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Tax Incentives and Housing Investment in Low-Income Neighborhoods

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Abstract

Governments often use tax incentives to encourage residential investment in blighted neighborhoods. Exploiting the lottery structure of Missouri's Neighborhood Preservation Act (NPA), this paper examines how tax incentives to promote housing investment affect communities. Missouri's NPA offers tax credits to homeowners and developers that improve or expand the owner-occupied housing stock in the state's poorer neighborhoods. Due to limits on the amount that can be awarded, the state uses a lottery to determine which applicants receive credits. Taking advantage of the random assignment of NPA tax credits and exploiting detailed property-level data, I find evidence that the program has positive but modest effects on construction activity. While there appear to be some positive spillovers on neighbors' investment behavior, the effects are confined to properties within 50 feet of those receiving credits. Impacts on property values are larger in geographic scope, implying important roles for both neighbor interactions and amenity effects in local housing markets.

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1. Introduction

Over the past several decades, federal, state, and local governments in the U.S. have instituted a large number of programs that involve market-based incentive schemes to encourage private activities considered important to mitigating externalities or solving coordination problems. Many of these programs have been centered on the housing market, where externalities are pervasive. Such programs often take the form of tax credits, grants, or low-interest loans to households or developers for housing construction, maintenance, and renovation projects.

These housing programs are typically justified on the grounds that such projects have substantial positive spillovers on neighborhoods. Not only might one homeowner's reinvestment activities increase property values of nearby homes, but they might also spur neighbors to reinvest themselves. Many rehabilitation programs are targeted at moderately and severely poor neighborhoods, where both increasing property values and instigating neighborhood revitalization efforts may be particularly important. However, one major concern regarding these programs is that they could merely displace or crowd out unsubsidized private investment in housing. That is, some or even all of the investment subsidized by the government might have happened even in the absence of any government subsidy.

This paper examines the impacts of Missouri's Neighborhood Preservation Act (NPA) in the City of St. Louis. The NPA offers tax credits to homeowners and developers that improve or expand the owner-occupied housing stock in low-income communities. Because there is a limit on the amount of credits that can be awarded, the state uses a lottery to determine which applicants receive the credits.

Taking advantage of the random assignment of NPA tax credits and detailed property-level data, I find evidence of positive but modest effects of the program on construction activity. Relative to those whose applications for tax credits were approved, a sizable fraction of new construction projects whose applications for tax credits were denied were never completed. Moreover, on average, roughly 70% more building permits are issued to properties for which developers or homeowners applied for and received tax credits than those for which developers or homeowners applied for but were denied credits. This difference in permitting activity shrinks little over time, suggesting that the credits are not merely shifting the timing of projects. These results point to the potential for housing subsidies to stimulate some degree of investment in new construction and rehabilitation in blighted areas.

I go on to study the external effects of the housing investment spurred by the NPA, and find that the impacts of the program extend beyond the properties that received tax credits. The results suggest that construction activity on one property has direct effects on neighbors' investment behavior. However, I find that, while positive spillovers on neighbors' behavior exist, the effects are modest and very limited in geographic scope. In particular, compared to properties close to those that were denied credits, properties close to those that received credits are more likely to apply for building permits, but the effects are small and dissipate within 50 feet of the property in question.

Finally, using property assessment data, I consider the impacts of the NPA's tax credits for housing investment on property values. For every $1 in credits authorized, tax credit recipients' property values increase by about $0.10 on average. Neighboring house values also increase, but the gradient is steep, with the effects largely disappearing within about 350 feet (roughly the length of a city block). Assuming a discount rate of 4%, it would take nearly 100 years for the implied increases in property tax revenues derived from the overall increase in property values spurred by the NPA to cover program costs.

The results provide new insights into neighborhood interactions and the mechanisms behind home price dynamics at a local level. The exogenous variation in housing investment induced by the NPA coupled with detailed property-level data allow me to shed light on the sources of housing externalities. In particular, the results suggest that the external effects of new housing investment are attributable both to changes in the investment behavior of neighbors and to amenity effects. However, the magnitudes of both effects are not large, highlighting the limitations of housing construction and rehabilitation subsidies in spurring broader neighborhood revitalization.

While programs similar to Missouri's NPA exist throughout the U.S. and abroad, what evidence exists on their effectiveness is mixed. Galster (1987), Galster and Hesser (1988), and Whalley (1988) evaluate a Minneapolis program administered in the late 1970s that subsidized property maintenance through loans and grants. They find that the program stimulated private upkeep expenditure above and beyond what would have occurred without the subsidies. They also find that subsidized reinvestment by one household prompted new unsubsidized spending on housing by neighboring households. Meanwhile, Galster et al. (2006) and Rossi-Hansberg et al. (2010) examined the Neighborhoods in Bloom program in Richmond, Virginia, which allocated public funds to improving the existing owner-occupied housing stock and constructing new mixed-income housing in certain neighborhoods. Both studies find that land prices in affected neighborhoods rose faster than in control communities and some evidence that investments had spillover effects on nearby areas. However, examining a program in the United Kingdom, Boyne et al. (1991) find that rehabilitation grants largely substitute for private renovation investments, paying for work that would have been undertaken regardless of the grant. They conclude that the program ultimately acted merely as an income transfer to grant recipients.[1]

Outside of the fairly small literature on housing maintenance and renovation incentives, a larger literature considers the impact of new subsidized housing on neighborhood conditions. For example, Ellen et al. (2001) examine the extent of spillovers associated with construction of new subsidized owner-occupied housing in distressed neighborhoods in New York City. Consistent with the presence of housing externalities, they find that prices of properties near construction sites rose. Other studies have considered the impact of new and rehabilitated rental housing subsidized by the federal government's Low-Income Housing Tax Credit and also have found important positive impacts on neighborhoods (Baum-Snow and Marion 2009, Freedman and Owens 2011). However, many of these programs are also associated with a substantial amount of crowd out of private funds (Sinai and Waldfogel 2005, Eriksen and Rosenthal 2011).

Much of the literature on the effects subsidized housing investment in general, and on tax incentives aimed at improving the owner-occupied housing stock in particular, relies on difference-in-differences approaches, comparing changes in conditions for properties or neighborhoods that receive subsidized investment to the same changes for observably similar properties or neighborhoods that do not receive subsidized investment. A major concern with this approach is that it is difficult to know whether treated properties or neighborhoods were similar to controls along unobserved dimensions, and whether, absent the treatment, they would have followed the same trajectory. All else being equal, we might expect developers and homeowners to apply for more subsidies in locations with better future prospects; in fact, I find that NPA

[1] See Kain and Apgar (1985), Galster (1987), and Rossi-Hansberg et al. (2010) for theoretical treatments of rehabilitation incentives.

applicants that lose the lottery apply for substantially more building permits than other observably similar property owners in St. Louis. In a difference-in-differences framework that does not exploit the experimental variation afforded by the NPA, this endogeneity tends to inflate estimates of program impacts on treated properties. Spillovers attributed to subsidies in a non-experimental setting could also be driven by unobserved heterogeneity across neighborhoods; to the extent that locations near those that receive subsidies also have relatively strong future prospects, we might ascribe improvements in the housing stock around a property that receives subsidies to externalities, when in reality the observed improvements would have occurred regardless.

Exploiting the lottery for tax credits under Missouri's NPA, I can overcome these endogeneity problems and more credibly identify the impacts of the program's tax credits on individual properties and their neighborhoods. The results in this paper suggest that government policies to encourage homebuilding and homeownership may be associated with some measurable, albeit modest, impacts on neighborhoods. This is consistent with other recent work suggesting that place-based programs can have important, if small, impacts on communities (Freedman 2012, Busso et al. 2013). In the case of Missouri's NPA, the external effects of the subsidies could be driven by neighborhood effects in renovation decisions (Ioannides 2002, Helms 2012), spillovers on nearby house values from improvements in property conditions (including, for example, the rehabilitation of dilapidated structures and the elimination of vacant lots), and the fact that homeownership itself could encourage further private investment in local amenities and social capital (DiPasquale and Glaeser 1999).[2] However, the results also highlight the limits of such policies in spurring broad-based neighborhood change where it would not happen otherwise.

The paper is organized as follows. The next section provides background on Missouri's NPA and the lottery system that determines which applicants receive tax credits for new construction or rehabilitation of owner-occupied housing in the state. I describe the data and provide descriptive statistics in Section 3. In Section 4, I present the results, including evidence on the program's impacts on both the extensive and intensive margins of construction activity as well as

[2] However, the marginal households induced into homeownership by the program may generate fewer externalities than the average homeowner (Eriksen et al. 2009). New housing supply could also diminish incentives for existing homeowners to invest in neighborhood-specific social capital (Hilber 2010).

on property values. The results not only shed light on the effectiveness of the program, but also the mechanisms behind housing externalities. I conclude in Section 5.

2. Missouri's Neighborhood Preservation Act

2.1. Program Structure

Missouri's NPA was authorized under Senate Bill 20, which was signed July 8, 1999 and went into effect January 1, 2000.[3] Its primary goal is to protect against neighborhood deterioration in the state's poorest communities. The NPA authorizes the use of state tax credits to offset part of the cost of investment in maintenance, repairs, or new construction of housing in low- to moderate-income communities. The program is limited to property that is currently owner occupied or that will be sold to an owner occupant.

Unlike preservation programs in other states, eligibility is not contingent on being an historic site (i.e., listed on a historical site registry) or on the income of the taxpayer. Instead, eligibility for the tax credits is based entirely on the location of the property.

In general, the size of the potential tax credits varies on the basis of initial income levels in the area, with properties located in so-called "qualifying areas" eligible to receive larger tax credits than those in so-called "eligible areas." For the purposes of the main analysis, I focus on projects in the City of St. Louis, the entirety of which is qualifying by virtue of being designated a "distressed community," or a municipality with median household income below 70% of that of the metropolitan area in which it is located. The household income data used for designation during the sample period were derived from the 2000 Decennial Census.[4]

Homeowners or developers building new owner-occupied housing in qualifying areas can receive tax credits amounting to 15% of eligible costs, with credits not to exceed $40,000 per residence per ten year period. Those investing in "substantial rehabilitation" of owner-occupied housing in qualifying areas can receive tax credits of 35% of eligible costs, with minimum costs the greater of $5,000 or 50% of the purchase price; for substantial rehabilitation credits, the tax credit cannot exceed $70,000 per residence per ten year period. Finally, those investing in "non-substantial rehabilitation" of owner-occupied housing in qualifying areas can receive tax credits

[3] Information in this section is drawn from Missouri's Department of Economic Development website (http://ded.mo.gov) and from conversations with program staff.
[4] According to the 2000 Decennial Census, at $27,156, the median household income of the City of St. Louis in 1999 was 60% of the median household income of the Metropolitan Area of St. Louis of $45,432.

amounting to 25% of eligible costs, with minimum costs of $5,000 and tax credits not to exceed $25,000 per residence per ten year period.[5] Appendix Table A1 provides a list of eligible and ineligible expenditures for new construction and rehabilitation projects under the program.[6]

2.2. Credit Lottery

The NPA authorizes $16 million in tax credits statewide each year, $8 million of which is earmarked for qualifying areas. Demand for credits has exceeded supply every year in qualifying areas.[7] To disperse the limited NPA funds to proposed projects in qualifying areas, the state's Department of Economic Development (DED) uses a lottery. In particular, the DED assigns a random number to all applicants conditional on satisfying all the eligibility requirements. It then ranks the applications based on this random number. Working down the list, it awards credits, deducting the amount of the credit from the total allocated to eligible or qualifying areas depending on the location of the project. When all the credits are exhausted or it runs out of applications, the DED stops.

