Effects of Gentrification on Homeowners: Evidence from a Natural Experiment

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Abstract

A major overhaul of the property tax system in 2013 in the city of Philadelphia has generated significant variations in the amount of property taxes across properties. This exogenous policy shock provides a unique opportunity to identify the causal effects of gentrification, which is often accompanied by increased property values, on homeowners' tax payment behavior and residential mobility. The analysis, based on a difference-in-differences framework, suggests that gentrification leads to a higher risk of delinquency on homeowners' tax bills on average, but there was no sign of a large-scale departure of elderly or long-term homeowners in gentrifying neighborhoods within five years after adoption of the new policy. While tax delinquencies were somewhat inflated by appeals for reassessments, programs designed to provide tax relief for long-term homeowners help mitigate the risk of tax delinquencies and displacement. Findings from this study help researchers, policymakers, and practitioners better understand the mechanisms through which gentrification may impact long-term homeowners and the effectiveness of policies to mitigate these tax burdens and displacement.

Keywords: gentrification, property tax, tax delinquency, residential mobility

JEL classification: H20, H31, H71, R51

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1. Introduction

Gentrification — the influx of investment and higher-income households in previously low-income neighborhoods — has sparked debate among researchers and the general public about its consequences for preexisting residents. One mechanism through which gentrification is purported to influence residents is by increasing tax burdens for homeowners, which could lead to tax delinquencies, tax foreclosures, and involuntary moves. In particular, these concerns apply to long-term and elderly homeowners, who may not be able to afford to pay skyrocketing tax bills owing to low or fixed incomes. Gentrification, on the other hand, may also entice homeowners to either stay to take advantage of future home price appreciation or to move so they can cash out on their increased home equity. A growing body of research has made notable progress on the relationship between gentrification and the residential mobility of renters, who hold more tenuous positions in the housing market than homeowners, but little is known about the effects of gentrification on homeowners and the potential mechanisms of such effects (Martin and Beck, 2018). Yet, the majority of housing units are still owner-occupied, and many homeowners are vulnerable to gentrification's negative consequences as well.

This study takes advantage of a sweeping property taxation system overhaul (the Actual Value Initiative, or AVI), which was adopted in 2013 and took effect in 2014 in Philadelphia, to identify the effects of gentrification on homeowners' tax payment behavior and residential mobility, through the channel of local property taxation.[1] Our identification strategy builds upon several unique features of the 2013 tax reform in Philadelphia. First, until 2013, Philadelphia had not conducted a comprehensive reassessment of market values for properties in the city since the 1980s, thereby keeping assessed values for most properties largely unchanged for several decades. For properties in gentrifying neighborhoods, gentrification increased homeowners' housing values but did not affect their tax burdens before 2013. By adopting the AVI, the city reassessed the market values of all properties in 2013, making tax assessed values closer to the properties' actual market values. Consequently, the effects of gentrification on property taxes become manifest through the changes in tax amounts and subsequent tax delinquencies after the AVI. Second, because the reform changed the way the city used individual assessments to

[1] Throughout this report, Philadelphia refers to the city of Philadelphia, rather than the metropolitan area.

calculate tax bills, and the tax reform was claimed to be "revenue neutral," the AVI generated significant variations in property taxes instead of uniform increases across properties. Third, as part of the tax reform, the city implemented programs designed for gentrification relief. Our data provide information on tax abatements and exemptions at the property level that allows us to examine whether the programs mediate the effects of gentrification on homeowners' tax behavior, shedding light on the effectiveness of these policies.

