before the national program was established in 1995. In an attempt to recapture manufacturing lost to the recession, the focus was initially placed on resurrecting the industrial core (Cuyahoga County Planning Commission 1993). In fact, city officials were closely involved in shaping the EPA's initial policy response to brownfields, and Cleveland was one of the recipients of the first round of Brownfield Pilot Program grants (McIntyre 1993).

Further, the state of Ohio has been proactive in improving the climate for brownfield redevelopment inside and outside its cities. Ohio developed Risk-Based Corrective Action (RBCA) cleanup standards and a voluntary cleanup program (VCP) that was accepted by the EPA through a memorandum of agreement (MOA) under Superfund. This MOA is significant in that the EPA has deferred to the state the authority for property cleanup. Most important, state standards allow for more flexible approaches to cleanup that can help contain costs and reduce the fears of liability associated with future EPA regulatory actions (Ohio Environmental Protection Agency 2001).

By contrast, the brownfield problem was underestimated in Atlanta during our period of analysis. In the same U.S. Conference of Mayors report (2000), Atlanta officials estimated that the city had 147 acres of brownfields, even though officially listed sites already totaled 308 acres (table 3) and more than 306 square miles in Atlanta is classified as industrial land—the use most often associated with brownfield contamination (Atlanta Regional Commission 1990).

Our own count of brownfields in tables 2 and 3 suggests that instead of Atlanta having only 2 percent of the brownfield acreage of Cleveland (147 acres versus 6,000 acres) per the U.S. Conference of Mayor's (2000) city-official-derived estimates, it actually has 3,244 acres of known and potential brownfields versus 3,701 acres in Cleveland. Thus, the brownfield problem was significantly overestimated in Cleveland and significantly underestimated in Atlanta.

Because of Atlanta's booming economy throughout the 1990s, brownfields simply did not draw the attention or action from policy makers, public officials, and legislators that they should have. Underutilized urban land has not been a problem since the region was not facing economic decline as Cleveland was.[4] A 1997 attempt to pass state legislation designed to encourage brownfield redevelopment failed because Georgia lawmakers stated that they did not see brownfields as a serious problem (Atlanta Chamber of Commerce 1997). In contrast to Ohio, Georgia does not have a formally legislated VCP, MOA, or RBCA process in place (Bartsch and Dorfman 2000). In the 2002 legislative session, however, two bills that sought to define and limit the liability of properties with hazardous releases, as well as provide for a separate classification and taxation of such properties, were passed and signed by the governor in May.[5]

Data development and model design

We have developed two hedonic models for isolating and examining the impact of brownfields and subsequent policies on property values. We first model the effects of several measures on property values before and after 1995 (our identified pivotal policy year) to estimate the effect that brownfields and their redevelopment have on property values. Widespread awareness of brownfields and of the difficulty and liability associated with their redevelopment did not exist before 1995. Further, since that date, there has been continuing growth in federal, state, and local programs to promote the reuse of brownfields. More than $250 million in federal funds has been spent on brownfield programs during this period (EPA 2002). Most recently, President Bush signed the bipartisan Public Law 107–118 (HR 2869), titled the Small Business Liability Relief and Brownfields Revitalization Act of 2002. These policies seek to target public funds and programs to the most marketable brownfields, thereby yielding the greatest return on investment for individual properties.

Before 1995, it was much more likely that brownfield property transactions occurred without knowledge of their status. We suggest that this may be particularly true for the group of properties we have labeled potential brown-

[4] Atlanta has been the recipient of a U.S. Department of Housing and Urban Development Empowerment Zone grant as well as an EPA Brownfield Redevelopment Pilot grant. However, at one point, its performance on the latter was found to be insufficient and the city was in danger of losing the funding.

[5] HB 1406 (Waste Management; Hazardous Sites; Amend Provisions) and HR 1111 (Hazardous Waste Sites; Redevelopment; Separate Class of Property).

fields. From 1995 on, however, we hypothesize that property transactions reflect such knowledge because lenders will not finance properties without due diligence on their known or potential contamination status (meeting the requirement of a Phase One Environmental Assessment). Property developers factor this requirement into their purchase and development decisions.