The lottery system for awarding credits under the NPA provides an ideal setting to examine the impact of tax incentives for housing investment on neighborhoods. Indeed, unlike with state allocations of other types of tax credits (including Low-Income Housing Tax Credits) that are also often in excess demand, Missouri's NPA credits will not necessarily be allocated to those

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[5] By comparison, those building new owner-occupied housing in eligible block groups can receive credits amounting to 15% of eligible costs, with credits not to exceed $25,000 per residence per ten year period. Substantial rehabilitations in eligible areas can receive tax credits up to 25% of eligible costs, with minimum costs of $10,000 and tax credits not to exceed $25,000 per residence per ten year period. There are no tax credits for non-substantial rehabilitations in eligible areas.

[6] Taxpayers cannot combine the program with other state or federal loans or tax credit programs, with the exception of the state's Historic Preservation Tax Credit program. If Historic Preservation tax credits are claimed, the maximum available credits under the NPA are the lesser of 20% of eligible costs or $40,000. It is possible that those denied NPA tax credits seek funding from other public sources for planned new construction or rehabilitations. To the extent that I do not observe and cannot control for applicants' financing from other public sources, this substitution will tend to bias my estimates of the impacts of the NPA toward zero.

[7] Demand has not exceeded supply each year in eligible areas, which have higher median household incomes. Because the probability of winning the lottery was higher for applicants in eligible areas relative to qualifying areas every year, some developers and homeowners in St. Louis may have entered their applications into the eligible pool even though they were technically in a qualifying area. Unfortunately, I do not observe which pool into which applications were initially entered. However, among applications submitted from eligible areas in St. Louis, 17% won credits on average between 2003 and 2006, compared to 7% among applications submitted for all other areas. This suggests that some applications submitted in St. Louis were actually entered into the eligible pool for the purposes of the lottery. Therefore, in the main analysis, I exclude 416 NPA projects (60 approved and 356 denied) located in eligible block groups in St. Louis. However, including these projects has little effect on the main results (results available upon request).

projects that program officers believe might have the greatest social benefit.[8] Rather, they are randomly assigned to those applicants who meet the eligibility criteria. Projects for which homeowners or developers applied for credits but were turned down provide a natural comparison group to projects for which homeowners or developers applied for and received credits.

The randomization thus allows me to more credibly identify the impacts of tax incentives for housing investment than past studies, which have typically relied on difference-in-differences approaches (Ellen et al. 2001, Galster et al. 2006, Schwartz et al. 2006, Rossi-Hansberg et al. 2010). A major concern in such studies is that the treatment is endogenous to outcomes of interest. This might happen, for example, if tax credits are awarded disproportionately in areas with better future prospects. Ignoring this endogeneity is likely to bias upward the estimated effects of subsidies at the property level as well as at the broader neighborhood level, as community improvement that would have happened regardless will be mistakenly attributed to government subsidies and their spillovers.[9]

3. Data

3.1. Sources

I use data from several sources. The first is Missouri's Department of Economic Development (DED), which publishes on its website information on areas eligible to receive the NPA tax credits. I obtained data on awarded NPA tax credits from the Missouri State Government's Accountability Portal, a website created to improve the transparency of the state government's programs and provide information on the uses of taxpayer money. Missouri's DED also provided supplemental information on NPA credit awards that were not claimed as well as information on the location of each proposed project, which allowed me to use commercial GIS software to assign each project a census block. Finally, the DED provided me a list of the locations of all the projects that lost the lottery, which I also assigned to blocks.

[8] There is also concern with the Low-Income Housing Tax Credit that program officials choose projects likely to be successful, which are more likely to be those that are inframarginal. This could contribute to recent findings of a substantial amount of crowd-out associated with the Low-Income Housing Tax Credit program (Eriksen and Rosenthal 2009).

[9] Notably, if there are important housing externalities that contaminate the control group in these studies, estimates based on a difference-in-differences strategy could also potentially understate the impact of such programs.

The tax credit data cover fiscal years 2000-2010, but I only focus on applications from 2003-2006 in the main analysis. The list of denied applications prior to fiscal 2003 contain some applications that were denied because the projects were ineligible as opposed to because they lost the lottery; based on the available information, it is not possible to identify those that were never entered into the lottery. Therefore, to ensure that the sample consists only of those applicants who actually took part in the lottery, I drop applications submitted before fiscal 2003. Meanwhile, for authorized applications submitted after fiscal 2006, a much larger fraction of credits have not yet been claimed, suggesting that proposed projects may not be complete.[10] In addition, focusing on projects in 2006 and before allows for some lag in the effect of projects on neighborhoods.[11] Finally, the sharp change in housing market conditions due to the late-decade recession likely changed rehabilitation and construction decisions in important ways. For these reasons, I focus in the main analysis on applications submitted between fiscal 2003 and fiscal 2006.

I restrict attention to projects in the City of St. Louis, where I could obtain extensive property-level data. I first matched each approved and denied project to parcels as delineated by Saint Louis' Assessor's Office, which for those properties that exist allowed me to obtain a city parcel identifier. To match NPA projects to parcels, I began with exact address matching using street number, street name, and zip code. When that failed, I used GIS software to map NPA projects to their respective parcels. A small fraction of the projects did not have an exact match in the parcel data, which is likely because these projects were never completed. In the empirical analysis, I examine the frequency of matches to parcels across approved and denied applications as one measure of the effectiveness of the program in spurring investment.

For those NPA projects with a parcel identifier, I could match them to data on issued building permits and assessments from the St. Louis Building Division and the Assessor's Office, respectively.[12] The permit data include complete information for 1990-2008, and are broken out by type of permit. These types include building permits (for new construction or additions),

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[10] Among all winning applications in qualifying areas, only 41% of the credits awarded between fiscal 2007 and fiscal 2009 had been claimed by the end of the decade. Part of this is because some projects have yet to be completed. The downturn in the housing market also likely reduced take-up.

[11] Many winning applicants use the credit in the calendar year in which they receive it (then claim it on their tax returns the subsequent year), but some do not. As further discussed in Section 4.2.2., the carryforward on the credit is five years.

[12] Ellen et al. (2013) also use permit data to study renovation activity, in their case in response to historic district designations in New York City.

demolition permits, occupancy permits, electrical permits, mechanical permits, plumbing permits, and permit waivers.[13]

Meanwhile, information on property values is based on tax assessment data provided by the City of St. Louis' Assessor's Office. The data include individual property assessments each year between 2001 and 2011. The Assessor's office generally appraises properties in the city every odd year unless there is new construction or if a property undergoes major rehabilitation or destruction (for example, as a result of flood, fire, or demolition). The Assessor's Office attempts to capture the fair market value of properties in its assessments using information on new construction that has occurred, sales prices of comparable properties located nearby, the condition of properties, and other factors.[14]

Finally, I extracted information from the 2000 Decennial Census on a host of census block-level demographic and housing characteristics, including population, racial and ethnic composition, the age distribution, the number of housing units, the share occupied, the share vacant, the share owner occupied, and the share renter occupied. I use this information to test whether neighborhood characteristics are balanced across approved and denied applications as well as to construct control variables for use in some of the regressions.

Notably, because the lottery takes place yearly, randomization is conditional on year of the lottery, with a different potential probability of winning each year. In principle, this could lead a sample pooled across several years to be unbalanced on covariates.[15] However, roughly the same fraction of applications (between 91% and 96%) were denied each year between 2003 and 2006, and as discussed in the next section, covariates are relatively balanced despite the pooling across years as well as the restricted attention on St. Louis.[16] Additionally, as shown in robustness tests, the results are very similar when I stratify the sample by year.

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[13] An occupancy permit verifies that a building is suitable for occupancy. In St. Louis, occupancy permits are generally not required for residential property. However, a developer may apply for such permits if some portion of the development is commercial or if they plan to receive Section 8 subsidies.

[14] Notably, the data provided by the Assessor's Office is the "assessed value," which is a fraction of the market value assigned by the Assessor's Office that depends on the type of the property in question (e.g., residential, agricultural, commercial). I adjust the assessed values using these fractions to reach estimates of market values.

[15] See Duflo et al. (2007) for a detailed discussion of how randomization conditional on observable variables (in this case, year) will lead to departures from perfect randomization.

[16] In fact, they are slightly more balanced than in several of the individual years, as randomization together with the law of large numbers (and not just randomization alone) result in treated and control groups that are balanced (Hoxby and Rockoff 2004).

3.2. Descriptive Statistics

Figure 1 maps all of the approved and denied applications in the City of St. Louis between 2003 and 2006. The boundaries delineate neighborhoods within St. Louis, of which there are 79. It is clear from the maps that, while there are substantially more denied projects than approved projects, their spatial distribution is very similar. Indeed, a disproportionate number of both approved and denied applications originate in neighborhoods just south of downtown (including Lafayette Square, McKinley Heights, and Benton Park) and on the west side of the city (including Skinker/DeBaliviere, West End, and Hamilton Heights).

The top panel of Table 1 describes the characteristics of approved and denied applications' neighborhoods using 2000 Decennial Census data at the block level. The columns break out approved and denied applications and reports for the census blocks in which they are located average housing characteristics, including total housing units, share occupied, and share owner occupied, as well as average demographic characteristics, including population, share white, share black, share under age 18, share age 65 and over, total households, and average household size.