Using a difference-in-differences (DID) framework, we compare changes in tax delinquencies and tract-level residential mobility before and after 2014 for homeowners in gentrifying neighborhoods with those changes for homeowners in nongentrifying neighborhoods. Empirical results suggest that gentrification, especially more intense levels of gentrification, leads to a significant increase in homeowners' risk of tax delinquency. On average, gentrification leads to increases of $540 in the annual tax amount and 4.1 percentage points in the tax delinquency rate post-AVI, with the neighborhoods that underwent *intense gentrification* experiencing the largest increases of $1,045 and about 6.1 percentage points, respectively. Results are consistent with the contention that under a fair tax system, properties in gentrifying neighborhoods generally experience a larger increase in property taxes, which increases homeowners' risk of tax delinquency.

We suspect that certain homeowners, such as elderly and longer-term homeowners — the latter of which are defined in this study as mortgage-holding homeowners who have lived in the same census tract for five or more years — are more vulnerable to property tax increases. In additional analysis using separate data sets to examine home sales and residential mobility, however, we do not observe either an increased volume of home sales or higher levels of outmigration among elderly or longer-term homeowners in gentrifying neighborhoods after the adoption of the AVI. Elderly homeowners, as well as longer-term homeowners, are no more likely to move out of gentrifying neighborhoods, despite increased assessed values. A few factors help explain these results. First, the well-targeted property tax relief programs enacted along with the AVI, such as the Longtime Owner Occupants Program (LOOP), which froze property tax assessments for longtime low- and middle-income homeowners in neighborhoods with larger increases in property values, help mitigate the risk of tax delinquencies and residential displacement. Second,

the larger increase in tax delinquencies in gentrifying neighborhoods were somewhat inflated by more appeals for reassessment, which do not necessarily lead to residential displacement. In addition, sharply increased property taxes appear to have reduced demand for owner-occupied housing in gentrifying neighborhoods, which helps explain the reduced outmigration rates as well. Finally, although our analysis of mobility examines the five years following the adoption of the AVI, the mechanisms that lead to displacement for homeowners through tax burdens may take longer to unfold.

This study contributes to the literature by shedding light on gentrification's effects on the displacement of homeowners through examining how a specific mechanism of displacement — increased tax burdens for liquidity-constrained residents — and the conditions under which it occurs can influence whether homeowners move out. Gentrification is an ongoing, evolving process that often occurs simultaneously with rising home values and increases in property taxes. Homeowners can benefit from rising home values by selling their property and liquidating their housing wealth (the wealth effect). Homeowners, especially long-term and older homeowners with liquidity constraints, however, may become cost-burdened and, in extreme cases, could be displaced from their homes by the increased property taxes that accompany gentrification (the liquidity constraint effect). While the latter channel is of great interest for policymakers and researchers, the endogenous nature of gentrification, changes in property values, changes in property taxes, and residential mobility make it difficult for researchers to isolate the impact of gentrification on homeowners' tax payment behavior and mobility patterns. Because of the unique design of Philadelphia's property tax system, gentrification and changes in assessments and property tax did not occur simultaneously before 2013. This one-time shock (i.e., the adoption of the AVI) is useful for separating the liquidity constraint effect from the wealth effect of gentrification, allowing us to identify the effects of gentrification on vulnerable homeowners' tax payment behavior and outmigration rates through property tax increases. After adopting the AVI, we expect that gentrifying areas experience larger spikes in property assessments and tax burdens; consequently, homeowners' response to gentrification, measured by tax delinquencies and residential outmigration, become observable. Findings from this study help inform our understanding of the consequences of neighborhood changes affecting cities across the nation.

More important, this study contributes to the literature by examining the effectiveness of tax policy on potential negative consequences of gentrification. It is rare to find tax programs like LOOP, designed specifically to mitigate the negative consequences of gentrification on long-term homeowners. Results confirm that gentrification relief programs reduce delinquency risk and help explain the observed pattern of outmigration of vulnerable homeowners in gentrifying neighborhoods. An early evaluation of these tax mitigation programs should help local governments design intervention programs to protect vulnerable and long-term residents in gentrifying neighborhoods.

