Brownfield Redevelopment Fund as an Environmental Policy:

Externality Effects of Brownfield Redevelopment Projects on Housing Sales Prices in Cuyahoga County of Ohio, USA

Eugene Choi

환경정책으로서의 브라운필드 개발 보조금

최유진

서울대학교 행정대학원(Graduate School of Public Administration, Seoul National University)

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국 문 요 약

오하이주에 위치한 클리블랜드 시(city of Cleveland)는 과거 자동차 공업을 중심으로 한 공업 중심 도시에서 생명공학 중심 도시로의 변화를 꾀하고 있다. 따라서 과거 공업부지(브라운필드)의 재사용 및 재개발이 클리블랜드 시의 환경정책에 큰 비중을 차지하게 되었다. 클리블랜드 시를 포함하고 있는 쿠야호가 카운티(Cuyahoga County)는 브라운 필드 재개발에 민간 영역의 투자를 유도하고자 보조금을 지급해 왔다. 카운티 정부의 브라운 필드 재개발 보조금(Brownfield Redevelopment Fund)은 지난 2십년간 많은 민간 부분의 투자를 유도하는 데 성공하였다. 본 연구는 브라운필드 보조금의 효과를 측정하고자 외부효과를 측정하는 전통적인 방법인 헤도닉 모형(Hedonic Model)을 이용하여 쿠야호가 카운티의 브라운필드 보조금이 주변 주택 판매가격 상승에 미치는 영향을 분석하였다.

주제어 브라운필드, 브라운 필드 재개발, 환경정책, 헤도닉 모형

Abstract

Many former industrial cities such as Cleveland, Ohio are trying to transform their identities from blue-collar manufacturing centers to white-collar professional hubs. As a result, the re-use of land previously occupied by industrial firms has been on the rise as an important sustainable land-use strategy in the United States. Ohio's Cuyahoga County offers a Brownfield Redevelopment Fund to overcome the environmental barriers inherent in re-use in order to obtain full use of underutilized properties in the county. This study estimates externality effects of brownfield redevelopment projects (BRPs) on nearby housing sales prices in Cuyahoga County. Typical hedonic regression models that employ "difference-in-difference" techniques are used to compare proximal housing sale prices before and after the completion of BRPs.

Keywords Brownfield, Brownfield Redevelopment Fund, Hedonic Model, Environmental Policy

* csueugene@gmail.com

Ⅰ. Introduction

Many former industrial cities such as the city of Cleveland, Ohio are trying to transform their identities from blue-collar manufacturing bases to white collar professional sectors. As a result, the public sentiment for the re-use of land previously used for industrial purposes has been on the rise as an important sustainable land-use strategy in the United States. Because of the problems of environmental contamination and the high costs associated with contamination removal, brownfield redevelopments are not preferred by private investors. Therefore, in many cases, redevelopment or expansion of such sites has been subsidized by various public investments.

Ohio's Cuyahoga County offers the Brownfield Redevelopment Fund (BRF) to help overcome the environmental barriers inherent in re-use in order to redevelop underutilized properties in the county. Public subsidies have emerged as a strong tool in many counties in the United States to improve urban sustainability converting environmentally contaminated sites to green places. The BRF provides loans for public or private investors at lower interest rates than bank loans; it does not provide tax credits or grants. It has been used for commercial redevelopment, brownfield prevention and site expansion projects, but it cannot be applied to for-sale housing redevelopment plans (Department of Development, Cuyahoga County, 2010).

The BRF has been considered an effective environmental policy tool. For the public consideration, the county can protect its environment through brownfield redevelopment projects as well as collect fiscal benefits from the spillover effects of such projects. In addition, because the BRF provides loans rather than grants or tax credits, it does not negatively affect the county's annual budget. For the private side of re-use, redevelopers can finance their projects through the BRF with lower interest rates.

The redevelopment of brownfields has earned political support in the U.S. as an essential ingredient of urban revitalization (De Sousa, Wu and Westphal, 2009).

Academic research has been focused on clean-up process issues[1]), including public management and public involvement, rather than investigating the economic and social impacts of brownfield redevelopment. Redevelopment of brownfield is expected to create new jobs, improve environmental justice, and positively affect nearby property values (Howland, 2007). This study estimates the externality effects of brownfield redevelopment projects (BRPs) on nearby housing sales prices in Cuyahoga County in Ohio. BRPs financed by the Brownfield Redevelopment Fund (BRF) and administered by the Department of Development in Cuyahoga County, Ohio are considered in this study.

