Decision Support for Property Intervention

Rehab Impacts in Greater Cleveland 2009 – 2015

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Cleveland Neighborhood Progress

investing for vibrancy

Visit **rehabimpact.com** to download the report and use the mapping tool to interact with results.

Acknowledgements

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Executive Summary

In 2013, U.S. Treasury authorized select states to use their Hardest Hit Fund allocations to eliminate blight through demolition. U.S. Treasury authorized demolition of blight because research established that it protects home values and preserves homeownership. Now, Cleveland Neighborhood Progress has asked us to investigate whether blight elimination through housing rehabilitation (rehab) also protects home values and preserves homeownership. Does rehabbing vacant and foreclosed properties increase surrounding property values? Is rehabbing associated with a lowering of mortgage foreclosure rates? These are the questions this study asks.

We estimate that 1,081 programmatic rehabs completed between 2009 and 2015 in Cuyahoga County preserved or increased just over half a billion dollars - $539,318,308 – in the values of surrounding homes. This averages out to $498,907 of property value impact per rehab. Rehab impacts vary by submarket, with weaker submarkets realizing less impact per rehab, and stronger submarkets more. The rehabs nevertheless show positive impacts in every submarket studied.

We also found that the occurrence of programmatic rehabs was strongly associated with faster declines in mortgage foreclosure rates over time. The relationship between rehabs and faster mortgage foreclosure rate declines over time is significant in all submarkets. This suggests that rehab is a significant determinant in the lowering of mortgage foreclosure rates.

The following sections explain our results in greater detail. The full report offers in-depth analysis and explanation. But first it is important to note what this study does not cover. This study does not measure the change in value of the rehabbed properties themselves. This study also does not calculate the impacts of the rehabs on property tax collection. This study does not compare the relative merits of rehab versus demolition in eliminating blight, preserving value, and growing the property tax base. This study does not measure the impacts of rehab on other, important factors of community well-being, such as crime rates, tenure, feelings of community well-being, etc. These are all worthwhile topics of investigation. This study is simply not designed to address those topics, although the property value impact spreads and other statistics in the full study may be helpful in addressing those questions.

Executive Summary (cont.)

PROPERTY VALUE IMPACTS FROM REHAB

The table below provides our estimates of the property value impacts caused by programmatic rehabilitation. Results are broken out by housing submarket. The submarkets are those areas of the county where rehabs occurred, and, additionally, areas similar to areas where rehab occurred. On the left the four submarkets are identified: Stressed Rental Areas, Special Rental Areas, Moderately Functioning Ownership Areas, and Higher Functioning Ownership Areas. "Rehab Count" shows a count of rehabs that occurred within each submarket during the 2009-2015 study period.

Table 1: How Much a Rehab Impacts Housing Values within 500 Feet, by Submarket

Submarket	Rehab Count	Property Value Impact	Avg. Impact Per Rehab
Stressed Rental Areas	247	$1,746,543	$7,071
Special Rental Areas	157	$106,098,226	$675,785
Moderately Functioning Ownership Areas	533	$267,380,189	$501,651
Higher Functioning Ownership Areas	144	$164,093,351	$1,139,537
TOTAL	**1,081**	**$539,318,308**	**$498,907**

"Property Value Impact" shows the sum total of positive value impacts rehabs had on houses within 500 feet of them in each submarket. Our study does not measure the value increase enjoyed by the rehabbed properties themselves; we only measure the impacts on properties near the rehabs. Then "Property Value Impact" is divided by Rehab Count to show the average impact of each rehab on the houses near it.

To determine these estimates, we used hedonic modeling. Hedonic modeling is used in the real estate industry to determine how the features of a home – number of bedrooms and bathrooms, square footage, age, etc. – impact the property value. Our modeling approach takes it further by determining, for example, how much less a home is worth if a vacant and tax-foreclosed house is within 500 feet of it. We also determine how much more that home is worth for each renter or owner-occupied, tax-current house within 500 feet. We then measure the difference, or "property value impact spread," between having the vacant house and the occupied house nearby. So, for example, if a nearby vacant house has a -1% impact on the home's value, and a nearby occupied house has a +1% impact, then the property impact spread is +2%. The table below shows the "before" and "after" spreads achieved through the rehabs.

Table 2: How Much a House's Value Changes When a Rehab Occurs within 500 Feet, By Transformation Type

Rehab Before and After Status	Stressed Rental Areas	Special Rental Areas	Moderately Functioning Ownership Areas	Higher Functioning Ownership Areas
Vacant Mortgage Foreclosure Becomes Owner Occupied Tax Current	0.46%	2.72%	2.06%	2.81%
Vacant Mortgage Foreclosure Becomes Renter Occupied Tax Current	0.00%	2.72%	1.54%	2.34%
Vacant Mortgage Foreclosure Becomes Vacant Tax Current	0.00%	1.02%	1.33%	0.53%
Land Bank Owned Becomes Owner Occupied Tax Current	0.46%	10.16%	6.07%	11.09%
Land Bank Owned Becomes Renter Occupied Tax Current	0.00%	10.16%	5.55%	10.63%
Land Bank Owned Becomes Vacant Tax Current	0.00%	8.46%	5.34%	8.82%
Land Bank Owned Becomes Owner Occupied Tax Delinquent	-0.98%	7.46%	3.61%	10.94%
Land Bank Owned Becomes Vacant Tax Delinquent	-0.48%	5.84%	3.21%	5.28%

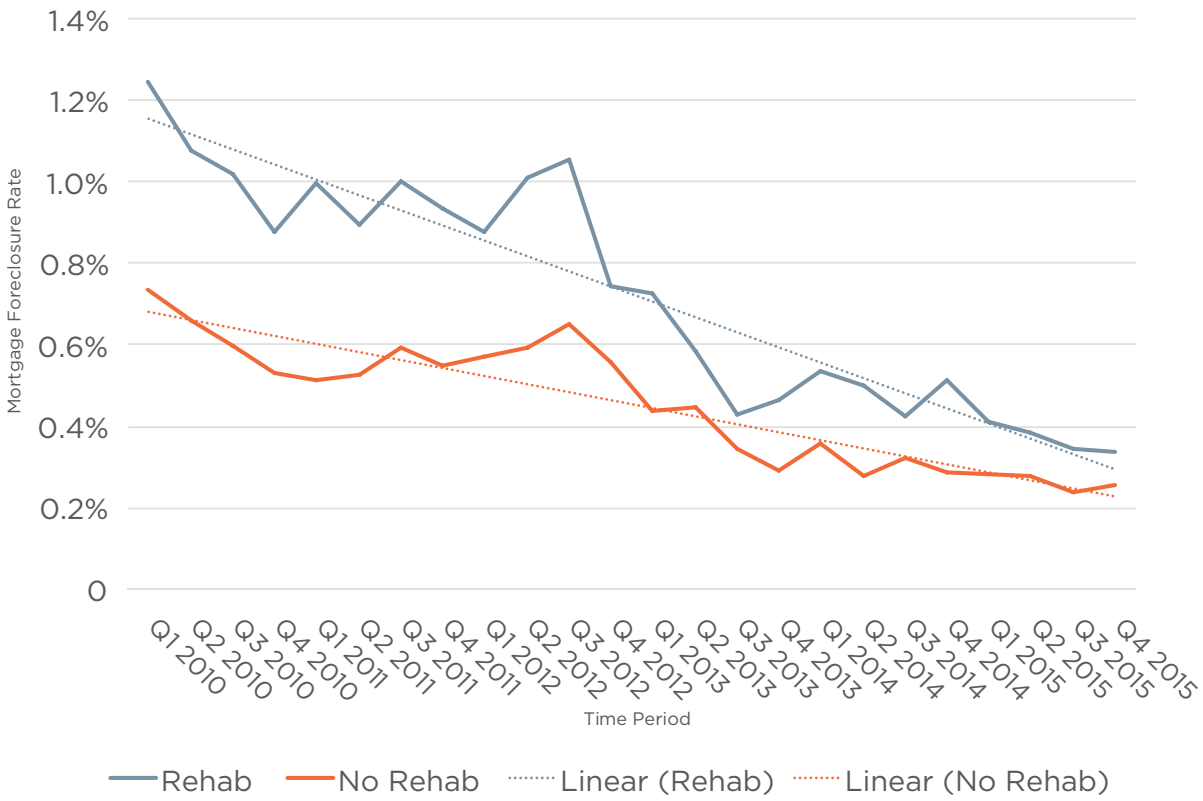
Executive Summary (cont.)

Now, what does a rehab do? As suggested in this table, a rehab usually but not always transforms a vacant, abandoned house into an occupied and tax-current home. Each type of transformation has an associated change in value for all the homes within 500 feet. We applied the appropriate value changes for all of the houses surrounding each of the 1,081 rehabs. The resulting sum is $539,318,308. This the estimated overall impact of all the rehabs on their nearby properties, and is expressed as "Property Value Impact."

REHAB AND MORTGAGE FORECLOSURE RATES

The chart below visualizes the results of a comparative trends analysis. We compared the mortgage foreclosure rates in areas with rehabs to the mortgage foreclosure rates in areas without rehabs. The trend shows that the rates of mortgage foreclosure are declining everywhere, but are declining faster in areas with rehabs. We ran a statistical test to make sure that this visualization reflects reality. It does. This visualization suggests, but does not prove, that the occurrence of rehabs has a relationship with faster declining mortgage foreclosure rates.

Chart 1: Mortgage Foreclosure Rates Over Time in All Submarket Areas Combined



As the executive summary above highlights, property value impacts caused by rehab vary by submarket, with weaker submarkets realizing less impact per rehab, and stronger submarkets more. Further, the relationship between rehabs and faster mortgage foreclosure rate declines over time is significant in all submarkets, suggesting that rehab is a determinant in lowering mortgage foreclosure rates. This study therefore finds that rehab protects home values and preserves homeownership in the Greater Cleveland study area.

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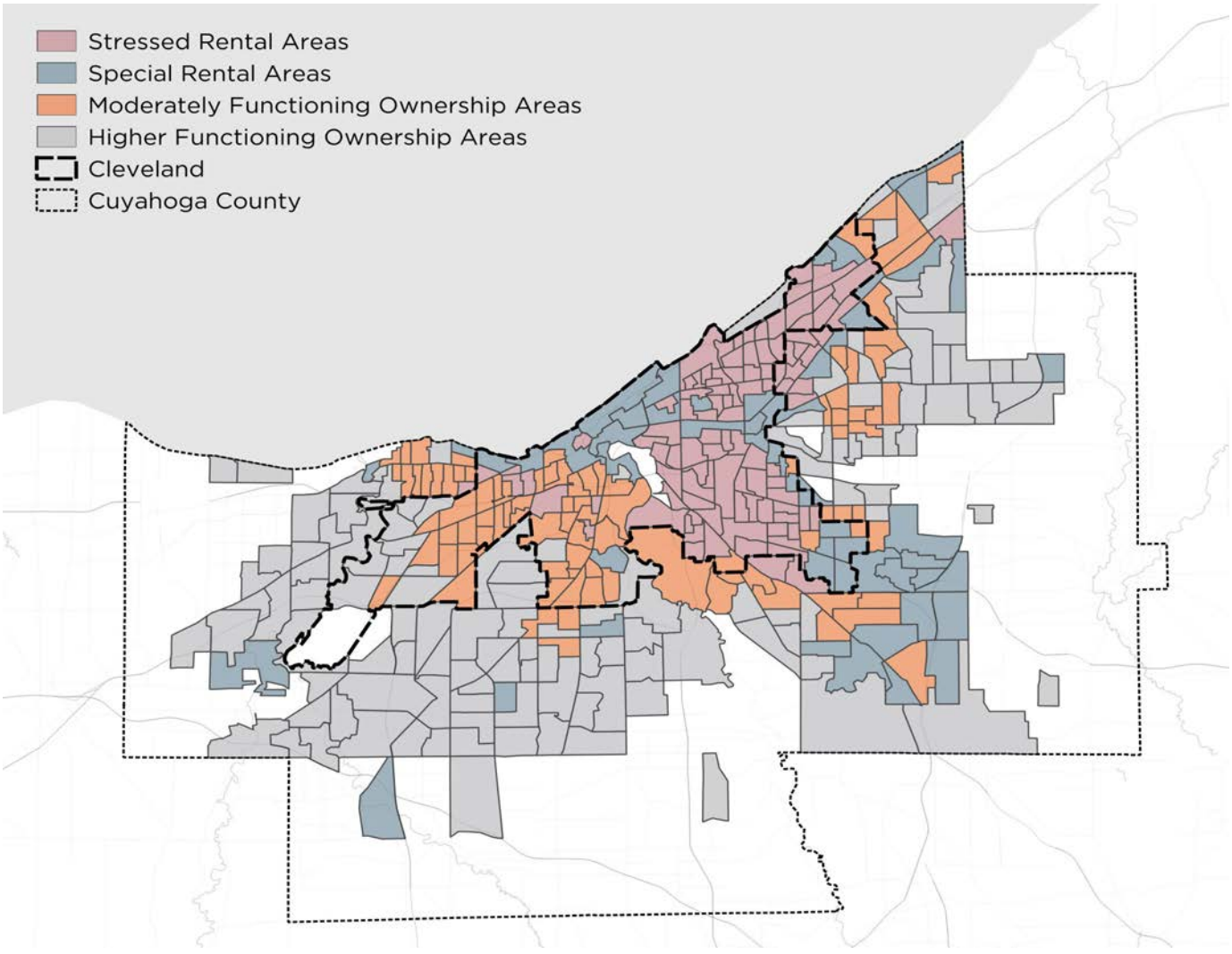
Display of findings

In 2013, U.S. Treasury authorized select states to use their Hardest Hit Fund allocations to eliminate blight through demolition[i]. U.S. Treasury authorized demolition of blight because research established that it protects home values and preserves homeownership[ii]. Now, Cleveland Neighborhood Progress has asked us to investigate whether blight elimination through housing rehabilitation also protects home values and preserves homeownership.