Data sources

Our model incorporates data variables created or obtained from local government agencies, public records, and published secondary data, as well as through geographic information system calculations. We use data that identify environmental, neighborhood, and economic characteristics to measure the effects of brownfield cleanup and redevelopment on property values. Our database of property and brownfield characteristics incorporates historical tax-assessed values, tax delinquencies, physical characteristics such as land and building amenities, concentrations of and distances to known and potential brownfields, and a vector of census tract variables that controls for the socioeconomic characteristics associated with the property. Further, we have constructed variables that measure the effects on properties of having a nearby brownfield and the effects of market activity on property values in brownfield neighborhoods. The specific data generated from these sources can be aggregated into real property characteristics and suspected and confirmed property contamination and remediation characteristics.

Real property characteristics. These characteristics are derived from county property tax assessor's records generated in Cuyahoga County, OH (where the city of Cleveland is located), and Fulton County, GA (the primary county in which Atlanta is located).[6] Although we recognize that there can be reliability issues associated with property tax assessment data, the alternative resource, sales data, would inherently bias our study. We are interested in comparing areas with active real estate markets with those areas where market activity is depressed. If we use sales data, results will exclude the very neighborhoods we are interested in studying. That is, using sales data as an indicator of market conditions would likely provide little data on depressed

[6] Atlanta is located in two counties, DeKalb and Fulton: Approximately 7 percent of the city falls within DeKalb County. We exclude this portion because tax assessment is conducted yearly there and is based on a different percentage of property market value. A comprehensive data set combining the property values for the two counties is not possible without significantly distorting the study results.

neighborhoods because of lack of sales. Our data would also not reflect consistent time intervals across neighborhoods. Although property tax assessment data may be biased downward for low-income neighborhoods because of the lack of sales activity triggering updates in comparable property assessments, we believe that this bias is less problematic for the time component of our modeling.

Given that we are using tax assessments, we have limited ability to develop annual time series data. Property tax assessment strategies are not uniform across localities. Further, few locales conduct annual assessments. In the years between assessments, tax bills are generated based on predictions of changes in property values. Thus, we must rely exclusively on the information generated in property tax reassessment years, since they reflect most closely actual—rather than predicted—changes. In Cleveland, these years are 1988, 1994, and 2000, since countywide reassessments are mandated every six years in Ohio. In the Fulton County portion of Atlanta, the years are 1992, 1995, and 1998, because reassessments occur every 3 years.

Suspected and confirmed property contamination and remediation characteristics. Information on suspected and confirmed contamination was collected from three sources: the EPA, state environmental agencies, and local business directories. The EPA provides a list of properties where investigations to determine the existence of health-threatening contamination have been conducted. The EPA lists are categorized by degree of concern, with the National Priorities List (NPL) identifying those properties posing the most immediate and serious threat to public health. The Active Sites list identifies properties where investigations or remediations are being conducted, and the No Further Action list identifies properties where investigation or remediation is complete and the property has been declared to present little or no threat to community health. Currently, there are no properties in either city listed on the NPL, so we used only the other two lists.[7]

State environmental agencies in Ohio and Georgia also maintain lists of leaking underground storage tanks (LUSTs), which we use in our analysis. While we recognize that such storage tank cleanups are not governed by the same laws as other contaminated sites, previous research indicates that LUSTs negatively affect property values (Simons, Bowen, and Sementelli 1997). Further, these tanks are generally included in discussions about brownfields.

[7] Given the historical stigma associated with even the threat of contamination, we are including those properties that appear on the No Further Action list.

Our final source of information on suspected contamination is generated from local business directories. We have used the directories from 1910, 1930, 1950, and 1970 to develop a list of historical land uses for both Cleveland and Atlanta. The methodology for the list of known and suspected sites follows the logic of the propensity for contamination based on previous land uses. In 1992, Noonan and Vidich surveyed environmental professionals about the various aspects of brownfield remediation, including the probability of contamination based on land use. Through the survey, these researchers developed a probability table that considered the likelihood of contamination. In developing our database of known and suspected brownfields, we used the Noonan and Vidich (1992) probabilities to determine those properties that had a 50 percent or greater likelihood of contamination based on the land use in the directory. We use the information in our database to generate the total acreage of potentially contaminated sites by census tract.

