Neighborhood Price Externalities of Foreclosure Rehabilitation: An Examination of the Neighborhood Stabilization Program

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Abstract

The federally-funded, HUD-administered Neighborhood Stabilization Program (NSP) was enacted in the wake of the financial recession to mitigate the underlying adverse neighborhood effects associated with foreclosed properties. We examined the neighborhood price impacts of NSP-funded foreclosure rehabilitation undertaken by Habitat for Humanity in Dallas County, Texas using a difference-in-difference framework. Foreclosure rehabilitation projects in Dallas County produced an average 15% increase in neighborhood home prices that sold up to 30 months after the rehabilitated property sale and within 0.1 miles of the rehabilitated property. Foreclosure rehabilitation that involved significant exterior repairs was associated with the largest estimated effect sizes. Results suggest that NSP-funding in Dallas County effectively targeted homes that had the potential to have the most severe neighborhood impacts, and that rehabilitation was an effective means of reversing neighborhood price externalities associated with blighted foreclosed properties.

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1 Introduction

Numerous studies have robustly shown that residential property foreclosures produce negative neighborhood price externalities (e.g., Campbell et al., 2011; Lee, 2008; Schuetz et al., 2008; Zhang and Leonard, 2014; Lin et al., 2009; Harding et al., 2009; Hartley, 2014; Rogers and Winter, 2009; Immergluck and Smith, 2006; Leonard and Murdoch, 2009). In the wake of the 2007-2009 financial recession, several programs emerged to rehabilitate foreclosed properties with the implied objective of stemming deleterious neighborhood price effects. The programs ranged from the large, publicly funded Neighborhood Stabilization Program (NSP) to smaller non-profit initiatives and private donations of REO properties on the part of banks. The majority of these programs provided funds for foreclosure property acquisition or directly donated properties to non-profit organizations in the community which in turn rehabilitated them and then returned them to the housing stock via a market transaction. However, the temporal and spatial nature of any neighborhood price externalities related to foreclosure rehabilitation have not been estimated.

We employed a spatial difference-in-difference approach to estimate the neighborhood price externalities associated with properties rehabilitated by Habitat for Humanity in Dallas County, TX through two waves of NSP funding (NSP1 and NSP3). Detailed appraisal reports and HUD-1 documentation for each property allowed us to identify the time when Habitat took ownership, completed rehabilitation, and executed a third party sale of each property. Additionally, we knew the extent of the work completed for each property and the increase in market appraisal estimated as a result of that work. This allowed us to explore the timing of foreclosure-rehabilitation effects, heterogeneity in the types of properties rehabilitated, and mechanisms producing externalities (e.g. blight, housing supply, or comparable-based pricing models).

1.1 Neighborhood Effects of Foreclosure

The estimated magnitude and geographic and temporal expanse of neighborhood foreclosure externalities varies across studies. Reported foreclosure price externalities within a block of foreclosed properties have ranged from 1% to 9% of home value (Lee, 2008). Negative neighborhood price externalities within approximately 500 feet[1] have been estimated to be 0.9 percent in Chicago, IL (Immergluck and Smith, 2006), 0.2% to 0.4% in New York City (Schuetz et al., 2008), 1% in St. Louis County, Missouri (Rogers and Winter, 2009), 0.61% in Sacramento California (Wassmer, 2011) and 0.5% in Dallas County, TX (Leonard and Murdoch, 2009). Using data on REO properties from 7 Metropolitan Statistical Areas, Harding et al. (2009) found that both the magnitude of the neighborhood price impact and the speed of distance decay differed by geographic region. These differences may be a result of different housing markets, different rules governing the foreclosure process, different intensities of foreclosure activity, or a variety of other factors which vary between urban areas.

However, even within the same housing market, heterogeneity in the foreclosure price externalities have been estimated. Properties with a larger degree of deterioration or blight (Fisher et al., 2015), longer foreclosure processes (Zhang et al., 2015; Daneshvary and Clauretie, 2012), and lower relative home values (Zhang and Leonard, 2014) have all been found to be associated with larger neighborhood price externalities compared to other properties in the same urban housing market. This suggests that foreclosure rehabilitation programs might be expected to produce positive neighborhood price externalities at least as great as the average local negative price externalities associated with foreclosure because they target for rehabilitation foreclosed properties in the most vulnerable neighborhoods and with the poorest conditions.

Alongside estimation of neighborhood foreclosure price externalities, researchers have attempted to characterize the mechanism through which price externalities are produced. Three primary channels have been identified: blight, valuation, and supply (Lee, 2008). These channels are distinct with respect to both the mechanism through which the externality is generated and the timing of the external impact. Similarly, one might suspect that positive neighborhood price externalities associated with foreclosure rehabilitation might operate through the reversal of these

[1] The Immergluck and Smith (2006) results are based on one-eighth of a mile; the Wassmer (2011) results are based on one-tenth of a mile; the Schuetz et al. (2008) and Leonard and Murdoch (2009) results are based on 250 feet; the Rogers and Winter (2009) results are based on 200 yards.

channels.

The blight channel occurs because foreclosed properties are poorly maintained. Foreclosure rehabilitation reverses blight. The timing of this impact, however, depends on whether housing market participants respond to expectations of blight reduction or actual blight reduction. For example, for the case of rehabilitation initiatives executed by Habitat for Humanity (the data examined in this study), immediately after property acquisition Habitat displayed signs in front of the property and began maintaining the lawn. These were signals that blight was being remedied and might be expected to drive expectations, but blight was not fully corrected until the rehabilitation was completed. Additionally, not all foreclosures produced the same "type" of blight. Property deterioration that affects the exterior of the home is more likely to produce blight that impacts the surrounding neighborhood.

The valuation channel occurs because foreclosed homes often sell at a discount and may produce negative neighborhood price externalities immediately following a market sale of a foreclosed property. This channel would be expected to work in reverse only following the market sale of a rehabilitated foreclosed property. Unlike blight, both interior and exterior property rehabilitation is likely to produce neighborhood externalities through the valuation channel. Further the valuation channel will likely produce price externalities that decay rapidly with time.

The supply channel occurs because foreclosed homes "recycle" back to the market and increase the supply of houses on the market. If the supply channel is responsible for negative foreclosure price externalities, we might expect it would also create negative price externalities associated with NSP-funded rehabilitation because in both cases, the supply of market-priced housing is increased.

Harding et al. (2009) found that, for real-estate owned (REO) properties, variations in the blight channel were the most likely source of heterogeneity in the degree of neighborhood price externalities. Similarly Zhang et al. (2015) found that for REO properties that do not result in a quick market sale, the blight channel was the most likely cause of price externalities, but there were slight negative price externalities associated with REO properties that re-sold quickly and these likely operated through either the valuation or supply channels. In the analysis that follows both the timing and direction of price externalities will inform the mechanism through which NSP-funded rehabilitation influences neighboring home prices.