The typical NPA application in St. Louis comes from a block with just over 40 housing units, close to 30% of which are vacant. Of those housing units not vacant, slightly more than 40% are owner-occupied on average. The average application is also on a block with around 80 total residents, of which approximately two-thirds are black.[17]

While it is clear based on columns (1) and (2) in Table 1 that approved and denied applications are located on blocks that are on average very similar, there are some notable differences. Approved applications are located on blocks with slightly larger populations and with higher homeownership rates. However, none of the difference in block characteristics for approved and denied applications in qualifying areas are statistically significant at the 5% level. Further, while the difference in homeownership rates is statistically significant at the 10% level, we would expect that, given the number of characteristics we are comparing, at least a few

[17] The City of St. Louis as a whole was 51% black in 2000. In interpreting the numbers in Table 1, it is important to remember that the data are at the project level as opposed to the block level such that some blocks are represented multiple times.

differences would show up as significant.[18] Importantly, though, all the differences in baseline block characteristics between approved and denied projects are small in magnitude

In the second panel of Table 1, I also report the average property value in 2001 among those properties that were approved and denied NPA tax credits. Excluding properties that applied for credits but did not exist in 2001, the average property value was just under $54,000 for those properties that were authorized credits, and just under $68,000 for those denied credits. Assigning a value to zero to those properties that applied for credits between 2003 and 2006 but did not exist in 2001, there is a similar difference between the values of those that were approved and denied; the average property value among those approved credits was about $14,000 lower than the average property value among those denied credits. However, the variance in property values is quite large, such that whether I exclude those properties that did not exist in 2001 or assign values of zero to them, I cannot reject the null hypothesis that average property values are the same for both groups.[19]

The final panel of Table 1 reports information on the median size of credits authorized (including breakouts for developers and homeowners), the fraction of credits claimed, and the median size of the credit conditional on being claimed (i.e., the median credit issued). Between 2003 and 2006, there were 197 approved applications and 2,912 denied applications in qualifying block groups in St. Louis. The median credit authorized to winning applications in St. Louis was $33,000. Over 94% of credits awarded between 2003 and 2006 were claimed, and the median issued credit was $27,573. The median credit awarded to and claimed by developers was similar, but slightly larger in size than the median credit awarded to and claimed by homeowners. Notably, relative to the average initial property values, the magnitudes of these credits are large.

[18] Under the null that there is no difference for all 10 of the characteristics and if they are independent, we would expect to observe at least one difference significant at the 10% level 65% of the time. Using a Bonferroni adjusted p-value for 90% confidence of 0.01, none of the differences are statistically significant. However, when estimates are correlated (as they likely are in this case), Bonferroni adjustments are too conservative.

[19] The p-value for the difference when I exclude properties that did not exist in 2001 is 0.83. The p-value for the difference when I assign a value of zero to properties that did not exist in 2001 is 0.68.

4. Results

4.1. New Housing Construction

In the first step of the analysis, I consider whether I was able to match an application to an exact parcel in the City Assessor's 2012 database.[20] I interpret the lack of a match as an indication that the proposed project was not completed. If the match rate were similar across approved and denied projects, it would serve as one indication that the NPA played little role in stimulating new housing investment, at least on the extensive margin. On the other hand, if the match rate were much lower for denied than approved projects, it would suggest that the NPA helped to encourage some new construction that would not have otherwise taken place.

Unfortunately, the application data I have do not contain information on whether a proposed project is new construction or a rehabilitation. By including both types of projects in the sample, we would expect to find many denied projects with matches in the parcel data even if no denied projects were completed; obviously, proposed rehabilitations of existing properties that are denied credits will still find matches in the Assessor's parcel data. The only cases in which I will find no match are when the address given for a proposed project is not one that exists in the Assessor's database, which would occur if a proposed new construction project was not carried out.[21]

In Table 2, I provide statistics on the percentage of all projects, denied projects, approved projects, and completed projects for which a parcel exists in the Assessor's database. Among denied projects, 11.5% have no match in the parcel data. In other words, the property that the developer or homeowner proposes to construct or rehabilitate in his or her NPA application actually exists in only 88.5% of cases for which the application was ultimately denied. In contrast, among approved applications, only 1 of 197 projects (or 0.5%) is not associated with an existing parcel by the end of the decade. All of the 186 completed projects (i.e., projects for which the credit was issued) are associated with an existing address. These results imply that NPA credits may have been instrumental in spurring some new construction that would not have otherwise taken place.

In a similar exercise, I searched Zillow.com, a website that aggregates and tracks information on homes and home sales nationwide, for every address in all qualifying areas in the entire state

[20] Prior years' parcel shapefiles were not available.
[21] A common reason appears to be that plans to split a single parcel into two were never carried out.

of Missouri (not only St. Louis) that was issued an NPA tax credit as well as a random sample of 500 addresses throughout the state that were denied a credit between 2003 and 2006. Whereas there was no registered address on Zillow.com for only 7% of projects issued credits in Missouri between 2003 and 2006, there was no registered address for nearly one-third of the random sample of projects denied credits during the same period. Additionally, among those properties whose addresses existed on Zillow.com, less than 5% of properties issued credits between 2003 and 2006 were empty lots, compared to over one-fifth of those denied credits during the same period. Finally, among those properties whose address and year built could both be verified on Zillow.com, 43% of properties issued credits between 2003 and 2006 were built after 2000, compared to only 27% of the random sample of properties denied credits. Consistent with the results for St. Louis alone, these results these results suggest that NPA credits may have helped encourage some new construction that would not have otherwise taken place.

4.2. Building Permit Issuance

4.2.1 Baseline Results for Permit Activity

New construction as well as any structural changes or major alterations to existing buildings require building permits from the city's Building Division. The majority of work that would qualify under the NPA program would require a building permit of some type. The city issues building permits for new construction, demolition permits, occupancy permits, electrical permits, mechanical permits, plumbing permits, and permit waivers. For each parcel in the city, I obtained the number and composition of permits obtained from the city.

Between 2003 and 2006, the Building Division of the City of St. Louis issued at least one permit (or permit waiver) to slightly over half of all parcels in the city. On average across all parcels, about 0.22 permits were issued each year between 2003 and 2006, or about one permit per parcel every five years.

Focusing on parcels for which an NPA application was received, and assuming that those with no match in the parcel data had zero permits, the average number of permits issued the year in which the application was submitted was 1.53. As can be seen in Table 3, among those projects for which credits were denied as a result of losing the lottery, an average of 1.47 permits were issued the year of the application. That is, relative to any randomly selected residence in the city, those denied credits are nonetheless more likely to undergo construction or rehabilitation. This points to the endogeneity of applications themselves; while those developers and homeowners who win and lose the credits are chosen at random, the pool of applicants is not representative. Those that enter the lottery have a greater underlying propensity to undertake projects, and even those that lose the lottery apply for permits at a much higher than average rate.

Meanwhile, those projects for which credits were authorized were issued 2.52 permits on average, or about one permit (approximately 71%) more than those that were denied credits. The subset of approved projects that were completed were issued 2.62 permits on average, or nearly 80% more than those that were denied credits. Reassuringly, as Table A2 in the Appendix shows, these differences are only slightly smaller when we restrict attention to those projects for which we found a match in the parcel data, which would tend to understate the effects of receiving tax credits on permitting by excluding proposed new construction that was not pursued as a result of losing the lottery. Overall, these results suggest that credits induce additional construction activity above and beyond what would have occurred in the absence of the credits.[22]

As can also be seen in Table 3, the impacts do not appear to be concentrated in any particular type of permits, but rather are similar across most types. For example, for the sample of all projects (including those with and without matches in the parcel data), projects whose applications were approved obtain 76% more permits for new construction or additions (i.e., building permits), 53% more electrical permits, and 77% more plumbing permits. At 54%, 33%, and 59%, respectively, the figures are only slightly smaller in the sample restricted to projects with identifiable parcels (see Appendix Table A2). The difference in permit issuance to approved projects and denied projects is statistically significant at the 10% level for every type of permit except demolition permits (p-value = 0.16), mechanical permits (p-value = 0.17), and permit waivers (p-value = 0.84).

The lottery structure of Missouri's NPA helps to ensure that the characteristics of approved and denied projects are similar. Nonetheless, we can control for each proposed project's block

[22] It is possible that the existence of the NPA may have spurred some investment that would not have otherwise occurred among denied applicants, who were arguably treated by virtue of applying. This would imply that the impact of the program is in fact larger than the difference in permitting between approved and denied applicants would suggest. However, given that only basic descriptions of planned work and estimated costs are required as part of the NPA application (not quotes from contractors), it is unlikely that the treatment effect of the program on denied properties is large.

characteristics, which may help to improve the precision of the estimated effects. In Table 4, I present the results of reduced-form regressions of the form

$$Permits_{ibt} = \beta_0 + \beta_1 Approved_i + \mu_t + \mathbf{X}_b\Omega + \varepsilon_{ibt} \tag{1}$$

where $Permits_{ibt}$ is the number of permits issued to project i in block b in year t, $Approved_i$ is a dummy that equals 1 if project i was approved and 0 otherwise, μ_t is a fixed effect for the year t in which the application was submitted, $\mathbf{X}_b$ is a vector of block b's characteristics measured in 2000, and ε_{ibt} is the error term. The vector of block characteristics includes the number of housing units, share occupied, share owner-occupied, total population, share white, share black, share under age 18, share age 65 and over, number of households, and average household size.[23] The standard errors in this and future regressions are adjusted for heteroskedasticity and clusters at the neighborhood level, which allows for arbitrary correlation in errors within neighborhoods but assumes that errors are independent across neighborhoods.[24]

Note that β_1 captures an intent-to-treat effect given that not all credits that were authorized were claimed. This is arguably the effect of interest from a policy perspective given that it is in the government's power to authorize more credits, but not to compel developers or households to actually use those credits. Nonetheless, we can estimate the effect of the treatment on the treated by simply scaling up the estimate of β_1 based on the fraction of credits actually issued. Given that 94% of authorized credits in my sample were issued, the average treatment effect is only slightly larger in magnitude than the intent-to-treat effects.

Consistent with the means in Table 3, the regression estimates in Table 4 suggest that relative to properties whose applications for tax credits were denied, properties whose applications for tax credits were approved were issued about one additional permit in the year of their application on average.[25] The difference in permit issuance to approved and denied projects is significant at

[23] Because I examine changes in house values as an outcome in Section 4.3, I refrain from including initial property values in **X**. However, regression results in which I also control for 2001 property values are qualitatively and quantitatively similar to those presented here.

[24] There are 67 neighborhoods represented in the data (12 neighborhoods in St. Louis had no NPA applications between 2003 and 2006). Clustering at the neighborhood level generally produces the most conservative standard errors; the standard errors are qualitatively similar, but tend to be smaller, if they are merely adjusted to be robust to arbitrary heteroskedasticity or if they are clustered at a lower geographic level (such as census block).

[25] Results excluding properties with no identifiable parcel in the Assessor's database appear in Appendix Table A3. As expected given that excluding these properties will tend to understate the effects of receiving tax credits on permitting by ignoring proposed new construction that was not pursued as a result of losing the lottery, the estimates are about 10% smaller in magnitude.

the 1% level and, as can be seen in columns (2) and (3) of the table, is highly robust to the inclusion of year dummies and baseline block-level demographic and housing controls.[26]

4.2.2. Stratifying the Sample by Lottery Year

As previously discussed, randomization for the NPA is conditional on the year of the lottery, with a potentially different probability of winning each year. While in principle this could lead the pooled sample I consider to being unbalanced on covariates, in practice it does not. Nonetheless, as a robustness test, I separately consider the impact of authorized credits by lottery year. The results appear in Figure 2. Although the smaller sample sizes reduce the statistical significance of the differences when I stratify the sample, the number of permits issued to approved projects exceeds the number issued to denied projects by a wide margin in each of the four years. The difference in permits issued to approved projects and denied projects is 0.78 in 2003 (p-value = 0.090), 0.70 in 2004 (p-value = 0.140), 2.28 in 2005 (p-value = 0.001), and 1.44 in 2006 (p-value = 0.038). These results suggest that pooling the applications across lottery years, which gives me more power to identify effects of interest, does not jeopardize my ability to exploit the random assignment of credits to applicants to establish unbiased causal impacts.[27]

4.2.3. Relaxing the Timing of Construction Activity

The NPA tax credit does not necessarily have to be claimed in the year it was issued, and as such, construction could begin well after the application was actually submitted. Indeed, the tax credit has a five-year carryforward, meaning that developers and homeowners could postpone planned construction for some time after the credit is authorized. That being said, at least prior to the recession at the end of the decade (my sample includes only applications between 2003 and 2006), the vast majority of tax credits were claimed within two years of being authorized.