This study estimates that 1,081 programmatic rehabs completed between 2009 and 2015 in Cuyahoga County preserved or increased just over half a billion dollars - $539,318,308 – of surrounding home value. This averages out to $498,907 of property value impact per rehab. This study also finds that neighborhoods with rehabs occurring in them experienced mortgage foreclosure rates that declined faster over time compared to neighborhoods where no rehabs took place.

The rehab impacts are displayed below for the entire study area and for each of the four submarkets. Neighborhoods are grouped into four housing submarkets to identify the varying impacts of rehabilitations in different types of residential areas. The submarkets are shown in Map 1 and described on page 22 of this study.

Map 1: Greater Cleveland Study Area by Housing Submarket



Rehab Programs

• **Slavic Village Recovery Partnership** (28 rehabs) is a collaborative effort between two large for-profits, RIK Enterprises and Forest City Development, and two much smaller non-profits, Cleveland Neighborhood Progress and Slavic Village Development. It is a for-profit rehab model. It is focused in a 524-acre target area within the Slavic Village neighborhood, and has a goal of restarting the stagnant housing market in one of Cleveland's, and the country's, hardest hit neighborhoods. The SVRP model anticipates an average of $50,000 - $60,000 in hard cost for rehab (including acquisition), and sales prices averaging $65,000-$75,000. The finished products are attractive, modest rehabs, often with several major mechanicals being replaced, but are not full gut rehabs.

• **The Cuyahoga Land Bank Deed-In-Escrow (CLB)** (548 rehabs) program is designed to facilitate the acquisition, renovation and sale of properties to small rehabbers or homeowners, who may not have an extensive history of home renovation but nevertheless demonstrate the ability and resources to meet program goals and objectives. All purchasers are obligated to renovate the properties according to mutually agreed-upon standards and specifications. Purchasers are screened to ensure that they are neither tax-delinquent or chronic building code offenders. To assure compliance with The Cuyahoga Land Bank's minimum renovation standards, the deed to a property will be held in escrow by the land bank until the renovation is satisfactorily completed. The rehab is paid for by the rehabber, not the land bank. Once an official certificate of occupancy (or equivalent) is secured by the rehabber from the municipality, the deed is delivered to the buyer as the buyer pays the agreed-upon price, averaging about $7,000.

• After acquiring a property through tax foreclosure or other means, sometimes **The Cuyahoga Land Bank** decides to act as the rehabber itself through its **In-house Renovation and Resale** (40 rehabs) program. It completes the rehab in-house by developing a rehab plan, selecting qualified contractors, and overseeing the rehab to completion. Once the renovations are complete, the property is listed and sold on the open market.

• For many years **Community Development Corporations** (276 rehabs) have rehabbed houses in Cleveland. Community Development Corporations (CDCs) have various property acquisition methods. CDCs also have various ways to manage or fund the rehab of houses. Breaking out these various ways of effectuating rehab is beyond the scope of this study. We presume that some CDC rehabs resemble land bank deed-in-escrow transactions, while others may involve significant expenditures of public or private money. The CDC rehabs observed in this study are limited to properties that the CDCs acquired title to from the Cuyahoga Land Bank.

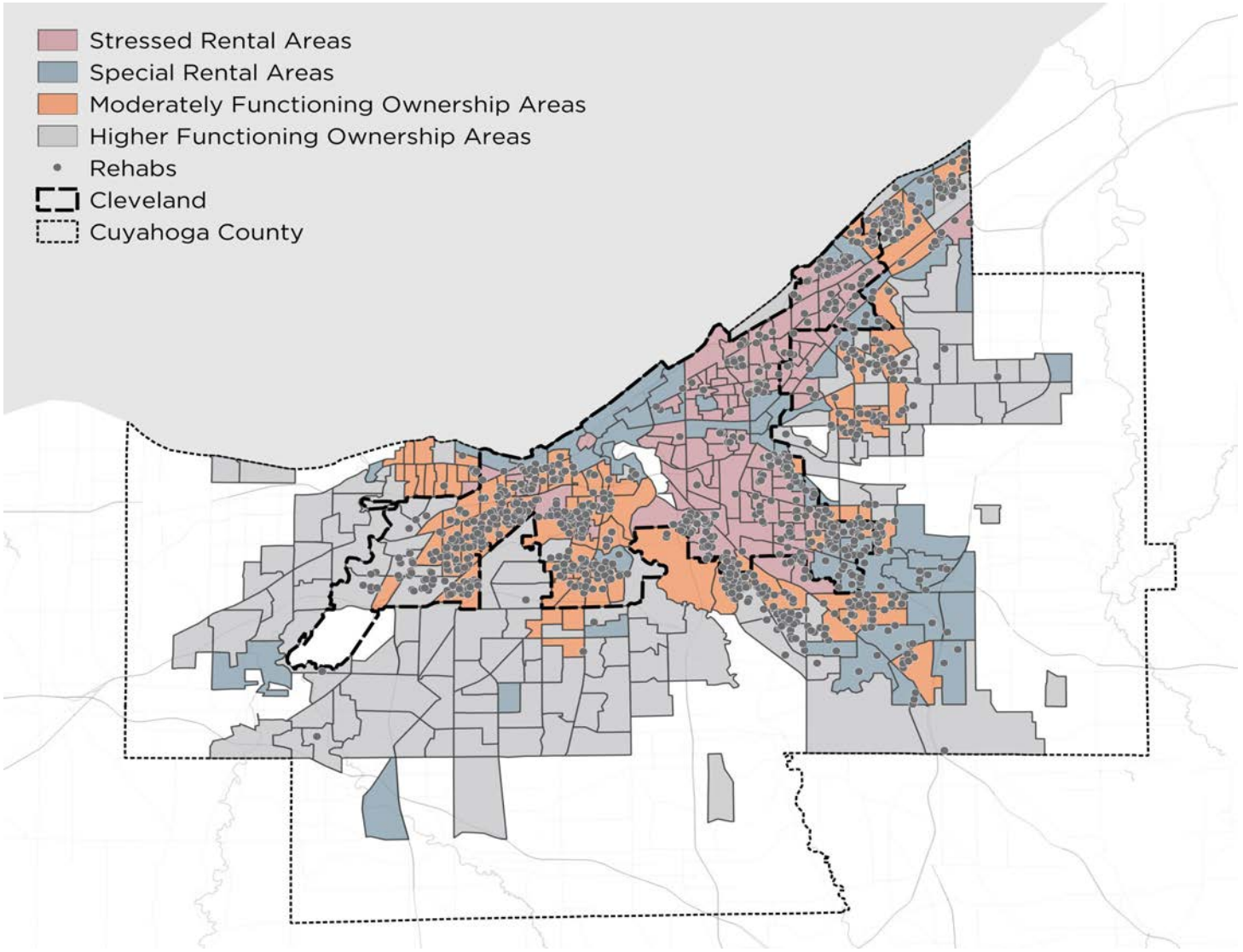
• **Opportunity Homes** (58 rehabs) was a collaborative effort between the Cleveland Housing Network and Cleveland Neighborhood Progress to do strategic rehab of vacant and abandoned homes, with a focus on bank-owned properties. It had six target areas in six neighborhoods on the east and west sides of Cleveland. Opportunity Homes focused on the strongest blocks in the target neighborhoods. Opportunity Homes was the federal government's primary housing-related response to the foreclosure crisis. The rehab activity was coordinated alongside strategic demolitions and vacant land reuse. A variety of funding sources were utilized for rehab, primarily Neighborhood Stabilization Fund (NSP) allocations.

• As mentioned above, **Neighborhood Stabilization Fund (NSP)** (60 rehabs) has been a response of the federal government to the foreclosure crisis. In this study we grouped together 60 rehabs that used NSP funds. It is also important to note that other rehabs, included in the programs above, may have used NSP funds, too.

• **Other** (71 rehabs) rehabs include municipal rehabs, and other forms of Cuyahoga Land Bank transfers involving rehabs, including direct transfers and transfers to entities assisting veterans and refugees.

Rehab Impacts in Greater Cleveland

Map 2: Greater Cleveland Study Area with Rehab Locations Identified by Submarket



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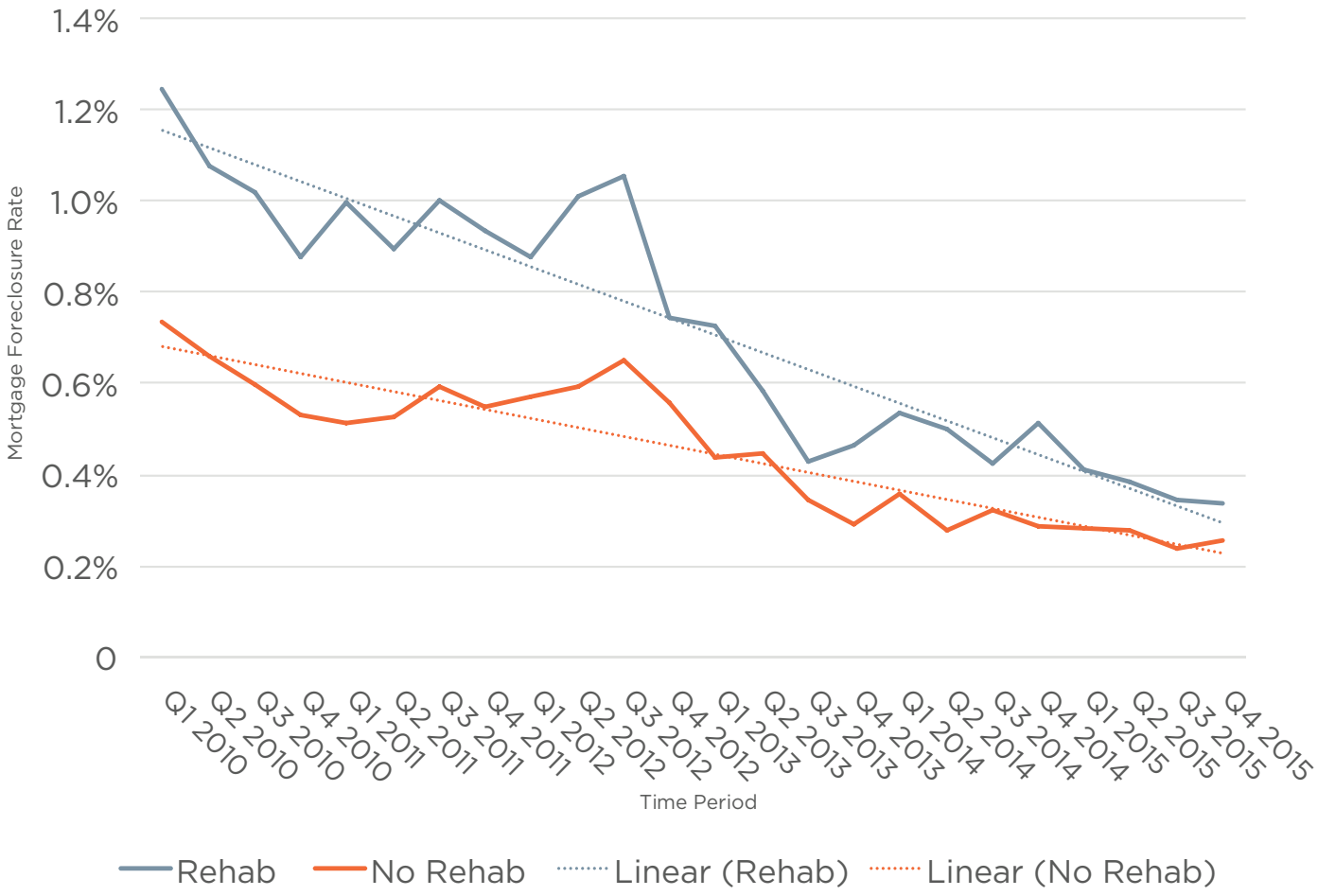
Rehab Impacts in Greater Cleveland