1.2 Foreclosure Rehabilitation Programs

Foreclosure rehabilitation programs that emerged in the wake of the 2007-2009 economic recession were primarily motivated by a fear of long-term neighborhood impacts of the unusually high level of foreclosure activity. The large spike of foreclosures during the recession led to a prolonged foreclosure process in many areas, as financial institutions struggled to manage an increasingly large stock of REO properties. REO properties became the property of the institution holding a failed mortgage when foreclosed properties did not achieve a sale at auction or were not returned to the market via a short sale. In most cases, REO properties included foreclosures in the poorest condition and/or located in neighborhoods where home values had dropped the most because it was these properties for which the alternatives (auction sale or short sale) were least likely. Alongside attempting to process a record high number of mortgage defaults, financial institutions were taxed with managing a record high level of REO stock. "Inadequate" management of this stock led to further property deterioration and the potential for larger neighborhood price externalities.

Beginning in 2006, government agencies began to develop policy supports to alleviate negative consequences of the pending housing market turmoil. These responses included supports to stimulate housing demand such as the home buyer tax credit, support for Fannie Mae and Freddie Mac, and maintaining low interest rates (Joice, 2011). NSP was a more targeted policy response aimed at the foreclosure epidemic and neighborhoods where foreclosures and vacancies were severe in particular. NSP provided federal funding for local non-profit agencies to acquire distressed foreclosed properties. The agencies then invested in these properties and returned them to the active housing stock through a market transaction.

NSP was rolled out in three phases (Joice, 2011) and included roughly $7 billion in funding. The first phase, NSP1 was part of the Housing and Economics Recovery Act (HERA) and allocated $3.92 billion beginning in July 2008. The funds were distributed among 309 local and state government entities. In January 2009, NSP2, part of the American Recovery and Reinvestment Act, provided an additional $1.93 billion which was dispersed to 56 grantees. An additional $1 billion was distributed among 270 state and local agencies through NSP3 in September 2010 as part of the Dodd-Frank Financial Reform Bill. An important feature of the NSP program was that the funds allocated had to be spent within a given time frame, generally within 3 years. For Dallas County, the NSP1 funds had to be spent by September of 2010. Most NSP3 funds had to be expended within 3 years (18 months for NSP1) (Fraser and Oakley, 2015; HUD, 2015a; Schuetz et al., 2015a).

NSP1 and NSP3 used formulas to distribute the funds resulting in broad participation across the U.S. while NSP2 utilized a more selective competitive funding mechanism.[2] Funds could be used for home financing mechanisms (e.g., down payment assistance), acquisition and rehabilitation, or land banking. In all cases, funds were required to target foreclosed, abandoned or vacant properties; and households assisted by the program were required to make less than 120% of Area Median Income (AMI), with at least 25% of funds allocated to households making less than 50% of AMI (HUD, 2015a).

It was the intent of NSP to provide a geographically targeted injection of funds to help revitalize neighborhoods, and administration of the program varied from NSP1 to NSP3 as HUD worked out the most effective ways to encourage beneficial geographic targeting. Geographic targeting constraints were loose and largely deemed ineffective in NSP1. For NSP2, HUD developed a GIS tool and method for assessing census track foreclosure risk scores. The foreclosure risk score was based upon the level of high cost loans in a Census tract, change in home values within the metro-area, 2008 county unemployment rate, and change in county-level unemployment between 2007 and 2008 (HUD, 2015b). To receive NSP2 funding, the target area must have had an average foreclosure risk score of 18 on a 20 point scale. This requirement was relaxed slightly in NSP3, which required an average risk score of at least 17 or an average risk score greater than 80 percent of census tracts in the state (Joice, 2011).

[2]The formula for NSP2 was based on the number and percentage of home foreclosures, mortgage defaults and sub-prime loans. For NSP2, grants provided considerable flexibility to HUD. See Joice (2011) for details.

Implementation of the NSP program in Dallas County (the location of our study) was limited to NSP1 and NSP3. Thirty percent of Texas's $102 million in funds received through NSP1 were allocated to the Dallas-Fort Worth MSA; and 14.5% ($4.4 million) were allocated to Dallas County. For NSP3, 51% of the state's funds went to the Dallas-Fort Worth MSA and 37% of these ($1.4 million) were allocated to Dallas County (Blum, 2011). Dallas County then contracted with Dallas Area Habitat for Humanity to use the funds to rehabilitate foreclosed properties. For both NSP1 and NSP3 all funding was used to purchase, repair and resell vacant properties.

Habitat was able to expend all of the NSP1 funding within the programs deadline. In total 40 homes were repaired using the Dallas County NSP1 funding and some additional funds acquired from the proceeds of homes sold early in the program. One-third of homes were sold to households making less than 50% of AMI, and on average repairs increased home appraisal values (comparing appraisal at purchase and at resell) by 25% (Dallas Area Habitat for Humanity, 2011).

NSP3 had a smaller budget, and allowed for 13 homes to be repaired and returned to the market. Homes rehabilitated through NSP3 were resold between June 2012 and October 2013.

1.3 Neighborhood Effects of Property Rehabilitation

The NSP program was undertaken with the intention of spurring neighborhood re-development. While NSP was a unique policy effort, its effects may also be compared to other neighborhood improvement initiatives aimed at blight removals such as Hope VI, low-income housing tax credits (LIHTC), and Community Development Block Grant (CDBG) programs. All of these program have been analyzed by various authors and with mixed results in terms of their neighborhood-level impacts (Schuetz et al., 2015a). Additionally, the few studies to date analyzing NSP effects have also had mixed results (Fraser and Oakley, 2015; Schuetz et al., 2015b; Spader et al., 2015).

The heterogeneity in results is likely an effect of the different contexts in which neighborhood improvement efforts were undertaken. In particular, a distinguishing feature of NSP was that the program had a wide range of flexibility with regards to implementation which gave rise to a wide range of documented potential benefits including stimulating market demand, spurring of private investment, building non-profit capacity in neighborhood redevelopment, alleviation of blight and land banking properties for future larger-scale development activities (Fraser and Oakley, 2015; Reid et al., 2011). All of these likely impacted neighborhoods in different ways, and at different time horizons. Thus estimating "average" treatment effects across a nationally representative sample of NSP funded projects is problematic because in fact there is no "average" outcome of NSP funding (Schuetz et al., 2015a).

Results from the few studies that have estimated neighborhood-effects of NSP have been mixed. One intended consequence of NSP was to reduce vacancy rates in targeted neighborhoods. However, REO properties in NSP neighborhoods may have been purchased by investors or land banked, thus vacancy reductions were not widespread–although in some locations NSP was associated with decreased vacancy rates and increased sales volume (Ergungor and Nelson, 2012; Immergluck, 2012; Schuetz et al., 2015b). NSP may be expected to generate neighborhood price externalities because rehabilitation reverses blight which occurred during the foreclosure process. Spader et al. (2015) documented evidence of blight reversal based on field observations in Cuyahoga County, Ohio, and Palm Beach County, Florida. However, there was no documented neighborhood price impacts observed in empirical analysis of NSP programs across a sample of counties and no significant difference in social conditions between NSP and control block groups in Boston (Graves et al., 2013; Spader et al., 2015).