In Table 5, I calculate the average number of permits issued to projects of each type (all, denied, approved, and completed) in different windows of time around when the application was

[26] Surprisingly, including additional demographic and housing control variables has little effect on the precision of the estimates of β_1.
[27] Another concern is that projects that were denied one year reapply the next year. About 29% of first-time applicants who are denied tax credits reapply for credits in subsequent years. If I limit the sample to first-time applicants (which reduces to the sample size to 2,207), the estimated effects are qualitatively and quantitatively similar to the main estimates; the raw difference in permits issued in the year of the application to approved and denied first-time applicants is a statistically significant 0.875.

submitted. In particular, I consider a two-year window (years *t* and *t*+1 if the application was submitted in year *t*), a three-year window (years *t*, *t*+1, and *t*+2), a four-year window (years *t*, *t*+1, *t*+2, and *t*+3), and a five-year window (years *t*, *t*+1, *t*+2, *t*+3, and *t*+4). Notably, the permit data end in 2008, so for the latter two windows, I drop applications submitted in 2006 and 2005-2006, respectively. As a result, the number of observations drops for the four-year and five-year windows.[28]

With wider windows, there are necessarily more permits issued in absolute terms to both denied and approved projects.[29] What is striking, however, is that the gap in permit issuance between denied and approved projects persists even with these wider windows. For example, in the year of the application and one year after, those properties with approved applications average 75% more permits than those properties with denied applications (4.79 versus 2.74). In the year of the application and two years after, those properties with approved applications still average nearly 70% more permits than those with denied applications (6.07 vs. 3.58).

In Table 6, I present regression estimates for each of the different windows. I consider a specification similar to (1), only with the dependent variable now measured over different spans of time. Consistent with Table 5, we see large and significant increases in the number of permits issued to approved relative to denied projects up through five years. Indeed, the results for all projects suggest that when we allow for some lag in investment, authorizing a credit boosts permit issuance by a cumulative 2-2.5 permits.[30]

Although the windows of time I consider here are relatively short, these results suggest that the credit is not merely shifting planned projects ahead in time. Rather, they appear to be spurring activity that would not have otherwise happened, at least in the near term.

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[28] While I was not able obtain data on electrical permits, mechanical permits, plumbing permits, or permit waivers for 2009-2013, I did collect data on building permits, demolition permits, and occupancy permits for 2009-2013. Reassuringly, the results are very similar when I restrict attention to these three types of permits and consider the full sample of properties for all time windows.

[29] This is not strictly true on aggregate given the sample changes for the four- and five-year windows. Indeed, the number of permits issued to approved and completed projects declines slightly in the five-year window, a result of the change in the composition of applicants being considered.

[30] The differences are very similar, but slightly smaller in magnitude, when I restrict attention to projects with identifiable parcels. Results are available upon request.

4.2.3. Heterogeneous Effects

Within the group of approved applications, there could be important differences in the effects depending on the characteristics of the projects or neighborhoods themselves. First, I consider differences across projects of different sizes. Unfortunately, due to lack of information on the size of credits requested but denied, I cannot compare permit issuance to similarly sized approved and denied projects. However, I can provide some descriptive evidence on permit issuance to larger and smaller approved projects relative to all denied projects. As can be seen in Figure 3 and as would be expected, larger approved projects (defined as those that are authorized credits amounting to more than the median of $33,000) are issued substantially more permits than smaller approved projects as well as those that are denied credits. This is true regardless of the timeframe considered. Smaller projects (those authorized credits amounting to less than the median) are issued only marginally more permits than denied projects. In unreported regressions in which I exploit more finely detailed credit amount categories, I find that those awarded amounts less than $10,000 are no more or less likely than denied applicants to request permits, whereas those awarded more than $10,000, and particularly those awarded more than $40,000, are issued more permits. This is not surprising given that larger projects are likely to require more permits than smaller projects, and that developers or homeowners may not need permits (or believe that they need permits) for very small projects.

In addition to heterogeneity in permit issuance across different sized projects, there is also heterogeneity across projects initiated by developers and projects initiated by homeowners. In Figure 4, I show the average number of permits issued to approved developer projects, approved homeowner projects, and denied projects for windows of one year, two years, three years, four years, and five years. Permit issuance to approved projects initiated by developers, which account for over 80% of approved projects in St. Louis between 2003 and 2006, is substantially greater than permit issuance to approved projects initiated by homeowners and permit issuance to denied projects. The difference in permit issuance to approved projects by developers and approved projects by homeowners is particularly striking given that the median credit authorized to developers and homeowners is quite similar ($33,360 vs. $28,000). While I hesitate to put too much emphasis on this result given that there are relatively few homeowners in the sample, one interpretation of this difference is that crowd out of private unsubsidized investment is more severe among homeowners relative to developers. However, the difference is also likely a function of differences in the types of projects in which developers engage. It could also reflect differences in the propensity of developers to apply for permits when they are required; homeowners may not be as cognizant of the rules for permits, a point to which I will return in Section 4.3.

The nature of demand in a neighborhood is also potentially important in determining the extent of crowd out associated with subsidies. Communities in which the housing stock is already expanding to meet growing demand driven by population growth are more likely to experience a large amount of crowd out of unsubsidized private investment, as many projects seeking applications are likely to be inframarginal. Conversely, many proposed projects are likely to be marginal in stable or declining neighborhoods, especially if property owners in those neighborhoods face more severe credit constraints (Sinai and Waldfogel 2005, Baum-Snow and Marion 2009).

In Figure 5, I plot the mean difference in permits issued in the year of the application to approved and denied projects for each neighborhood against that neighborhood's population growth between 2000 and 2010.[31] The sizes of the dots are proportional to the number of applications received from that neighborhood. As the figure makes clear, there were smaller differences in permitting between approved and denied applications in neighborhoods with stronger population growth than in neighborhoods with weaker population growth. For example, in the gentrifying neighborhoods of Peabody-Darst-Webbe and Downtown West, the average number of permits issued to approved projects exceeds the number of permits issued to denied projects only modestly. In the more affluent neighborhoods of Lafayette Square and Central West End, the average number of permits issued to denied projects actually exceeded the number issued to approved projects. However, in the historically poorer neighborhoods that continued to depopulate over the course of the last decade (e.g., JeffVanderLou, Mark Twain, and the Ville), the average number of permits issued to approved projects far exceeded the number issued to denied projects; in the cases of Mark Twain and JeffVanderLou, there were on average about

[31] I restrict attention to neighborhoods from which at least 25 applications were received between 2003 and 2006. The figure looks similar with different measures of neighborhood growth, such as the change in the number of households.

four more permits issued to a project whose application was approved than a project whose application was denied.

Thus, the NPA appears to be more effective in spurring housing investment that would not otherwise take place in declining neighborhoods than in gentrifying ones. These results are consistent with past work on other housing programs, including the federal government's Low-Income Housing Tax Credit. For example, Baum-Snow and Marion (2009) find that the private market would have created over 60% of the new rental housing construction subsidized by the Low-Income Housing Tax Credit in gentrifying areas, but almost none of the new rental housing construction subsidized by the Low-Income Housing Tax Credit in stable or declining areas. Murray (1999) and DiPasquale (1999) also argue that housing production subsidies targeted at lower income households are associated with less crowd out than subsidies for moderate income households.

4.2.4. Spillovers

Winning a tax credit for a particular property might be expected to have two opposing effects on construction activity in nearby properties. On the one hand, by making it cheaper to build in one place rather than another, it might merely shift construction activity in space. If, for example, a developer had two possible sites in mind for new construction but received a tax credit for building at only one of those two sites, the tax credit might have implications for the location of new investment but not the total stock of new housing. This type of crowd out of housing investment has been documented for other major housing programs in the U.S., such as the Low-Income Housing Tax Credit (Eriksen and Rosenthal 2009, Baum-Snow and Marion 2009). On the other hand, new construction activity at one property could induce nearby homeowners to invest more in their properties. Such positive spillovers are often cited as motivation for housing programs that subsidize rehabilitation, and some empirical evidence suggests that households are responsive to their neighbors' investments in housing (Ioannides 2002, Helms 2012).[32]

To test for the existence of spillovers, I first examine whether properties adjacent to those that win tax credits are issued fewer or more permits than those adjacent to properties that fail to win tax credits.[33] We would expect negative effects on permit issuance to these properties next to

[32] In the case of the NPA, it is also possible that a tax credit for even one property might make a larger development involving multiple adjoining properties worthwhile.

[33] I exclude any neighboring properties that applied for an NPA tax credit, whether they were awarded a credit or not.

winning properties if the tax credit is generally shifting construction activity in space (although this assumes that only adjacent properties are substitutes; I relax that assumption in the ring analysis that follows), and positive effects if housing investment at one location typically induces neighbors to invest as well. In Table 7, I present the mean number of permits issued to each adjacent property in the year of the application as well as in windows of time up to and including a five-year window. While a property immediately adjacent to a property that was denied a credit is issued about 0.20 permits on average (close to the mean for all properties in the city), a property immediately adjacent to one that was authorized a credit is issued 0.37 permits on average. This differential persists when I include more of the carryforward period.

Corresponding regression estimates without additional controls and with year fixed effects and block-level demographic and housing characteristics appear in Table 8.[34] The differences in the propensity for properties neighboring those that are authorized credits vs. those neighboring properties that are denied credits is statistically significant at least at the 10% level for each of the five windows when we include demographic and housing controls.[35]

While we observe positive average spillovers on the behavior of neighbors, a natural question is whether these spillovers extend beyond just these proximal properties. In Figure 6, I plot the difference in permit issuance per parcel in mutually exclusive rings of 0-50 feet, 50-100 feet, 100-150 feet, 150-200 feet, 200-250 feet, 250-300 feet, 300-350 feet, 350-400 feet, 400-450 feet, and 450-500 feet around properties with approved and denied applications for tax credits.[36] In Panel (a) of Figure 6, we see that when we just consider the year of the application itself, parcels within 50 feet of a parcel whose NPA application was approved apply for significantly more permits than parcels within 50 feet of a parcel whose NPA application was denied (0.31 compared to 0.14).[37] While there remains a slight difference in permit issuance for parcels further than 50 feet away, the gap is no longer statistically significant. When we expand the time

[34] There is some loss in precision for the 4-year and 5-year windows due to the drop in sample size. Also, every coefficient reported in Table 8 (including those from regressions without additional controls) is statistically significant at least at the 10% level if the standard errors are clustered at the census block level instead of the neighborhood level.