Further, we developed a brownfield remediation variable based on the three environmental lists and real estate market activity. We assume that if a property was sold after 1995, some form of environmental investigation had occurred and had resulted in either remediation or discovery of little or no contamination. This assumption is based on due diligence in real estate finance: That is, a financial institution funding a real estate investment requires environmental audits and provision for required remediation before the loan is approved. Thus, if we identify a property as being a potential or officially recognized brownfield *and* the property has had a real estate transaction any time after 1995, we assume that this property is a remediated brownfield.[8]

Development of the model

We use two hedonic models to examine the effects of brownfield characteristics on property values, following the method employed by Galster, Tatian, and Smith (1999), which statistically measures threshold effects and estimates their impact on neighborhoods. We use the threshold effect in two ways. First, we measure what we refer to as the neighborhood effect, which indicates, dichotomously, the impact on value that a brownfield has if it is within 500 feet, between 501 and 1,000 feet, and between 1,001 and 1,500 feet of a property. Second, we measure the magnitude of brownfield effects by estimating the

[8] We acknowledge that this may result in an overcount of remediated brownfields because of the small (and impossible to quantify) number of real estate transactions that may take place through entirely private financing and land trades where the parties involved either do not know about or are not concerned about contamination.

impact on property values of concentrations of brownfields within the same distance from a property.

The threshold effects measure is another unique feature of our work, since this methodology has yet to be applied to the impact of brownfields on residential property values in the United States. While Simons, Bowen, and Sementelli (1997) employed a variable that indicated whether a tank was located within one block to measure the effects of LUSTs on property values, their static measure does not capture the variation within a city block. Also, it assumes uniformity in the size and distribution of city blocks.

We incorporate these threshold effects variables into a series of model specifications that measure the various brownfields while controlling for the structural characteristics of the building improvements, real estate market activity, and socioeconomic characteristics of the community. We test our hypothesis in the following sequence (the acronyms are defined in table 4).

Model 1: Base Property Effects Model (with values measured before 1995)

$$LnP_{pre1995} = c + [\mathbf{Struct}] + [\mathbf{Size}] + [\mathbf{Invstmt}] + [\mathbf{TRACT}] + [\mathbf{BFMAG_{500}}] + [\mathbf{BFMAG_{1,000}}] + [\mathbf{BFMAG_{1,500}}] + [\mathbf{BFNB_{500}}] + [\mathbf{BFNB_{1,000}}] + [\mathbf{BFNB_{1,500}}] + [\mathbf{BFDIST}] \quad (1)$$

Model 2: Post Policy Property Effects Model (with values measured after 1995)

$$LnP_{post1995} = c + [\mathbf{Struct}] + [\mathbf{Size}] + [\mathbf{Invstmt}] + [\mathbf{TRACT}] + [\mathbf{BFMAG_{500}}] + [\mathbf{BFMAG_{1,000}}] + [\mathbf{BFMAG_{1,500}}] + [\mathbf{BFNB_{500}}] + [\mathbf{BFNB_{1,000}}] + [\mathbf{BFNB_{1,500}}] + [\mathbf{BFRENB_{500}}] + [\mathbf{BFRENB_{1,000}}] + [\mathbf{BFRENB_{1,500}}] + [\mathbf{BFDIST}] \quad (2)$$

Discussion

Property effects models

The first of the two models estimates the effects of brownfields on property values before the 1995 policy shift and examines the extent of the effect by means of the threshold measures described earlier. There are no remediated brownfields in the pre-1995 period because they are defined as those properties that have either potential or known contamination and for which there was a real estate transaction after 1995. The second model also examines these threshold effects while further considering the shift following the 1995 policy year. Table 5 presents the results from the property models, showing the comparisons between the two cities.