The structure of the paper is as follows: Section 2 describes the policy design and the cross-sectional variation that we exploit for identification, as well as related literature. Section 3 presents the data and the empirical identification strategy. Section 4 presents the main results on the effects of gentrification on property tax delinquencies and mobility, together with the empirical results on the effectiveness of several tax relief programs. Section 5 concludes.

2. Background and Related Literature

This section first provides an overview of the old property tax system in Philadelphia and the specific context in which the AVI was introduced in 2013. This section then discusses the key features of the AVI, the relevant literature, and how the adoption of the AVI provides a unique opportunity to examine the effects of gentrification on homeowners.

2.1. Property Taxes in Philadelphia Before 2013

Before 2013, the property tax system in Philadelphia was characterized by low assessments of properties, extremely high rates of tax delinquency, and lesser reliance on property taxes compared with other jurisdictions (Pew Charitable Trusts, 2012 and 2013). Since the 1980s, Philadelphia had not conducted a comprehensive reassessment of the market value for properties in the city, and the assessed values for most properties had been substantially lower than their actual market values until 2013. The city only reassessed the value of very few homes

during this time period, most of which were new construction. The main reason behind this low assessment was that, unlike most other states, the state of Pennsylvania imposes no reassessment timetables or standard assessment methods on local governments (Pew Charitable Trusts, 2012).

Philadelphia has been one of the poorest major cities in the U.S. (with about one in four residents living below the poverty line) and has long been a community of homeowners (with a homeownership rate of 59 percent in 2000 and 54 percent in 2010, a higher percentage than most peer cities, such as 45 percent in Chicago, 44 percent in Atlanta, and 46 percent in Washington, D.C., according to census data). Philadelphia officials had been reluctant to risk upsetting this large constituency by making any changes that could result in higher property tax bills for homeowners. The Pew Charitable Trusts (2012) estimates that properties in Philadelphia, on the whole, were taxed on only about 13 percent of their true market value, significantly lower than the city's official predetermined ratio of 32 percent. This means the assessed values listed on tax bills were, on average, about 60 percent lower than true market values. Growth in property taxes during these years was mainly attributable to small increases in the property tax rate, which rose from 8.264 percent in 2000 to 9.771 percent in 2013.

Philadelphia also had a long-standing problem with property tax collection. Over the years, about one-fifth of all parcels, or more than 100,000 properties, had outstanding tax bills, much higher than most other big cities in the United States (Pew Charitable Trusts, 2013). In April 2012, almost 18 percent of properties in Philadelphia were delinquent on their property tax payments. The relatively high concentration of people below the poverty line and the high homeownership rate help explain the high delinquency rates. In addition, the lack of a state-mandated time frame to start various enforcement actions and a lack of political will to impose strict enforcement measures against delinquent property owners contributed to the serious tax collection issue Philadelphia faced.

Philadelphia also relied less on property taxes (and more on wage and business taxes) than most other major cities. In 2011, Philadelphia's property tax per capita was only $729 per resident, compared with $2,799 in Washington, D.C., $2,213 in Boston, $1,191 in Pittsburgh, and $1,181

in Chicago (Pew Charitable Trusts, 2012). As a result, far more attention had been directed at the income tax or other taxes, instead of property taxes.

2.2. The Actual Value Initiative

In 2013, after several years of public discussion and debate, Philadelphia adopted a comprehensive property tax reform known as the AVI, effective for tax bills due in early 2014. Under the AVI, Philadelphia conducted the first comprehensive reassessment of the market value of every property in Philadelphia since the 1980s. Consequently, the assessed values under the AVI generally reflect more accurately the properties' market values. After the comprehensive reassessment in 2013, residents were allowed to file appeals to adjust valuations through targeted reassessments. As of spring 2015, owners of more than 10 percent of the properties in the city, almost 60,000 properties in all, had sought reviews and appealed for reassessments (Pew Charitable Trusts, 2015).