[35] The results for adjacent properties are very similar when I restrict attention to approved and denied projects with identifiable parcels. Results are available upon request.

[36] I exclude properties in each ring that applied for an NPA tax credit, whether they were awarded a credit or not. The observed differences are slightly larger when I include properties in each ring that applied for a credit, which is likely attributable to larger developers' applying for credits for multiple adjacent properties at once.

[37] The average number of parcels within 50 feet of a property in the sample is six.

frame to three years in Panel (b) of Figure 6, there is a similar pattern; that is, there is a significant difference in permit issuance within 50 feet of the property that dissipates as we move further away.

These results suggest that spillovers on neighbor behavior associated with NPA tax credits tend to be positive on net, inducing neighbors to reinvest themselves more so than merely shifting the location of construction activity. However, those positive externalities attenuate quickly in space, largely disappearing after 50 feet from the property in question. Notably, past papers measuring housing investment spillovers have typically measured them using only house values, which will capture changes in the value of the house due to the owner's investment plus changes in the value of the house due to changes in neighboring properties' conditions. The results in this section suggest that actual housing investment in response to neighbors' investment activity is an important channel by which house values could change in the immediately vicinity of a property that receives subsidies. This is consistent with recent work that suggests that social interactions and neighborhood effects are a driver of actual housing renovation activity (Helms 2012).[38]

4.2.5. Bias in Non-Experimental Estimates

If one only had data on issued credits, comparing permits issued to credit recipients to those issued to all other parcels in St. Louis would yield an estimated impact of the program 150% larger than that which we get by comparing approved and denied applicants. Even if I regression-adjust or use propensity score matching to help ensure that properties receiving credits and similar to those in the comparison group, failing to exploit the lottery structure of the program still yields estimated effects of the program that are between 130% and 150% too big.[39] As the results on spillovers above suggest, using neighboring parcels (which tend to be very similar in at least age and access to amenities) as controls for those issued credits and assuming no spillovers would attenuate the estimated effect of the program. However, not only would doing so obscure

[38] In additional tests not shown, I find that the magnitude of spillovers does not differ across neighborhoods that are initially more or less densely populated. This suggests that it is unlikely that the observed spillovers are driven entirely by informational effects, as sharing of information about the program is more likely in neighborhoods that are initially more built up (Hilber 2010).

[39] The average property in St. Louis receives 0.22 permits per year. In a sample of properties propensity-score weighted to look more like those that received credits (whether using kernel or nearest neighbor matching), the number of permits issued per year is still below 0.30.

the nature and extent of spillovers, but it would also still yield an estimated effect of the program that is about 140% larger than the experimental evidence would suggest.

4.3. Property Values

Building permit issuance is one measure of housing investment that has the advantages of being easily observed and measured. It also captures the majority of construction and rehabilitation activity that we might expect to have important impacts on housing values. Additionally, using building permit issuance to measure externalities allows me to measure changes in neighbor behavior in response to housing investment; changes in the values of neighboring properties, which are more often used to measure externalities in the housing market, necessarily confound the effects of changes in neighbor behavior and changes in the effects of local amenities on house values.

However, using building permits alone to measure the impacts of the NPA has several drawbacks. It is possible, for example, that tax credit applicants do not apply for permits for some projects. Even more problematically, applicants' propensity to apply for a permit for a given job may depend on whether they win the lottery; for example, a homeowner might apply for a permit to build a porch on his or her house if he or she received a tax credit, but neglect to apply for a permit for the same job if he she did not receive the tax credit. Such selection in permit applications would result in upward biased estimates of the impact of the tax credit on construction activity. Further, from a policy perspective, it is important to know whether the construction activity induced by the program is translating into higher home values, or whether the projects being funded have relatively low returns to credit recipients and their neighbors. Large effects on house values would imply greater property tax revenues, which could potentially cover some or all of the cost of the program.

Therefore, I consider the effect of winning a tax credit on the value of the house in question. I use property assessment data from the City of St. Louis' Assessor's Office, which have a number of advantages. First, the Assessor's Office assessments are intended to reflect market values; they use a number of different methods, including cost, income, and market (i.e., sales comparison) methods, to reach estimates of market values. Second, the office reassesses properties frequently; reassessments occur every odd year unless there is new construction or other major structural change (e.g., demolition, new additions, etc.), in which case it is reassessed that year (even if it is even-numbered). Thus, we would expect large projects spurred by the NPA to be reflected in the assessed values. Further, unlike house values based on surveys of households, assessed values are universally available and not subject to biases that might arise if some types of households systematically over- or under-value their houses.[40] The assessment data are also not subject to the sample selection problems that arise in merely using sales data. Finally, because the assessments are the basis for taxing properties in St. Louis, we can better assess whether the returns in terms of additional tax revenues from higher home values offset program costs.

However, the assessment data have several disadvantages. While reassessments occur at least every other year, they may not immediately or accurately reflect changes to the house that are not large or conspicuous. In other words, they may not adequately capture changes in quality of housing over time (Pollakowski 1995). Because the assessor in part uses nearby properties as comparisons, the assessments also may fail to accurately capture price level or trends for newer and unusual properties as well as they do for older properties that are more similar to the existing housing stock in a neighborhood. To the extent that the values of proximal properties are used to determine the assessed value of a given property, there is also a sense in which observed spillover effects could be more mechanical than actually related to changes in the quality of the housing stock or nearby amenities. This will tend to bias upward any estimated positive externalities on property values. Finally, though this issue would apply to any measure of property values, it is difficult to know what values to assign to properties that were not delineated and assigned a parcel number before or after the sample period. For example, if one large parcel is divided into two for the purpose of building a new house on what was previously empty land, it is not reasonable to assume that the property on which the new home is built was worth nothing before construction.[41] In what follows, I consider alternative approaches and samples in an attempt to address this complication.

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[40] For example, Kiel and Zabel (1999) find that recent buyers tend to overvalue their houses relative to owners with longer tenures. To the extent that many of the properties receiving NPA tax credits are new construction, this could bias estimates based on survey data. Clapp and Giaccotto (1992) and Gatzlaff and Ling (1994) also highlight how using assessed values mitigates measurement error problems.

[41] Indeed, doing so would tend to inflate estimates of the impact of the program on property values given the difference in extensive-margin construction documented in Section 4.1.

With these issues in mind, I compare changes in values of properties that were approved and denied NPA tax credits in St. Louis between 2001 and 2011. Data from 2011 should capture changes made to properties seeking credits between 2003 and 2006;[42] the carryforward period for those seeking credits in 2006 would only stretch to 2011. Using data from 2011 also avoids the worst of the recession in the late 2000s. Between 2001 and 2011, the average increase in value among properties zoned as residential in the assessment data (which includes single-family units, apartment and condominium buildings, and other group quarters) was about $32,000 (or 31%), and the median increase was just over $15,000.[43]

Table 9 presents the average change in log property values between 2001 and 2011 for all properties that applied for credits, for those that were denied credits, for those that were authorized credits, and for those that were issued credits. Notably, I add $1 to all property values to ensure that the log values are defined for all properties (including those that did not appear in the data in 2001 but were in the data in 2011).[44] The average change in property values among those properties that applied for but were denied NPA tax credits was about 0.235 log points, which translates into about $11,000. In percentage terms, this is not substantively different than the average increase for all residential properties in the City of St. Louis between 2001 and 2011.

Meanwhile, the average increase in property values among those approved credits is 0.382 log points. The implied difference-in-difference estimate of the impact of winning an NPA tax credit (i.e., the change in property values among those approved credits relative to those denied credits) is 0.147 log points. Therefore, the values of properties that are authorized credits increase about 16%, or about $8000, more than properties that were denied credits in the lottery.[45] The subset of approved projects that were completed experienced increases in property values that were very similar, but slightly larger, than those merely approved credits. Again in

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[42] Data for 2012 are available, but the assessments in 2012 are very similar to those of 2011 given that reassessments normally occur only in odd years. Using changes between 2002 and 2012 yields very similar results as using changes between 2001 and 2011.

[43] In 2001, the average residentially zoned property in St. Louis, which includes single-family dwellings as well as multi-family buildings, was assessed at $103,000. The rise in property values as measured by the Assessor's Office during the early part of the 2000s was only partially reversed with the subsequent recession. The average residential property value as measured in the assessment data rose 15% between 2002 and 2003, 34% between 2004 and 2005, and 22% between 2006 and 2007. It fell by about 1% between 2008 and 2009 and 5% between 2010 and 2011.

[44] There are no parcels that appear in the 2001 data but do not appear in the 2011 data. Results excluding parcels that did not exist in 2001 are very similar to those reported here and are available upon request.

[45] Given the average value of properties in the sample in 2001 was $39,754, the relative gain between those approved and denied tax credits is (exp(0.382)-exp(0.235))×$39,754 = $7963.

line with the results on permit issuance, these differences suggest that the NPA program is having an impact on residential construction activity, which is in turn affecting property values.[46]

While the NPA program may have notable impacts on property values, that does not immediately imply that the program is worthwhile. To explore this issue further, I consider an instrumental variable (IV) approach. Specifically, given that the randomization occurs over applications (with the dollar amounts requested being endogenous), I regress the change in log property values on total authorized credits, instrumenting the latter with a dummy for whether or not the application was approved. Therefore, the first stage and reduced form are

$$AuthorizedCredits_{ibt} = \delta_0 + Approved_i \delta_1 + \tau_t + \mathbf{X}_b \Phi + v_{ibt} \qquad (2)$$

and

$$\ln(PropertyValue_{ibt}^{2011}) - \ln(PropertyValue_{ibt}^{2001}) = \gamma_0 + Approved_i \gamma_1 + \eta_t + \mathbf{X}_b \Psi + e_{ibt} \qquad (3)$$

where $AuthorizedCredits_{ibt}$ is the dollar amount of authorized credits to project i in block b in year t (measured in \$10,000s), $PropertyValue^{Y}_{ibt}$ is the dollar value of that property in year Y, and the remainder of the variables are defined as in equation (1). Given the randomization, approved status should only affect changes in property values through its effect on the amount of credits authorized to a project. Given the model is just-identified, the IV estimate of the impact of an additional dollar of authorized credits on the change in property values is just the ratio of the reduced-form and first-stage parameters γ_1 and δ_1.