Since 1990, 29 brownfields have been redeveloped utilizing BRF invested by the county. These 29 projects may be classified into two broad categories: first, commercial and industrial revitalization projects and second, affordable residential housing development projects. I mainly draw hypotheses on the price effects of nine brownfield commercial revitalization projects in Cleveland area[2]). Typical hedonic regression models that employ "difference-in-difference" techniques are used to compare nearby housing sales prices before completion of BRPs with housing sales prices after completion of BRPs.

Ⅱ. Literature Review

Numerous academic studies have revealed that environmentally contaminated properties have a negative impact on nearby property values. Contamination sources include superfund sites,[3]) landfills,[4]) Toxic Release Inventories,[5]) power lines,[6])

1) Such as Greenberg, Lowrie, Mayer, Miller and Solitare, 2001; Tedd, Charles and Driscoll, 2001; Howland, 2003; Page and Berger, 2006.

2) I do not test effects of brownfield redeveloped for industrial purposes or affordable housing because it is a well known academic findings that reuses for industrial sites or affordable housing should generate negative effects or no effects while commercial redevelopment plans may generate positive externalities (Green, Malpezzi, and Seah, 2002).

3) Such as Noonan, Krupka and Baden, 2007; Gayer and Kip Viscusi, 2002; Kiel and Zabel, 2001; Greenberg and Hughes, 1992.

4) Such as Hite, 2009; Arimah, 1996; Bleich, Findlay and Phillips, 1991.

5) Such as Lee, Taylor and Hong, 2008; Hanna, 2007; Decker, Nielsen and Sindt, 2005; Mathur, Waddell and Blanco, 2004.

pipeline ruptures, nuclear power plants,[7] several other urban nuisance uses (Simons and Saginor, 2006). Simons and Saginor (2006) conducted a meta-analysis to address the overall effects of proximity influences of environmental contamination on residential property values. They summarized a literature review of 75 peer-reviewed journal articles and selected case studies. They then generated a data set of approximately 290 observations that contain information about each study's loss (the dependent variable), with the independent variables being: distance from the source, type of contamination, urban or rural environment, geographic region, market conditions, and several other explanatory variables. Using a typical Ordinary Least Squares (OLS) model they confirmed that distance from the source was strongly, but negatively, related to residential property values.

While Simons and Saginor focused on the proximity effects of environmentally contaminated sources on property values, their paper did not address environmental clean-up effects on property values. Narrowing the investigation to literature that addresses environmental clean-up effects on property values, Noonan, Krupka and Baden (2007) addressed price effects of Superfund site clean-up. Their paper estimated a neighborhood transition model to capture the direct price effect from Superfund site clean-up and the indirect price effects arising from residential sorting as well as changes in investment in the housing stock following clean-up. They failed to find consistent positive direct price effects of clean-up though they did see that positive indirect effects may arise through residential sorting and neighborhood investment spurred by remediation.

De Sousa, Wu and Westphal (2009) measured and compared the impact of publicly assisted brownfield redevelopment on nearby residential property values in Milwaukee and Minneapolis. Their paper incorporated a hedonic method to quantify nearby property value effects at more than 100 brownfield projects and they included stakeholder interviews to assess the perceived impacts on real estate conditions. They found that the spillover effect, in terms of raising surrounding

6) Such as Bajic, 1983.

7) Such as Clark and Allison, 1997; Clark, Lisa, Allison and Metz, 1997.

property values, is significant in both quantity and geographic scope, as redevelopment led to a net increase of 11.4% in nearby housing prices in Milwaukee and 2.7% in Minneapolis.

In addition to the literature addressed above it is worth briefly addressing reviews of literature related to property values (housing sales prices) and general redevelopment plans. Previous studies generally concluded that redevelopments of abandoned or underused urban sites for affordable or low income housing might generate negative externality effects on surrounding property values even various public investment such as tax credits were involved (see DeSalvo; 1974; Butler, 1982; Farber, 1986; Green, Malpezzi and Seah, 2002). Using similar approach, Choi (2010) found that a redevelopment of an underused church in Cleveland, Ohio has generated positive spillovers on surrounding housing sales prices after the redevelopment was completed. New residential projects seem to have positive spillover effects on surrounding housing sales prices. Ding, Simons and Baku (2000) and Simons, Quercia and Levin (1998) conducted hedonic regression models to enumerate price effects of new residential investments on nearby housing properties in Cleveland, Ohio with different residential projects. They similarly found that property values can be increased up to approximately 20% as a result of new residential projects. However, these findings were not confirmed by Newell's project (2009) conducted in a different location, Durham, NC. According to his paper, there was no evidence of positive development externalities reflected in improved real estate values for surrounding properties.