The literature exposes several areas for further investigation of NSP effects. First, the neighborhood-level effects of NSP funding should be evaluated within singular contexts to improve our understanding of how different implementations of NSP impacted neighborhoods (Fraser and Oakley, 2015; Reid et al., 2011; Schuetz et al., 2015a). Second, a more robust assessment of the temporal variation in neighborhood price effects is warranted. Existing studies were only able to examine very short-term price impacts and no studies have systematically examined temporal variation in NSP neighborhood price effects (Schuetz et al., 2015a). Third, the geographic scope of neighborhood-level effects has not been adequately assessed. Existing studies have utilized Census boundaries to define neighborhoods and did not test for the impact of alternative neighborhood definitions (Ergungor and Nelson, 2012; Graves et al., 2013; Spader et al., 2015).

2 Methodology

A spatial difference-in-difference (DID) framework, similar to that of Cui and Walsh (2015), was used to compare the change in property prices of properties nearer and farther from foreclosures rehabilitated using NSP funding (hereafter "NSP-properties"). Unbiased estimation of the DID model required (1) accurate definition of spatial and temporal boundaries for assignment of treatment/control and Pre-/Post- status, respectively; and (2) proper selection of treatment/control areas such that underlying fundamentals governing house price trends within control and treated areas, conditional on observable house and neighborhood characteristics, were the same. In the results section, we will discuss these two requirements in light of our sample data.

To construct the DID model, we first assigned houses to treatment or control conditions based on their proximity to an NSP-property. $Treatment$ is the variable which indicates house sale observations assigned to the treatment group. Figure 1 illustrates the boundaries used to assign treatment status in our baseline models. House sales occurring in the area nearer to rehabilitated foreclosure properties were considered "treated". In baseline models, houses within a 0.10 mile buffer around a rehabilitated property were assigned to the treatment group ($Treatment = 1$). The control group ($Treatment = 0$) was comprised of houses in a concentric circle doughnut around the treatment group. Properties considered in a treatment group for any other NSP properties and NSP properties themselves were excluded from all control groups. Both treatment and control areas were within 0.20 miles of an NSP-property, or a 0.13 square mile area around an NSP-property. It is important to note that this area is small so that one might expect house price trends, conditional on house characteristics, should be quite similar between treatment and control groups with the exception of the foreclosure rehabilitation.

In subsequent models, we allowed the radius of the treatment group to vary from that used in the baseline models. We explored the price externalities associated with foreclosure rehabilitation across treatment group buffers ranging from 0.05 miles from the NSP-property to 0.15 miles from the NSP-property. The control group ($Treatment = 0$) remained the same for all models and was defined as house sales occurring between 0.15 and 0.20 miles from the rehabilitated property (Figure 1). Varying the area used for assigning houses to the treatment group while holding the control group constant allowed us to explore the geographic extent of treatment effects and to test the robustness of our results to alternative treatment boundaries.

Identification of the correct treatment boundary was critical for estimating unbiased treatment effects. Figure 2 illustrates how treatment effect sizes will be impacted if the treatment boundary is inaccurately defined. Our model assumed that treatment was a decreasing function of distance from the NSP-treated property as depicted by the downward sloping line in Figure 2.[3] If the treatment boundary is too small such that some "treated" properties end up in the control condition, then the DID estimator of the average treatment effect size will be downward biased. Alternatively, if the treatment boundary is too large such that some "untreated" properties are included in the treatment condition, then the average treatment effect size will also be downward biased.

The variable $After$ indicates house sales which took place after foreclosure rehabilitation occurred. We defined the time at which treatment took place in two different ways as illustrated in Figure 3. Our first definition (Anticipated Treatment), assumed treatment occurred during the 12-month window beginning immediately after Habitat took ownership of the foreclosed property. This might be the case if, for example, foreclosure rehabilitation effects were based upon reputation effects, or maintenance of the yard surrounding the property. Our second definition (Completed Treatment) assumed that treatment occurred in the 12-month window after Habitat had completed renovations and executed a successful market sale of the property. In all models, the Pre-treatment period was the 12-months prior to Habitat acquiring the property. In the event that a home sale was near to more than one rehabilitated property, its status (and the associated value of $After$) was assigned based on its relationship with the nearest rehabilitated property. In subsequent models we relaxed the 12-month time-window assumption maintained in the baseline models and tested

[3]Figure 2 displays a linear function relating treatment effect size to distance from NSP-property, but the implications hold for any function so long as effect size decreases to zero beyond some distance.

the temporal extent of foreclosure neighborhood price externalities by allowing the post-treatment time window to vary from 9 to 30 months.

The DID model provided estimates of the average change in house prices in treated neighborhoods between the pre- and post-treatment periods while "netting out" the average change in house prices in control neighborhoods. The resulting estimate measured mean treatment effects of foreclosure rehabilitation under the assumption that house sales assigned to treatment and control groups were similar except for their proximity to the rehabilitated foreclosure property. To account for individual and neighborhood level differences between houses in treatment and control neighborhoods we employed a multi-variate difference-in-difference model. In particular, we estimated the model below, where matrices are indicated by bolded variables:

$$
\begin{aligned}
Y = & \alpha + \mathbf{X}\beta_1 + \mathbf{N}\beta_2 + \mathbf{D}\beta_3 + \gamma Treatment + \tau After + \theta Treatment * After \\
& + \epsilon
\end{aligned} \tag{1}
$$

The natural log of house sale prices for all houses in treatment and control groups is contained in the vector Y. **X** is a matrix of house characteristics including: house condition as rated by the local appraisal district, number of stories, presence of fireplace, presence of pool, number of baths, square feet of living area, lot size, house age, and whether or not the property was a foreclosure sale. **D** is a matrix of dummy variables to account for year and month of sale fixed effects. Similarly, **N** is a matrix of neighborhood characteristics including Census block group proportion of each major race/ethnic group[4], census block group proportion of households below the federal poverty line, existence of other NSP-properties in the neighborhood [5], number of foreclosure sales within the same year and within 2000 feet, and the average sale price within 2000 feet for each of the previous 3 years. The difference-in-difference estimate is given by $\hat{\theta}$.

We took a step-wise approach to estimating (1) in order to observe how treatment effects in the

[4]Race/ethnic groups include non-Hispanic black, non-Hispanic white, Asian and Hispanic.

[5]Specifically, we adjust for neighborhood NSP activity by including measures for distance to nearest NSP property, number of NSP properties with 2000 feet and within 4000 feet

baseline models varied with the addition of controls to account for neighborhood heterogeneity. In the first step, we assumed $\beta_2 = 0$ and $\beta_3 = 0$. Thus, we obtained the difference-in-difference estimator that did not take into account seasonality in home prices or neighborhood influences on home prices that might have differed between treatment and control groups. Next, we lifted the restrictions on β_2 and β_3 sequentially.

After assessing treatment effects in the baseline model, we explored spatial and temporal variation of the estimated treatment effects. First, maintaining the baseline temporal assignment of $After$, we varied the spatial boundaries that determined the size of the treatment area around the rehabilitated foreclosure property. Comparison of estimated average treatment effects across this set of models provided an indication of the spatial extent of treatment. Second, we held the treatment area constant as in the baseline models, and varied the duration of the post-treatment period to estimate temporal variation in the treatment effects. Comparison of estimates across this set of models informed the degree to which treatment effects attenuated with time.