Under the AVI, the city also changed the way individual assessments are used to calculate tax bills. Before 2013, the city levied taxes on only 32 percent (the predetermined ratio) of a property's total assessed market value, and the tax rate was 9.771 percent as of 2013. Therefore, for a property assessed at $100,000 in 2013, the tax bill would have been $3,130 ($100,000 × 0.32 × 0.09771), resulting in an effective tax rate of 3.13 percent of the assessed value. The AVI, however, changed this fractional assessment system so that 100 percent of a property's assessed market value is used to calculate tax bills. To keep this adjustment revenue-neutral, the city lowered the property tax rate from 9.771 percent in 2013 to 1.34 percent in 2014. Using the previous example, a property assessed at $100,000 in 2014 would have been taxed $1,340 ($100,000 × 0.0134). Thus, properties with no or smaller increases in assessed values experienced a decline in the amount of property taxes, whereas those with larger increases in assessments saw significant increases.

In addition, the two major programs adopted along with the AVI to mitigate tax increases on owner-occupied properties and for long-term homeowners, who were likely to face sharp increases in property tax bills after the reassessments. The homestead exemption, the biggest

single mitigation program, is available for all owner-occupied primary residences in Philadelphia, regardless of a homeowner's income or the length of tenure in the residence. The homestead exemption, at it its introduction, provided eligible homeowners an exemption of up to $30,000 of a property's assessed value from taxation (about $400 in taxes in 2014). The other program, LOOP, caps a property's taxable value for 10 years for eligible long-term homeowners — people who have been in their homes at least 10 years, who are below 150 percent of the area median income, and who see their assessed values increase by 300 percent in one year.[2] Homeowners who qualify for both LOOP and the homestead program may apply for whichever one results in the lower bill, but not both. The Pew Charitable Trusts (2015) estimated that about 18,000 homeowners received tax relief through LOOP by spring 2015, and about 216,000 homeowners (about 37 percent of all properties) received homestead exemptions. In addition to two tax mitigation programs adopted in 2013, the 10-year tax abatement program that was enacted in 1997 also helps reduce tax burdens for eligible homeowners (Gillen and Westrum, 2014). Under this program, new construction or major rehabilitation projects are entitled to a 10-year tax abatement on the value of the newly constructed or significantly rehabilitated homes. Because of the changed method to calculate tax bills and the introduction of new exemption programs, property taxes increased for certain properties and decreased for others, although the assessed values generally increased across properties.

After the adoption of the AVI, there have been a few changes in property taxation that may impact our analysis. First, there was a slight increase in the tax rate in 2016 (an increase from 1.34 percent to 1.3998 percent). Although the rate increase was uniform, the increase in tax amounts may be larger for properties in gentrifying neighborhoods. Second, there were no new comprehensive, citywide revaluations until 2019, so assessed values remained largely unchanged during the 2014–2018 period. Third, Philadelphia has made significant progress on collecting delinquent property taxes. As a result, the tax delinquency rate has been significantly lower in

[2] LOOP's assessment criteria was later changed to homeowners whose property assessments increased by 50 percent or more from last year, but there were no comprehensive reassessments until 2019. Except for LOOP, there exist unofficial gentrification alleviation policies that may have the effect of buoying the finances of long-term owners in gentrifying neighborhoods. For example, assessments on abated properties have been assessed differently than nonabated properties, which may somewhat benefit long-term homeowners with unabated properties. The practical consequence of this is that long-term occupied properties have been somewhat sheltered from the full increase in assessed value because the AVI segregates improved and unimproved properties into two different assessed value categories.

recent years. The improvement in tax collection has been attributed to a strong economy and real estate market, as well as changes in collection strategies that include more foreclosure warnings and expanded payment plans.

