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Financing Brownfield Redevelopment and Housing Market Dynamics: Evidence from Connecticut

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Abstract: Brownfield redevelopment projects are often perceived as more risky than greenfield investment, and financing opportunities may be more limited and expensive. Different financial support projects have been developed to support regeneration projects, and empirical evidence has shown that all buildings near the intervention area may benefit from an increase in prices once the brownfield project is complete. The article considers the Connecticut market and evaluates the characteristics of the brownfield projects that had access to a financial support program (loan or grant), the impact of the regeneration process on the liquidity of the housing market, and the gap between the price and the appraisal value of the residential unit. Target areas for this type of financing program are mainly characterized by low income, a high density of population, a high incidence of homeowners, and a high crime rate. Once completed, the brownfield requalification has an impact on the housing market because the brownfield recovery reduces the number of house sales due to the increase in the average price in the surrounding area and makes the selling price more consistent with the appraisal valuation. The empirical evidence provided may be useful for public institutions that are suffering from budget constraints and have to prioritize areas for financial support solutions.

Keywords: brownfield; regeneration process; spillover effect; housing market

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1. Introduction

The real estate market is exposed to distortions arising from environmental liabilities [1], as is the case for brownfield sites, that may affect land or premises that have previously been used or developed and are not currently entirely in use. As a consequence, old sites may be partially occupied or used, and, in extreme cases, they can become vacant or derelict [2]. The existence of brownfield sites can determine spillover effects on nearby property values when potential buyers fear that the contaminants may migrate to surrounding properties or, in any case, create a hazard to the neighborhood [3]. Brownfields may negatively affect the prices of surrounding real estate, and several homeowners will suffer capital losses, (especially those with little home equity) which may prevent them from leaving the area [4].

Brownfield projects face critical financing gaps that can foil efforts to assemble a complete package as lenders and investors will not finance beyond the current market value of the asset [5]. These gaps typically involve capital shortages for three activities specific to brownfield sites: early-stage site assessment to determine precisely what contamination needs to be addressed; defining a site remediation plan, which owners need to take the site through a voluntary cleanup program (VCP) that allows the use of institutional controls or provides some finality on liability; and implementing cleanup [6]. The attention of the public authorities to brownfield redevelopments has grown in the last decades, and nowadays land and building revitalization represent a national priority [7].

Many financial tools are available to brownfield developers. Nevertheless, brownfields almost invariably have to pledge a higher rate of return to their investors or lenders to persuade them to assume the higher perceived risk associated with the project [6]. Additional underwriting costs can also significantly add to the costs of loan processing and review procedures. Lenders usually require developers to have a non-relevant percentage of equity in the project to ensure that the borrower has sufficient capital at risk [8]. Consequently, brownfield redevelopment is increasingly driven by the availability of development grants and subsidies to compete with greenfield programs [9].

In light of the wide range of federal, state and local level programs [10] and given the importance of grant funding more than property values, private investment, and public investment in redevelopment programs [11], the paper analyzes the public database of brownfield redevelopment created by the state of Connecticut over a 13-year time horizon (2008–2020) (The choice of the time horizon is constrained from the availability of the data about the brownfield redevelopment that are available only from 2008) to evaluate the stock of brownfields existing in the area and the number of redevelopment projects in progress or already completed focusing the attention on the role of grants and financing solutions to support private intervention. Results provide evidence about the main target areas for brownfield refinancing, the impact of the completed intervention on house sales, and the difference between the selling price and the appraisal value. The main results are mostly relevant for government and public administrators that have a lack of resources for supporting all the brownfield redevelopment and have to prioritize the areas in which the benefits are maximized for the citizens that are living nearby.

The paper is organized as follows: Section 2 describes the literature on the impact of brownfield refinancing on the value of housing stock, and Section 3 describes the relevance of brownfield areas in Connecticut and values the characteristics of the areas for which the state program for brownfield refinancing exists and the impact of the refinancing on market liquidity.