3 Data

The primary variables considered in the analysis were obtained from a spatial merge of home sales and characteristic data obtained from the University of Texas at Dallas Real Estate Research Database and administrative data from Dallas Area Habitat for Humanity. Additional neighborhood-level controls were obtained from the American Community Survey (US Census).

3.1 Rehabilitated Properties Data

We examined 47 NSP properties which were acquired by Habitat for Humanity of Dallas County between August 26, 2009 and February 22, 2014 and for which complete appraisal records and dates of acquisition and rehabilitation completion could be documented. These properties were acquired through either NSP1 funding (37 properties acquired in 2009) or NSP3 funding (10 properties acquired from 2011-2013). Figure 4 shows the spatial distribution of rehabilitated properties. All properties were clustered within residential neighborhoods in the southern sector of Dallas county.

3.2 Sales Data

The sales data includes historical records of all Dallas county residential real-estate transactions recorded in the multiple listing service from 2006 through 2013. For each property, data include property characteristics including sale prices, month and year of sale, and physical address of the home. Each sale was temporally and geographically associated with the nearest NSP-property. Characteristics of the nearest NSP-property including, dates of acquisition and sale of the rehabilitated property, and type of rehabilitation work completed were appended to the sales record. Additionally, we appended the following to the sales data: census block group characteristic data (ACS 2006-2010 5-year estimates), other measures related to neighborhood foreclosure sales, house price trends (computed from DCAD records), and measures of proximity to other NSP-properties in the neighborhood.

3.3 Summary Statistics

Summary statistics of all properties within 0.25 miles of a rehabilitated foreclosure that sold within a pre-treatment or treatment period are displayed in Table 1. The average sale price was approximately $109,000. On average, these properties were just over 2000 square feet, had roughly 2 bathrooms and were around 12 years old at the time of NSP1. Most were one-story dwellings (70%) with a fireplace (85%), but without a pool (97%). On average the neighborhoods were majority African American (64%) with modest poverty rates (8.6% of households below poverty).

In total there were 2201 properties that sold within a quarter-mile of the rehabilitated foreclosures. A subset of these properties was used to estimate the empirical models based on the definitions for the treatment/control area and the pre- / post-treatment assignment. For example, properties located in the treatment or control areas as depicted in Figure 1 for each foreclosure rehabilitation that also occured during the pre-treatment period or one of the two treatment periods were used to estimate the baseline models.

4 Results

A prerequisite for unbiased difference-in-difference estimates is for the treatment and control groups to exhibit similar price trends prior to treatment. Figure 5 presents predicted sale price trends for properties within 0.25 miles of rehabilitated foreclosures. Predicted prices were obtained using locally weighted scatter plot smoothing (LOWESS). The graph illustrates overlapping conditional house price trends prior to treatment and an abrupt decline in conditional house prices for the treated group following treatment.

Next we explored treatment effects as a function of distance from NSP properties using local polynomial regression. The results are presented in Figure 6 and were based upon all sales occurring within 12-months of foreclosure rehabilitation for the nearest NSP property. Conditional home prices[6] declined most steeply with distance from the nearest NSP property until around 0.1 miles; then they plateaued. Between about 0.15 to 0.42 miles home prices again declined with distance but at a decreasing rate. Beyond 0.45 miles, the conditional price trend increased with distance from the nearest NSP property.

4.1 Difference-in-Difference Analysis of Baseline Models

Table 2 presents coefficient estimates for the baseline difference-in-difference model described in (1) and illustrated in Figures 1 and 3. The top panel contains estimates for which $After$ was defined based on Anticipated Treatment, while the bottom panel contains estimates for which $After$ was defined based on Completed Treatment. In all of the models, the pre-treatment period was the 12 months preceding Habitat ownership of the property. In models 1 through 3, additional controls were added to the models to account for house characteristics, year and month of sale fixed effects and neighborhood characteristics, respectively.

[6] Home prices are conditional on housing characteristics.

There were no statistically significant estimates of foreclosure rehabilitation treatment effects in the Anticipated Treatment models. However, for the Completed Treatment models, there were statistically significant, positive neighborhood price externalities associated with foreclosure rehabilitation after accounting for the full set control variables (model 3). Foreclosure rehabilitation was associated with a 15% increase in neighborhood home prices.

Next, we examined the difference between foreclosure rehabilitation that addressed only interior defects vs rehabilitation that addressed only exterior defects. Considering only the subsample for which rehabilitation addressed exterior defects, we estimated a 14% increase in neighborhood home prices associated with foreclosure rehabilitation. For the model examining properties with only interior renovations, we estimated a 9% increase in neighborhood home prices associated with foreclosure rehabilitation, but this point estimate was not statistically different from zero due to the considerably larger standard errors in this model.

In subsequent models we consider only the post-treatment period that begins after the market sale of the rehabilitated property (Completed Treatment) because this was where we observed statistically significant neighborhood price impacts.[7]

4.2 Temporal and Geographic Variation in Foreclosure Rehabilitation Neighborhood Price Externalities

Next, we investigated the temporal duration of the neighborhood price externalities. Table 3 presents estimates of (1) in which the post-treatment period began after the market sale of the foreclosed property and lasted for durations ranging from 9 to 30 months. The pre-treatment period and treatment and control areas were the same as those employed in the baseline models and the full set of controls (i.e. house characteristics, year and month fixed effects, and neighborhood characteristics) were included in all models. Positive, statistically significant neighborhood price externalities were estimated in all models, but begin to decline in magnitude at more distance time

[7] We thoroughly explored the Anticipated Treatment period in additional models not reported here to check that treatment effects were not evident at different treatment/control boundaries and different time windows. No statistically significant treatment effects were estimated.

horizons. Beyond 30 months the estimated price externality was no longer statistically different from zero (results available upon request).

To investigate the geographic extent of neighborhood price externalities, we varied the radius of the treatment area from 0.05 miles to 0.15 miles while keeping the control area and $After$ assignment the same as was used in the baseline models. Results are presented in Table 4. The estimated treatment effect was only statistically significant when the treatment boundary was based on a 0.10 mile radius. In further analysis, we found positive statistically significant treatment effects for treatment radii between 0.10 and 0.11 miles and the results were robust to changes in the control boundary and alterations to the specification of $After$.[8]

4.3 Sensitivity Analysis

Critical to our identification strategy, was the assumption that house prices in treatment and control areas followed similar trends after controlling for the covariates in our model. To account for the potential for unobserved differences across neighborhoods, we also analyzed the baseline models using census tract fixed effects, and found substantively similar results. Additionally, we conducted sensitivity tests by altering the control boundaries, and the $After$ period (i.e. 0-6 months instead of 0-12 months) and found our results to be robust to these alternative specifications. The exception was that the estimated neighborhood price externalities associated with foreclosure rehabilitation lost statistical significance as the control boundary became large.