In this paper, I test spillover effects of brownfield redevelopment projects on nearby property values with real housing sales prices collected by Cuyahoga County Auditor's Office. There are two important meanings in conducting this research: first, this paper adds to the literature empirical results that tell us positive spillovers of brownfield redevelopments. This is very important because even if brownfield redevelopments have been emerged as a considerable environmental policy tool that may positively affect local economy I have found a lack of literature on the subject; second, this study deals with a distressed area. Unlike De Sousa, Wu and Westphal's study, this study reveals whether or not brownfield redevelopment projects can be used as a tool to revitalize urban area even in the severely distressed areas.

Ⅲ. Research Methods

1. "Difference-in-Difference" Technique

Houses sold within the 3,000-foot radius from nine BRPs during the period of January 1997 to December 2007 were included in the sample to estimate the proximity effects of such projects. Table 1 lists the BRPs included in this study with their basic information. Six of the BRPs are located in the City of Cleveland, one BRP is in Euclid, Ohio (an adjacent eastern suburb) and two BRPs are in Fairview Park, Ohio (an adjacent western suburb). For the nine BRPs, Cuyahoga County invested over $10 million and estimates that more than one thousand jobs were created by those projects. Figure 1 maps the areas of this study.

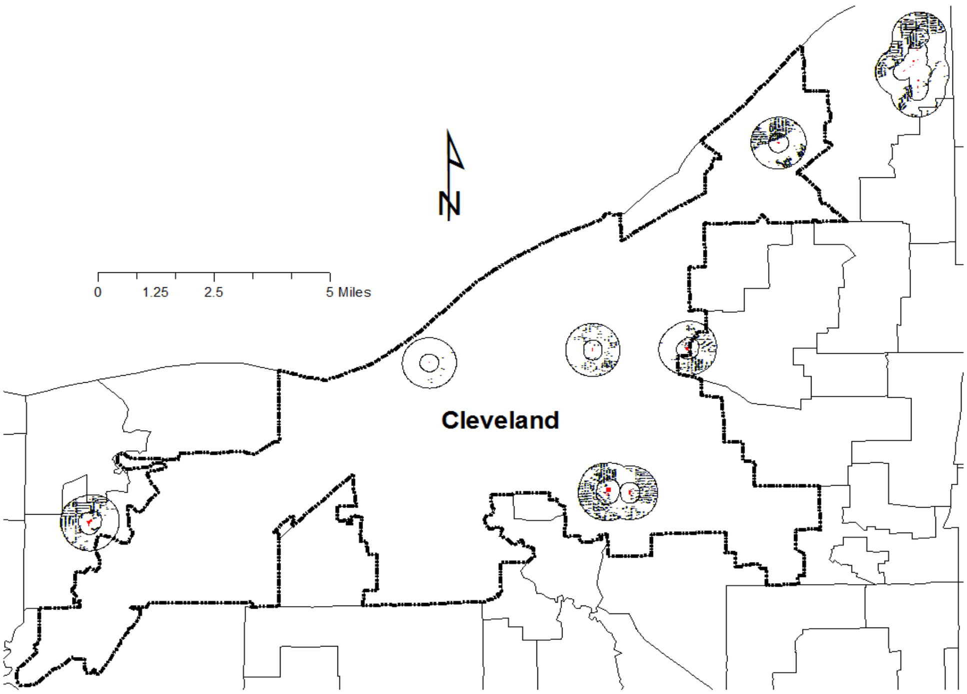
Table 1 A Profile of BRPs in this Study

Project Name	City	Zip Code	BRF	Job Created
7100 Euclid Ave	Cleveland	44103	$1,000,000	93
Cleveland Pneumatic	Cleveland	44105	$500,000	250
Flats East Bank	Cleveland	44113	$4,000,000	250
Garland Company Expansion	Cleveland	44105	$950,000	45
Morrison Products	Cleveland	44110	$500,000	38
Nottingham Spirk	Cleveland	44106	$1,000,000	75
Euclid-PMX	Euclid	44132	$1,000,000	100
City of Fairview Park	Fairview Park	44126	$1,210,000	170
West Valley Medical	Fairview Park	44126	$458,000	150
Total			$10,618,000	1,171

Note: Data includes single family homes sold between 1997 and 2007; the number of jobs created from the project was estimated by the Department of Development, Cuyahoga County.
Source: Department of Development of Cuyahoga County, Ohio

The BRPs were completed in various years and thus the metrics denoting housing sales "Before" and "After" are different in each case. For example, the renovation and contamination remediation of the Nottingham Spirk project was completed in 2005; thus houses sold between 1997 and 2005 are considered "Before" while those sold in 2006-2007 are considered "After." The Garland Company Expansion project was completed in 2003; houses sold between 1997 and 2003 are considered "Before" while those sold from 2004-2007 are considered "After."