2. Literature Review

Brownfield areas represent an issue for the value of houses in the surrounding areas due to the real or perceived contamination that may affect all buildings nearby [12]. Literature has shown that simple disclosure of environmental issues related to abandoned or derelict buildings has an impact on the values of the entire neighborhood [13]. The economic impact for the nearby houses depends on the size, location, and level of contamination, and the decrease in value for existing houses will happen every time the alarm related to the brownfield is considered sufficient by the citizens [14]. Literature shows that the impact of brownfields does not increase proportionally to the number of nearby properties or areas, and the negative could be maximized even if they are nearby residential areas only with one or two derelict and/or abandoned buildings or sites [15].

Externalities related to brownfield proximity are normally negatively related to the distance of the house from the contaminated site, even if there is no consensus about which proxy fits better for measuring the distance, and the relationship could be not linear but exponential [16]. The impact is economically significant for the wealth of households, and the loss can be recovered only if a successful clean-up process takes place in the area and the family is not obliged to sell the building before the area is requalified [17].

The existence of brownfield areas and the risk of additional costs related to the clean-up process may represent a significant disincentive to invest in the area, and developers may prefer to avoid the risk related to an investment in areas exposed to this type of risk [18]. Moreover, revenues from the regeneration project are not easy to forecast because the expected selling price of the refurbished assets will be affected by the gap between demand and supply once the project is completed [19].

During brownfield redevelopment, the influence of financial, legal, regulatory, and policy incentives leads to uncertainty about redevelopment costs and land values [20]. As a consequence, uncertainty can affect the development of a well-functioning finance

market for brownfield remediation investments [21] because financial risks are difficult to predict due to uncertainties about social responsibilities under land reuse plans [22]; furthermore, the trade-off between land value and the environmental health impact of brownfields makes banks and private developers reluctant to support the programs [23] without implementing a flexible land management approach [24]. In light of the relevance assigned by developers to financial, market, and site-specific risks [25], the solution adopted in several countries is to enact a set of rules that allow the creation of a limited liability program that, under some circumstances, may avoid responsibilities related to unexpected events that may occur during the demolition or construction stage [26].

Urban recovery has higher and less predictable costs and execution times than real estate properties in ex novo areas, and the relevance of this difference increases with the costs of land reclamation and the administrative and community constraints on the urban recovery intervention [27]. Greenfield investments, on the other hand, allow the costs of the intervention to be cut and profit margins to be potentially maximized, given the lower constraints on the construction of new buildings in areas not previously intended for development [28].

The execution of the clean-up process of real estate assets has normally a positive effect on the building value, and after the brownfield recovery process, all the real estate assets nearby may increase their value over time due to the better living conditions in the surrounding area [29]. In particular, brownfield areas characterized by a risk of contamination have a significant effect on prices [30] and frequently have a contagion effect on all nearby areas [31]. When the risk of contamination is lower or there is a program to reduce liability and risk for owners, the impact on the price of surrounding buildings is lower because the brownfield area will be redeveloped faster [28].

On closer inspection, the impact on urban areas of brownfield remediation may be different concerning the average of the market, as it is significant on surrounding housing prices in low- and middle-income neighborhoods [32]; moreover, because the consumer attitude is the main factor explaining the intention to acquire [33], stigma negatively affects the value of housing even after the brownfield recovery process with a long-term potential [34] or, in contrast, it can determine gentrification of the area due to improvement of quality of life quality [35].

Fundraising for brownfield intervention is limited due to the additional risks that characterize these projects with respect to greenfield developments. Issues are related not only to the cost estimate (such as clean-up cost, site preparation, and time for the development process) but also to the revenue forecast for areas that are in decline and that are normally characterized by low volumes of sales [36]. Lenders are normally reluctant to offer loans for brownfield investment, and the loan-to-value offered could be significantly lower than the average amount offered for greenfield projects [37].