5 Discussion

We found robust evidence for positive neighborhood price externalities associated with foreclosure rehabilitation projects undertaken by Habitat for Humanity in Dallas County, TX as part of the federally funded NSP program. The magnitude of the neighborhood price externality far exceeded (in absolute value) the effects estimated in Dallas County for foreclosures in general (-.5%

[8] Specifically, we allowed $After$ to be defined as 0-6 months following foreclosure rehabilitation, and we both increased and decreased the distance from the NSP-property to the control area boundary by 0.025 miles.

price impact within 250 feet) (Leonard and Murdoch, 2009) and those estimated in the poorest neighborhoods (3.5% price impact within 250 feet) (Zhang and Leonard, 2014). Additionally, the effect size for NSP-property externalities, was comparable (in absolute value) to the effect size estimated for properties that spent the longest time in the foreclosure process (-19% price impact within 250 feet) (Zhang et al., 2015). Thus, we found that foreclosure rehabilitation has the potential to reverse negative neighborhood price externalities and likely was implemented in Dallas County in such a way that the "worst" foreclosures were targeted.

Results suggest that the geographic extent of neighborhood price externalities was within 0.10 miles of the NSP-property. This is similar to the distance over which foreclosure price externalities were observed (i.e. 250-500 feet for foreclosure externalities vs 0.10 miles = 528 feet for NSP-property externalities). Estimated price externalities for NSP-properties were not statistically significant when both smaller and larger $Treatment$ area boundaries were employed; but this may be explained by the fact that treatment effects will be biased downward if the proper treatment boundary is not identified (i.e. Figure 2). Similiarily, estimated neighborhood price externalities were no longer statistically significant when the control area was expanded.

Temporal decay of the neighborhood price externalities associated with NSP-properties was slow to emerge. Price externalities were statistically significant up to 30 months following the completion of NSP renovation.

One of our goals in estimating foreclosure rehabilitation price externalities was to provide additional insight regarding the mechanism(s) through which the neighborhood price externalities operate. The absence of statistically significant treatment effects for the Anticipated Treatment period suggests that expectations did not play a substantial role in producing price externalities as suggested in some early studies of the likely effects of NSP (Schuetz et al., 2015a). The positive price externalities observed for the Completed Treatment period indicate that the valuation and blight channels (indicated by positive price externalities) dominated any supply channels that may be operating. However, our inability to rule out the possibility of a supply channel suggests that our estimates might be considered as a lower bound for positive price externalities associated with the blight and valuation channels. Nevertheless, for any rehabilitation efforts for which properties are returned to the housing stock, the supply channel will operate in tandem with blight and valuation channels. In stratified models, neighborhood price externalities were only observed for the sub-sample of properties with significant exterior repairs; however, the model examining interior repairs produced point estimates of similar magnitude, but with much higher standard errors. Thus, it is difficult to conclude anything regarding differences in the neighborhood price externalities associated with interior and exterior repairs. Nevertheless, the neighborhood price externalities were long-lasting suggesting a primary role for the blight channel.

Estimates of the treatment effects can be used to understand the efficiency of public expenditures on the NSP program. In total $5.8 million dollars in NSP funding went into the rehabilitation of the 47 NSP properties considered in this study. Considering an average home price in the NSP-targeted neighborhoods of $109,000, an average neighborhood price increase of 15%, and 2463 homes in the treatment area of the rehabilitated properties examined, the NSP funding for the 47 properties produced an estimated $40.3 million (95% CI: [$8 million, $72.5 million]) in property price increases. Of course, these property price increases are only "theoretical" in that most of these properties did not sell during the 30 month window over which we observed the price increase. However, if the property price increases led to an increase in appraisal values and hence the basis for assessment of property taxes, then at least a portion of the price increases were recouped by the various county and local agencies collecting property taxes. For example, at a 2% property tax rate, the price increases associated with NSP-funded renovations would lead to $805,400 in additional tax receipts on an annual basis. Further, these estimates do not necessarily represent the full effects of the NSP intervention. One of the beliefs underlying NSP funding was that without intervention, neighborhoods might eventually fall into severe decay. In our analysis of neighborhood price trends, we do not find evidence for this belief as treatment and control neighborhoods exhibit very similar price trends prior to foreclosure rehabilitation efforts. However, there is the possibility that these trends may have eventually diverged had rehabilitation efforts not been undertaken.

Our results should be considered in light of the study's limitations. We were only able to analyze the effects of foreclosure rehabilitation in one urban county and external validity to other implementations of NSP depends upon the extent of similarity to the implementation examined here. Further, we did not have complete data on all rehabilitation efforts that may have been occurring during the study window. Failure to account for other rehabilitation efforts leaves open the possibility of "contamination" of our control area, which would downward bias our treatment effect estimates. Likewise it is possible that some other unobserved factors that affect neighborhood home prices were not randomly distributed across treatment and control areas resulting in biased treatment estimates. However, the close proximity of treatment and control areas and our inclusion of a wide range of individual and neighborhood-level controls (including census-tract fixed effects) helps to mitigate this concern. Finally, our assessment of the efficiency of public NSP expenditures assumes that market sales observed are representative of the type of housing stock available in the neighborhoods of the NSP properties. Our assessment of the total gain in local property prices associated with the NSP activity may be biased if this assumption does not hold.

In conclusion, we found that foreclosure rehabilitation efforts in Dallas County resulted in positive neighborhood price externalities within 0.10 miles of the rehabilitated property. Further, these price effects were observed for up to 30 months following the foreclosure rehabilitation effort. Previous authors have noted the necessity of analyzing NSP effects within local contexts since there was significant heterogeneity in program implementation across the country (Fraser and Oakley, 2015; Reid et al., 2011; Schuetz et al., 2015a). Further study of NSP effects in other locations will help to inform the extent to which the effects of NSP in Dallas County are representative of the programs effect in other areas.