2.3. Related Literature and Contribution of This Study

Our study builds on several strands of empirical research. First, this study's use of property-level data, local tax policy, and a natural experiment builds on research examining the relationship between property taxes and the mobility of existing homeowners, especially elderly and financially vulnerable homeowners. While some studies find little evidence that property taxes impact elderly homeowners' decisions to move or to liquidate their housing wealth (e.g., Seslen, 2005), Shan (2010) finds significant evidence that higher property taxes raise mobility among elderly homeowners: A $100 increase in annual property taxes is associated with a 0.73 percentage point increase, or a relative increase of 8 percent, in the two-year mobility rate for elderly homeowners. However, Shan does not link gentrification to the mobility of elderly homeowners directly and instead uses variation in state property tax policy as an identification strategy. Martin and Beck's (2018) study explicitly examines the effects of gentrification on the residential mobility of both homeowners and renters using longitudinal Panel Study of Income Dynamics (PSID) data. Taking advantage of the variation in state-level property tax policy, they find some evidence that property tax pressure based on state-level policies can trigger involuntary moves by homeowners, but such displacement is no more common in gentrifying neighborhoods than elsewhere. Property taxes, however, are likely to be endogenous to individuals' moving decisions because many local public services are financed through property taxes, and homeowners who pay high property taxes also tend to live in areas with good local public services. Thus, studies linking state-level property taxes directly to residential mobility may suffer from selection bias. Our study builds on their analysis by considering local tax policy, which plays a more direct role — as we will show — when it comes to gentrification and the prospects of displacement.

Second, our study adds nuance to recent quantitative findings tracking individual residents that primarily focus on residential mobility and displacement of vulnerable residents, which generally

do not find consistent evidence that gentrification leads vulnerable households to move more often relative to similar residents in nongentrifying neighborhoods (Ding, Hwang, and Divringi, 2016; Ellen and O'Regan, 2011; Freeman, 2005; McKinnish, Walsh, and White, 2010; Vigdor, 2002). These studies were either unable to distinguish between owners and renters in their analysis, or they have focused on renters and found mixed results. For example, Ellen and O'Regan (2011) do not find evidence of higher outmigration rates among homeowners in gentrifying neighborhoods relative to nongentrifying neighborhoods, although they find that those homeowners who exit gentrifying neighborhoods have relatively lower average incomes than the neighborhood average itself and those exiting nongentrifying neighborhoods.

Overall, existing empirical evidence on the consequences of gentrification on homeowners is limited and far from conclusive. Gentrification, often accompanied with increased property values, could increase the likelihood of outmigration to better neighborhoods for homeowners in gentrifying neighborhoods by prompting them to liquidate their increased home equity. Gentrification, however, could also make property taxes unaffordable for low-income homeowners who have liquidity constraints, forcing them to sell their home or end up in tax foreclosure. Past research has been unable to separate these two possible mechanisms, the liquidity constraint effect and the wealth effect, both of which could impact the moving patterns of elderly and long-term homeowners. This study tries to fill the gap in the literature by isolating the impact of gentrification on homeowners though the liquidity constraint channel, based on the natural experiment introduced by the adoption of the AVI in Philadelphia.

3. Methodology and Data

3.1 Methodology

This study isolates the effects of gentrification on the rate of tax delinquency for owner-occupied residential properties and vulnerable homeowners' outmigration rates by comparing these outcomes in gentrifying tracts before and after the adoption of the AVI with those of the

nongentrifying tracts in the control group.[3] The two-way, property-level, DID model can be specified as:

$$Y_{ijt} = \beta_0 + \beta_1 * GENTRIFY_j + \beta_2 * AVI_t + \beta_3 * GENTRIFY_j * AVI_t + \gamma * X_i + TRACT_j + YEAR_t + \varepsilon_{ijt} \quad (1)$$