Uncertainty related to time and costs for the brownfield recovery process makes the projects less appealing for lenders that would prefer safer real estate investments [38]. The high risk of regeneration projects is frequently unsustainable for private investors (debt holders or equity holders), and public support is necessary to make the financial burden more sustainable [39].

The literature has shown that public financial support may never represent the only solution to support brownfield redevelopment due to the high expenditure related to real estate projects and the large number of potential areas of intervention. The issue is to measure the externalities that may be driven by a successful clean-up process and to identify area features that allow one to maximize the return for the community [40]. Although public investments in brownfield redevelopment may not result in an economic endeavor, they positively affect nearby communities, leading to increased property values that ultimately result in increased tax revenue [41]. Therefore, the capitalization effect produced by the remediation on the housing prices approximates the lower bound of the return for the community [42].

The main incentive for brownfield recovery is always the grant, but in some markets (main cities), a public entity can create an incentive for urban recovery by using a mix of grants and lending instead of offering a full, non-refundable grant, giving rise to the popular public-private partnership contract form [5]. The brownfield refinancing project has localized impacts on the real estate market, affecting market liquidity by modifying the frequency of trades and the gap between appraisal values and housing prices [43].

Empirical evidence on the impact of completed projects on the characteristics of the housing market is still limited, and the paper will test the following research hypothesis:

Hypothesis 1. *Less developed city areas are most likely to benefit from a brownfield recovery financial support program.*

Less developed areas are normally characterized by lower housing prices and worse living conditions, and so the public and private interest in brownfield redevelopment is maximized.

Hypothesis 2. *The volume of house sales is not growing immediately after the brownfield recovery intervention.*

The brownfield intervention determines an increase in average prices, and so until the quality of the services (private and public) provided in the area does not improve, the number of house trades will not change significantly.

Hypothesis 3. *Houses are traded at a lower discount on the appraisal values once the recovery process is complete.*

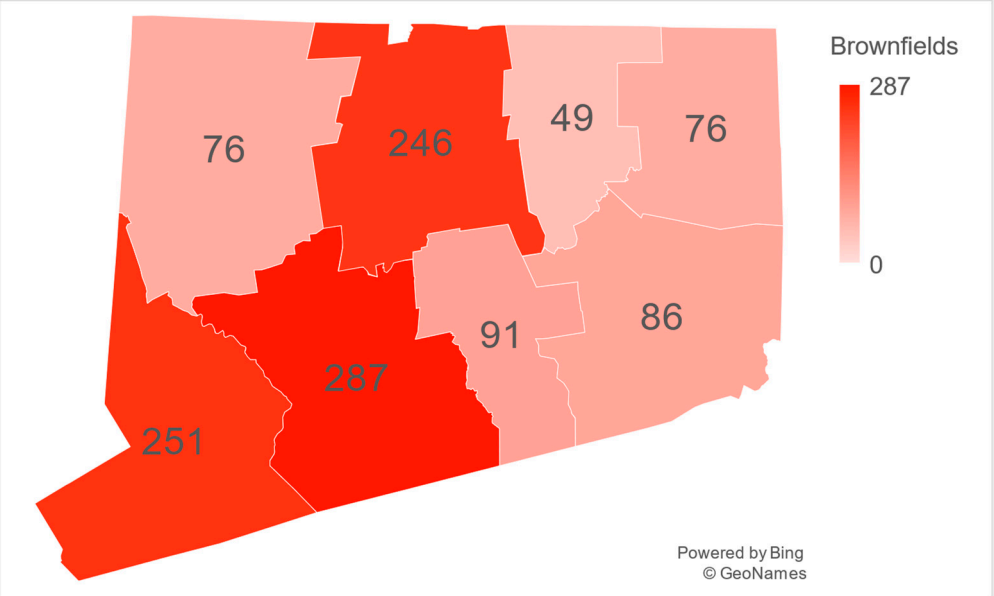
The existence of derelict or abandoned areas does not allow the sale of houses at their appraisal value due to the negative externalities of these assets. Brownfield recovery will increase the quality of life for people living in the surrounding areas, and so the price of the houses for sale will be revised upwards by the landlords.