Figure 1: A Study Area with Buffer Rings



3.2 The Baseline Model

Utilizing a typical hedonic approach, a baseline OLS model of this study compares differences in housing sales prices before and after the completion of BRPs within a 1,000-foot radius[8] from BRPs to differences in housing sales prices before and after completion of BRPs outside of this 1,000-foot buffer ring. The hedonic regression equation for the model[9] is expressed as:

$$y = \alpha_0 + \alpha_1 x_1 + \alpha_2 x_2 + \alpha_3 x_3 + \alpha_4 INPRE + \alpha_5 (D \times INPRE) + \alpha_6 INPOST + \alpha_7 (D \times INPOST) + \varepsilon_1 \quad (1)$$

Where y is a natural log of housing sales prices, x_1 is a vector indicating physical building characteristics, x_2 is a vector indicating transaction timing, x_3 is a vector indicating location characteristics of transactions, and ε_1 is the error term of the equation.

The main variables that measure the proximity effects of brownfields before and after the completion of redevelopments are the ring variables. In the baseline OLS Model, "$INPRE$" and "$(D \times INPRE)$" were included to capture the proximity effects of brownfields before redevelopment projects were completed. A negative relationship between brownfields and nearby housing sales prices is expected as numerous studies have pointed out that environmentally contaminated properties have a negative impact on housing demand (refer to Literature Review of this stud). "$INPRE$" is a dummy variable indicating single-family homes were sold in the 1,000-foot ring before brownfields were redeveloped. "$INPRE$" was interacted with the Euclidian Distance (D) between single family homes and the nearest brownfield; this interaction term, "$(D \times INPRE)$," allowed an estimation of how the effects of proximity to brownfields vary according to distance to the subject, within the 1,000-foot ring before BRPs were completed. The other ring variables, "$INPOST$" and "$(D \times INPOST)$" were included to capture the proximity effects of BRPs on nearby housing sales prices after such projects completed. "$INPOST$" is a dummy variable indicating single-family homes sold in the 1,000-foot ring after BRPs were completed.

8) I consider housing sales prices before and after the completion of BRPs within a 1,000-foot radius as an experimental group. The 1,000-foot radius has been used as a cutting point to measure positive or negative externalities in several previous studies (e.g. Voicu and Been, 2008).

9) The methodology followed Voicu,and Been (2009)'s method to capture spillover effects of urban amenities in the 1,000-foot ring.

3. The Job Model

BRPs vary in terms of the number of jobs created, leading to the logical assumption that BRPs that created more jobs should have more impact on nearby single family housing sales prices. The Job Model in this study forwards this hypothesis. Cuyahoga County estimated that the projects at Cleveland Pneumatic generated approximately 250 jobs, Flats East Bank generated approximately 250 jobs, City of Fairview Park generated approximately 170 jobs and West Valley Medical generated approximately 150 jobs. Other BRPs were estimated to have generated fewer than 100 jobs each. Utilizing a typical hedonic approach, the Job Model in this study tests whether or not houses located in the 1,000-foot ring from BRPs which generated more than 150 jobs were sold at higher prices than houses located in the 1,000-foot ring from BRPs which generated fewer than 150 jobs. Thus the hedonic equation for the Job Model is expressed as:

$$
\begin{aligned}
y &= \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 INPRE\_M + \beta_5 (D \times INPRE\_M) \\
&+ \beta_6 INPOST\_M + \beta_7 (D \times INPOST\_M) + \beta_8 INPRE\_L + \beta_9 (D \times INPRE\_L) \\
&+ \beta_{10} INPOST\_L + \beta_1 (D \times INPOST\_L) + \varepsilon_2 \qquad (2)
\end{aligned}
$$

"$INPRE$" in Equation (1) is specified into two different terms in Equation (2): "$INPRE\_M$" and "$INPRE\_L$." "$INPRE\_M$" is a dummy variable indicating houses located in the 1,000-foot radius from BRPs which generated more than 150 jobs before BRPs were completed, and "$INPRE\_L$" is a dummy variable indicating house located in the 1,000-foot radius from BRPs which generated more than fewer than 150 jobs before BRPs were completed. "$INPRE\_M$" and "$INPRE\_L$" are interacted with the Euclidian Distance (D) between single family homes and the nearest brownfield, giving "$(D \times INPRE\_M)$" and "$(D \times INPRE\_L)$" in Equation (2). Such interaction terms allow estimation of how the effects of proximity to brownfields vary according to distance to the subject due to the number of job created within the 1,000-foot ring before BRPs were completed. The variable "$INPOST$" in Equation (1) is also specified into two different terms in Equation (2), "INPOST_M" and "INPOST_L", as the variables above were treated, resulting in the interacted variables "(D×INPOST_M)" and "(D×INPOST_L)" in the equation (2).