Chart 1: Mortgage Foreclosure Rates Over Time in All Submarket Areas Combined



Rehab Impacts in Stressed Rental Areas

Map 3: Stressed Rental Areas with Rehab Locations Identified

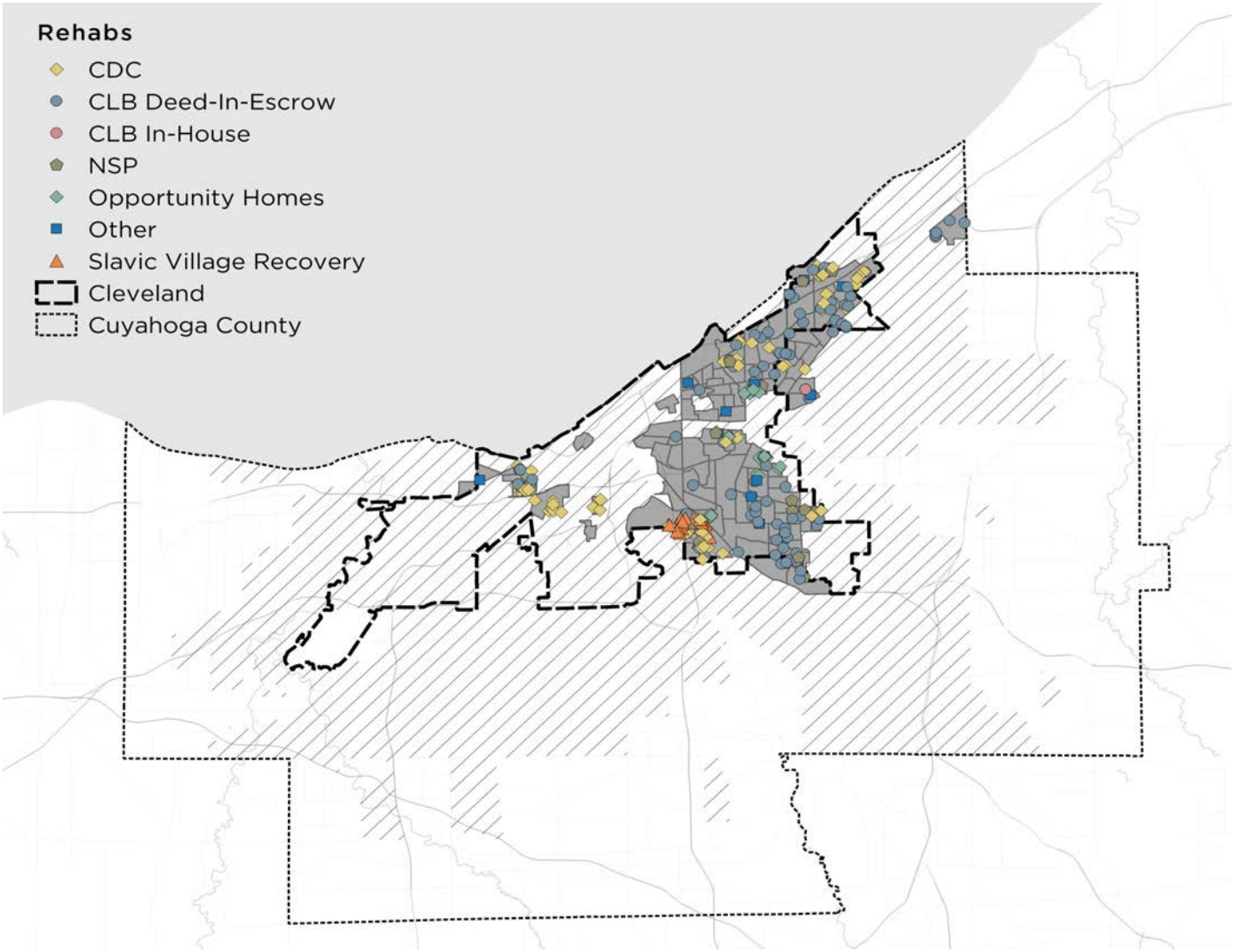
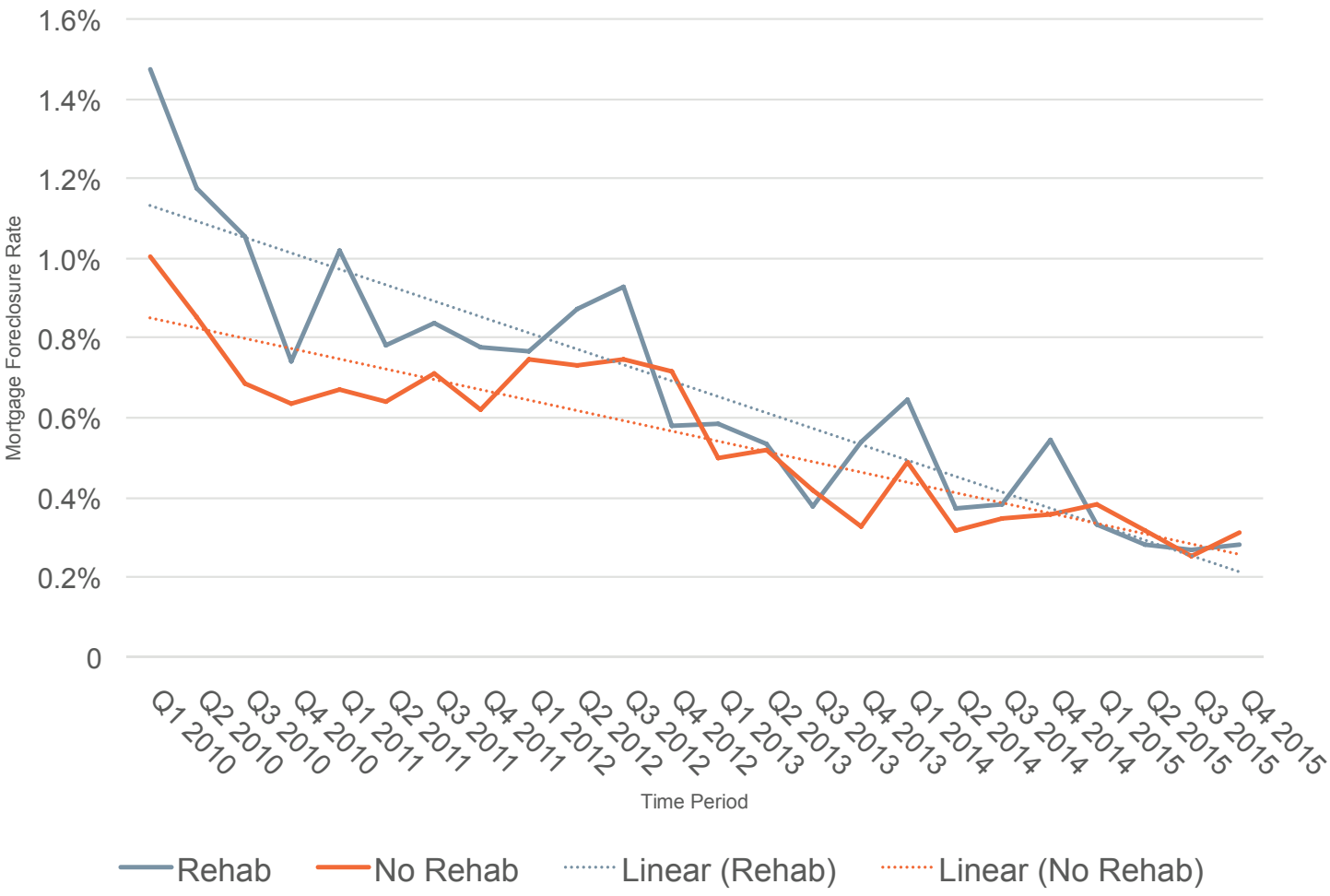


Table 3: Rehab Property Value Impacts by Program in Stressed Rental Areas

Submarket	Program Name	Rehab Count	Property Value Impact	Avg. Impact Per Rehab
Stressed Rental Areas	Slavic Village Recovery	28	$221,399	$7,907
	Cuyahoga Land Bank Deed-In-Escrow	83	$194,629	$2,345
	Cuyahoga Land Bank In-House	2	$0	$0
	CDC	70	$451,399	$6,449
	Opportunity Homes	32	$612,257	$19,133
	NSP	19	$181,846	$9,571
	Other	13	$85,012	$6,539
	TOTAL	**247**	**$1,746,543**	**$7,071**

Rehab Impacts in Stressed Rental Areas

Chart 2: Mortgage Foreclosure Rates Over Time in Stressed Rental Areas



Rehab Impacts in Special Rental Areas

Map 4: Special Rental Areas with Rehab Locations Identified

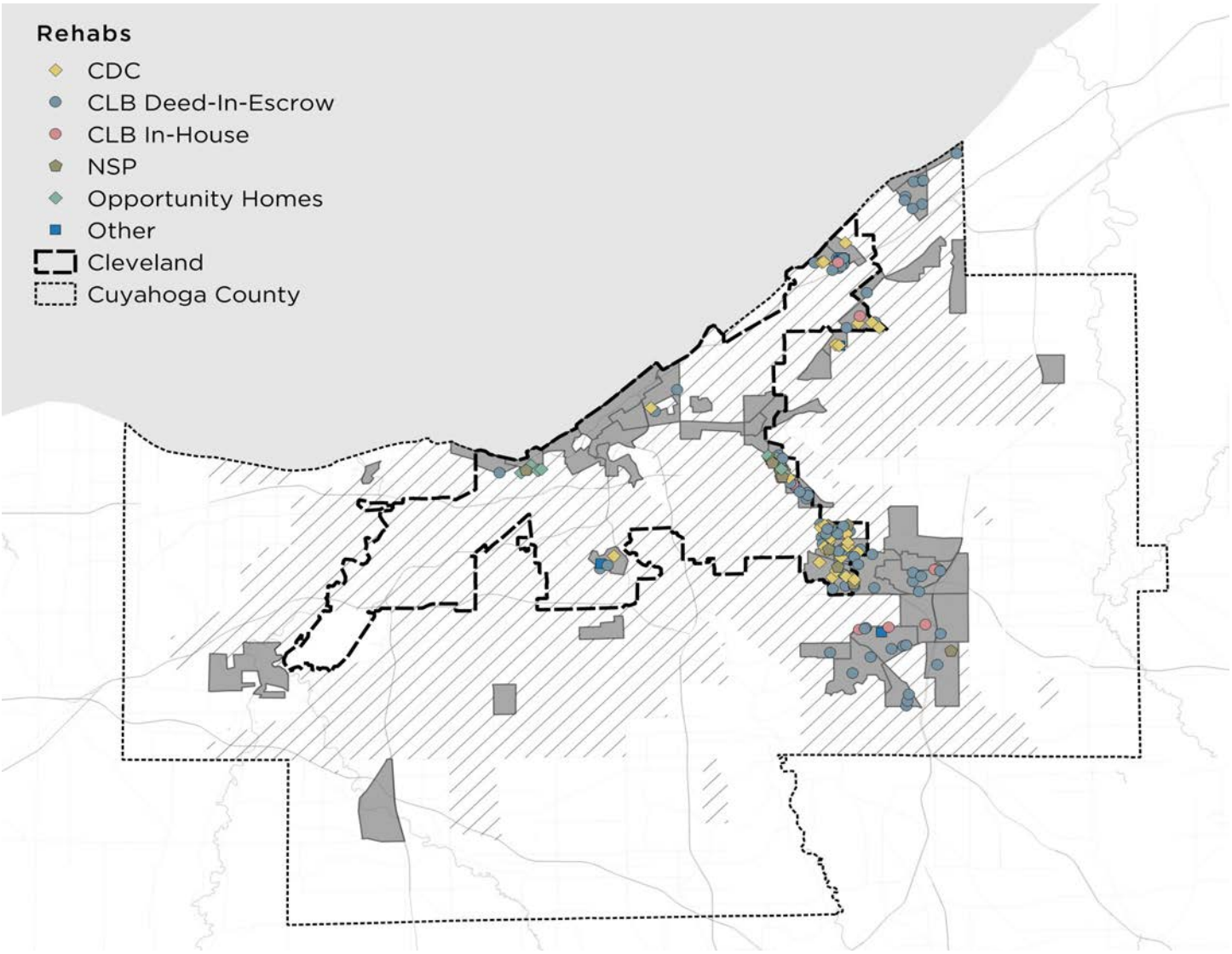
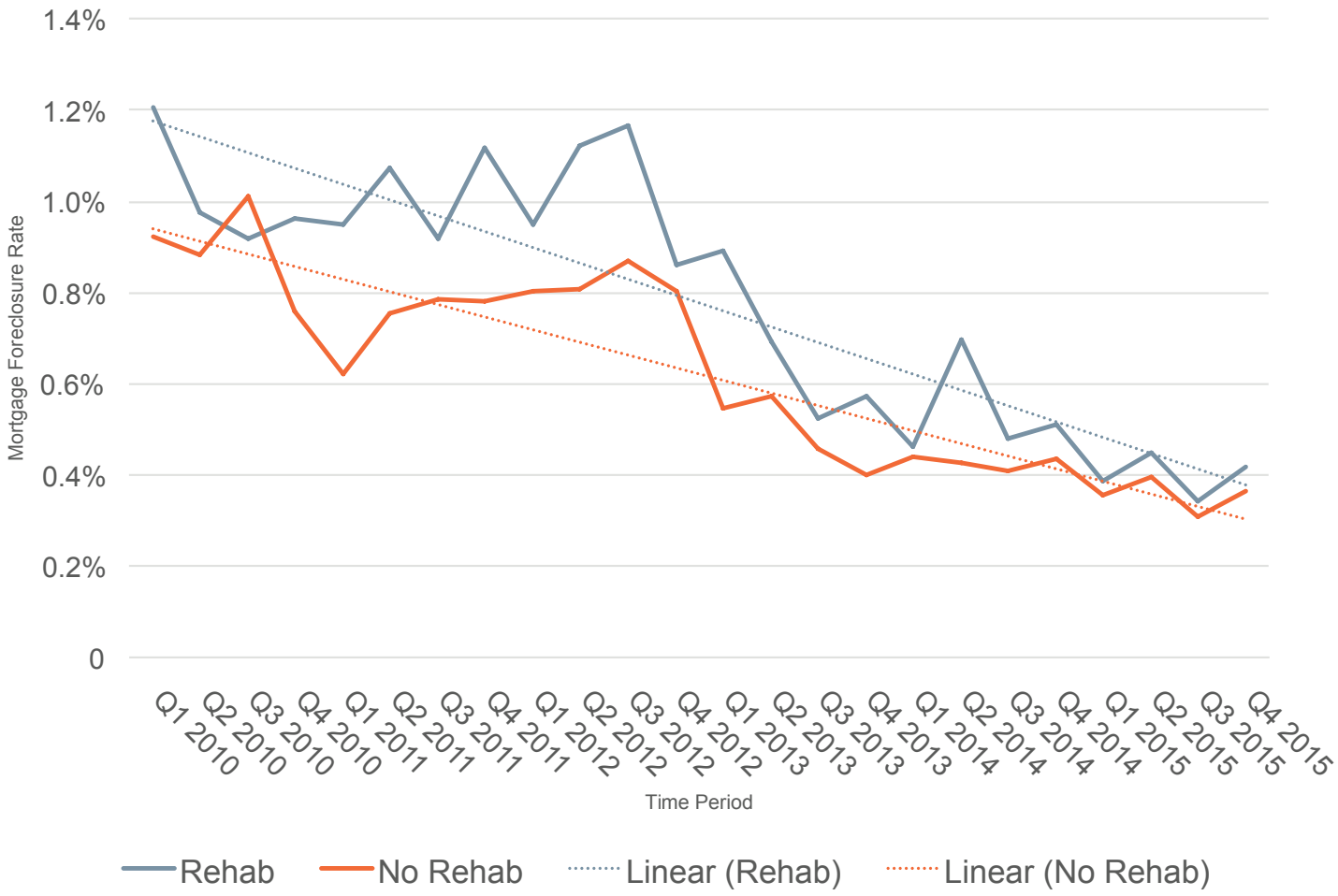