In Cleveland, for the brownfield neighborhood effects variables of the first model, we first notice a significant and negative impact on property values for the listed sites within a 500-foot radius of a property in both policy years. That is, the presence of a listed unremediated brownfield in the immediate vicinity decreased property values by 6.24 percent before 1995 and 7.55 percent after

Table 4. Description of Variables

Variable Name	Variable Description
Dependent variables	
$LnP_{pre1995}$	Natural log of tax-assessed property value, before 1995
$LnP_{post1995}$	Natural log of tax-assessed property value, after 1995
Independent variables	
c	Constant term
[Struct]	Vector of housing structure characteristics. These include the style of house; the presence and/or type of garage, attic, and basement; the number of bedrooms, bathrooms, and fireplaces; and the age of the structure.
[Size]	Vector of housing/property size characteristics. These include the number of acres and the size of the total living area.
[Invstmt]	Vector of real estate market activity variables. These include a dummy variable indicating whether there had been a property transaction during the study period and the ratio of the building to the land value.
[TRACT]	Vector of census tract dummy variables that control for socioeconomic effects on property values.[a]
[$BFMAG_{500}$]	Vector of brownfield variables showing the number of listed and potential brownfields within 500 feet of the property.
[$BFMAG_{1,000}$]	Vector of brownfield variables showing the number of listed and potential brownfields within 1,000 feet of the property.
[$BFMAG_{1,500}$]	Vector of brownfield variables showing the number of listed and potential brownfields within 1,500 feet of the property.
[$BFNB_{500}$]	Vector of brownfield variables indicating whether there is an unremediated listed or potential brownfield within 500 feet of the property.
[$BFNB_{1,000}$]	Vector of brownfield variables indicating whether there is an unremediated listed or potential brownfield within 1,000 feet of the property.
[$BFNB_{1,500}$]	Vector of brownfield variables indicating whether there is an unremediated listed or potential brownfield within 1,500 feet of the property.
[$BFRENB_{500}$]	Vector of remediated listed and potential brownfield variables indicating whether there is a remediated brownfield within 500 feet of the property.
[$BFRENB_{1,000}$]	Vector of remediated listed and potential brownfield variables indicating whether there is a remediated brownfield within 1,000 feet of the property.
[$BFRENB_{1,500}$]	Vector of remediated listed and potential brownfield variables indicating whether there is a remediated brownfield within 1,500 feet of the property.
[BFDIST]	Vector of distance variables indicating the distance in feet to the nearest remediated or unremediated brownfield.

[a] The logic for this variable follows the methodology used in Galster, Tatian, and Smith (1999), where they controlled for socioeconomic effects on property values when seeking to isolate impacts of Section 8 properties on neighborhood values.

Table 5. Comparison of Brownfield Impacts on Property Values before and after 1995[a]

Variable Affected	Atlanta Pre 1995	Atlanta Post 1995	Cleveland Pre 1995	Cleveland Post 1995
Brownfield neighborhood effects				
Unremediated listed sites				
Within 500 feet	–4.57%	–3.93%	–6.24%	–7.55%
Within 1,000 feet	–1.55%	NS	–6.21%	–4.62%
Within 1,500 feet	–1.28%	–1.01%	–4.88%	–4.26%
Unremediated potential sites				
Within 500 feet	–4.93%	NS	NS	NS
Within 1,000 feet	–1.90%	1.02%	NS	NS
Within 1,500 feet	–1.26%	NS	NS	NS
Remediated listed sites				
Within 500 feet	NA	–3.89%	NA	5.72%
Within 1,000 feet	NA	–1.02%	NA	7.79%
Within 1,500 feet	NA	–2.94%	NA	13.90%
Remediated potential sites				
Within 500 feet	NA	–0.80%	NA	NS
Within 1,000 feet	NA	NS	NA	NS
Within 1,500 feet	NA	1.53%	NA	NS
Magnitude of brownfield effects				
Unremediated listed sites				
Within 500 feet	–2.70%	–3.62%	NS	NS
Within 1,000 feet	–1.36%	–2.53%	–0.99%	–0.58%
Within 1,500 feet	–1.72%	–1.86%	–0.47%	–0.46%
Unremediated potential sites				
Within 500 feet	–2.65%	–2.66%	–1.36%	–0.60%
Within 1,000 feet	–1.21%	–0.65%	–0.27%	–0.15%
Within 1,500 feet	–0.25%	NS	–0.16%	–0.07%
Model statistics				
Adjusted R^2	0.89	0.93	0.77	0.33[b]
F statistic	1,523.88	7,182.79	1,731.16	253.82

[a] The variance inflation factor for the variables within each model was less than 3, indicating that multicollinearity was not a concern.