The results appear in Table 10. The first panel presents first-stage estimates, the second panel presents reduced-form estimates, and the final panel presents IV estimates. In the first column, I show results without any other controls such that the reduced form estimate is exactly the difference between the average change in log property values among projects approved and denied credits in Table 9 (0.147). Given the first-stage estimate of the average credit authorized to projects, the IV estimate in the final panel implies that \$10,000 in authorized credits increases

[46] In separate tests, I used actual home sales data to estimate the impact of winning an NPA tax credit. The results for changes in sales prices were qualitatively similar, but larger in magnitude than those for changes in assessed values. This could be due in part to larger changes in actual property values than what are reflected in assessed values, but it is also likely attributable to selection in which properties changed hands both before and after applying for the tax credit; sales were observed both pre- and post-credit for less than one-fifth of properties. Notably, however, relative to those who applied for but did not win an NPA tax credit, those who applied for and won a credit were a statistically significant ten percentage points more likely to be sold between 2006 and 2011 (on a base of about 25%).

property values by a statistically significant 2.2%.[47] Adding dummies for the year of the credit application and for other block demographic and housing characteristics does not affect this estimate substantially; with the complete set of year dummies and block-level housing and demographic controls, the estimated effect is 1.7%. This additional roughly 2% increase in property values on top of the on average roughly 27% increase for denied properties in the sample implies that for each $1 authorized, property values increase by only about $0.10. Thus, only about one-tenth of the money authorized to be spent under the program is reflected in increased property values among those receiving the credit.[48]

However, there may also be important positive spillovers on nearby properties that could enhance the return to the program. Indeed, examining new construction and rehabilitations by Community Development Corporations in Cleveland, Ohio, Ding et al. (2000) find that spillovers on local property values are strongest within 150 feet and nearly vanish completely at 500 feet. Others who have looked at typically larger interventions have found that externalities have slightly larger geographic scope; for example, examining the effects of new subsidized owner-occupied housing in New York City, Schwartz et al. (2006) find impacts on property values that extend up to 2000 feet from a project site. Similarly, looking at the spillovers associated with new public housing in Denver, Santiago et al. (2001) find effects on the prices of homes up to 2000 feet from the site of the investment. Finally, again using property values to measure externalities, Rossi-Hansberg et al. (2010) find that the external effects of housing services fall by half for every 990 feet from a project site.

In Figure 7, I present results for the average per parcel increase in property values in successive rings around properties that were approved or denied credits. Notably, average increases in home values near properties that applied for credits tend to be lower than those among properties that actually applied (whether they were approved or not), highlighting again the selection in properties that that participate in the program. Further, increases in home values are greater among those near properties that were authorized credits as compared to those near

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[47] Note that for all specifications, the F-statistic for the excluded instrument is over 35, implying that the instrument is quite strong.

[48] Which authorized credits are actually claimed is also endogenous. However, replacing the dollar value of authorized credits with the dollar value of issued credits in the IV regressions, I find that every $10,000 in issued credits increases property values by at most 3.3%.

properties that were denied credits. The estimated differences are not highly precise, but are statistically significant at least at the 10% level for rings as far out as 350 feet.

Including both the direct effects on recipient properties and the spillover effects on properties within 350 feet, the higher property values resulting from program-induced investment generate approximately $132,500 in additional tax revenues per year.[49] If I assume a discount rate of 4%, it would take 98 years to recoup the annual cost to administer the program in St. Louis, which over this period averaged $3.375 million.

Thus, the impact of NPA tax credits on the value of properties that receive them is substantially less than one-for-one, and the program will not pay for itself in the near term. However, crowd out of private unsubsidized investment is not complete. Moreover, investment in housing spurred by the program appears to have externalities that are sizable, albeit limited in geographic scope; the values of homes within 350 feet appear to benefit from housing investment activity spurred by the program. These changes are likely in part due to improvements in local amenities related to the investment; for example, NPA-induced investment may replace blighted properties or vacant lots that may signal neighborhood deterioration and depress nearby property values. However, as the results in the previous sections suggest, the changes in nearby property values are also in part due to changes in neighbor behavior; indeed, I find evidence that at least for very close properties, one neighbor's reinvestment activity (as measured by permit issuance) spurs others to also reinvest. In other words, beyond its direct impact on recipient properties, the NPA appears to affect communities both through its effects on neighbor behavior and through its effects on local amenities.

5. Conclusion

The merits of subsidizing investment in housing construction and rehabilitation in low-income neighborhoods have long been debated. Proponents of tax incentives to encourage such

[49] I reach this by first multiplying the total dollar amount authorized in St. Louis between 2003 and 2006 ($13.5 million) by the fraction of each dollar that is capitalized into house values (0.10). I then take that amount and divide it by four to get an annual value (given that the sample includes 2003-2006). I do the same for properties in each ring, assuming that relative prices change by the same percentage across all properties within each ring. I then take the aggregate amount ($9.96 million) and multiply it by the residential assessment rate (0.19), which determines the assessed value. I then apply the average property tax rate between 2001 and 2011 of 7% to arrive at my estimate of annual tax revenues of $132,500. Assuming that tax rates do not change and that the price differentials persist, the present discounted value of tax revenues over 98 years would be $3.375 million given a discount rate of 4%.

residential investment highlight their potential to revitalize struggling communities in which private incentives to invest may be lacking but the social benefits of doing so could be large. However, whether subsidies under such programs merely crowd out private unsubsidized investment or have any persistent effects remains unclear.

In this paper, I take advantage of the lottery structure of Missouri's Neighborhood Preservation Act (NPA) to examine the effects of tax incentives for housing investment in low-income areas. Missouri's NPA offers tax credits to homeowners and developers that improve or expand the owner-occupied housing stock in the state's poorer communities. Due to limits on the amount that can be awarded, the state uses a lottery to determine which applicants receive credits. Exploiting the random assignment of NPA tax credits and exploiting detailed property-level data from the City of St. Louis, I find evidence of incomplete crowd out of unsubsidized housing investment. While there appear to be some positive spillovers on neighbors' investment behavior, the effects are confined to properties within 50 feet of those receiving credits. Impacts on property values are larger in geographic scope, implying important roles for both neighbor interactions and amenity effects in local housing markets.

This paper contributes not only to the literature on the impacts of subsidies for residential investment and on housing externalities, but also to a growing body of research on government incentives aimed at improving economic and social conditions in low-income neighborhoods. Evidence on the efficacy of place-based incentives is mixed at best (Glaeser and Gottlieb 2008). While the results in this paper are to some extent specific to the institutional features and context of Missouri's NPA, they suggest that the types of tax incentives for home construction and rehabilitation used across the U.S. and in other countries can have measurable effects on targeted communities. However, given the degree of crowd out and the limited extent of positive spillovers, the results indicate that housing production subsidies are likely to be expensive and crude tools in pursuing neighborhood revitalization goals.

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Figure 1. Locations of Approved and Denied NPA Projects in the City of St. Louis, Missouri

(a) Approved Projects (b) Denied Projects

Note: Points represent projects for 2003-2006. Red points in (a) are approved but incomplete projects. Boundaries represent the 79 neighborhoods of the City of St. Louis.

Figure 2. Mean Number of Permits for Approved and Denied Applications by Application Year

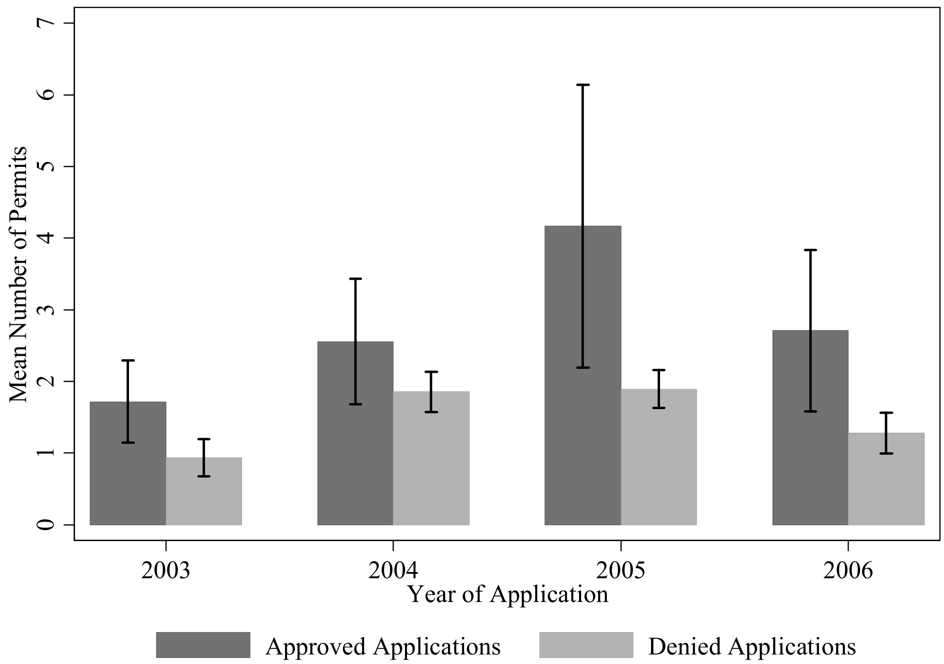


Figure 3. Mean Number of Permits for Large Approved, Small Approved, and Denied Applications for Different Timeframes

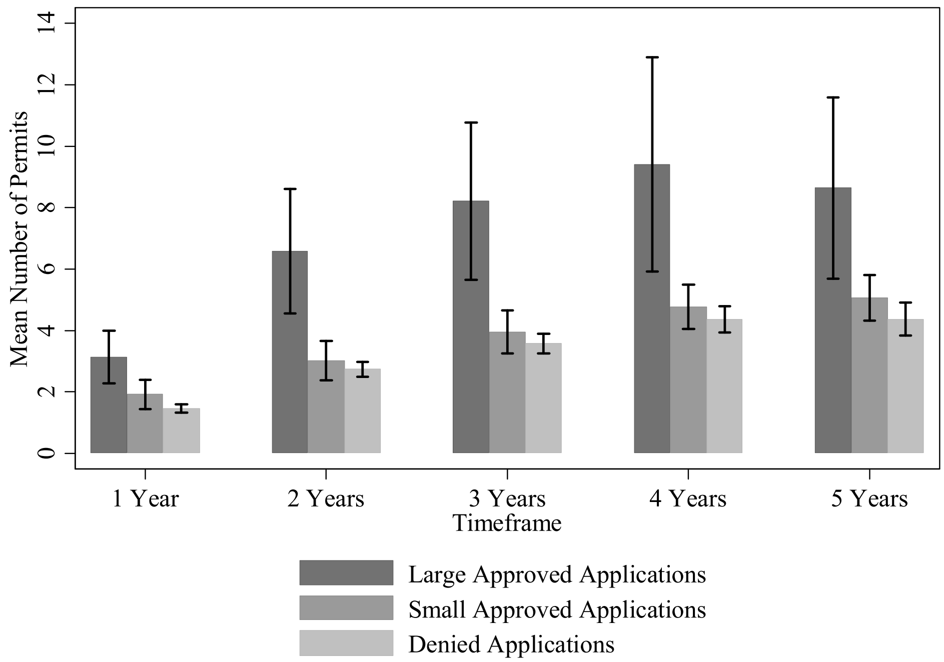


Figure 4. Mean Number of Permits for Approved Developer-Initiated Applications, Approved Homeowner-Initiated Applications, and Denied Applications for Different Timeframes