4. The Data

Table 2 presents the independent variables and their descriptions. A housing dataset obtained from the database of the Cuyahoga County Auditor's Office included physical building characteristics, such as the building size and the number of rooms, as well as the location characteristics (exact addresses), the year, and the season of sales transactions. Each house in the dataset was geo-coded by ArcGIS, attaching detailed information of physical building characteristics, location characteristics and transaction timing. In addition, demographic information obtained from Census 2000 was attached to each house. Using ArcGIS, houses located in each buffer ring were coded as "1" and the distances between houses and the nearest brownfield were calculated. ArcGIS also calculated interaction terms. To control for physical building characteristics, the natural log of the basement size (LNBASESQFT), the number of bed rooms (BEDROOMS), baths (BATHS), half baths (HALFBATH) and fire place (FIREPL), the natural log of the garage size (LNGARSIZE), total living area (LNLIVATOT), lot size (LNLOTSIZE), and the age of homes (AGE) were included. Dummy variables indicating the year of transactions and the season were also included. To control for effects of surrounding demographic information on housing sales prices, the natural log of the median residential rent (LNRENT), the natural log of household income (LNINCOME), the percentage of white residents (WHITE) and the percentage of young population (YOUNG) were included. This study also controlled for city locations, as they are proxies of price effects of school districts and city policies. D_EUCLID indicates houses are located in the city of Euclid and D_FAIRVIEW indicates houses are located in the city of Fairview Park.

Table 2 Independent Variables and Their Descriptions

Variables	Description
LNBASESQFT	The natural log of the size of basement
BEDROOMS	The number of bedrooms
BATHS	The number of baths
HALFBATH	The number of half baths
FIREPL	The number of fireplace
LNGARSIZE	The natural log of garage size
LNLIVATOT	The natural log of the size of total living area
LNLOTSIZE	The natural log of total lot size
AGE	Property Age (year of transaction - year of built)
D__1997	If houses were sold in the year 1997, yes=1 or no=0 (a reference category)
D__1998	If houses were sold in the year 1998, yes=1 or no=0
D__1999	If houses were sold in the year 1999, yes=1 or no=0
D__2000	If houses were sold in the year 2000, yes=1 or no=0
D__2001	If houses were sold in the year 2001, yes=1 or no=0
D__2002	If houses were sold in the year 2002, yes=1 or no=0
D__2003	If houses were sold in the year 2003, yes=1 or no=0
D__2004	If houses were sold in the year 2004, yes=1 or no=0
D__2005	If houses were sold in the year 2005, yes=1 or no=0
D__2006	If houses were sold in the year 2006, yes=1 or no=0
D__2007	If houses were sold in the year 2007, yes=1 or no=0
D__SPRIMG	If houses were sold in March, April or May, yes=1 or no=0 (a reference category)
D__SUMMER	If houses were sold in June, July or August, yes=1 or no=0
D__FALL	If houses were sold in September, October or November, yes=1 or no=0
D__WINTER	If houses were sold in December, January or February, yes=1 or no=0
LNRENT	The natural log of the median residential rent by block group
LNINCOME	The natural log of the median household income by block group
WHITE	The natural log of White residents by block group
YOUNG	The natural log of young residents (aged 22-35) by block group
D__EUCLID	If houses are located in the city of Euclid, yes=1 or no=0
D__FAIRVIEW	If houses are located in the city of Fairview Park, yes=1 or no=0
INPRE	If houses are sold in the 1,000-foot ring before BRPs were completed, yes=1 or no=0
(D×INPRE)	INPRE multiplied by the Euclidian Distance between houses and the nearest Brownfield
INPOST	If houses are sold in the 1,000-foot ring after BRPs were completed, yes=1 or no=0
(D×INPOST)	INPOST multiplied by the Euclidian Distance between houses and the nearest Brownfield

Variables	Description
INPRE_M	If houses are sold in the 1,000-foot ring before BRPs which generated more than 150 jobs were completed, yes=1 or no=0
(D×INPRE_M)	INPRE__M multiplied by the Euclidian Distance between houses and the nearest Brownfield
INPRE_L	If houses are sold in the 1,000-foot ring before BRPs which generated fewer than 150 jobs were completed, yes=1 or no=0
(D×INPRE_L)	INPRE__L multiplied by the Euclidian Distance between houses and the nearest Brownfield
INPOST_M	If houses are sold in the 1,000-foot ring after BRPs which generated more than 150 jobs were completed, yes=1 or no=0
(D×INPOST_M)	INPOST__M multiplied by the Euclidian Distance between houses and the nearest Brownfield
INPOST_L	If houses are sold in the 1,000-foot ring after BRPs which generated fewer than 150 jobs were completed, yes=1 or no=0
(D×INPOST_L)	INPOST__L multiplied by the Euclidian Distance between houses and the nearest Brownfield

Note: Physical building characteristics, transaction timing, and location information were obtained from the Cuyahoga County Auditor's Office. Demographic information was obtained from Census 2000.