in which Y_{ijt} represents the outcome measure for property i in tract j and in year t. $GENTRIFY_j$ is the dummy variable that represents whether tract j had been gentrifying during 2000–2013. AVI_t is the time dummy and is assigned a value of one for the post-2014 period. $GENTRIFY_j*AVI_t$ is the two-way interaction of the time and treatment dummies. While both $GENTRIFY_j$ and AVI_t are omitted in the estimation because we include the tract and yearly fixed effects in our model, we can still identify the effects of gentrification by estimating the coefficient, β_3, of the interaction, $GENTRIFY_j*AVI_t$. X_i represents a set of property characteristics that help predict property values, including square footage of living area, land size, year built, basement finish type, number of bedrooms, number of bathrooms, and building condition. $TRACT_j$ represents the tract fixed effect, and $YEAR_t$ represents yearly time dummy. We also examine how homeowners fare in neighborhoods with different levels of gentrification relative to those in adjacent nongentrifying neighborhoods. We achieve this by using interaction terms between categorical gentrification variables and the *AVI* dummy in additional models.

We further employ a three-way DID regression and separately evaluate the effects of the tax exemption and abatement programs, including LOOP and the homestead exemption.[4] The three-way DID model allows us to use several control groups to account for correlated trends associated with gentrification and the AVI. Our model compares the outcomes of owners receiving tax relief (a homestead exemption or other tax abatements/exemptions) in gentrifying neighborhoods after 2014 with: (1) outcomes before the AVI, (2) outcomes in adjacent low-income tracts not experiencing gentrification, and (3) outcomes of properties in gentrifying neighborhoods that do not receive the corresponding tax relief. Thus, we observe the outcome for

[3] The treatment is the AVI itself, but it can be roughly considered to be the gentrification, coupled with various tax relief programs.

[4] Because of confidentiality considerations, the city cannot share the data with information on specific abatements/exemption programs at the property level besides the homestead exemption. We used LOOP exemptions or tax abatements and a proxy of LOOP in the empirical analysis.

owners receiving tax relief post-AVI in gentrifying neighborhoods, whereas the other groups were either not exposed to the tax relief programs or not in gentrifying neighborhoods.

We use linear models for continuous outcome measures and linear probability models for binary outcomes to estimate the effect of gentrification. We rely on linear models partly for ease of interpretation of the coefficients. The first set of outcome measures are assessed values and tax amounts, which can be used to test whether they are the mechanisms behind tax delinquencies. The second outcome measure (Y_{ijt}) is the incidence of tax delinquencies for individual residential properties. The property tax payment behavior of homeowners provides one indication of how they are faring financially in the face of higher taxes induced by gentrification.[5] We define two types of property tax delinquencies: any tax delinquencies at the end of the year and new tax delinquencies in the current year. Delinquent property taxes may indicate that a homeowner is cost-burdened as the owner fails to keep up on their tax payments because of financial hardship. Another possibility is that homeowners stop paying the full amount of property taxes while filing appeals for reassessments because they are unsatisfied with the significantly higher assessments under the AVI. We cannot observe this outcome directly in our data, but we evaluate this possibility in more detail later in the paper.

In addition to measures of tax delinquencies, we also examined the effect of the AVI's adoption on a third set of outcome measures on residential mobility rates based on the outmigration of existing homeowners by examining sales of existing properties and residential mobility of elderly (ages 55–84) homeowners, proxied by consumers who have mortgages, and longer-term homeowners, proxied by those who have lived in the same neighborhood for five or more years. We focus on elderly homeowners and longer-term homeowners with outstanding mortgages because elderly and long-term homeowners, especially those relying on fixed incomes and having insufficient liquid assets, are more vulnerable to rising property taxes. Because of liquidity constraints, they may be forced to liquidate their housing wealth and move, even if they

[5] In Philadelphia, each year's property tax payments are mailed to property owners in November and are due in full by March 31 of the following calendar year. Property taxes are officially considered delinquent if they are not paid in full by the end of the calendar year in which the taxes were levied. Department of Revenue tax payment data provide information on the outstanding balance of principal, interest, and penalty at the end of the year. We consider the owner of a property to be delinquent on property tax for a particular year if the total outstanding balance of principal, interest, or penalty is greater than $1. Results using alternative cutoffs of $10 and $100 are similar.

feel attached to their houses and would prefer not to move. Longer-term homeowners, as well as elderly homeowners, are also more likely to be the target population for many tax relief programs, such as LOOP, so the results can shed light on whether these programs are effectively mitigating outmigration among these groups.