3. Empirical Analysis

3.1. Sample

At the beginning of the twentieth century, Connecticut was already one of the tenth-most industrialized states in the USA, and the main specialization areas were highly polluting productions (such as brass casting and finishing, shipbuilding, and the iron and steel industry) [44]. During the First and Second World Wars, Connecticut's industries were converted into war productions for all the suppliers necessary for the US Army [45]. As for all the countries characterized by the development of the hard industry, a lot of brownfield sites exist in the area, and the United States Environmental Protection Agency has established a regional office in the area since 1994 [46].

The brownfield area sample was constructed by the Department of Energy and Environmental Protection of Connecticut. The data available allows for identifying for each town in the state the number and address of areas that are classified as brownfields and other contaminated sites in Connecticut. The inventory considers both hazardous waste disposal sites and the comprehensive environmental response compensation and liability information system at the end of 2020 and provides information about the address and the company or individual that started the recovery process (Figure 1).



Source: Connecticut Department of Energy and Environmental Protection data

Figure 1. Brownfield location in Connecticut.

In Connecticut, we have 1347 areas that are classified as brownfields, and the majority of them are in the counties of Fairfield (251), Hartford (246), and New Haven (287), but the brownfield areas are widespread throughout the state, and it is not a phenomenon that matters only for the big cities.

Connecticut has developed several programs for supporting the brownfield recovery process for areas or buildings that, without public financial support, cannot represent a convenient investment opportunity for developers (e.g., [47]). To evaluate the impact of refinancing brownfield recovery, we collected from the Department of Economic and Community Development the data on brownfield assets financed by the state of Connecticut and the percentage of financing (loan or grant) for each project selected for the program (Table 1).

Table 1. Brownfield location in Connecticut.

County	N° of Towns	N° of Towns with Brownfield	Average Percentage Financed by the Special Programs
Fairfield	23	19	15.33%
Hartford	29	18	19.08%
Litchfield	26	17	8.16%
Middlesex	15	15	11.56%
New Haven	27	25	15.92%
New London	21	13	33.92%
Tolland	13	11	13.64%
Windham	15	11	7.38%
Overall	169	129	15.64%

Source: Connecticut Department of Energy and Environmental Protection data.

Brownfield sites are widespread in the state, with 129 towns with at least one contaminated site. The county of Middlesex has no town without brownfield sites. On average, less than 16% of brownfields have access to financial support for redevelopment, with counties

such as New London, Hartford, and New Haven having an above-average percentage of contaminated sites that obtained a grant or loan for the regeneration project.

For each town, data on macroeconomic and social features are collected in order to identify the most relevant characteristics of the social environment of towns with or without brownfields and to highlight the main characteristics of areas that are targets of brownfield redevelopment financing (Table 2).

Table 2. Summary statistics of the characteristics of the macroeconomic and social district classified according to the existence of brownfields.