Table 3 and Table 4 present descriptive statistics of continuous variables and frequencies of binary variables.

Table 3 Descriptive Statistics of Continuous Variables

Variables	Minimum	Maximum	Mean	Std. Deviation.
LNBASESQFT (in SQFT)	0	4,155	725.98	391.44
BEDROOMS	0	14	3.11	1.12
BATHS	0	6	1.30	0.57
HALFBATH	0	3	0.17	0.41
FIREPL	0	6	0.18	0.48
LNGARSIZE	0	1500	291.89	188.10
LNLIVATOT	0	7718	1440.92	661.97
LNLOTSIZE	1,258	17,685,360	9,800.61	198,278.35
AGE	0	170	69.73	25.39
LNRENT (in dollar)	0	$1,327	$554.77	$152.37
LNINCOME (in dollar)	0	$130,550	$31,846.90	$12,693.38
WHITE (in percentage)	0	100%	58.21%	32.06%
YOUNG (in percentage)	0	91%	24.08%	7.41%

Note: Total N: 7,963. For logged variables, descriptive statistics of unlogged values are presented.

Table 4 Frequencies of Binary Variables

Variables	Frequency	Percentage as to Total N
D__1997	715	8.98%
D__1998	825	10.36%
D__1999	887	11.14%
D__2000	825	10.36%
D__2001	575	7.22%
D__2002	529	6.64%
D__2003	581	7.30%
D__2004	641	8.05%
D__2005	729	9.15%
D__2006	689	8.65%
D__2007	996	12.51%
D__SPRIMG	1,999	25.10%
D__SUMMER	2,343	29.42%
D__FALL	2,053	25.78%
D__WINTER	1,597	20.06%
D__EUCLID	2,245	28.19%
D__FAIRVIEW	937	11.77%

Note: Total N: 7,963

Ⅳ. Estimation Results

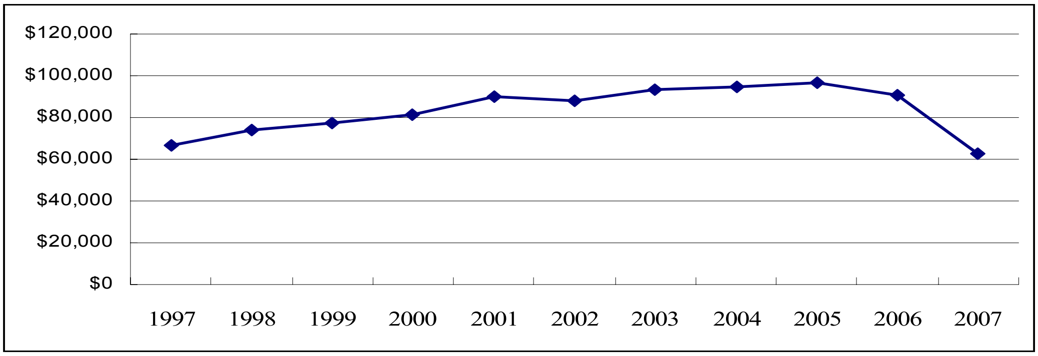
1. The Baseline Model

Table 5 presents the estimation results of the baseline OLS model. The R-Squared was approximately 0.56, indicating that the variables included in this model explain 56% of total variation. The variables of particular concern in this model were the ring variables. INPRE was statistically significant at the 99% level with a coefficient of -0.2153, indicating that houses sold in the 1,000-foot ring before the completion of BRPs were sold at a 21.53% discount compared to houses located between the 1,000-foot radius and 3,000-foot radius. The variable (D×INPRE) was statistically significant at the 99% level with the 0.0005 coefficient, indicating that there is a 0.05%

discount rate per 1 foot from the nearest BRP in the 1,000-foot ring (an approximately 5% discount rate per 100 feet). INPOST was statistically significant at the 99% level with 0.3569 coefficient, indicating houses sold in the 1,000-foot-ring after the completion of BRPs were sold at 35.69% premium rates compared to houses located between 1,000 feet radius and 3,000-foot radius. Finally, (D×INPOST) was statistically significant at the 99% level with the -0.0006 coefficient meaning there there is a 0.06% premium rate per 1 foot from the nearest BRP in the 1,000-foot ring after BRPs were completed (approximately 6% premium rates per 100 feet). In these results, it may be concluded that BRPs have generated an estimated 57.22% premium effect on single family home values in the 1,000-foot ring.