Table 4: Rehab Property Value Impacts by Program in Special Rental Areas

Submarket	Program Name	Rehab Count	Property Value Impact	Avg. Impact Per Rehab
Special Rental Areas	Cuyahoga Land Bank Deed-In-Escrow	77	$55,681,749	$723,140
	Cuyahoga Land Bank In-House	8	$6,362,601	$795,325
	CDC	33	$23,322,176	$706,733
	Opportunity Homes	19	$4,941,346	$260,071
	NSP	14	$11,107,811	$793,415
	Other	6	$4,682,542	$780,424
	TOTAL	**157**	**$106,098,226**	**$675,785**

Rehab Impacts in Special Rental Areas

Chart 3: Mortgage Foreclosure Rates Over Time in Special Rental Areas



Rehab Impacts in Moderately Functioning Ownership Areas

Map 5: Moderately Functioning Ownership Areas with Rehab Locations Identified

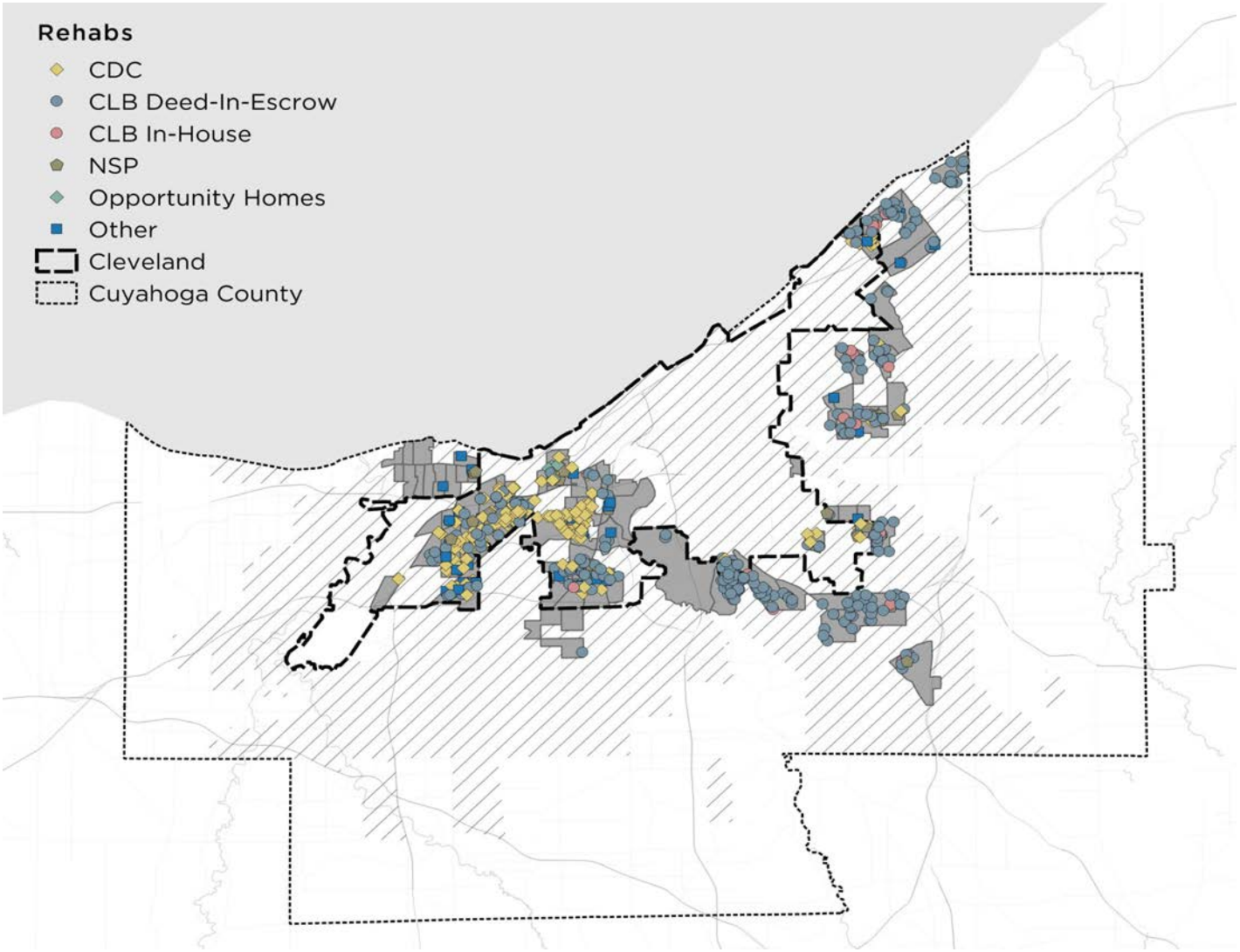
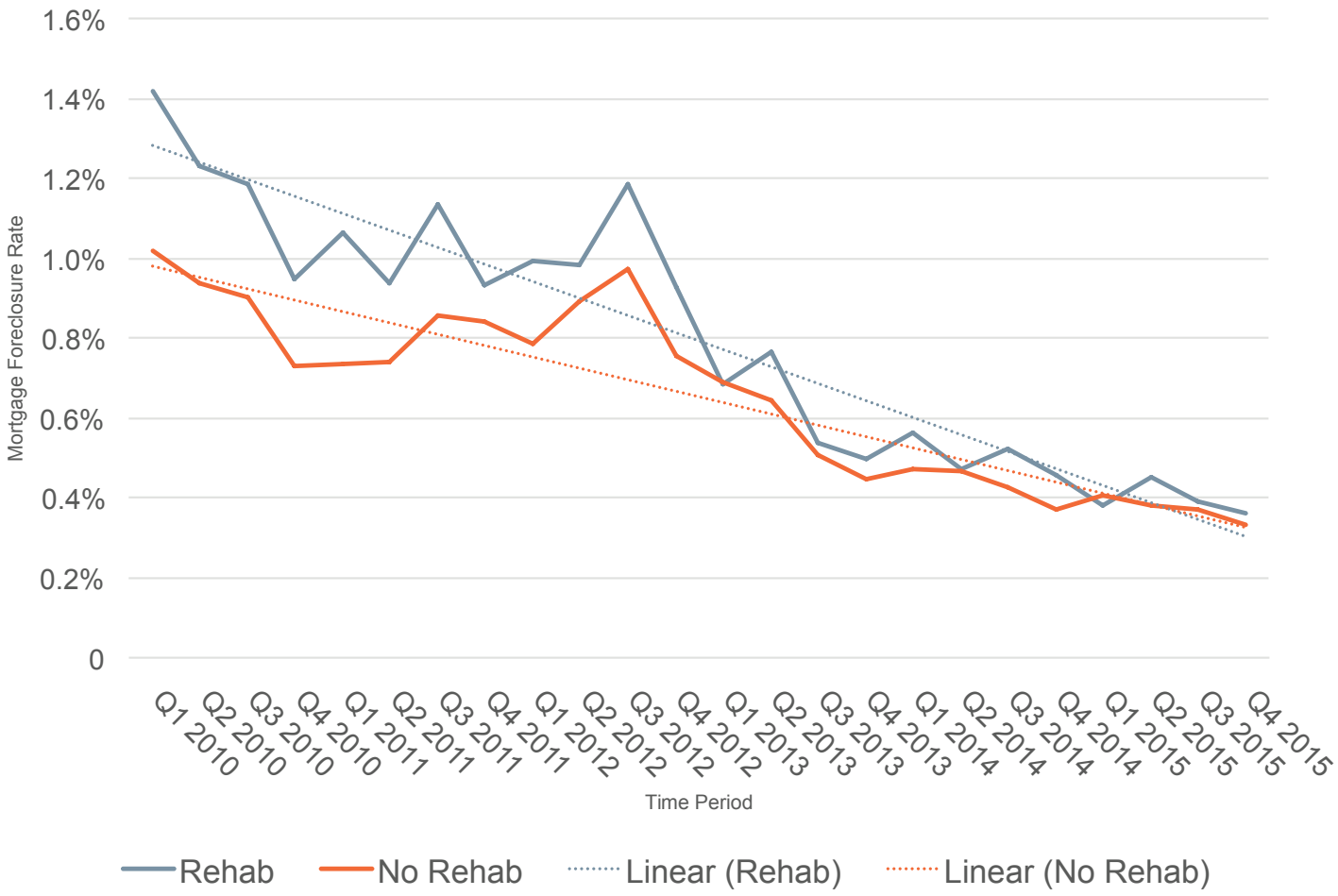


Table 5: Rehab Property Value Impacts by Program in Moderately Functioning Ownership Areas

Submarket	Program Name	Rehab Count	Property Value Impact	Avg. Impact Per Rehab
Moderately Functioning Ownership Areas	Cuyahoga Land Bank Deed-In-Escrow	294	$150,643,678	$512,393
	Cuyahoga Land Bank In-House	17	$9,973,413	$586,671
	CDC	156	$71,432,303	$457,899
	Opportunity Homes	4	$730,674	$182,669
	NSP	24	$14,150,092	$589,587
	Other	38	$20,450,028	$538,159
	TOTAL	**533**	**$267,380,189**	**$501,651**

Rehab Impacts in Moderately Functioning Ownership Areas

Chart 4: Mortgage Foreclosure Rates Over Time in Moderately Functioning Ownership Areas



Rehab Impacts in Higher Functioning Ownership Areas

Map 6: Higher Functioning Ownership Areas with Rehab Locations Identified

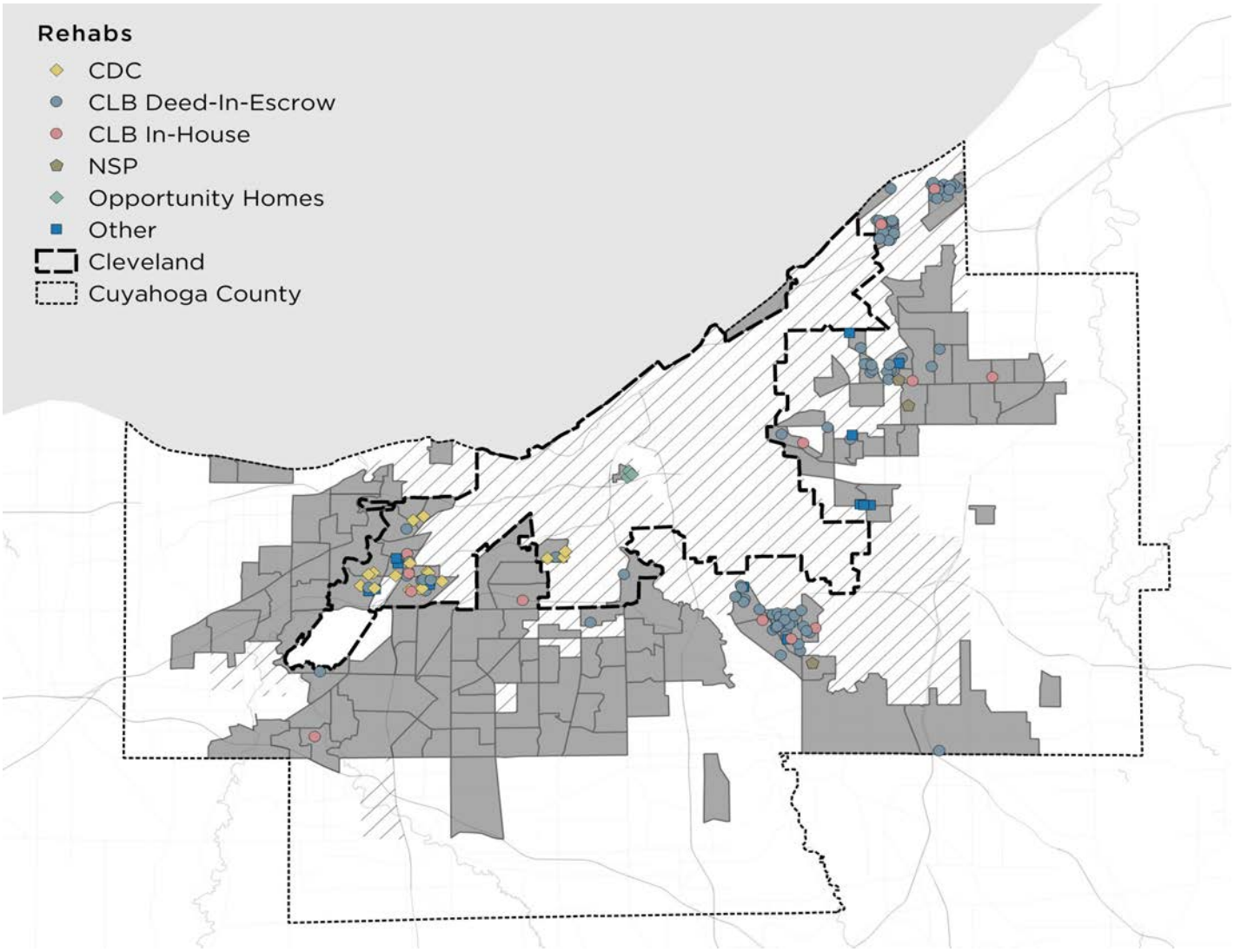
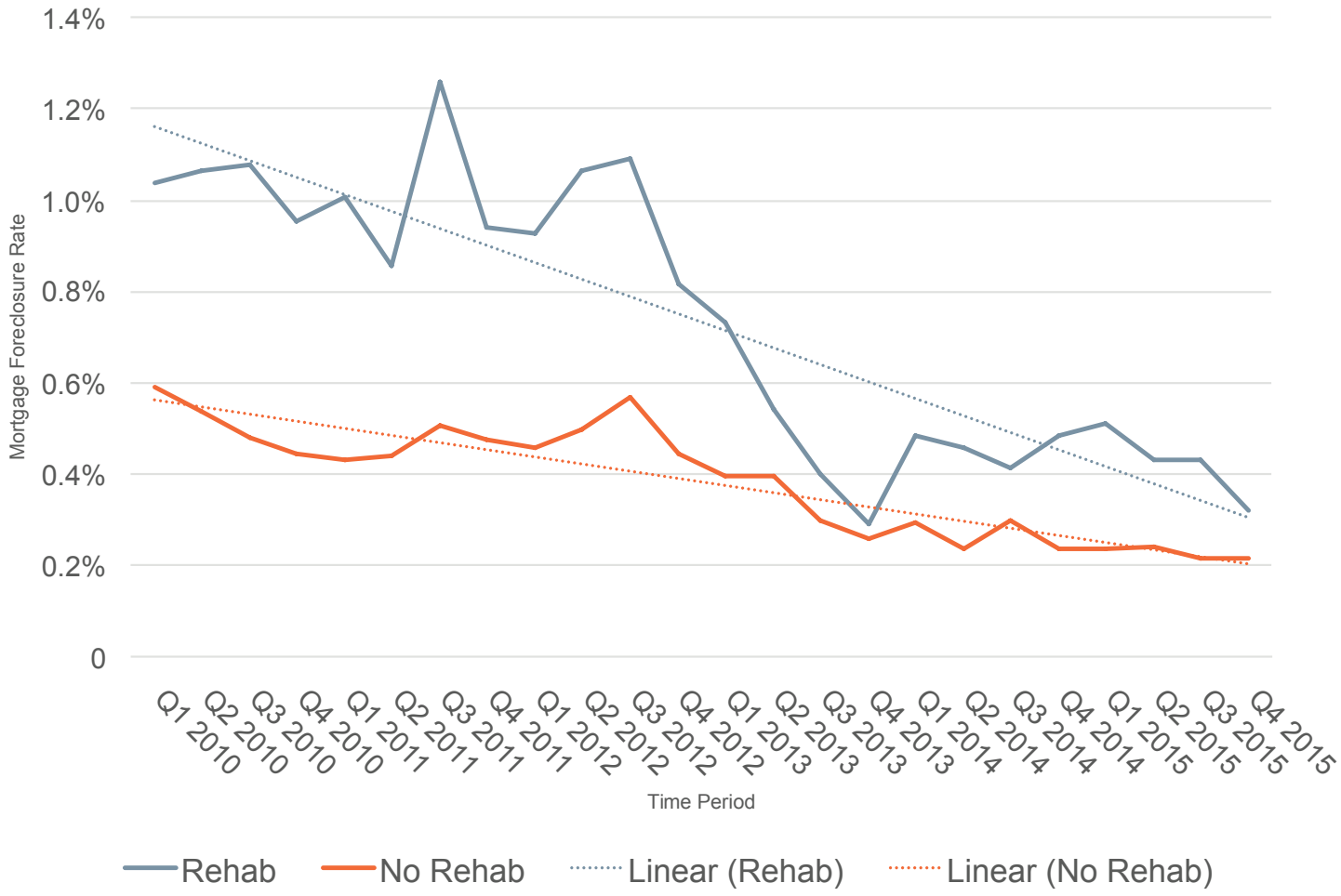