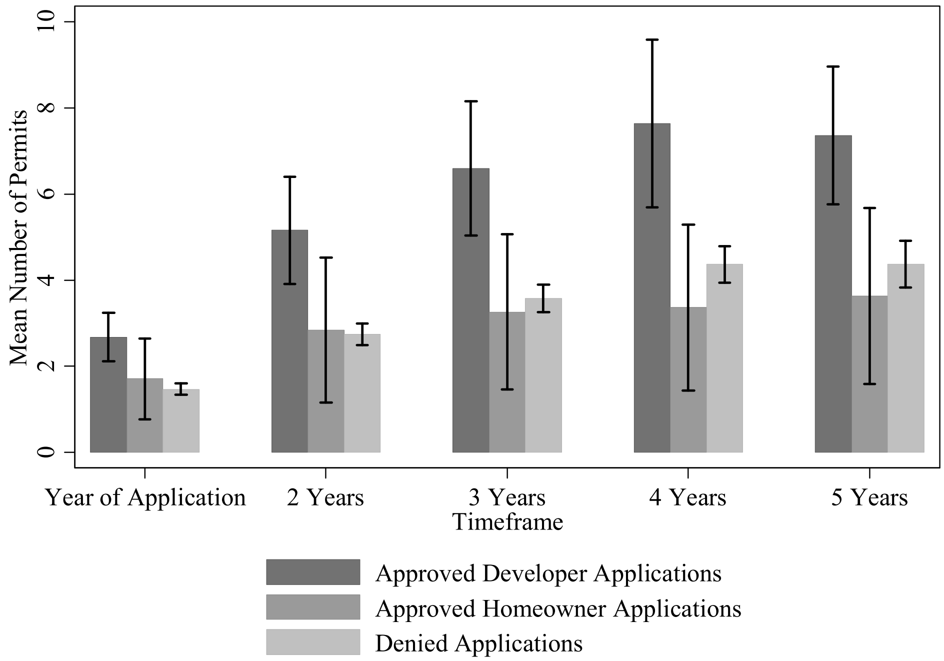


Figure 5. Mean Difference in Permits for Approved and Denied Application by Neighborhood

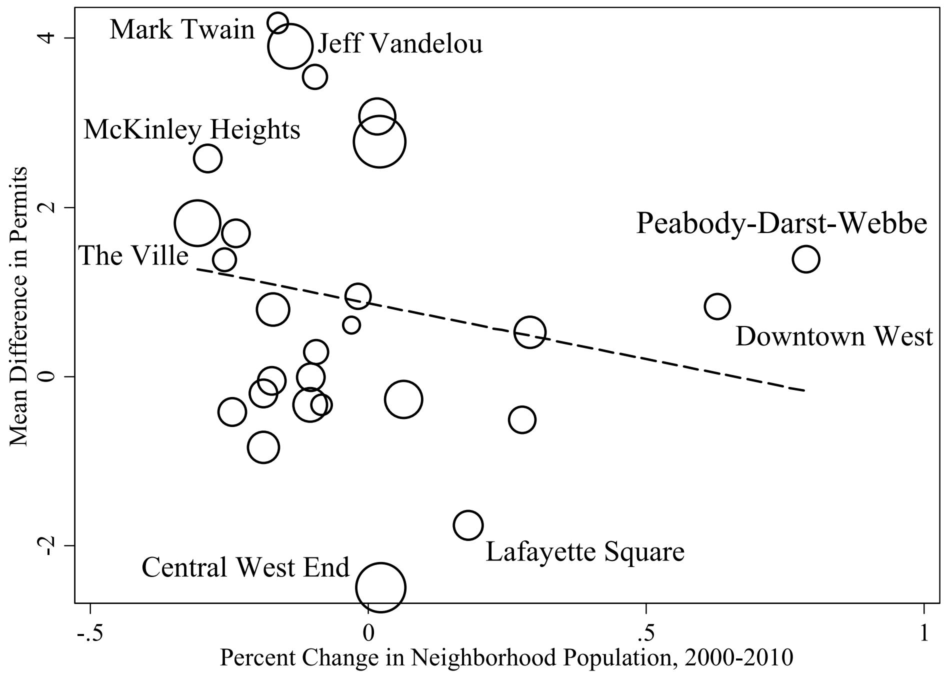
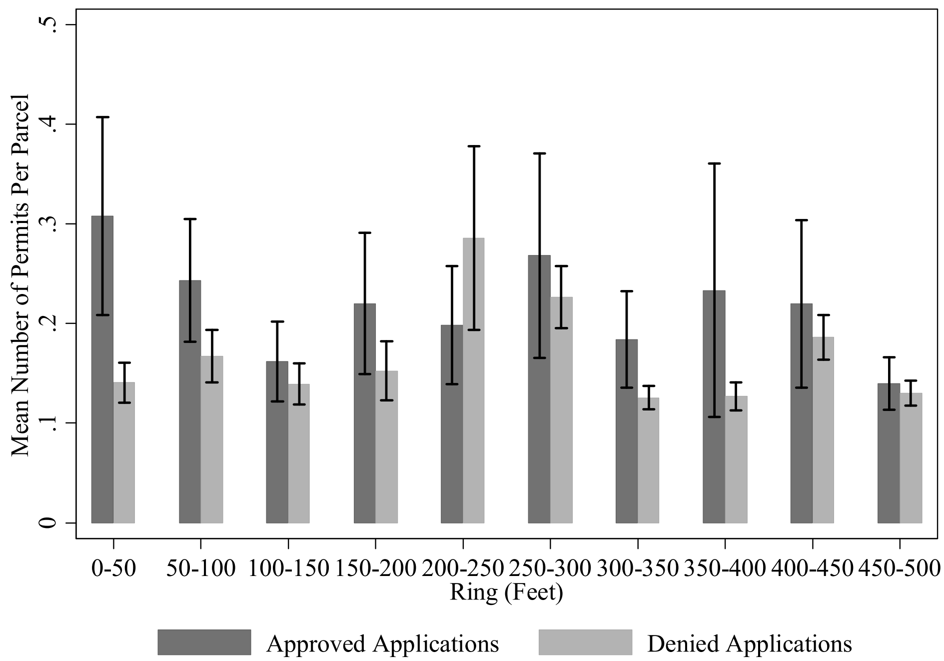


Figure 6. Mean Number of Permits per Parcel in Rings around Properties with Approved and Denied Applications

(a) Permits in Same Year



(b) Permits in Three-Year Window

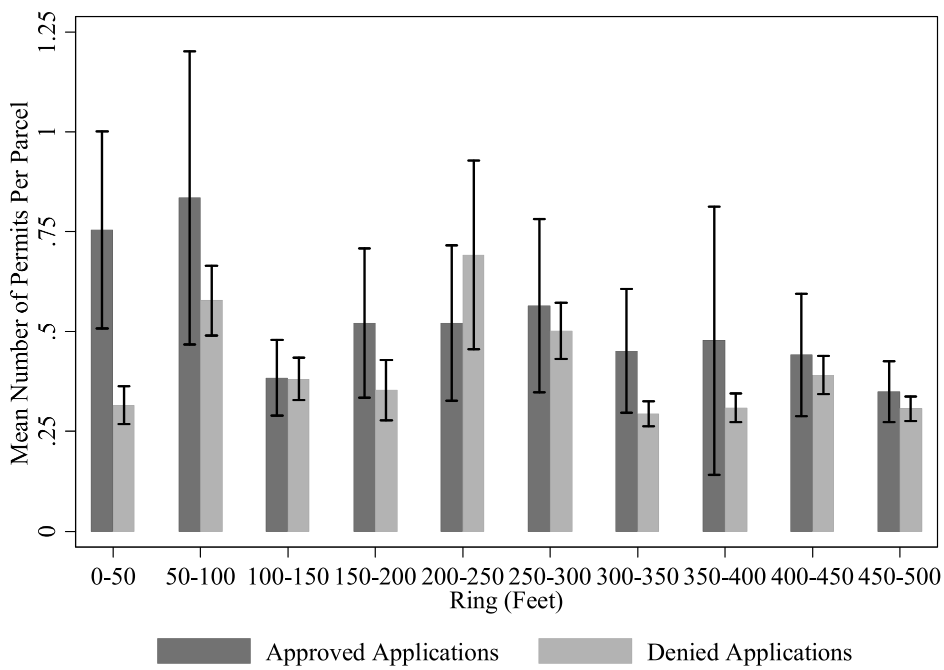


Figure 7. Mean Change in Log Property Values in Rings around Properties with Approved and Denied Applications, 2001-2011

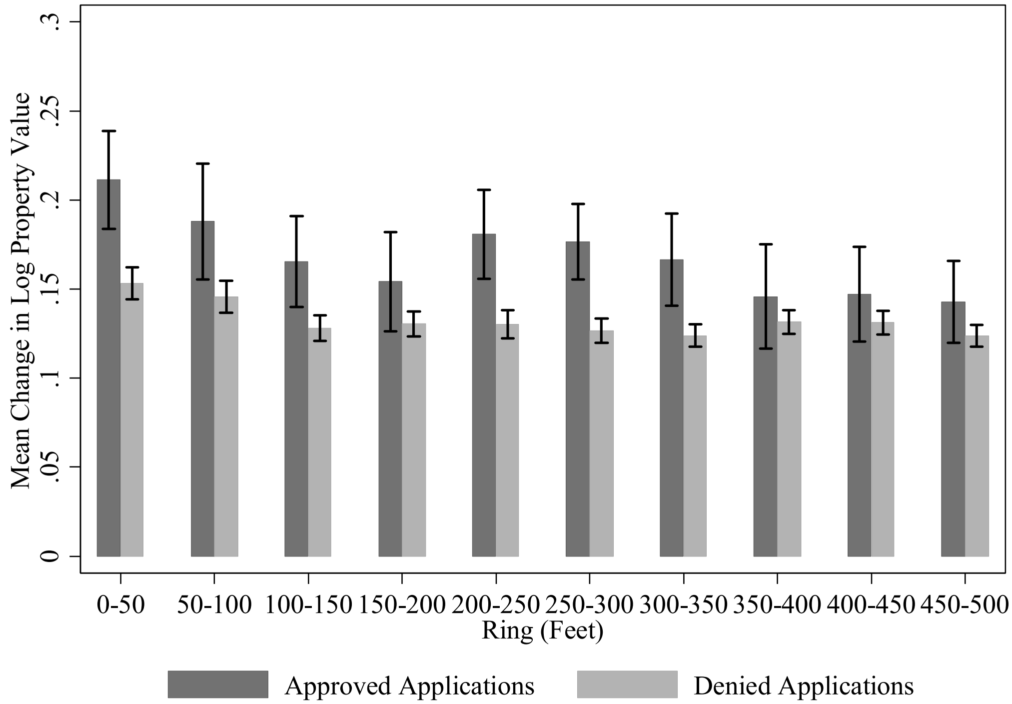


Table 1. Characteristics of Approved and Denied Applications' Neighborhoods, 2000 Decennial Census

	(1) Approved	(2) Denied	(3) Difference (1)-(2)
Census Block Characteristics, 2000			
Housing Units	44.61	41.10	3.51
Share Occupied	0.73	0.71	0.02
Share Owner-Occupied	0.44	0.41	0.04*
Population	84.66	76.00	8.66
Share White	0.28	0.25	0.04
Share Black	0.63	0.65	-0.02
Share Under 18	0.26	0.26	-0.01
Share 65 and Over	0.11	0.12	-0.01
Number of Households	34.49	31.52	2.97
Average Household Size	2.51	2.55	-0.04
Property Characteristics, 2001			
Property Value, Excluding Missing ($)†	54,480	67,701	-13,221
Property Value, Including Missing ($)††	26,272	40,666	-14,394
NPA Tax Credits, 2003-2006			
Median NPA Credit Authorized ($)	33,000	0	
Developers	33,360	0	
Homeowners	28,000	0	
Fraction Claimed	0.94	0	
Median NPA Credit Issued ($)	27,573	0	
Developers	28,042	0	
Homeowners	22,904	0	
Number of Projects	197	2912	

Note: Includes applications submitted in St. Louis between fiscal 2003 and 2006. † Excludes properties that applied for a tax credit but did not exist in 2001 (sample includes 1844 total properties). †† Assigns a value of zero to properties that applied for a tax credit but did not exist in 2001. Difference significant at the *10%, **5%, and ***1% level.