Dummy variables indicating the years of transactions were statistically significant with positive signs except for D_2007. Such results indicate that housing sales prices between 1998 and 2006 were significantly higher than housing sales prices in 1997, while sales prices in 2007 were lower by 5.64% than housing sales prices in 1997. Figure 2 shows a trend of housing sales prices of the sample between 1997 and 2007. The median sale price in 1997 was approximately $66,598; after 1997, the percent changes obtained from estimations of the basic OLS model were multiplied from that price. For example, because D_1998 was statistically significant at the 99% level with the positive 0.1115 of coefficient, the median sales prices in 1998 was "$66,598 + ($66,598 multiplied by 0.1115)".

Figure 2 A Trend of Housing Sales Prices of the Sample in This Research



City dummy variables also played an important role in determining housing sales prices: D_EUCLID was statistically significant at the 99% level with a -0.0911 coefficient, meaning that if single family homes are located in Euclid, such homes were sold for 9.11% lower prices than homes in Cleveland. D_FAIRVIEW was statistically significant at the 90% level with 0.0337 coefficient; single family homes in Fairview Park sold at 3.37% higher prices compared to homes in Cleveland.

Table 5 Estimation Results of the Basic OLS Model

Variables	Coefficient	Std. Error	t-Statistic	Probability
CONSTANT	3.6649	0.2666	13.7491	0.0000
LNBASESQFT	0.0137	0.0029	4.7356	0.0000
BEDROOMS[10)	-0.0271	0.0073	-3.7003	0.0002
BATHS	0.0845	0.0141	5.9888	0.0000
HALFBATH	0.1676	0.0161	10.4173	0.0000
FIREPL	0.1988	0.0136	14.5953	0.0000
LNGARSIZE	0.0229	0.0026	8.8943	0.0000
LNLIVATOT	0.4016	0.0253	15.9021	0.0000
LNLOTSIZE	0.1030	0.0121	8.4832	0.0000
AGE	-0.0086	0.0003	-29.8853	0.0000
D__1998	0.1115	0.0254	4.3859	0.0000
D__1999	0.1607	0.0251	6.4069	0.0000
D__2000	0.2218	0.0255	8.7020	0.0000
D__2001	0.3549	0.0281	12.6527	0.0000
D__2002	0.3258	0.0287	11.3398	0.0000
D__2003	0.4014	0.0280	14.3588	0.0000
D__2004	0.4182	0.0273	15.3249	0.0000
D__2005	0.4507	0.0265	17.0349	0.0000
D__2006	0.3592	0.0268	13.3887	0.0000
D__2007	-0.0564	0.0250	-2.2535	0.0243
D__SUMMER	-0.0109	0.0152	-0.7167	0.4736
D__FALL	-0.0241	0.0156	-1.5397	0.1237
D__WINTER	-0.0392	0.0167	-2.3472	0.0189
LNRENT	-0.0202	0.0072	-2.8156	0.0049
LNINCOME	0.3289	0.0196	16.8212	0.0000
WHITE	0.0039	0.0002	16.9842	0.0000
YOUNG	0.0118	0.0008	14.6892	0.0000
D__EUCLID	-0.0911	0.0135	-6.7559	0.0000
D__FAIRVIEW	0.0337	0.0186	1.8113	0.0701
INPRE	-0.2153	0.0956	3.5644	0.0000
(D×INPRE)	0.0003	0.0002	3.2791	0.0000
INPOST	0.3569	0.0003	4.5076	0.0000
(D×INPOST)	-0.0003	0.0002	3.9153	0.0000

Note: N = 7,963; R-squared = 0.56; F-statistic = 364.95.

2. The Job Model

Table 6 presents estimation results of the Job Model. Estimation results for control variables in the Job Model were similar to results of the Baseline Model, therefore only the ring variables are interpreted here. It seems as though before BRPs were completed, larger brownfields generated more negative spillover effects on nearby housing values. INPRE_M was statistically significant at the 99% level with -0.5213 coefficient; houses sold in the 1,000-foot ring were sold at 52.13% discount rates before BRPs that generated over 150 jobs were completed. INPRE_L was statistically significant at the 99% level with the -0.1956 coefficient indicating houses sold in the 1,000-foot ring were sold at 19.56% discount rates before BRPs that generated fewer than 150 jobs were completed. On the other hand, such negative externalities were remediated by BRPs. INPOST_M was statistically significant at the 99% level with the 0.1224 coefficient, meaning houses sold in the 1,000-foot ring were sold at 12.24% premiums after BRPs that generated over 150 jobs were completed. INPOST_L was statistically significant at the 99% level with the 0.4235 coefficient; houses sold in the 1,000-foot ring were sold at 42.35% premiums after BRPs that generated fewer than 150 jobs were completed. These results indicate that BRPs generating over 150 jobs and fewer than 100 jobs both created more than 50% premium effects on single family homes in the 1,000-foot ring.