Table 6: Rehab Property Value Impacts by Program in Higher Functioning Ownership Areas

Submarket	Program Name	Rehab Count	Property Value Impact	Avg. Impact Per Rehab
Higher Functioning Ownership Areas	Cuyahoga Land Bank Deed-In-Escrow	94	$105,654,788	$1,123,987
	Cuyahoga Land Bank In-House	13	$14,767,968	$1,135,998
	CDC	17	$19,896,004	$1,170,353
	Opportunity Homes	3	$2,020,614	$673,538
	NSP	3	$2,285,631	$761,877
	Other	14	$19,468,344	$1,390,596
	TOTAL	**144**	**$164,093,351**	**$1,139,537**

Rehab Impacts in Higher Functioning Ownership Areas

Chart 5: Mortgage Foreclosure Rates Over Time in Higher Functioning Ownership Areas



Study Methodology

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Protecting Home Values and Reducing Mortgage Foreclosure

This study tests whether or not residential rehabbing could be an appropriate use of Hardest Hit Fund[iii] resources. Congress intended[iv] Hardest Hit Fund (HHF) funds to protect home values, preserve homeownership and maximize the return on these investments. While originally set aside for mortgage assistance, approximately three years ago U.S. Treasury allowed HHF funds to be used for demolition of blighted housing because doing so was proven[v] to further Congressional intent[vi]. Now, CNP and its partners have hired Dynamo Metrics to see if rehabbing abandoned houses – instead of demolishing them – will also protect home values, preserve homeownership and thereby maximize the return on the HHF investment.

Two questions must be answered. First, does programmatic rehabilitation of residential vacant land bank-owned or mortgage-foreclosed properties have a positive impact on neighboring property values? The research hypothesis for this question is, if residential vacant land bank-owned or mortgage-foreclosed properties are programmatically rehabbed and result in renter- or owner-occupied homes, then neighboring property values will increase.

Second, does programmatic rehabilitation of residential vacant land bank-owned or mortgage-foreclosed properties have a positive impact on mortgage foreclosure rates? The research hypothesis for this question is, if residential vacant land bank-owned or mortgage-foreclosed properties are programmatically rehabilitated and result in renter- or owner-occupied homes, then neighboring mortgage foreclosure rates will decrease over time.

DATA SET

Before these two questions could be answered, we needed to construct a data system that allows us to perform fully-specified, spatially-oriented hedonic modeling and comparative trend analysis. We call our Cleveland version of this data system C-STADS, or the Cuyahoga Space Time Analytics Data System. The base of C-STADS is data from NEO CANDO, the Northeast Ohio Community and Neighborhood Data for Organizing. NEO CANDO is a free and publicly accessible social and economic data system of the Center on Urban Poverty and Community Development, a research institute housed at Case Western Reserve University's Mandel School of Applied Social Sciences[vii]. NEO CANDO is a groundbreaking achievement: it contains parcel level, time-series property data going back decades for every parcel in all of Cuyahoga County. NEO CANDO allows a researcher to determine the property tax payment status, mortgage status, occupancy status, and ownership status of each property in the county dynamically over a significant time-series.

We take data from NEO CANDO and further manipulate it for spatial counting. First, we incorporate the NEO CANDO data into a GIS-based platform. Then we use GIS to make data out of the data: we create spatial variables by counting the multiple statuses of properties surrounding every property in the county. In other words, because NEO CANDO allows us to know the status (taxes current, in mortgage foreclosure, owner-occupied, etc.) of the properties around each home, for each home we can create "counts" of such properties surrounding it using GIS. The attributes of each and every home in the study area, therefore, include the statuses of the houses around them. The residential environment around each sales observation in our models for this study are fully specified: there is no double counting, and the occupancy, ownership, tax, and foreclosure status of every residential structure within 500 feet of each property is accounted for.

Although NEO CANDO data stretches back decades, we selected the study time period for this study as the 6 $^{3}/_{4}$ years beginning in April 2009 and ending in December 2015. This 27-quarter period was selected because data is most rich for modeling purposes during this time period.

Protecting Home Values and Reducing Mortgage Foreclosure (cont.)

STUDY AREA

We are studying the impact of 1,081 programmatic rehabs[viii] undertaken across Greater Cleveland during the study time period. For our purposes, a programmatic rehab, sometimes referred to just as a "rehab" in this study, is a significant home improvement project on an unoccupied and abandoned residential structure under the auspices of one of several program sponsors or managers listed above. It is important to note that this study does not observe the rehab activities occurring outside these rehab programs.

Selecting the study area was straightforward: we included all the Census tracts where programmatic rehab occurred during the study time period, and all the other Census tracts in the county that were like the Census tracts where the programmatic rehabs occurred. How we determined the alike Census tracts for inclusion in the study area is explained below. The study area includes 374 of the 443 Census tracts in Cuyahoga County. Map 1 provides a simple view of the study area's extent.

SUBMARKETING

Place matters. A rehab in one neighborhood will have a different impact than a similar rehab in another part of town. Everyone intuitively understands this, and the scientific literature confirms this.[ix] So we needed to divide the study area into several submarkets to get a better estimate of how rehabs impact their neighborhoods.

To create these submarkets, we ran a two-stage multivariate cluster analysis at the Census tract level. The first stage was a county-wide principal component analysis[x] (PCA) of 23 Census tract level socio-economic variables. The average of these 23 variables in each final submarket are shown in Table 7 on the following page. The second stage leveraged the power of the PCA outputs by taking the sum of the predicted values of the first 3 principal components and clustering them by alikeness using a k-means approach.[xi] The best "k" fit was found to be k = 5, meaning that all rehab observations were well distributed into specified clusters of Census tracts under this configuration. Only four of the five clusters had rehabs occur in them, producing the final study area with four submarkets.

In naming the submarkets, we took into account some of the submarkets' key characteristics, and also local insight. It is always hard to name submarkets. We invented names that seemed to us to give a good sense of things from a residential property point of view. **"Higher Functioning Ownership Areas"** are grey. These areas are predominated by owner-occupied homes. **"Moderate Functioning Ownership Areas"** are orange, and are also largely owner-occupied, but experiencing more stress than the grey areas. **"Stressed Rental Areas,"** purple, are predominantly tenant-occupied and facing significant stress, such as higher poverty and lower educational levels. **"Special Rental Areas,"** blue, consist primarily of tenant-heavy neighborhoods that may have special attributes: proximity to downtown or the medical/educational/cultural districts; inner-ring suburbs with solid housing and preferred educational options; or an ex-urban lifestyle preference option.

Protecting Home Values and Reducing Mortgage Foreclosure (cont.)

Table 7: Summary Statistics for Submarket Areas

	Neighborhood Typologies			
	Stressed Rental Areas	Special Rental Areas	Moderate Functioning Ownership Areas	Higher Functioning Ownership Areas
VARIABLES				
Census Tracts in Each Area	99	55	94	126
# Rehabs in Each Area	247	157	533	144
# Sales Observations in Each Area	8,342	4,432	14,608	18,060
Population per Square Mile	6,434	5,181	7,415	4,115
Median Household Income	$20,622	$31,129	$37,760	$56,226
Median Rent	$615	$707	$782	$874
Median Home Value	$63,841	$103,109	$86,324	$139,019
% Unoccupied	28.8%	15.3%	14.4%	6.6%
% Owner Occupied	36.6%	36.8%	53.9%	74.6%
% Bachelor's Degree or Greater	7.0%	24.0%	20.1%	33.1%
% Poverty	44.4%	25.6%	25.2%	8.6%
% Unemployment	27.5%	13.0%	13.9%	6.7%
% 2-3 Bedrooms	65.0%	58.8%	71.5%	69.2%
% 4 Bedrooms or More	18.0%	7.7%	16.9%	20.0%
% Home Built 2000-Present	5.7%	3.4%	1.5%	2.6%
% Homes Built 1980-1999	6.4%	8.4%	2.3%	7.7%
% Homes Built 1960-1979	9.7%	31.4%	8.8%	29.8%
% Homes Built 1940-1959	19.4%	26.9%	32.9%	41.2%
% Homes Built 1939 and Before	55.7%	26.3%	51.5%	15.3%
Average Household Size	2.4	1.9	2.4	2.3
% HH With Kids Under 18	27.2%	14.5%	27.2%	22.3%
Median Age	35.1	42.0	35.5	42.7
% White	13.9%	36.7%	57.2%	82.0%
% African American	81.6%	56.6%	34.0%	12.1%
% Hispanic	3.8%	3.1%	13.0%	3.8%
Average Travel Time (Minutes)	27.0	23.5	23.4	22.7

Hedonic Price Modeling

We know that prior to acquisition for rehab almost all the houses were vacant, and recently tax- or mortgage-foreclosed. And we also know that the rehabber's goal is always the same: use the rehab – the physical improvement of the house – to get somebody to live there and (by implication) pay the property taxes. Furthermore, we know how things actually turned out for occupancy and tax payment for each rehab. So, as will become clear below, we are observing the effects of rehab by observing the home value impacts of transforming an empty, foreclosed property into an occupied tax-current home. By doing it this way – studying rehab indirectly by comparing the "before rehab" and "after rehab" - we can more easily determine the effects of the rehab, meaning the effects of the change in property status, on all the neighboring houses. Table 8 provides a view into the status changes that the 1,081 programmatic rehabs underwent[xii].

Table 8: Before and After Status of All Programmatic Rehabs

Rehab Before and After Status	Rehab Count	Percent of Total
Vacant Mortgage Foreclosure Becomes Owner Occupied Tax Current	52	4.8%
Vacant Mortgage Foreclosure Becomes Renter Occupied Tax Current	10	0.9%
Vacant Mortgage Foreclosure Becomes Vacant Tax Current	7	0.6%
Land Bank Owned Becomes Owner Occupied Tax Current	371	34.3%
Land Bank Owned Becomes Renter Occupied Tax Current	466	43.1%
Land Bank Owned Becomes Vacant Tax Current	146	13.5%
Land Bank Owned Becomes Owner Occupied Tax Delinquent	22	2.0%
Land Bank Owned Becomes Vacant Tax Delinquent	7	0.6%
TOTAL	**1,081**	**100%**

We can now proceed to address the first question: does programmatic rehabilitation aimed at transforming residential vacant land bank-owned or mortgage-foreclosed properties into renter- and owner-occupied tax current homes have a positive impact on neighboring property values? We decided to answer the question with hedonic modeling. Hedonic modeling has been developed over the last 40 years.[xiii] Hedonic modeling provides estimates of the marginal implicit value of structural and neighborhood characteristics associated with residential housing[xiv]. In other words, the sales price of a house can be predicted if you know all the house's attributes: how many bedrooms and bathrooms; square footage; does it have a deck, or a two car garage, did the owner put in a new kitchen, etc. For our modeling, attributes of a house also include: how many properties around it are late on their property taxes; how many are vacant; how many are owner-occupied, etc. If you know the attributes of a house – both its physical characteristics and the characteristics of its micro-neighborhood – you can also know how changes to those attributes will adjust the home value.