	Formula	Towns without Brownfields	Towns with Brownfields	Towns with Brownfields Redevelopment
Income	$\frac{Income_{Town_i}}{\frac{1}{n}\sum_{i=1}^{n} Income_{Town_i}}$	0.71 (0.17)	0.65 (0.23)	0.57 ** (0.17)
Population	$\frac{Population_{Town_i}}{\frac{1}{n}\sum_{i=1}^{n} Population_{Town_i}}$	1.00 (1.85)	1.83 (2.00)	2.60 ** (2.41)
Homeownership	$\frac{Homeownership_{Town_i}}{\frac{1}{n}\sum_{i=1}^{n} Homeownership_{Town_i}}$	0.32 (0.07)	0.31 (0.07)	0.31 (0.07)
Housing value	$\frac{Housing\ value_{Town_i}}{\frac{1}{n}\sum_{i=1}^{n} Housing\ value_{Town_i}}$	1.21 (0.42)	1.17 (0.76)	0.98 ** (0.37)
Vacancy rate	$\frac{Vacancy\ rate_{Town_i}}{\frac{1}{n}\sum_{i=1}^{n} Vacancy\ rate_{Town_i}}$	0.14 (0.09)	0.10 (0.07)	0.10 (0.05)
Rent value	$\frac{Rent\ value_{Town_i}}{\frac{1}{n}\sum_{i=1}^{n} Rent\ value_{Town_i}}$	1.12 (0.33)	1.07 (0.26)	1.03 (0.18)
Crime rate	$\frac{Crime\ rate_{Town_i}}{\frac{1}{n}\sum_{i=1}^{n} Crime\ rate_{Town_i}}$	1.00 ** (0.97)	1.54 (1.08)	1.97 ** (1.18)
Housing permits	$\frac{Housing\ permits_{Town_i}}{\frac{1}{n}\sum_{i=1}^{n} Housing\ permits_{Town_i}}$	0.99 ** (1.79)	3.48 (5.92)	4.09 (6.67)

Notes: the table reports average values and standard deviations (in brackets) and the results of a mean comparison test for the subsamples of towns with respect to the full sample (** statistically significant at the 99% level). Source: Census 2010 & 2020 data available at www.ctdata.org.

The simple existence of a brownfield is not associated with a significant impact on the town's socio-economic features, with the exception of the criminality rate and the number of new construction permits that are below average. Conversely, areas that are targeted for brownfield refinancing projects are those with a lower average population income, a higher density of citizens living in the area, a lower percentage of homeownership, and a higher crime rate.

3.2. Methodology

The analysis of the role of financing opportunities for brownfield redevelopment considers the impact of socioeconomic features on the probability of being financed by using the following formula:

$$Financing(D)_i = \alpha + Distance\ from\ CBD_i + \sum_{k=1}^{n} Area_k^i + \varepsilon_i \quad (1)$$

where the dependent variable ($Financing(D)_i$) is a dummy, assuming value one for brownfields financed and zero otherwise.

Since brownfield recovery interventions determine the greatest positive reaction to commercial services [48], the independent variables are the distance from the central business district of the town where the brownfield is located ($Distance\ from\ CBD_i$) and, additionally, a set of socio-economic factors that describe the town are considered [49]. On the basis of the availability of data, the socioeconomic variables are the average income of

citizens, population number, percentage of homeownership, average housing value, the vacancy rate, average rent value, the crime rate, and the number of housing permits. To obtain a comparable value for large and small towns, all data are rescaled on the basis of the average value at the county level. The data analysis is performed using a panel logit regression model, and all the control variables are considered on the basis of the last available census.

The analysis of the subsample of brownfields refinanced allows for the study of the impact on the percentage of different financial supports of the same independent variables plus the value of contribution to brownfield development. In formulas:

$$GTC_{it}(\%) = \alpha + Distance\ from\ CBD_i + \sum_{k=1}^{n} Area_{kt} + Financial\ support_i + \varepsilon_i \quad (2)$$

$$LTC_{it}(\%) = \alpha + Distance\ from\ CBD_i + \sum_{k=1}^{n} Area_{kt} + Financial\ support_i + \varepsilon_i \quad (3)$$

$$FTC_{it}(\%) = \alpha + Distance\ from\ CBD_i + \sum_{k=1}^{n} Area_{kt} + Financial\ support_i + \varepsilon_i \quad (4)$$

where the dependent variables are the percentage of the overall investment necessary for the brownfield re-development financed with a grant $(GTC_i(\%))$, with a loan $(LTC_i(\%))$, or with both the solutions available $(FTC_i(\%))$. The independent variables are the same as used in Equation (1) plus a variable related to the size of the financial support given $(Financial\ support_i)$ and the choice of including the variable related to the size is necessary because some type of brownfield refinancing may be used only up to the maximum amount. The data analysis is performed by using a linear regression model only for the brownfields that were financed, and the control variable values are assigned based on the last census data available before the brownfield recovery project.