Table 6 Estimation Results of the Job Model

Variables	Coefficient	Std. Error	t-Statistic	Probability
CONSTANT	22.8131	0.6912	33.0046	0.0000
LNBASESQFT	0.0250	0.0051	4.9039	0.0000
BEDROOMS	-0.0371	0.0129	-2.8875	0.0039
BATHS	0.1089	0.0248	4.3920	0.0000
HALFBATH	0.3067	0.0283	10.8267	0.0000

10) In general, hedonic regression models in the Cleveland market tend to have negative signs for bedrooms because this is an indicator of numerous smaller “chopped up” rooms (for larger families), which is considered a functionally obsolete housing characteristic (Choi, 2010).

Variables	Coefficient	Std. Error	t-Statistic	Probability
FIREPL	0.3546	0.0240	14.8042	0.0000
LNGARSIZE	0.0243	0.0045	5.3747	0.0000
LNLIVATOT	0.5349	0.0444	12.0456	0.0000
LNLOTSIZE	0.1556	0.0213	7.2878	0.0000
AGE	-0.0143	0.0005	-28.1671	0.0000
D__1998	0.1285	0.0447	2.8741	0.0041
D__1999	0.1779	0.0441	4.0349	0.0001
D__2000	0.3087	0.0448	6.8886	0.0000
D__2001	0.4602	0.0493	9.3296	0.0000
D__2002	0.3708	0.0505	7.3401	0.0000
D__2003	0.5028	0.0492	10.2290	0.0000
D__2004	0.4527	0.0480	9.4335	0.0000
D__2005	0.5591	0.0465	12.0174	0.0000
D__2006	0.4438	0.0472	9.4091	0.0000
D__2007	-0.1192	0.0440	-2.7094	0.0067
D__SUMMER	0.0068	0.0267	0.2566	0.7975
D__FALL	-0.0371	0.0275	-1.3504	0.1769
D__WINTER	-0.0518	0.0294	-1.7643	0.0777
LNRENT	-0.1186	0.0127	-9.3141	0.0000
LNINCOME	0.8121	0.0350	23.1765	0.0000
WHITE	0.0067	0.0004	16.5938	0.0000
YOUNG	0.0148	0.0014	10.4886	0.0000
D__EUCLID	-0.1087	0.0237	-4.5808	0.0000
D__FAIRVIEW	0.6199	0.0367	16.8790	0.0000
INPRE _ M	-0.5213	0.9452	4.2543	0.0000
(D × INPRE _ M)	0.0007	0.0004	4.1546	0.0000
INPRE _ L	-0.1956	0.8017	3.5648	0.0000
(D × INPRE _ L)	0.0004	0.0002	3.8650	0.0000
INPOST _ M	0.2224	1.0025	4.0258	0.0000
(D × INPOST _ M)	-0.0006	0.0002	3.6543	0.0000
INPOST _ L	0.4235	0.9656	3.5486	0.0000
(D × INPOST _ L)	-0.0005	0.8965	3.4785	0.0000

Note: N = 7,963; R - squared = 0.57; F - statistic = 381.24.

Ⅴ. Summary and Conclusion

This study has addressed externality effects of BRPs on nearby housing sales prices in Cuyahoga County, Ohio. BRPs financed by the BRF are considered in this study to evaluate the effects of BRPs as an environmental policy regarding spillovers on nearby property values as a proxy of urban revitalization. In other words, the purpose of this study was to evaluate effectiveness of environmental policies. The study employed two variations of the typical hedonic regression model: the first model estimated overall effects of the proximity to BRPs on houses in the 1,000-foot ring before and after BRPs were completed; the second model estimated whether or not there were differences in price effects of BRPs due to the number of jobs created by such BRPs. This study also controlled for physical building characteristics, demographic conditions and transaction timing which are shown to affect housing sales prices.

Based on the estimation results of both models, this study concluded that BRPs have a positive impact on nearby housing sales prices regardless of the number of job created by the projects, and that this premium reached approximately 50% within the 1,000-foot ring of project locations. This result is considerably higher than the empirical findings of De Sousa, Wu and Westphal (2009). Their study may have underestimated the effects of BRPs because it included houses in buffer rings from small brownfields which are doubted to have significant effects on nearby residential property values. For this reason, the investigation of this study only considered BRPs that created more than 30 jobs.

The findings of this study contribute to the argument for future public subsidies for BRPs. Cities transforming their identities and structures from industrial-oriented to professional services and IT-oriented sectors tend to have many brownfield sites that must be re-used for the needs of the community. In many cases, BRPs are not preferred by private developers because of the relatively high costs due to environmental remediation. More assertive actions to provide public subsidies are needed.

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