[b] The model statistics for the Cleveland post-1995 model decline significantly from the pre-1995 model, indicating that this second model is not as successful as the first in capturing the variation in the dependent variable. We suspect that this may be due to the extensive revitalization that is occurring in the city and is not captured by the model.

NA = not applicable (the indicator of remediation for a brownfield is based on a property transaction after 1995, so all brownfields in the pre-1995 model are considered to be unremediated).

NS = not significant at the 0.05 level.

1995. While the negative impact weakened for listed sites within 1,000 and 1,500 feet, it was still substantial. The impact of unremediated potential sites was not found to be significant. The impact of listed remediated sites on property values, however, was significant and strong. The presence of a listed remediated brownfield within a 500-foot radius after 1995 increases the value of the property by 5.72 percent.[9] Overall, for Cleveland, we can reject our first hypothesis that brownfields have no effect on property values.[10]

In contrast to Cleveland, the first model does not show the expected results for Atlanta. Listed unremediated sites had less of an impact on property values after 1995. Unremediated potential brownfields had a positive impact on property values after 1995 for one interval only (within 1,000 feet). The presence of listed remediated sites had a negative impact on property values. While the null hypothesis can still be rejected, since brownfields did affect residential property values, the difference in the direction of the post-1995 impact suggests different explanations for Cleveland and Atlanta. Cleveland's proactive approach to brownfield redevelopment, which gained national attention early on, may have created a strong comfort level with redeveloped listed properties that resulted in their positive impact on property values. By contrast, Atlanta has been very slow to address its brownfield problems and, consequently, public awareness has also been slow to develop. Thus, even when listed properties have been remediated, the brownfield stigma appears to remain. As our subsequent discussion suggests, proximity to any form of commercial or industrial property continued to have a negative impact on residential property values. However, in the years since the properties were assessed—these are not reflected in our data—Atlanta has seen a proliferation of loft-type housing created from the conversion of industrial property (or even built from scratch to look like converted industrial property) such that the negative impact on residential property values from proximity to commercial and industrial may have ameliorated.

Next, we observe the difference in the magnitude of brownfield effects before and after 1995. As noted earlier, increased awareness after 1995 appears to have had an impact on property values in Cleveland. While the

[9] Contrary to expectations, the effect strengthened with increasing distance, which suggests that other effects not accounted for in the model are present.

[10] The impact actually shifts to a positive influence for both listed and potential unremediated sites at the 1,500-foot threshold, thereby suggesting that the threshold stands at a 500-foot radius around a property. Other factors appear to influence property values as the threshold is moved farther away. This finding demonstrates the importance of using threshold measures over the more traditional, static measures in the literature we surveyed for this article.

effect is significant and negative, it has actually weakened since the pre-1995 period for unremediated potential brownfields within 500 feet of an actual brownfield. Thus, for every additional unremediated potential brownfield within 500 feet of a property, the impact is reduced by 0.76 percent after 1995. By contrast, for Atlanta properties where unremediated listed brownfields were within 500 feet, the strong negative effect on property values changes little (from –2.65 percent to –2.66 percent). This finding, suggesting that Cleveland's 1995 brownfield pilot program had a positive influence on sites where there is known or suspected contamination, is consistent with the fact that the city received funding in the first round of pilot projects. The findings for listed remediated brownfields in Atlanta suggest that the post-policy awareness of brownfields, combined with a lack of proactive remediation policy, leads to continued depressed property values. Yet unlike Cleveland, where policy awareness yielded a proactive response, it seems that the stigma is strengthened slightly in Atlanta.[11] Thus, moving to our second hypothesis, we again reject the null, that there is no difference in the strength of the effect of brownfields on property values as modeled before and after 1995.