The analysis of the impact of brownfield redevelopment on real estate prices is performed considering both the number of housing trades [50] and the gap between prices and appraisal value [49] for each town. In formulas:

$$Sales\ \%_{it+k} = \alpha + \sum_{k=1}^{n} Area_{kt} + Brownfield\ Financing_{it} + \varepsilon_i \quad (5)$$

$$Sales\ ratio_{it+k} = \alpha + \sum_{k=1}^{n} Area_{kt} + Brownfield\ Financing_{it} + \varepsilon_i \quad (6)$$

where the dependent variables are respectively the percentage of sales in the town i with respect to the overall sales in Connecticut $(Sales\ \%_{it+k})$, the yearly growth in the number of sales in the town i, and the average ratio between the appraisal value and the selling price of houses sold in the town i at the time t $(Sales\ ratio_{it+k})$. (Data about the number of sales by town and the ratio between the appraisal value and selling price are provided by the open-access database provided by the State of Connecticut, Office of Policy and Management (https://data.ct.gov/ accessed on 1 June 2023)). The analysis is performed by using a panel linear regression model and by considering the effect in the same year of the brownfield refurbishment ($k = 0$) and in the following two years (k equal to 1 and 2).

The independent variables related to the area $(\sum_{k=1}^{n} Area_{kt})$ are the same as in the previous Equations (1)–(4) but computed year by year over the full time horizon 2010–2020, and the Brownfield financing $(Brownfield\ Financing_{it})$ is a dummy variable assuming value one when at least one brownfield redevelopment project was financed in the town i, in the year t or before.

3.3. Results

The analysis of the refinancing policy of the brownfield areas in Connecticut shows some interesting results about the areas that are more interested in the redevelopment financing support and the type of grant offered (Table 3).

Table 3. Brownfield refinancing and town features.

	$Financing\ (D)_i$	GTC_i (%)	LTC_i (%)	FTC_i (%)
Distance from the CBD	0.01	0.01	0.01	0.01
Income	−1.54 **	0.08	0.56	0.07
Population	0.06 **	−0.01 *	−0.03 *	−0.01 *
Homeownership	0.62 *	0.01 *	0.87 *	0.10
Crime Rate	0.11 *	−0.01	−0.01	−0.02
Housing Value	−0.09 *	−0.06 *	−0.10 *	−0.02
Vacancy rate	−0.75 *	−0.37 *	−1.04 *	−0.07 *
Rent Value	0.21	−0.11	−0.14	0.06
Housing permits	−0.03 **	−0.06	−0.01	0.01
Financial support	-	−0.02 *	−0.14 **	−0.17 **
Constant	−0.53	0.24 *	0.28 **	2.94 **
Pseudo R^2	10.48%	28.55%	33.52%	22.09%
N° Observations	1347	291	291	291

Notes: ** statistically significant at the 99% and * statistically significant at the 95% level. Source: Census 2010 and 2020 data and Connecticut Department of Energy and Environmental Protection data processed by the authors.

Brownfield refinancing does not target the central areas of the city, where market-based financing solutions may normally represent an economically reasonable solution available for redevelopment projects. The areas that are more interesting for this type of project are those with lower incomes, a higher density of population, a higher incidence of homeowners, and a higher crime rate. Markets where brownfield redevelopment projects are financed more frequently are those in which the value of housing, the vacancy rate, and the number of housing permits are lower.

When considering the type of financial support, the main drivers of the grant and the loan amount are the population, the percentage of homeownership, the value of the home, the rate of vacancy, and the overall amount of the contribution. Data show that the percentage of grants and loans is lower when the population is higher, homeownership is higher, the value of the home is lower, and the vacancy rate is lower. The percentage of support given by the brownfield refinancing program is normally larger for towns that are overcrowded, where the house renting market is residual, the value of the real estate investment is not high, and there is not an excessive supply of housing units already vacant in the market. Furthermore, independently of the town considered, the larger the financial support requested, the lower the weight on the overall resources necessary for the project.