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6 Figures

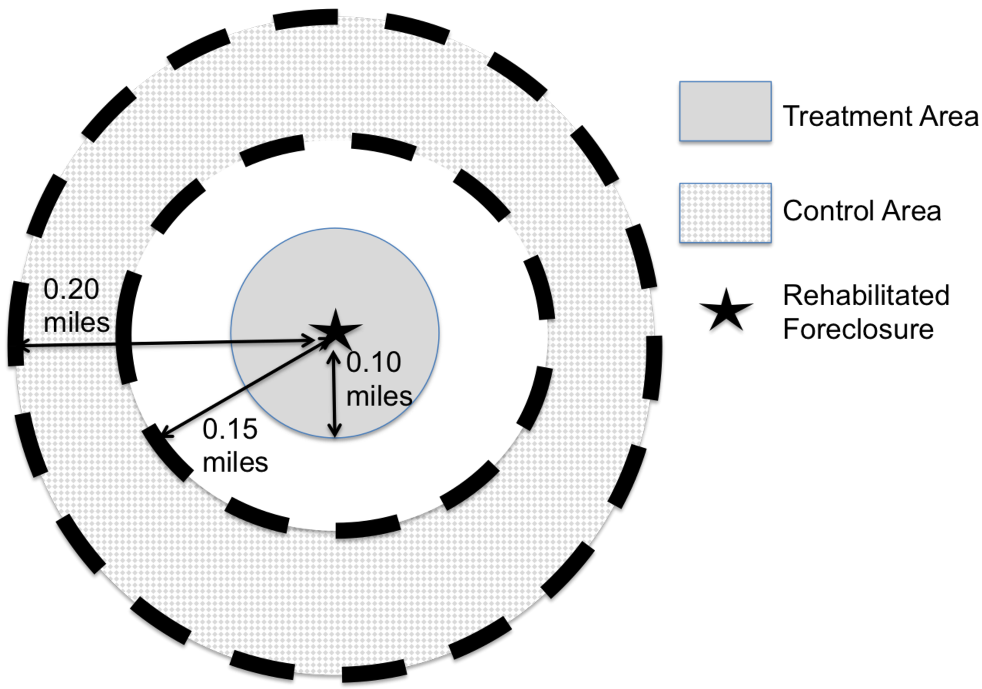
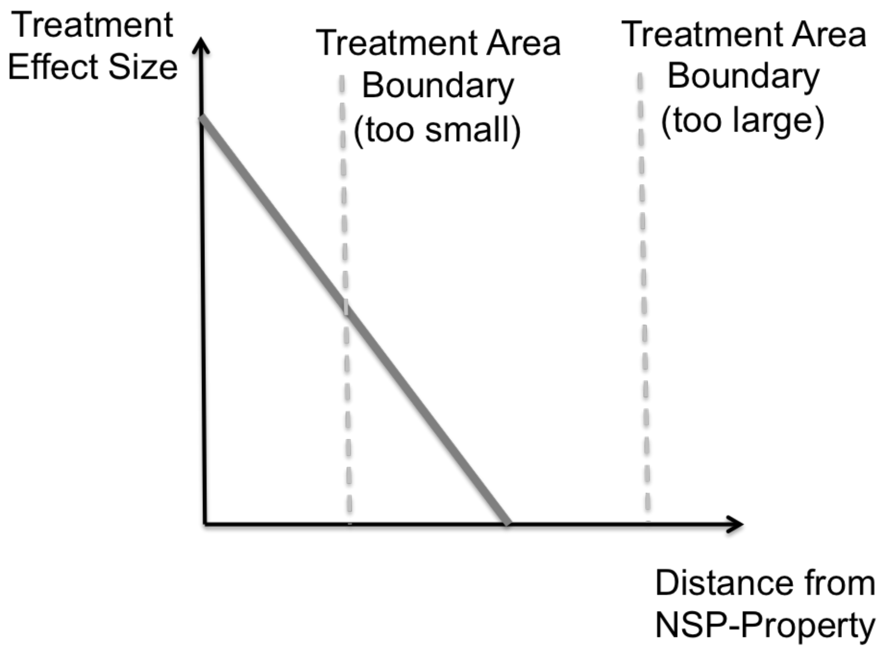


Figure 1: Baseline Treatment and Control Areas



Treatment area is defined as distances less than the treatment boundary.
Control area contains properties at distances greater than the treatment boundary.