Cross-city comparison

The results from the two cities suggest that before 1995, brownfields had a blighting effect on property values within the immediate vicinity in both cities. More important, the results suggest that for the heavily industrialized city of Cleveland, awareness of the known sites (listed brownfields) led to considerable uncertainty before 1995, while federally supported efforts to clean up listed sites after that date helped reduce that uncertainty. Conversely, brownfield awareness in Atlanta after 1995 became more acute for neighborhoods with unremediated listed brownfields, with the magnitude effects having an even greater negative impact. However, for unremediated potential brownfields, the awareness was overshadowed by the strong real estate market.

Even so, as table 6 shows, property values are negatively affected by proximity, an effect that occurs with each 100-foot increment closer to a brownfield. While the magnitude of the effect is not, at first glance, what might be

[11] For potential, remediated properties in Atlanta, which after 1995 show a decrease in property values of 16.2 percent within 500 feet, the model appears to be picking up other influences outside the remediation effect. While further investigation would be warranted, one influence that might have a bearing is the city's response to its significant tax-delinquent property inventory. After reforming its property tax collection policy to speed up foreclosure, the city disposed of a large inventory of foreclosed properties.

Table 6. Impact of Distance to the Nearest Brownfield on Property Value[a]

Cleveland
Pre 1995
Property values decrease by 1.87 percent for every 100 feet closer to a potential brownfield.
Property values decrease by 0.33 percent for every 100 feet closer to a listed brownfield.
Post 1995
Property values decrease by 2.08 percent for every 100 feet closer to a potential brownfield.
Property values decrease by 0.48 percent for every 100 feet closer to a listed brownfield.
Property values decrease by 1.17 percent for every 100 feet closer to a potential remediated brownfield.
Property values decrease by 0.49 percent for every 100 feet closer to a listed remediated brownfield.
Atlanta
Pre 1995
Property values decrease by 0.53 percent for every 100 feet closer to a potential brownfield.
Property values decrease by 0.26 percent for every 100 feet closer to a listed brownfield.
Post 1995
Property values decrease by 0.26 percent for every 100 feet closer to a potential brownfield.
Property values decrease by 0.40 percent for every 100 feet closer to a listed brownfield.
Property values decrease by 0.20 percent for every 100 feet closer to a potential remediated brownfield.
Property values increase by 0.20 percent for every 100 feet closer to a listed remediated brownfield.

[a]Again, the variance inflation factor for the variables within each model was less than 3, indicating that multicollinearity was not a concern.

predicted, the effect is consistently negative for both cities and for each of the property categories: pre-1995 listed and potential sites and post-1995 listed and potential remediated and unremediated sites, with the noted exception of listed remediated brownfield sites in Atlanta. For Cleveland, it can be seen that the decrease in property values grew between the two periods: For every 100 feet closer to a potential brownfield, the negative impact on property values grew from 1.87 percent (line 1) to 2.08 percent (line 3). For every 100 feet closer to a listed brownfield, it grew from 0.33 percent (line 2) to 0.48 percent (line 4). The impact on listed remediated brownfields was essentially the same (0.49 percent, line 6), while the impact on potential remediated brownfields was less severe (1.17 percent, line 5).

Instead of the negative impact on property values being the same or smaller for remediated than for unremediated brownfields, we might have expected remediation to create a positive impact. One possible explanation is that the sheer number and high density of brownfields in Cleveland (as can be seen in figure 2) means that while a property may be close to a remediated brownfield, it may also be close to other unremediated brownfields that continue to depress property values. Combining the data from tables 2 and 3, Cleveland had 10,947 known and potential brownfields versus 4,154 for Atlanta. Further, Cleveland's combined brownfield acreage was 3,701 versus 3,244 for Atlanta, even though we can calculate from table 1 that its landmass was only 62 percent of Atlanta's.

There are two other possible explanations. The first is that even when an individual property is cleaned up, some aspects of neighborhood blight that are not captured in our model continue to have a negative effect on property values. The second is that since the brownfields in our data set are either commercial or industrial properties, the proximity of these uses continues to have a negative effect on property values, albeit a lesser one than when the property had not been remediated.