The analysis of the sales trend before and after brownfield refinancing shows some interesting differences among the proxy variable related to sale concentration $(Sales\ \%_{it})$, and the ratio between selling price and appraisal value $(Sales\ ratio_{it})$ (Table 4).

After brownfield refinancing, the concentration of sales in one town with respect to the overall market is decreasing, showing a higher interest in areas that were considered not appealing before the requalification project, and the average price is significantly increased for all houses in the area, even if there are significant differences town-by-town that confirm the localized effects of brownfield redevelopment [13]. On average, appraisal values are revised upwards after the brownfield recovery, and so the selling price is better proxied by the expert valuation. The evidence related to the price dynamics is coherent with other evidence related to the US [51] and European [52] markets that showed that the proximity to brownfield areas affects negatively the price of the houses in the nearby areas until the area is refurbished.

The analysis of the sales proxies for the sample shows some interesting results related to the brownfield refinancing project that allow one to evaluate more effectively the impact

of positive externalities related to the requalification project for all houses in the same town (Table 5).

Table 4. Summary statistics of sales proxies.

	$Sales\ \%_{it}$		$Sales\ Ratio_{it}$	
	Before Brownfield Refinancing	**After Brownfield Refinancing**	**Before Brownfield Refinancing**	**After Brownfield Refinancing**
Average	0.87%	0.55%	89.89%	96.29%
St. Dev.	0.73%	0.59%	18.16%	17.58%
Minimum	0.05%	0.00%	18.16%	17.58%
Maximum	3.97%	4.11%	167.08%	220.36%

Source: Census 2010–2020 data and Connecticut Department of Energy and Environmental Protection data processed by the authors.

Table 5. Brownfield refinancing and the impact on housing sales.

	$Sales\ \%_{it}$			$Sales\ Ratio_{it}$		
	t + 0	**t + 1**	**t + 2**	**t + 0**	**t + 1**	**t + 2**
$Income_{it}$	0.00	0.00	0.00	−0.32 **	−0.36 **	−0.34 *
$Population_{it}$	0.00 **	0.00 **	0.00 **	0.01 **	0.01 **	0.01 **
$Homeownership_{it}$	−0.01 **	−0.01 **	−0.01 **	0.42 **	0.50 **	0.48 **
$Crime\ rate_{it}$	0.01 **	0.01 **	0.01 **	−0.04 **	−0.04 **	−0.04 **
$Housing\ value_{it}$	0.03	0.01	0.01	0.03 **	0.03 *	0.02
Vacancy rate	0.01	0.01	0.01	0.38 **	0.33 **	0.34 **
$Rent\ value_{it}$	0.01	0.01	0.01	0.00	0.00	0.00
$Housing\ permits_{it}$	0.01 **	0.01 **	0.01 **	−0.00 **	−0.00 **	−0.00 **
$Brownfield\ financing_{it}$	−0.01 **	−0.01 **	−0.01 **	0.02 **	0.07 **	0.07 **
Constant	0.01 *	0.01 *	0.01	0.82 **	1.01 **	1.01 **
Pseudo R^2	0.75	0.76	0.76	0.21	0.11	0.11
Fixed effects for the town	☑	☑	☑	☑	☑	☑
Fixed effects per year per year	☑	☑	☑	☑	☑	☑
N° towns	169	169	169	169	169	169
N° Observations	2197	2018	1849	2197	2018	1849

Notes: ** statistically significant at the 99% and * statistically significant at the 95% level. Source: Census 2010–2020 data and Connecticut Department of Energy and Environmental Protection data processed by the authors.