Because our data do not distinguish renters from owners directly, we focus on individuals with outstanding mortgages as our proxy for homeowners. While mortgage-holding individuals serve as an imperfect proxy of homeowners, these homeowners are generally more "vulnerable" than other homeowners to move because of financial burdens imposed by increased taxes since they also have to pay their mortgages while paying their property tax bills.[6] As a robustness check, we also examine the residential mobility of all elderly residents and all longer-term residents to include those homeowners who have paid off their mortgages (although this inevitably includes some elderly or longer-term renters).

3.2 Gentrification Measures

Gentrification, put broadly, is the socioeconomic upgrading of a previously low-income neighborhood characterized by the influx of higher socioeconomic status residents and an increase in housing prices. Therefore, we measure gentrification by specifically concentrating on shifts in the socioeconomic status of residents and neighborhood housing prices. The gentrification measure that we use in this study employs the same methodology as in Ding et al. (2016) but is based on 2010 census tract boundaries.

By definition, for tracts to gentrify, they have to have been lower-income tracts at the beginning of the period. We consider tracts to be *gentrifiable* if their median household income was below the citywide median household income in the year 2000, using estimates from the 2000 U.S. census. We consider a tract to be *gentrifying* if it was gentrifiable in 2000 and experienced both a percentage increase above the median increase among city tracts in either its median gross rent or median home value *and* an increase above the median increase among city tracts in its share

[6] Owing to data limitations, we are unable to identify those outright owners or homeowners holding reverse mortgages only, which are not reported in the credit bureau data.

of college-educated residents from 2000 to 2013, based on data from the 2000 census and the American Community Survey (ACS) 5-year estimates from 2009 to 2013. We rely on housing values and rents because they reflect the demand for various amenities and investment in the neighborhood. We include changes in *either* rents or home values because these changes do not necessarily occur in step with each other but nonetheless indicate changing value in a previously low-income neighborhood. We additionally include criteria for demographic changes to deal with issues with past strategies, which misidentified gentrification in neighborhoods that only experienced housing price spillovers without demographic changes. We rely on above-median increases in the share of college-educated residents, rather than incomes, so we can capture young professionals who may have relatively lower incomes and so we can better distinguish an influx of new residents from incumbent upgrading (Clay, 1979; Freeman, 2005). Figure 1 provides a map of gentrifying neighborhoods based on our measure. Of Philadelphia's 365 tracts with population sizes over 50, we categorized 51 of its 182 gentrifiable tracts as gentrifying from 2000 to 2013.[7] The remaining 131 tracts are *nongentrifying*; that is, they were gentrifiable in 2000 but did not meet the criteria listed previously.

Among tracts classified as gentrifying, we further categorize tracts to reflect different stages or paces of gentrification. Table 1 provides a summary of the gentrification measures. We use the following categories:

- *Weak/moderate gentrification:* Tract is not in the top quartile of all city tracts for either median rent or median home value in the 2009–2013 ACS estimates and was not gentrifying before 2000
- *Intense gentrification:* Tract is in the top quartile of all city tracts for either median rent or median home value in the 2009–2013 ACS estimates and was not gentrifying before 2000
- *Continued gentrification:* Tract had been gentrifying in the 20 years prior to 2000 and continued gentrifying from 2000 to 2013[8]

[7] The data exclude census tracts that had fewer than 50 residents or had fewer than 10 owner-occupied single-family housing units (based on the CoreLogic Solutions data) during the entire period of analysis.

[8] We find 11 out of the 20 tracts classified as continued gentrification have home values or rents in the top quartile of the city at the end of the period, making them on par by price with the intense gentrifying tracts.