Table 6 shows that in Atlanta, as in Cleveland, property values tend to decrease because of proximity to brownfields. The effect lessened from 0.53 percent for every 100 feet closer to a potential brownfield before 1995 (line 7), to 0.26 percent after 1995 (line 9). At the same time, it grew from 0.26 percent for every 100 feet closer to a listed brownfield before 1995 (line 8) to 0.40 percent after 1995 (line 10). One interpretation of these two trends is that either a hot property market or lack of brownfield awareness—or both—helped decrease the negative effect of proximity to unremediated brownfields on property values.

Conclusion

Our findings confirm the importance of a proactive approach to furthering brownfield redevelopment efforts such as the one being pursued at the national level. Using hedonic modeling that controls for neighborhood and property characteristics, we found that brownfields do affect residential property values.

As we stated at the beginning, the public sector response to brownfields has been focused on the economic efficiency of the cleanup and redevelopment of individual properties instead of on how remediation and redevelopment can contribute to overall neighborhood economic revitalization. As a result of the public sector's redevelopment strategy, the brownfields in the most distressed neighborhoods may well be the most difficult to develop for reasons extending beyond their contamination. This, in turn, further dims the prospects for improving the economic condition of poor neighborhoods and promoting greater economic justice. Brownfield status not only affects the property labeled as such, it also stigmatizes and devalues surrounding properties.

Our research has confirmed our hypothesis that brownfields, both listed and potential, lower property values in Atlanta and Cleveland. The effect is strongest in the immediate vicinity (within 500 feet) of a brownfield, thus demonstrating the blighting influence that these properties have on properties in urban neighborhoods. Moreover, our results confirm the hypothesis that brownfield awareness strengthened the negative effect of brownfields on property values. At the same time, our model provides support for the idea that brownfield policy has real influence. Our results for Cleveland suggest that its brownfield program and EPA pilot funding had a positive influence on listed brownfields, while the stigma generated by uncertainty over potential brownfields had a stronger discounting effect. Conversely, in Atlanta, the overheated property market generated a creaming process for potential brownfields as developers sought the deeper discounts expected for these sites. Yet for those properties where contamination was identified, uncertainty was greater following brownfield awareness.

As a supplement to our modeling efforts and to explore the economic justice implications of our results, we analyzed redevelopment rates (proxied by property turnover) in high- and low-poverty neighborhoods in both cities after our pivotal policy year. Defining high-poverty and low-poverty neighborhoods as census tracts with a poverty rate of 20 percent or greater or less than 20 percent, respectively, we found that the average percentage of property turnovers in high-poverty census tracts was 9.5 percent in Atlanta and 8.7 percent in Cleveland. By contrast, the average percentage of turnovers in low-poverty census tracts was 13 percent in Atlanta and 15.2 percent in Cleveland. To the extent that brownfields act as a barrier to turnover occurring with redevelopment in weak markets, the prospects for revitalization in high-poverty neighborhoods are thwarted by the continued presence of brownfields.

These findings suggest that even in strong urban economies, there may be a need for increasing the level of redevelopment activity in poor neighborhoods; this calls for reconsidering how public brownfield reinvestment dollars are being spent.

Available public funds represent only a fraction of what is required to bring all brownfields, known and potential, back into productive use. The market-based approach runs the risk of publicly subsidizing redevelopment from which the marginal utility is less than what would be derived from redeveloping brownfields in poorer neighborhoods. We suggest that the public brownfield redevelopment strategy needs to be reconsidered. The more appropriate intervention for accelerating brownfield redevelopment in healthy neighborhoods is to strengthen smart growth strategies that end the public subsidizing of greenfield properties. Limited public funds should be carefully invested in brownfield redevelopment strategies that foster community revitalization in persistently poor neighborhoods. If the predominantly market-based approach to public brownfield redevelopment continues unabated, it is possible that intraurban inequality will rise as unremediated brownfields become increasingly associated with poor neighborhoods.

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