Areas that are increasing the volume of sales are those with higher population density, lower homeownership, and a higher crime rate, for which the frequency of new construction permits is higher, and so new houses will be available in the market year-by-year. Financing brownfield regeneration projects decreases the frequency of new trade because the average price of houses in the surrounding areas increases [28,31]. Brownfield regeneration process impacts on the volume of sales are persistent over time, even after two years from the completion of the real estate project.

Looking at the ratio between appraisal values and selling prices, the areas that have values more coherent with the expert valuation (values close to one) are highlighted by lower income, higher population density, a higher percentage of homeownership, and a lower crime rate. In addition, normally, the house value is higher, the vacancy rate is higher, and the number of new construction permits is below the average of the market.

The choice to finance a brownfield redevelopment has a positive impact on the sales ratio and increases the number of house trades at prices similar to or higher than the appraisal estimate, ensuring consistency in the process of valuation [53]. The impact on the price-to-appraisal ratio after one or two years from the brownfield regeneration is even stronger than in the year when the refurbishment was completed.

4. Conclusions

Brownfield represents a unique opportunity to make land use flexible [26], but such flexibility comes at costs and risks related to the clean-up process, representing a significant disincentive to invest in the area and inducing developers to prefer greenfield projects [9]. Through public financial support, investors can be attracted by a not otherwise economically sustainable initiative, and developers can apply their know-how in redeveloping a land, determining multiple-level benefits for different stakeholder categories [54].

The benefits following brownfield redevelopment justify the public financial support received by those programs over years in many countries, but the features of the brownfield area affect the public finance support and the achieved results on the real estate market depending on the type of facility selected to finance the program (grant, loan, or both). Looking at Connecticut brownfields, areas that are the target for refinancing support are those with a lower average population income, a higher density of citizens living in the area, a lower percentage of homeownership, a higher crime rate, and a depressed housing market. When it comes to the type of financial support, the main drivers of the grant and the loan amount are the population, the percentage of homeownership, the value of the house, the vacancy rate, and the total amount of financial support. Additionally, it appears that a substitution effect between public and private funds holds because the larger the financial support requested, the lower the weight on the overall resources necessary for the project. The impact of the financial program on the real estate market trades determines a lower concentration because of a wider urban area to satisfy housing demand, and the average price is increased in the surrounding area, even though local effects emerge. Lastly, financially supporting redevelopment refinancing favors the consistency between market prices and expert valuation.

Empirical evidence is focused on a developed market in which the price and volume of trades may react better to a brownfield recovery due to the higher demand for houses in the area. Literature has already shown that developing countries and markets behave differently on this issue [55], and the results cannot be generalized to small markets on a worldwide scale. Moreover, the analysis is focused only on residential real estate and does not consider the spillover effect that may happen in commercial real estate (e.g., [56]), especially for the retail sector that is servicing new citizens that will live in the area.

The results obtained contribute to the understanding of the financing determinants of brownfield redevelopment intended to reduce urban sprawl [57]; nonetheless, the increase in the prices of the houses close to the re-developed area raises the issue of gentrification [45]. Results could be useful to evaluate opportunities related to regeneration projects in brownfield areas, and this evidence will be even more important in EU countries and other historical countries in which millions of brownfield areas are still to be recovered. Government budgets do not allow the recovery process for more than a few thousand projects by country [58], and it is necessary to prioritize intervention in areas that will maximize the benefits for the population and homeowners.

The increasing attention to the ESG principles by investors and regulators points out that the housing supply cannot be based only on greenfield projects, and a lot of local administrations are currently applying density constraints and reducing the number of new construction permits [59]. The development of green mortgages will represent, in the near future, a solution for making the regeneration projects of brownfield areas more affordable, and the analysis provided may represent a useful benchmark for prioritizing the area of interest for private special loans [60].

Future research developments concern delving into the relationship between the public financial program and the affordability of the housing market after the redevelopment [61]. More detailed datasets on the building features and transaction data will allow identifying houses' and owners' features that matter the most in accessing the financial support program.

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