Hedonic Price Modeling (cont.)

SUBMARKETS HEDONIC MODEL

There are several different ways to set up a hedonic model. Each has its strengths and weaknesses. For reasons described below, we chose a submarket model. But we also ran a global model and a global model with fixed effects (by submarket) to identify and investigate the nature of any existing spatial heterogeneity.

A total of 45,442 arms-length sales observations were identified in the study area over the study time period. The specification of the submarkets model is,

Equation 1: Submarkets Hedonic Model

$$lnP_{ir} = \alpha + \beta_{0_{ir}} R_{ir} + \beta_{1_{ir}} L_{ir} + \beta_{2_{ir}} S_{ir} + \beta_{3_{ir}} M_{ir} + \beta_{4_{ir}} T_{ir} + \varepsilon_r$$

where the natural log of the price of the (*i*)th sale in the (*r*)th spatial regime is a function of:

• "R" - a vector of spatial count variables of the status of residential properties within 500 feet of the sale property;
• "L" – a spatial lag operator that is estimated by averaging the sales price of the nearest six arms-length sales in the previous quarter;
• "S" – a vector of structural attributes of the sale property;
• "M" – a vector of dummy variables that account for deed transfer type and property status at time of sale;
• "T" – a vector of time series dummy variables that denote which of the 27 quarters the sale of the property took place;
• "ε" – an error term with assumed conditional mean of zero and constant variance.

The semi-log functional form was chosen in the empirical analysis such that individual variable coefficients can be interpreted as estimates of the approximate percentage change in price when a marginal increase of a variable in question occurs, all else equal[xv]. In all model specifications (See Appendix 1) of the empirical analysis the presence of heteroscedasticity was detected in the error term[xvi], and thus White's robust standard errors were used as a corrective measure[xvii]. Given the likely existence of spatial autocorrelation and as suggested in the literature[xviii] to manage this effect, the spatial lag operators were deployed.

The submarkets model is designed to control for spatial heterogeneity[xix] and the existence and nature of the effect was investigated through the comparison of the global model, global model with fixed effects and the Chow Test[xx] (See Appendix 1 and 2) of model variables across the four identified submarkets. Given many market irregularities in Greater Cleveland – i.e. low value sales and many non-traditional but definitional arms-length sales[xxi] – dummy variables for deed sales type and property status at the time of sale were used to control for these irregularities.

While the global model and the global model with fixed effects performed better overall in "goodness of fit" than any of the individual components of the submarkets model, the Chow Test for the submarkets model (See Appendix 2) and the fixed effects coefficients in the global model with fixed effects show clear evidence of spatial heterogeneity across the submarkets regimes. The specific application of interest in this part of the study is to estimate the varying effects of programmatic rehab in varying neighborhood environments. Estimating how the individual effects of the key neighborhood proximity variables vary across submarkets is critical to test this aspect of the application. The final model chosen was therefore the submarkets model's specification because it allows investigation of these variations across the key variables.

Hedonic Price Modeling (cont.)

IMPACTS ON PROPERTY VALUE

Let's start with an example. The submarkets model lets us know, as shown in Table 9, how much one land bank-owned property near a house depresses the value of that house. The land bank generally gets properties only after they have been abandoned for a long time. As expected, the results vary by submarket:

Table 9: Property Value Impact of an Additional Nearby Land Bank Property

Submarket	Impact of Additional Nearby Land Bank Property
Stressed Rental Area	0.00%
Special Rental Area	-9.80%
Moderate Functioning Ownership Area	-5.74%
High Functioning Ownership Area	-10.94%

The submarkets model also lets us know, as shown in Table 10, how much having an additional property that is tax-current and owner-occupied near a house increases the value of that house. Again, the results vary by submarket:

Table 10: Property Value Impact of an Additional Nearby Owner Occupied Tax-Current Property

Submarket	Impact of Additional Nearby Tax-Current Owner-Occupied Property
Stressed Rental Area	0.46%
Special Rental Area	0.36%
Moderate Functioning Ownership Area	0.33%
High Functioning Ownership Area	0.15%

Measuring the spreads from a status change of land bank-owned to tax-current and owner-occupied in each submarket in Tables 9 and 10 creates Table 11: you get the property value impact of the rehab on each of the other houses in the rehab's micro-neighborhood:

Table 11: Property Value Impact Spreads for Nearby Homes from Rehab

Submarket	Property Value Impact Spread
Stressed Rental Area	0.46%
Special Rental Area	10.16%
Moderate Functioning Ownership Area	6.07%
High Functioning Ownership Area	11.09%

Table 12 shows the property value impact spreads available when a Cuyahoga Land Bank-owned or a mortgage foreclosed vacant property is transformed by rehab into each of the possible outcomes that were actually observed for the 1,081 rehabs in this study. This example is highlighted in gray in Table 12 on the next page.

Hedonic Price Modeling (cont.)

Table 12: Property Value Impact Spreads Available in Each Submarket from Rehab

Rehab Before and After Status	Stressed Rental Areas	Special Rental Areas	Moderately Functioning Ownership Areas	Higher Functioning Ownership Areas
Vacant Mortgage Foreclosure Becomes Owner Occupied Tax Current	0.46%	2.72%	2.06%	2.81%
Vacant Mortgage Foreclosure Becomes Renter Occupied Tax Current	0.00%	2.72%	1.54%	2.34%
Vacant Mortgage Foreclosure Becomes Vacant Tax Current	0.00%	1.02%	1.33%	0.53%
Land Bank Owned Becomes Owner Occupied Tax Current	0.46%	10.16%	6.07%	11.09%
Land Bank Owned Becomes Renter Occupied Tax Current	0.00%	10.16%	5.55%	10.63%
Land Bank Owned Becomes Vacant Tax Current	0.00%	8.46%	5.34%	8.82%
Land Bank Owned Becomes Owner Occupied Tax Delinquent	-0.98%	7.46%	3.61%	10.94%
Land Bank Owned Becomes Vacant Tax Delinquent	-0.48%	5.84%	3.21%	5.28%

To take it one step further, Table 13 shows all the property value impacts that are measurable by the submarkets model. Table 13 offers much more insight than what is reported in this study. To our knowledge, this is the most comprehensive residential neighborhood specification ever developed in intervention-impact hedonic modeling. As little as ten years ago, hedonic modeling this robust would usually be impossible because of data constraints. Not so today. Today, any community that can stitch together its treasurer's and assessor's files can create an impact table like this:

Table 13: Significant Hedonic Model Results Showing Value Impacts of Nearby Properties

			FINAL MODEL			
	Global Model	**Global Model with Fixed Effects**	**Stressed Rental Areas**	**Special Rental Areas**	**Moderately Functioning Ownership Areas**	**Higher Functioning Ownership Areas**
Sales Observations	**45,442**	**45,442**	**8,342**	**4,432**	**14,608**	**18,060**
Adjusted R-Squared	**0.647**	**0.653**	**0.226**	**0.540**	**0.509**	**0.616**
500 Feet Neighborhood Proximity Variables	**Percent Impact from an Additional Property**					
Owner Occupied and Tax Current Within 500 Feet	0.39%	0.29%	0.46%	0.36%	0.33%	0.15%
Renter Occupied and Tax Current Within 500 Feet	-0.17%	-0.20%	N/A	0.35%	-0.19%	-0.31%
Unoccupied and Tax Current Within 500 Feet	-1.22%	-1.16%	N/A	-1.35%	-0.40%	-2.12%
Owner Occupied and Tax Delinquent Within 500 Feet	-0.88%	-0.70%	-0.98%	-2.35%	-2.13%	N/A
Renter Occupied and Tax Delinquent Within 500 Feet	-2.58%	-1.63%	-1.48%	-2.55%	-0.91%	-4.13%
Unoccupied and Tax Delinquent Within 500 Feet	-1.08%	-0.54%	-0.48%	-3.96%	-2.53%	-5.66%
Mortgage Foreclosed and Occupied within 500 Feet	-2.80%	-2.22%	N/A	N/A	N/A	-3.22%
Mortgage Foreclosed and Unoccupied within 500 Feet	-2.26%	-2.13%	N/A	-2.36%	-1.73%	-2.66%
Land Bank Owned Residential Structure Within 500 Feet	-4.92%	-4.84%	N/A	-9.80%	-5.74%	-10.94%
Vacant Residential Lot Within 500 Feet	-0.44%	-0.23%	-0.29%	-0.45%	N/A	N/A

Hedonic Price Modeling (cont.)

COUNTERFACTUAL SIMULATION AND HOME VALUE IMPACT CALCULATIONS

Once we completed the submarkets model and got the property value impact percentages (coefficients), we ran a counterfactual simulation. In doing so, we first established the median home value in each Census tract where rehabs occurred. Then we posited these median values as the actual values of each occupied and tax-current house within 500 feet of each rehab. Then we adjusted the value of each house within 500 feet of each rehab by the appropriate property value impact spread. Doing so simulated a reality in which none of these rehabs occurred. In other words, what would the neighborhood property values be if rehab had not transformed those houses? The results of the preserved and increased value of nearby homes caused rehab are in Table 14 and 15.

Table 14: Counterfactual Simulation Aggregated Results

Submarket	Rehab Count	Property Value Impact	Avg. Impact Per Rehab
Stressed Rental Areas	247	$1,746,543	$7,071
Special Rental Areas	157	$106,098,226	$675,785
Moderately Functioning Ownership Areas	533	$267,380,189	$501,651
Higher Functioning Ownership Areas	144	$164,093,351	$1,139,537
TOTAL	**1,081**	**$539,318,308**	**$498,907**

The status of each property in the fourth quarter of 2015 was used to quantify the property value impact spread on nearby properties. For example, if a property was land bank-owned, then it was rehabbed and occupied, but then slid back into tax delinquency in Q4 2015, the appropriate multiplier, tax delinquency multiplier, was applied. The predominate outcome of programmatic rehab is renter- or owner-occupancy (see Table 8) but some houses then become vacant, or tax delinquent, or both. The actual occurrence of subsequent vacancy and tax delinquency are accounted for and built into the counterfactual simulation.

It is important to note that we constructed the counterfactual simulation in such a way that it most likely underestimates the rehab property value impacts, for two reasons. First, the increased property values of the rehabs themselves are not included in the value impact sums. Only the impact on surrounding properties is estimated. Second, we applied the property value adjustments only to occupied and tax-current homes. The values of vacant or tax-delinquent houses were not adjusted upwards. We did it this way because the U.S. Census tract median home price valuation does not seem to contemplate either heightened-vacancy conditions or elevated tax-delinquency conditions, while one or both of these conditions exist in many parts of the study area.

Hedonic Price Modeling (cont.)

Table 15: Counterfactual Simulation Results by Submarket

Submarket	Program Name	Rehab Count	Property Value Impact	Avg. Impact Per Rehab
Stressed Rental Areas	Slavic Village Recovery	28	$221,399	$7,907
	Cuyahoga Land Bank Deed-In-Escrow	83	$194,629	$2,345
	Cuyahoga Land Bank In-house	2	$0	$0
	CDC	70	$451,399	$6,449
	Opportunity Homes	32	$612,257	$19,133
	NSP	19	$181,846	$9,571
	Other	13	$85,012	$6,539
	TOTAL	**247**	**$1,746,543**	**$7,071**
Submarket	**Program Name**	**Rehab Count**	**Property Value Impact**	**Avg. Impact Per Rehab**
Special Rental Areas	Cuyahoga Land Bank Deed-In-Escrow	77	$55,681,749	$723,140
	Cuyahoga Land Bank In-house	8	$6,362,601	$795,325
	CDC	33	$23,322,176	$706,733
	Opportunity Homes	19	$4,941,346	$260,071
	NSP	14	$11,107,811	$793,415
	Other	6	$4,682,542	$780,424
	TOTAL	**157**	**$106,098,226**	**$675,785**
Submarket	**Program Name**	**Rehab Count**	**Property Value Impact**	**Avg. Impact Per Rehab**
Moderately Functioning Ownership Areas	Cuyahoga Land Bank Deed-In-Escrow	294	$150,643,678	$512,393
	Cuyahoga Land Bank In-house	17	$9,973,413	$586,671
	CDC	156	$71,432,303	$457,899
	Opportunity Homes	4	$730,674	$182,669
	NSP	24	$14,150,092	$589,587
	Other	38	$20,450,028	$538,159
	TOTAL	**533**	**$267,380,189**	**$501,651**
Submarket	**Program Name**	**Rehab Count**	**Property Value Impact**	**Avg. Impact Per Rehab**
Higher Functioning Ownership Areas	Cuyahoga Land Bank Deed-In-Escrow	94	$105,654,788	$1,123,987
	Cuyahoga Land Bank In-house	13	$14,767,968	$1,135,998
	CDC	17	$19,896,004	$1,170,353
	Opportunity Homes	3	$2,020,614	$673,538
	NSP	3	$2,285,631	$761,877
	Other	14	$19,468,344	$1,390,596
	TOTAL	**144**	**$164,093,351**	**$1,139,537**

Reducing Mortgage Foreclosure

We have spent a lot of time discussing how we answered the first question. Now, let's address the second question: does programmatic rehabilitation of residential vacant land bank-owned or mortgage-foreclosed properties have a positive impact on neighboring mortgage foreclosure rates? To answer this question, we produced a comparative trends analysis. Like the property value impact question, the mortgage foreclosure impact question relied upon our converting the NEO CANDO data into our spatially-oriented, time-series organized C-STADS. Specifically, the comparative trends analysis utilizes two neighborhood control mechanisms to test for a significant relationship between changing mortgage foreclosure rates over time, on one hand, and programmatic rehabilitation, on the other. The first control that is implemented mirrors the alike neighborhoods identified in the submarketing process that divided the study area. In addressing the mortgage foreclosure rate question, we use the same submarkets: Stressed Rental Areas, Special Rental Areas, Moderately Functioning Ownership Areas, and High Functioning Ownership Areas. The second control focuses on the identification of Census block areas within each submarket where rehab has occurred or not occurred. The comparative trends are therefore the mortgage foreclosure rates between Q1 2010 and Q4 2015 in the "with" versus "without" rehab Census blocks in each of the four submarkets. There is also a global comparative trends performed to test the difference overall of mortgage foreclosure rates over time that received rehab at the Census block level and those that did not. This is similar in purpose to testing for spatial heterogeneity.