Figure 2: Treatment Effect Size Estimation

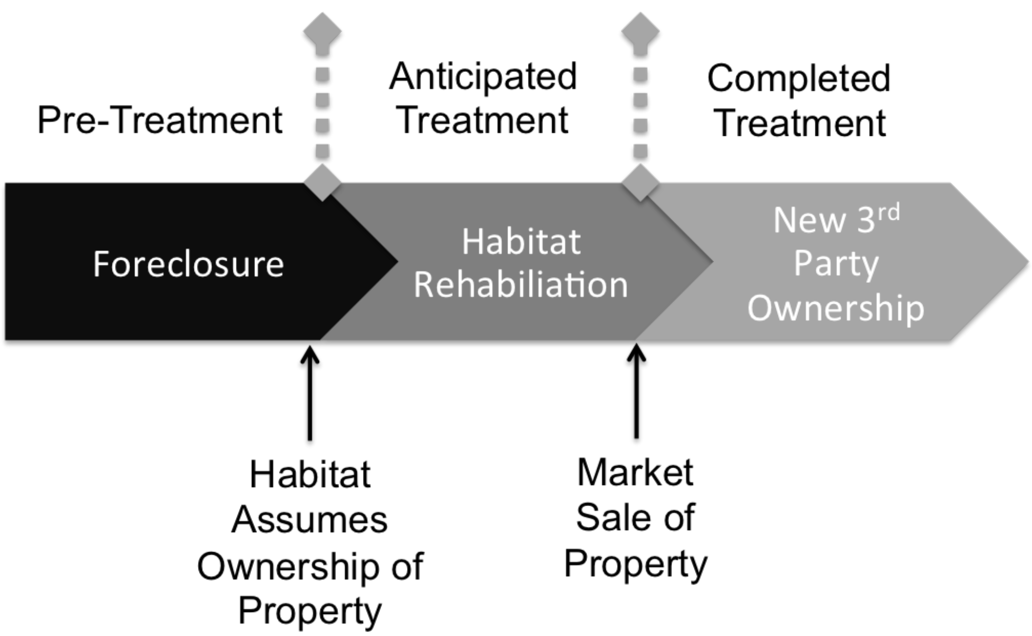


Figure 3: Baseline Pre-Treatment and Post-Treatement Definitions

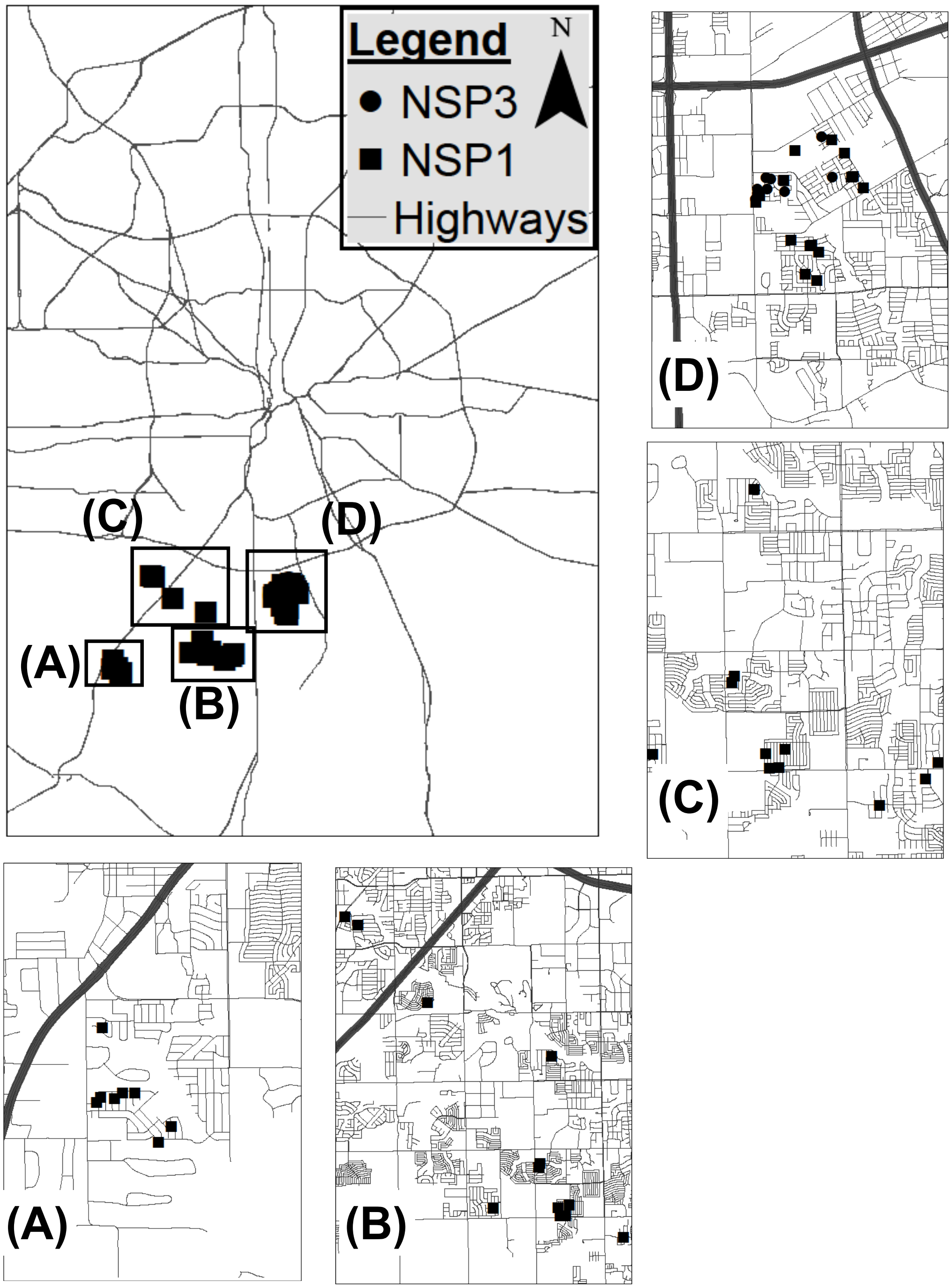


Figure 4: NSP-Properties in Dallas County, TX Rehabilitated by Habitat for Humanity

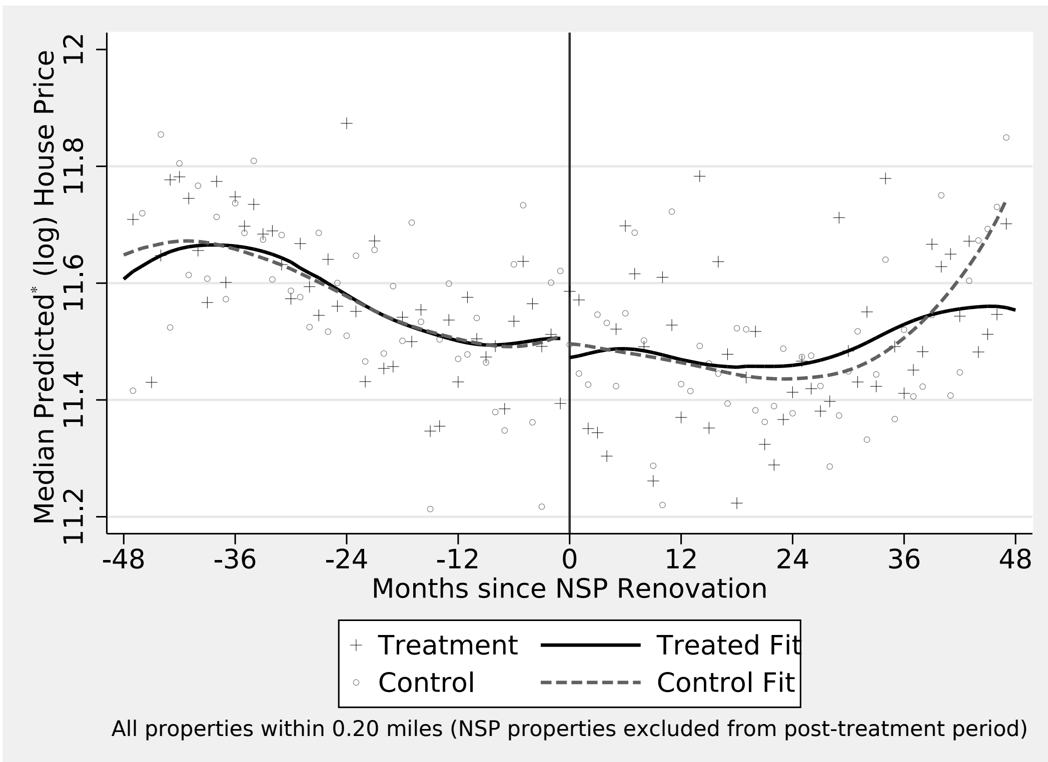


Figure 5: Predicted House Price Trends for Treatment and Control Groups using LOWESS Smoothing

*Predicted prices based on house characteristics and year of sale

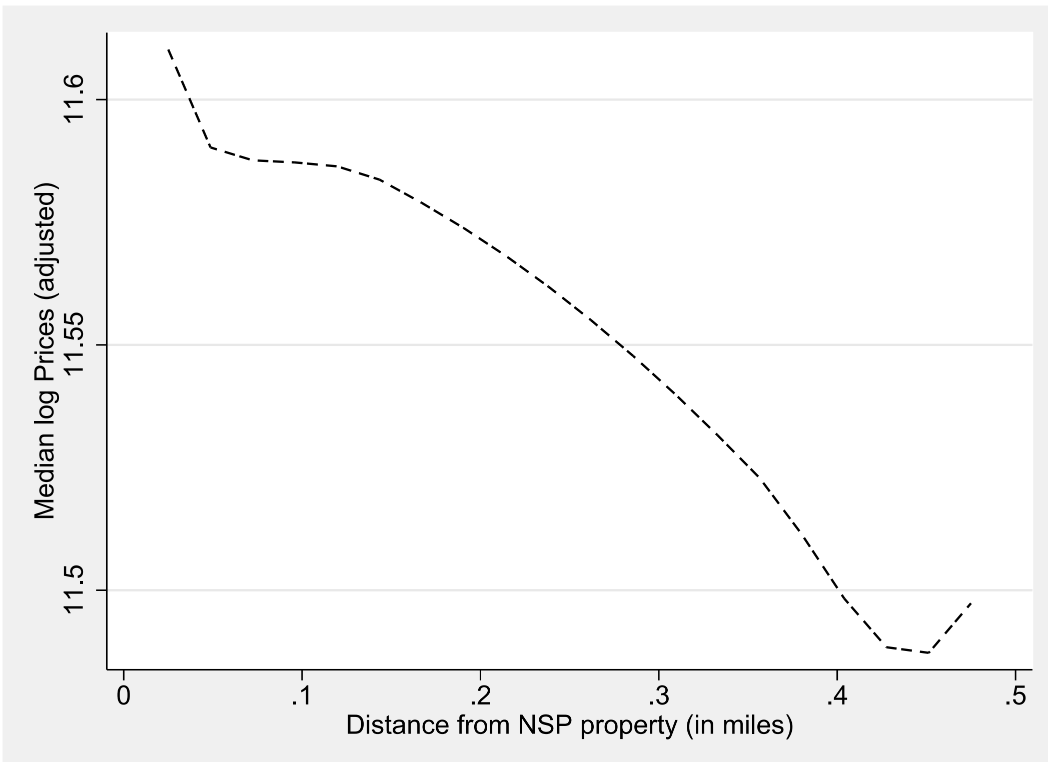


Figure 6: Local Polynomial Regression of Adjusted Log House Price and Distance from NSP Properties