Table 2. Existence of Parcel by Application and Project Status

	(1) All	(2) Denied	(3) Approved	(4) Completed
Parcel Exists	89.2%	88.5%	99.5%	100.0%
Parcel Does Not Exist	10.8%	11.5%	0.5%	0.0%
Number of Projects	3109	2912	197	186

Note: Includes applications submitted in St. Louis between fiscal 2003 and 2006.

Table 3. Building Permits for Properties with Denied, Approved, and Completed Projects – Year of Application

	(1)	(2)	(3)	(4)
	All	Denied	Approved	Completed
Mean Number of Permits	1.53	1.47	2.52	2.62
Building Permits	0.36	0.34	0.60	0.61
Demolition Permits	0.02	0.02	0.04	0.03
Occupancy Permits	0.18	0.17	0.38	0.40
Electrical Permits	0.57	0.55	0.84	0.88
Mechanical Permits	0.03	0.03	0.05	0.05
Plumbing Permits	0.36	0.35	0.62	0.65
Permit Waivers	0.01	0.01	0.01	0.01
Number of Projects	3109	2912	197	186

Note: Includes 3109 NPA applications submitted between 2003 and 2006.

Table 4. Permit Regression Estimates – Year of Application

	(1)	(2)	(3)
Approved	1.055***	1.098***	0.970***
	[0.381]	[0.369]	[0.432]
Year Dummies		Y	Y
Demographic and Housing Controls			Y

Note: Includes 3109 NPA applications submitted between 2003 and 2006. Demographic and housing controls include the census block's total population, share white, share black, share under age 18, share age 65 and over, number of households, average household size, number of housing units, share occupied, and share owner-occupied. Standard errors in brackets are adjusted for heteroskedasticity and clusters at the neighborhood level. Statistically significant at the * 10% level, ** 5% level, and *** 1% level.

Table 5. Building Permits for Properties with Denied, Approved, and Completed Projects – Different Windows of Time

	All	Denied	Approved	Completed
Two-Year Window	2.87	2.74	4.79	4.99
Three-Year Window	3.74	3.58	6.07	6.34
Four-Year Window†	4.54	4.37	6.87	7.07
Five-Year Window††	4.56	4.37	6.62	6.81

Note: Includes 3109 NPA applications submitted between 2003 and 2006. † Due to missing data on permits after 2008, the four-year window includes only the 2397 applications submitted between 2003 and 2005. †† Due to missing data on permits after 2008, the five-year window includes only the 1608 applications submitted between 2003 and 2004.

Table 6. Permit Regression Estimates – Different Windows of Time

Two-Year Window	2.055***	2.062***	1.819***
	[0.498]	[0.520]	[0.566]
Three-Year Window	2.490***	2.494***	2.185***
	[0.645]	[0.691]	[0.734]
Four-Year Window†	2.502***	2.599***	2.268**
	[0.885]	[0.889]	[0.929]
Five-Year Window††	2.245*	2.136*	1.774
	[1.249]	[1.198]	[1.300]
Year Dummies		Y	Y
Demographic and Housing Controls			Y

Note: Includes 3109 NPA applications submitted between 2003 and 2006. Demographic and housing controls include the census block's total population, share white, share black, share under age 18, share age 65 and over, number of households, average household size, number of housing units, share occupied, and share owner-occupied. † Due to missing data on permits after 2008, the four-year window includes only the 2397 applications submitted between 2003 and 2005. †† Due to missing data on permits after 2008, the five-year window includes only the 1608 applications submitted between 2003 and 2004. Standard errors in brackets are adjusted for heteroskedasticity and clusters at the neighborhood level. Statistically significant at the * 10% level, ** 5% level, and *** 1% level.

Table 7. Building Permits Issued to Adjacent Properties

	All	Denied	Approved	Completed
Year of Application	0.21	0.20	0.37	0.40
Two-Year Window	0.36	0.34	0.61	0.65
Three-Year Window	0.47	0.45	0.85	0.90
Four-Year Window†	0.63	0.60	1.02	1.06
Five-Year Window††	0.76	0.72	1.10	1.13

Note: Includes 3109 NPA applications submitted between 2003 and 2006. † Due to missing data on permits after 2008, the four-year window includes only the 2397 applications submitted between 2003 and 2005. †† Due to missing data on permits after 2008, the five-year window includes only the 1608 applications submitted between 2003 and 2004.

Table 8. Permit Regression Estimates – Adjacent Properties

Year of Application	0.176**	0.152	0.157*
	[0.087]	[0.098]	[0.093]
Two-Year Window	0.268**	0.227*	0.235*
	[0.116]	[0.128]	[0.121]
Three-Year Window	0.405**	0.358*	0.370*
	[0.201]	[0.206]	[0.198]
Four-Year Window†	0.424	0.401	0.442*
	[0.255]	[0.256]	[0.241]
Five-Year Window††	0.375	0.377	0.414*
	[0.229]	[0.231]	[0.209]
Year Dummies		Y	Y
Demographic and Housing Controls			Y

Note: Includes 3109 NPA applications submitted between 2003 and 2006. Demographic and housing controls include the census block's total population, share white, share black, share under age 18, share age 65 and over, number of households, average household size, number of housing units, share occupied, and share owner-occupied. † Due to missing data on permits after 2008, the four-year window includes only the 2397 applications submitted between 2003 and 2005. †† Due to missing data on permits after 2008, the five-year window includes only the 1608 applications submitted between 2003 and 2004. Standard errors in brackets are adjusted for heteroskedasticity and clusters at the neighborhood level. Statistically significant at the * 10% level, ** 5% level, and *** 1% level.

Table 9. Mean Change in Log Property Values for Denied, Approved, and Completed Projects, 2001-2011

	All	Denied	Approved	Completed
	All Projects			
Mean Change in Log Property Values	0.24	0.24	0.38	0.39
Number of Projects	3109	2912	197	186

Note: Includes NPA applications submitted between 2003 and 2006.

Table 10. Property Value First Stage, Reduced Form, and IV Regression Estimates, 2001-2011

First Stage			
Dependent Variable: Authorized Credits ($10,000s)			
Approved	6.855***	6.847***	6.843***
	[1.331]	[1.322]	[1.324]
Reduced Form			
Dependent Variable: Change in Log Property Value			
Approved	0.147*	0.149*	0.113
	[0.084]	[0.079]	[0.070]
IV			
Dependent Variable: Change in Log Property Value			
Authorized Credits ($10,000s)	0.022*	0.022*	0.017*
	[0.012]	[0.011]	[0.010]
Year Dummies		Y	Y
Demographic and Housing Controls			Y
Observations	3109	3109	3109
F-Statistic	35.523	36.145	36.735

Note: Includes NPA applications submitted between 2003 and 2006. Demographic and housing controls include the census block's total population, share white, share black, share under age 18, share age 65 and over, number of households, average household size, number of housing units, share occupied, and share owner-occupied. Standard errors in brackets are adjusted for heteroskedasticity and clusters at the neighborhood level. Statistically significant at the * 10% level, ** 5% level, and *** 1% level.

Appendix

Table A1. Eligible and Ineligible Expenditures under Missouri's NPA

Eligible Expenditures	
New Construction	Rehabilitation
Property acquisition	Site preparation
Development	Surveys
Site preparation	Architectural and engineering services
Surveys	Construction
Architectural and engineering services	Modification
Construction	Expansion
Utility extensions on the property (water, sewer, electrical)	Remodeling
Sidewalks and driveways directly attached to the building	Structural alteration
	Replacements and alterations
	Costs directly attributed to the rehabilitation
	Utility extensions on the property (water, sewer, electrical)
	Sidewalks and driveways directly attached to the building
Ineligible Expenditures (Not Exhaustive)	
Costs not directly attached to the building	
Landscaping, including privacy fencing	
Buildings other than garages	
Appliances	
Mirrors	
Awnings	
Marketing	
Parking lots	
Window treatments	
Items that are removable without damage to the property	

Source: Missouri Department of Economic Development.
http://www.ded.mo.gov/BCS%20Programs/BCSProgramDetails.aspx?BCSProgramID=68

Appendix

Table A2. Building Permits for Properties with Denied, Approved, and Completed Projects – Year of Application
Projects with Identifiable Parcels

	(1)	(2)	(3)	(4)
	All	Denied	Approved	Completed
Mean Number of Permits	1.72	1.66	2.54	2.62
Building Permits	0.40	0.39	0.60	0.61
Demolition Permits	0.02	0.02	0.04	0.03
Occupancy Permits	0.20	0.19	0.38	0.40
Electrical Permits	0.64	0.63	0.84	0.88
Mechanical Permits	0.03	0.03	0.05	0.05
Plumbing Permits	0.41	0.39	0.62	0.65
Permit Waivers	0.01	0.01	0.01	0.01
Number of Projects	2773	2577	196	186

Note: Includes 2773 NPA applications submitted between 2003 and 2006 with matches in the Assessor's Office's parcel database.

Table A3. Permit Regression Estimates – Year of Application
Projects with Identifiable Parcels

	(1)	(2)	(3)
Approved	0.878**	0.929**	0.807*
	[0.415]	[0.403]	[0.460]
Year Dummies		Y	Y
Demographic and Housing Controls			Y

Note: Includes 2773 NPA applications submitted between 2003 and 2006 with matches in the Assessor's Office's parcel database. Demographic and housing controls include the census block's total population, share white, share black, share under age 18, share age 65 and over, number of households, average household size, number of housing units, share occupied, and share owner-occupied. Standard errors in brackets are adjusted for heteroskedasticity and clusters at the neighborhood level. Statistically significant at the * 10% level, ** 5% level, and *** 1% level.