After we visually identified that the mortgage foreclosure rates in the alike submarket areas appeared statistically significantly different from one another over time, we needed to run a further test to determine whether the control of rehabs truly is responsible for what appeared to be the differing mortgage foreclosure rates. So a "paired t-test" was utilized to discern as much as possible whether a statistically significant difference exists between the two trends, given the controls that are in place.[xxii] The study area-wide t-test and the submarket t-tests all show a statistically significant difference between mortgage foreclosure rates where rehab has and has not occurred, suggesting that programmatic rehab is a determinant of faster declining mortgage foreclosure rates over time.

Unlike with the hedonic modeling used in the property value impact question, the comparative trend analysis is not causal in nature. In other words, this method does not allow us to say, "rehab caused a change in foreclosure rates by (for example) 1%." Instead, we can only say, in essence, "rehabs are significantly associated with changes in foreclosure rates, but we don't know the exact magnitude of impact." Because it is not causal, the comparative trends analysis should be used by decision-makers in conjunction with other analytics.

Afterword:

Overcoming Limitations to Hedonic Power

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Afterword: Overcoming Limitations to Hedonic Power

In his 2012 article, "Nonprofit Housing Investment and Local Area Home Values," Federal Reserve Bank senior economist Kelly D. Edmiston discusses the persistent problems in using hedonic modeling to estimate impacts of interventions on surrounding housing values[xxiii]. Edmiston elegantly describes the three perennial problems: 1) hedonic modeling requires a substantial amount of data on the individual characteristics of homes, which may not be readily available; 2) even if large amounts of data on home characteristics are available, the quality of the analysis depends heavily on how well the characteristics capture the quality of the homes, and; 3) because hedonic models typically capture a single point in time, they may miss important dynamics that must be included to get a full appraisal of the value of specific features that may or may not be present and that may vary in quality over time. Edmiston then explains that the repeat sales method, a hedonic derivation advanced famously by Case and Schiller in 1987[xxiv] has become, in the face of these data constraints, the go-to method of measuring the value impacts of property intervention.

We suggest the foregoing study demonstrates that the traditional constraints on hedonic modeling, as articulated by Edmiston (2012), have been overcome. Below we address each of Edmiston's observations in turn:

1. Hedonic modeling requires a substantial amount of data on the individual characteristics of homes, which may not be readily available.

By incorporating the NEO CANDO data into C-STADS, we have access to a full set of county-wide, parcel-level, time-series information from the county treasurer, auditor (assessor), recorder, sheriff, and clerk of courts, not to mention Census data and other sources. Admittedly, Cuyahoga County has been ahead of its time in getting its data resources together. But our recent experiences in other communities, including Detroit and Gary, Indiana, have shown us that communities can quickly and cost-effectively get their county-level data together if the government leadership is willing to advocate it. Given recent advances in data storage and computing, a data system capable of running a study like this one can quickly be put together almost anywhere.

2. Even if large amounts of data on home characteristics are available, the quality of the analysis depends heavily on how well the characteristics capture the quality of the homes.

What we take Edmiston to mean here is that just because you know how many bedrooms or bathrooms a house has, it doesn't mean you have a good idea of the house's worth in the market. This is certainly true. Our response is, what is of essential importance in grasping the quality of a house is grasping the quality of the houses around it. That is why we incorporate spatial counts into our data systems. By using GIS and computing power to create micro-neighborhood counts for each and every parcel, and then by incorporating those counts as characteristics of those parcels, we can make sure that the price estimation of each house takes into account the characteristics of the houses around it. This is an intensive process: to perform this recently in Detroit, over 250 million calculations were run in the GIS software. Innovations like this have "big data" potential for hedonic modeling, and can be run on a single computer and small server overnight.

3. Because hedonic models typically capture a single point in time they may miss important dynamics that must be included to get a full appraisal of the value of specific features that may or may not be present and that may vary in quality over time.

As stated above, time-series, spatially-oriented, parcel-level data systems can now be constructed wherever there is the political will to do so. This study includes 27 quarterly time slices with unique parcel-level information for each parcel in each of the 27 time periods. Most for-profit vendors of property tax services to county governments and the real estate industry have this historical public data archived and available for retrieval. But their clients, local governments, don't ask for it. A few short meetings between a passionate elected leader and the data services vendor gets the public data in the hands of the local government trying use it to make better decisions for its citizens.

Afterword: Overcoming Limitations to Hedonic Power (cont.)

It is clear that Case and Schiller did not intend the repeat sales method to be used to measure change at the neighborhood level. As they make clear in their seminal 1987 paper, they were only able to use the repeat sales method to develop a housing price index because they had a very large, geographically disparate number of observations over a long period of time, and knew (or could reasonably detect) when the quality of the units changed so they could exclude those observations. In other words, they built a telescope, not a microscope. Because of advances in data science, hedonic modeling can now take a microscope's precision to an entire city, county, or region without ever losing resolution. This study represents to our knowledge the fullest specification ever used for a hedonic model. We believe specifications like this can and will quickly become the new standard for building decision support tools for local and regional governments. Hedonic modeling is at last ready for use in decision support.

Appendices

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Appendix 1

Appendix 1: Full Model Specifications of Empirical Hedonic Analysis

	Global Model		Global Model with Fixed Effects		Stressed Rental Area Regime		Special Rental Area Regime		Moderate Functioning Ownership Area Regime		Higher Functioning Ownership Area Regime	
Sales Observations	**45,442**		**45,442**		**8,342**		**4,432**		**14,608**		**18,060**	
Adjusted R-Squared	**0.647**		**0.653**		**0.226**		**0.540**		**0.509**		**0.616**	
Variable Types	**Coefficient**	**Probability**	**Coefficient**	**Probability**	**Coefficient**	**Probability**	**Coefficient**	**Probability**	**Coefficient**	**Probability**	**Coefficient**	**Probability**
Neighborhood Variables												
Owner Occupied and Tax Current Within 500 Feet	0.004	0.000	0.003	0.000	0.005	0.000	0.004	0.000	0.003	0.000	0.002	0.000
Renter Occupied and Tax Current Within 500 Feet	-0.002	0.000	-0.002	0.000	0.000	0.876	0.004	0.013	-0.002	0.001	-0.003	0.000
Unoccupied and Tax Current Within 500 Feet	-0.012	0.000	-0.012	0.000	-0.001	0.687	-0.013	0.005	-0.004	0.029	-0.021	0.000
Owner Occupied and Tax Delinquent Within 500 Feet	-0.009	0.000	-0.007	0.000	-0.010	0.001	-0.023	0.000	-0.021	0.000	-0.001	0.141
Renter Occupied and Tax Delinquent Within 500 Feet	-0.026	0.000	-0.016	0.000	-0.015	0.000	-0.025	0.000	-0.009	0.003	-0.041	0.000
Unoccupied and Tax Delinquent Within 500 Feet	-0.011	0.000	-0.005	0.001	-0.005	0.018	-0.040	0.000	-0.025	0.000	-0.057	0.000
Mortgage Foreclosed and Occupied within 500 Feet	-0.028	0.000	-0.022	0.000	-0.011	0.112	-0.032	0.101	-0.005	0.364	-0.032	0.000
Mortgage Foreclosed and Unoccupied within 500 Feet	-0.023	0.000	-0.021	0.000	0.002	0.532	-0.024	0.000	-0.017	0.000	-0.027	0.000
Land Bank Owned Residential Structure Within 500 Feet	-0.049	0.000	-0.048	0.000	-0.017	0.121	-0.098	0.000	-0.057	0.000	-0.109	0.000
Vacant Residential Lot Within 500 Feet	-0.004	0.000	-0.002	0.000	-0.003	0.003	-0.004	0.003	-0.001	0.254	0.000	0.682
Spatial Lag Variable												
Avg. Price of Nearest 6 Sales in Previous Quarter/1000	0.006	0.000	0.005	0.000	0.006	0.000	0.005	0.000	0.007	0.000	0.003	0.000
Structural Variables												
Number of Full + Half Bathrooms	0.177	0.000	0.186	0.000	0.076	0.000	0.253	0.000	0.156	0.000	0.249	0.000
Age of Home When Sold	-0.006	0.000	-0.005	0.000	-0.007	0.000	-0.004	0.000	-0.004	0.000	-0.004	0.000
Number of Fireplaces	0.126	0.000	0.119	0.000	0.068	0.012	0.137	0.000	0.095	0.000	0.101	0.000
Lotsize in Square Feet/1000	0.000	0.233	0.000	0.300	0.000	0.000	0.003	0.000	0.000	0.010	-0.000	0.979
Air Conditioning	0.110	0.000	0.105	0.000	0.457	0.000	0.143	0.000	0.112	0.000	0.051	0.000
Finished Attic	0.100	0.000	0.116	0.000	0.067	0.045	0.131	0.043	0.187	0.000	0.115	0.000
Finished Basement	0.020	0.018	0.010	0.242	0.042	0.572	0.038	0.229	0.037	0.027	-0.010	0.220
Brick Exterior	0.067	0.000	0.062	0.000	0.020	0.703	0.032	0.277	0.097	0.000	0.055	0.000
Garage	0.163	0.000	0.144	0.000	0.057	0.010	0.202	0.000	0.151	0.000	0.170	0.000
Porch	0.023	0.000	0.037	0.000	-0.047	0.155	0.036	0.117	0.044	0.001	0.024	0.000
Terrace	0.077	0.000	0.070	0.000	0.078	0.231	0.085	0.005	0.087	0.000	0.041	0.000
Sales Transfer Type Dummy Variables												
Sold as Quit Claim Deed	-0.421	0.000	-0.406	0.000	-0.270	0.000	-0.477	0.000	-0.550	0.000	-0.320	0.000
Sold as Limited Warranty Deed	-0.214	0.000	-0.215	0.000	-0.267	0.000	-0.262	0.000	-0.220	0.000	-0.175	0.000
Sold with LLC as the Grantee	-0.290	0.000	-0.298	0.000	-0.191	0.000	-0.352	0.000	-0.265	0.000	-0.354	0.000
Sold while Exiting REO	-0.444	0.000	-0.445	0.000	-0.539	0.000	-0.484	0.000	-0.438	0.000	-0.367	0.000
Sold while Owner Occupied and Tax Current	0.553	0.000	0.554	0.000	0.521	0.000	0.461	0.000	0.674	0.000	0.357	0.000
Sold while Renter Occupied and Tax Current	0.372	0.000	0.379	0.000	0.301	0.000	0.260	0.006	0.469	0.000	0.232	0.000
Sold while Unoccupied and Tax Current	0.364	0.000	0.362	0.000	0.098	0.120	0.318	0.001	0.454	0.000	0.230	0.000
Sold while Owner Occupied and Tax Delinquent	0.412	0.000	0.424	0.000	0.434	0.000	0.142	0.342	0.545	0.000	0.097	0.193
Sold while Renter Occupied and Tax Delinquent	0.347	0.000	0.346	0.000	0.330	0.000	0.214	0.072	0.393	0.000	0.105	0.160
Sold while Unoccupied and Tax Delinquent	0.154	0.000	0.163	0.000	0.043	0.546	-0.039	0.764	0.265	0.000	0.187	0.039
Sold while Mortgage Foreclosed and Occupied	0.181	0.000	0.184	0.000	0.051	0.540	0.002	0.985	0.277	0.000	0.090	0.183
Sold while Mortgage Foreclosed and Unoccupied	0.253	0.000	0.258	0.000	0.152	0.035	0.135	0.206	0.379	0.000	0.105	0.099
Time Period of Sales Dummy Variables												
Sold in 2009, 3rd Quarter	0.014	0.538	0.013	0.561	0.091	0.170	0.068	0.374	-0.008	0.847	-0.025	0.215
Sold in 2009, 4th Quarter	0.067	0.004	0.059	0.010	0.258	0.000	0.137	0.069	-0.008	0.837	-0.020	0.338
Sold in 2010, 1st Quarter	0.220	0.000	0.162	0.000	0.509	0.000	0.287	0.002	0.220	0.000	0.046	0.058
Sold in 2010, 2nd Quarter	0.201	0.000	0.174	0.000	0.387	0.000	0.240	0.003	0.165	0.000	0.060	0.002
Sold in 2010, 3rd Quarter	0.013	0.610	-0.004	0.885	0.304	0.000	-0.050	0.569	-0.076	0.072	-0.077	0.003
Sold in 2010, 4th Quarter	0.128	0.000	0.110	0.000	0.424	0.000	0.053	0.572	0.070	0.117	-0.008	0.743
Sold in 2011, 1st Quarter	0.075	0.006	0.056	0.035	0.340	0.000	0.141	0.132	0.003	0.939	-0.063	0.017
Sold in 2011, 2nd Quarter	0.144	0.000	0.102	0.000	0.519	0.000	0.090	0.304	0.089	0.038	-0.047	0.045
Sold in 2011, 3rd Quarter	0.083	0.001	0.044	0.074	0.500	0.000	0.161	0.073	-0.069	0.109	-0.070	0.002
Sold in 2011, 4th Quarter	0.030	0.236	-0.002	0.930	0.393	0.000	0.053	0.527	-0.064	0.142	-0.141	0.000
Sold in 2012, 1st Quarter	0.121	0.000	0.064	0.011	0.474	0.000	0.096	0.227	0.079	0.065	-0.091	0.000
Sold in 2012, 2nd Quarter	0.116	0.000	0.070	0.003	0.396	0.000	0.127	0.101	0.026	0.526	-0.053	0.015
Sold in 2012, 3rd Quarter	0.066	0.004	0.029	0.203	0.378	0.000	0.057	0.475	-0.053	0.186	-0.050	0.021
Sold in 2012, 4th Quarter	0.062	0.009	0.026	0.272	0.323	0.000	0.013	0.867	0.004	0.921	-0.086	0.000
Sold in 2013, 1st Quarter	0.073	0.003	0.022	0.361	0.353	0.000	0.134	0.118	-0.005	0.911	-0.052	0.025
Sold in 2013, 2nd Quarter	0.171	0.000	0.119	0.000	0.384	0.000	0.108	0.181	0.148	0.000	-0.001	0.943
Sold in 2013, 3rd Quarter	0.141	0.000	0.099	0.000	0.387	0.000	0.149	0.047	0.127	0.002	-0.018	0.346
Sold in 2013, 4th Quarter	0.083	0.000	0.047	0.039	0.457	0.000	0.127	0.123	0.015	0.711	-0.078	0.000
Sold in 2014, 1st Quarter	0.133	0.000	0.082	0.001	0.594	0.000	-0.051	0.540	0.110	0.010	-0.055	0.031
Sold in 2014, 2nd Quarter	0.159	0.000	0.115	0.000	0.512	0.000	0.175	0.036	0.140	0.001	-0.034	0.115
Sold in 2014, 3rd Quarter	0.109	0.000	0.072	0.001	0.604	0.000	0.038	0.625	0.007	0.858	-0.022	0.276
Sold in 2014, 4th Quarter	0.179	0.000	0.114	0.000	0.609	0.000	0.204	0.012	0.178	0.000	-0.048	0.022
Sold in 2015, 1st Quarter	0.110	0.000	0.062	0.015	0.565	0.000	0.162	0.055	0.040	0.366	-0.069	0.008
Sold in 2015, 2nd Quarter	0.180	0.000	0.140	0.000	0.663	0.000	0.188	0.021	0.108	0.008	0.017	0.433
Sold in 2015, 3rd Quarter	0.105	0.000	0.069	0.002	0.536	0.000	0.062	0.433	0.081	0.048	-0.035	0.075
Sold in 2015, 4th Quarter	0.076	0.001	0.041	0.072	0.530	0.000	0.152	0.062	0.046	0.248	-0.099	0.000
Census Tract Fixed Effect Dummy Variables												
Sold Within Special Renters Area			0.320	0.000								
Sold Within Higher Functioning Ownership Area			0.445	0.000								
Sold Within Moderate Functioning Ownership Area			0.358	0.000								
MODEL CONSTANT	9.982	0.000	9.698	0.000	9.514	0.000	9.879	0.000	9.712	0.000	10.648	0.000