*Log house prices are adjusted for house characteristics

7 Tables

Table 1: Summary statistics for Properties within 0.25 miles of NSP properties

Variable	Mean	Std. Dev.	Min.	Max.
Hedonic Characteristics				
Price ($)	108608	41008	18000	700000
Age (years)	12.6	12.4	0	72
Bathrooms	2.2	0.51	0	4.5
Living area (sqft)	2164	703	736	4530
Land area (sqft)	8447	2827	2701	33521
Fireplace	0.86	0.40	0	3
Number of Stories	1.3	0.45	1	2
Pool	0.03	0.18	0	1
Neighborhood Characteristics				
White (%)	19.9	17.5	0.6	74.1
Black (%)	63.9	23.4	0.00	94.8
Hispanic (%)	13.1	10.3	0.00	92.3
Asian (%)	1.4	2.3	0.00	8.6
Below Poverty (%)	8.6	7.6	0	49.7
Distance to nearest NSP property (feet)	702.9	348.1	0	1319.7
No. of observations	2201			

Table 2: Neighborhood Price Effects of NSP-Property Rehabilitation–Baseline Models

	Model 1	**Model 2**	**Model 3**	**Interior Renovation Only**	**Exterior Renovation Only**
Treatment Effects based on Anticipated Treatment					
Treatment[◇]	-0.070	-0.070*	-0.156	0.028	0.015
	(0.049)	(0.040)	(0.158)	(0.086)	(0.058)
After[◇◇]	0.010	0.082**	0.078**	0.052	0.065
	(0.041)	(0.036)	(0.034)	(0.048)	(0.054)
*Treatment**After*	-0.055	-0.034	-0.009	-0.164	0.034
	(0.057)	(0.040)	(0.043)	(0.105)	(0.070)
Observations	171	171	171	100	134
R-squared	0.774	0.807	0.866	0.917	0.896
Treatment Effects based on Completed Treatment					
Treatment[◇]	-0.123**	-0.128**	-0.099	-0.043	0.099
	(0.045)	(0.052)	(0.135)	(0.097)	(0.065)
After[◇◇]	-0.034	-0.021	-0.212***	-0.097	-0.199**
	(0.041)	(0.056)	(0.069)	(0.057)	(0.073)
*Treatment**After*	0.042	0.050	0.151**	0.090	0.140**
	(0.052)	(0.063)	(0.061)	(0.210)	(0.064)
Observations	138	138	138	81	110
R-squared	0.802	0.819	0.888	0.932	0.912
Controls					
House Characteristics[†]	✓	✓	✓	✓	✓
Year & month fixed-effects	✗	✓	✓	✓	✓
Neighborhood Characteristics[‡]	✗	✗	✓	✓	✓

The dependent variable is log price of the property.
Standard errors clustered at census tract-year level (in parentheses).
*** p<0.01, ** p<0.05, * p<0.10.

◇ The Treatment Group is properties with at least one NSP property within .1 miles and the control group is any home not in the treatment group and within .15-.2 miles of an NSP property.
◇◇ After is defined as the period 0-12 months after the treatment of the nearest NSP property.
†: House characteristics include house condition as rated by the local appraisal district, number of stories, presence of fireplace, presence of pool, number of baths, square feet of living area, lot size, house age, and whether or not the property was a foreclosure sale.
‡: Neighborhood characteristics include census block group proportion of each major race/ethnic group, census block group proportion of households below the federal poverty line, existence of other NSP-properties in the neighborhood, number of foreclosure sales within the same year and within 2000 feet, and the average sale price within 2000 feet for each of the previous 3 years

Table 3: Treatment Effects Based on Completed Treatment: Expanding Post-Treatment period

Length of *After* period in months	<= 9	<= 12	<= 15	<= 18	<= 21	<= 24	<= 27	<= 30
Treatment◇	-0.172	-0.099	-0.128	-0.121	-0.105	-0.126	-0.138	-0.119
	(0.140)	(0.135)	(0.131)	(0.131)	(0.124)	(0.124)	(0.121)	(0.125)
After◇◇	-0.221***	-0.212***	-0.200**	-0.202***	-0.203***	-0.194***	-0.199***	-0.190***
	(0.075)	(0.069)	(0.071)	(0.061)	(0.062)	(0.057)	(0.058)	(0.057)
*Treatment***After*	0.152**	0.151**	0.145**	0.144**	0.143**	0.139**	0.145**	0.127**
	(0.066)	(0.061)	(0.057)	(0.053)	(0.052)	(0.052)	(0.051)	(0.052)
Observations	132	138	141	144	148	150	153	158
R-squared	0.890	0.888	0.888	0.891	0.888	0.894	0.897	0.897

The dependent variable is log price of the property. All models contain the following controls: housing characteristics, year & month fixed effects, and neighborhood characteristics. The period when $After = 0$ is always 12 months prior to the beginning of NSP-funded renovation.
Standard errors clustered at census tract-year level (in parentheses).
*** p<0.01, ** p<0.05, * p<0.10.

◇ *Treatment* is defined as in the baseline models.
◇◇ After is defined as the period after renovation of the NSP property is complete. The length of the period following renovation is expanded from 9 to 30 months in successive models.

Table 4: Results for varying the treatment area radius: Effects for the first 12 months

Treatment Radius (miles)	0.05	0.075	0.10	0.125	0.15
Treatment◇	0.293	-0.294	-0.099	0.033	0.002
	(0.735)	(0.274)	(0.135)	(0.086)	(0.042)
After◇◇	-0.209***	-0.194***	-0.212***	-0.141*	-0.123
	(0.071)	(0.060)	(0.069)	(0.080)	(0.079)
*Treatment*After*	0.014	0.068	0.151**	0.110	0.092
	(0.059)	(0.040)	(0.061)	(0.085)	(0.076)
Observations	85	112	138	174	209
R-squared	0.940	0.904	0.888	0.860	0.860

The dependent variable is log price of the property. All models contain the following controls: housing characteristics, year & month fixed effects, and neighborhood characteristics.
Standard errors clustered at census tract-year level (in parentheses).
*** p<0.01, ** p<0.05, * p<0.10.

◇ *Treatment* radius is expanded in successive models. The area used to define properties in the control group is the same as in the baseline models. Properties considered in a treatment group for any other NSP properties are excluded from all control groups.
◇◇ *After* is defined as in the baseline models.