Appendix 2

Appendix 2: Chow Test Results from Submarket Hedonic Model

Variable Types	Chow Test Score	Probability
Neighborhood Variables		
Owner Occupied and Tax Current Within 500 Feet	65.779	0.000
Renter Occupied and Tax Current Within 500 Feet	22.491	0.000
Unoccupied and Tax Current Within 500 Feet	57.142	0.000
Owner Occupied and Tax Delinquent Within 500 Feet	94.106	0.000
Renter Occupied and Tax Delinquent Within 500 Feet	29.523	0.000
Unoccupied and Tax Delinquent Within 500 Feet	68.811	0.000
Mortgage Foreclosed and Occupied within 500 Feet	13.224	0.004
Mortgage Foreclosed and Unoccupied within 500 Feet	43.535	0.000
Land Bank Owned Residential Structure Within 500 Feet	23.576	0.000
Vacant Residential Lot Within 500 Feet	8.982	0.030
Spatial Lag Variable		
Avg. Price of Nearest 6 Sales in Previous Quarter/1000	249.063	0.000
Structural Variables		
Number of Full + Half Bathrooms	92.185	0.000
Age of Home When Sold	47.751	0.000
Number of Fireplaces	4.095	0.251
Lotsize in Square Feet/1000	20.381	0.000
Air Conditioning	88.619	0.000
Finished Attic	11.362	0.010
Finished Basement	8.092	0.044
Brick Exterior	7.751	0.051
Garage	15.814	0.001
Porch	6.93	0.074
Terrace	7.514	0.057
Sales Transfer Type Dummy Variables		
Sold as Quit Claim Deed	58.746	0.000
Sold as Limited Warranty Deed	12.015	0.007
Sold with LLC as the Grantee	38.321	0.000
Sold while Exiting REO	42.499	0.000
Sold while Owner Occupied and Tax Current	17.828	0.001
Sold while Renter Occupied and Tax Current	11.847	0.008
Sold while Unoccupied and Tax Current	22.388	0.000
Sold while Owner Occupied and Tax Delinquent	21.539	0.000
Sold while Renter Occupied and Tax Delinquent	9.982	0.019
Sold while Unoccupied and Tax Delinquent	7.489	0.058
Sold while Mortgage Foreclosed and Occupied	8.483	0.037
Sold while Mortgage Foreclosed and Unoccupied	14.478	0.002
Time Period of Sales Dummy Variables		
Sold in 2009, 3rd Quarter	3.929	0.269
Sold in 2009, 4th Quarter	18.428	0.000
Sold in 2010, 1st Quarter	42.686	0.000
Sold in 2010, 2nd Quarter	27.215	0.000
Sold in 2010, 3rd Quarter	25.602	0.000
Sold in 2010, 4th Quarter	30.111	0.000
Sold in 2011, 1st Quarter	27.716	0.000
Sold in 2011, 2nd Quarter	54.207	0.000
Sold in 2011, 3rd Quarter	49.608	0.000
Sold in 2011, 4th Quarter	47.781	0.000
Sold in 2012, 1st Quarter	52.263	0.000
Sold in 2012, 2nd Quarter	33.732	0.000
Sold in 2012, 3rd Quarter	29.278	0.000
Sold in 2012, 4th Quarter	26.711	0.000
Sold in 2013, 1st Quarter	27.044	0.000
Sold in 2013, 2nd Quarter	33.599	0.000
Sold in 2013, 3rd Quarter	38.597	0.000
Sold in 2013, 4th Quarter	53.648	0.000
Sold in 2014, 1st Quarter	64.316	0.000
Sold in 2014, 2nd Quarter	55.242	0.000
Sold in 2014, 3rd Quarter	66.281	0.000
Sold in 2014, 4th Quarter	80.373	0.000
Sold in 2015, 1st Quarter	53.398	0.000
Sold in 2015, 2nd Quarter	64.231	0.000
Sold in 2015, 3rd Quarter	55.19	0.000
Sold in 2015, 4th Quarter	68.639	0.000
Model Constant and Global Chow Test		
MODEL CONSTANT	112.313	0.000
GLOBAL REGIMES CHOW TEST	2925.851	0.000

Endnotes

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Endnotes

(i) https://www.treasury.gov/initiatives/financial-stability/TARP-Programs/housing/hhf/Documents/FINAL%20Q2%202013%20Hardest%20Hit%20Fund%20Program%20Performance%20Summary.pdf

(ii) http://www.neighborhoodindicators.org/library/catalog/estimating-effect-demolishing-distressed-structures-cleveland-oh-2009-2013

(iii) https://www.treasury.gov/initiatives/financial-stability/TARP-Programs/housing/hhf/Pages/default.aspx

(iv) https://www.congress.gov/110/plaws/publ343/PLAW-110publ343.pdf; see Section 2 "Purposes,"; 12 U.S.C. 5201

(v) See Endnote ii.

(vi) See Endnote i.

(vii) http://NEO CANDO.case.edu/

(viii) The number of rehabs initially provided to us was about 1,383. We culled the list using the following factors:

• Rehabs had to complete between Q2 2009 and Q4 2015 The impacts of some rehabs underway in 2016 were not analyzed.

• If a rehab occurred in Q3 or Q4 of 2015 and its change of status from land bank-owned was not yet reflected as of Q4 2015, it was not analyzed.

• If, according to the NEO-CANDO system, there was not a residential structure on a property, the rehab was not analyzed.

• If a parcel was not in the GIS parcel map of Cuyahoga, it was not analyzed.

(ix) See: **Kuminoff, N. V., Parmeter, C. F., & Pope, J. C.** (2010). Which hedonic models can we trust to recover the marginal willingness to pay for environmental amenities? Journal of Environmental Economics and Management, 60(3), 145–160. http://doi.org/10.1016/j.jeem.2010.06.001; **Anselin, L., & Arribas-Bel, D.** (2013). Spatial fixed effects and spatial dependence in a single cross-section. Papers in Regional Science, 92(1), 3–17. http://doi.org/10.1111/j.1435-5957.2012.00480.x. In preparing this study, we also found the following articles useful or insightful: **Bayram, A., Solak, S., and Michael Johnson**. 2014. "Stochastic models for strategic resource allocation in nonprofit foreclosed housing acquisitions." European Journal of Operational Research, vol. 233 (1), pp 246-262; **Ding, Chengri, Robert Simons, and Esmail Baku**. 2000. "The Effect of Residential Investment on Nearby Property Values: Evidence from Cleveland, Ohio," Journal of Real Estate Research, vol. 19 (1/2), pp. 24-48; **Edmiston, Kelly D. 2011.** "Low-Income Housing Tax Credit Developments and Neighborhood Property Conditions," Federal Reserve Bank of Kansas City Community Development Research Working Paper 11-10; **Frame, Scott W**. 2010. "Estimating the Effect of Mortgage Foreclosures on Nearby Property Values: A Critical Review of the Literature," Federal Reserve Bank of Atlanta Economic Review, Q4, pp 1-11; **Galster, George, Peter Tatian, and John Accordino**. 2006. "Targeting Investments for Neighborhood Revitalization," Journal of the American Planning Association, vol. 72 (4), pp. 457-474; **Goetz, Edward G., Kristin Cooper, Bret Thiele, and Hin Kin Lam**. 1997. "The Fiscal Impacts of the St. Paul Houses to Homes Program," Unpublished manuscript, Neighborhood Planning for Community Revitalization, Center for Urban and Regional Affairs, University of Minnesota, February; **Hackworth, J**. 2016. "Demolition as urban policy in the American Rust Belt," Environment and Planning; **Haurin, Donald R**., **Robert D. Dietz, and Bruce A. Weinberg**. 2002. "The Impact of Neighborhood Homeownership Rates: A Review of the Theoretical and Empirical Literature," Journal of Housing Research, vol. 13 (2), pp. 119-151; **Herath, Shanaka, and Gunther Maier.** 2010. "The Hedonic Price Method in Real Estate and Housing Market Research: A Review of the Literature," SRE – Discussion Papers, 2010/03, WU Vienna University of Economics and Business; **Margulis, Harry L., and Catherine Sheets**. 2008. "Housing Rehabilitation Impacts on Neighborhood Stability in a Declining Industrial City," Journal of Urban Affairs, vol. 7 (3), pp. 19-37; **Voicu, Ioan, and Vicki Been**. 2008. "The Effect of Community Gardens on Neighboring Property Values," Real Estate Economics, vol. 36 (2), pp. 241-283; **Ioannides, Yannis**. 2002. "Residential Neighborhood Effects," Journal of Urban Economics, vol. 32 (2), pp. 145-165; **Johnson, M.P.,**

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(x) James, G., et al., 2013. An Introduction to Statistical Learning: with Applications in R, Springer Texts in Statistics 103, DOI 10.1007/978-1-4614-7138-7 10, © Springer Science+Business Media New York

(xi) MacQueen, J.B., 1967. "Some Methods for classification and Analysis of Multivariate Observations, Proceedings of 5-th Berkeley Symposium on Mathematical Statistics and Probability", Berkeley, University of California Press, 1:281-297

(xii) It is noteworthy that 97.4% of the rehabs were tax current as of the end of 2015. We were surprised that tax timeliness rates remained very high, given that many of these rehabs occurred in areas with chronically-high tax delinquency rates. Although not tested in this study, from our experience we think much of this success can be credited to the soundness of the discretion of the programmatic rehabbers concerning to whom they sell the properties.

(xiii) Rosen, S. (1974). Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition. Journal of Political Economy, 82(1), 34–55.

(xiv) Taylor, Laura O. 2003. "The Hedonic Method." Chapter 10 in (Champ et al. eds.) A Primer for Non-Market Valuation. Kluwer Academic Publishers: Netherlands. pp. 331-393.

(xv) Ibid.

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(xviii) Anselin, L. (1988). Spatial Econometrics: Methods and Models (Vol. 4). Dordrecht: Springer Netherlands. Retrieved from http://link.springer.com/10.1007/978-94-015-7799-1

(xix) See: Kuminoff, N. V., Parmeter, C. F., & Pope, J. C. (2010). Which hedonic models can we trust to recover the marginal willingness to pay for environmental amenities? Journal of Environmental Economics and Management, 60(3), 145–160. http://doi.org/10.1016/j.jeem.2010.06.001; Anselin, L., & Arribas-Bel, D. (2013). Spatial fixed effects and spatial dependence in a single cross-section. Papers in Regional Science, 92(1), 3–17.

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(xxi) Whitaker, S., & Fitzpatrick, T. (2013). Deconstructing distressed-property spillovers: The effects of vacant, tax-delinquent, and foreclosed properties in housing submarkets. Journal of Housing Economics, 22(2), 79–91.

(xxii) See page 2 of the linked PDF for explanation of difference in means t-test performed: http://www.stata.com/manuals13/rttest.pdf

(xxiii) Edmiston, K. D. (2012). Nonprofit housing investment and local area home values. Economic Review-Federal Reserve Bank of Kansas City, 67.

(xxiv) Case, K. E., & Shiller, R. J. (1987). Prices of Single Family Homes Since 1970: New Indexes for Four Cities (Working Paper No. 2393). National Bureau of Economic Research. Retrieved from http://www.nber.org/papers/w2393

(xxv) Photos courtesy of Youngstown Neighborhood Development Corporation.

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United States

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