For the purposes of this analysis, we primarily use a control group for the gentrifying tracts that consists of nongentrifying tracts within a half-mile radius of the boundary of a gentrifying tract. We recognize that there is heterogeneity across gentrifying areas that shapes how they unfold. For example, gentrification can be a slow process that may take decades for a neighborhood to experience full class turnover. Consequently, as with all neighborhood-level studies, there are selective differences between who ends up in which neighborhood. Nonetheless, we use the nongentrifying tracts in adjacent areas as our comparison because they are proximate to gentrifying tracts and thus at least account for differences in proximity to downtown or other amenities. While these tracts may eventually gentrify, they did not meet our criteria during the time period analyzed, and our analysis using the various stages of gentrification provide some insight into these differences. Nongentrifying neighborhoods that are farther away may have unobserved characteristics that make them less comparable with gentrifying neighborhoods. The final analytic sample thus includes a total of 50 gentrifying tracts and 72 nongentrifying tracts in the control group (Figure 2).[9] Tracts in the control group are in the same submarket of gentrifying neighborhoods and with similar or slightly lower property values at the beginning of the century, but they did not experience the same level of neighborhood change as gentrifying neighborhoods from 2000 to 2013. Table 2 summarizes the neighborhood characteristics of gentrifying and adjacent nongentrifying neighborhoods used in the empirical analysis.

3.3 Tax Assessments and Property Tax Payment Data

This study primarily uses administrative data from the Department of Revenue (DOR) of the City of Philadelphia, which provide property-level information on tax assessments, tax amounts, whether properties have tax abatements and tax exemptions, and tax payment behavior for all properties in Philadelphia from 2010 to 2018.[10] The DOR property tax data have an identifier for

[9] One tract that we identify as gentrifying is far from all other gentrifying neighborhoods and is surrounded by several nongentrifying and nongentrifiable tracts with market conditions that are distinct from the other clusters of gentrifying tracts and those within a half-mile radius of them. We drop this gentrifying tract from the final sample to limit biasing estimates of the gentrification effect.

[10] The data reflect the adjusted values resulting from appeals by the end of 2018, which might be different from the assessed values or property taxes in the initial tax bill after the AVI was implemented.

homestead exemptions and an identifier for tax abatements or LOOP exemptions. The DOR data are complemented by data from CoreLogic Solutions, which further provide information on property characteristics, the census tract in which the property is located, and deed transactions for residential properties in Philadelphia.[11]

We use the panel data from 2010 to 2018 for the analysis of tax delinquencies and property sales. We use only the 2013 and 2014 data for the analysis of tax assessments and tax amounts, because there was no systematic variation in the value of the outcome variables during the years before or after 2014.

We made a few additional decisions in creating the final study sample of residential properties used in our analysis. First, the analysis focuses on owner-occupied,[12] single-family residential properties, as identified in the CoreLogic Solutions data, only in Philadelphia. Second, a small number of properties with extremely low or extremely high values (those with assessed values below $10,000 and above $2,000,000 in 2014) were excluded from the analysis. Consequently, we end up with a final sample of 89,712 properties in 122 census tracts in Philadelphia in our baseline regression.

3.4 The Federal Reserve Bank of New York/Equifax Consumer Credit Panel

While the DOR data provide information on properties themselves, they do not contain information on the occupants for us to analyze whether they move out of their homes.[13] Following the methodology in Ding et al. (2016), we use the Federal Reserve Bank of New York/Equifax Consumer Credit Panel (CCP) data to evaluate the effect of gentrification coupled with the AVI's adoption on short-term mobility patterns among vulnerable homeowners. The

[11] These data sets were linked by property parcel numbers, but all personally identifiable information was removed from the merged data for the empirical analysis.
[12] Data from CoreLogic Solutions define owner occupancy based on the comparison of the mailing address of the property owner and the property address. If the mailing address and the property address do not match, the owner is considered an absentee owner; otherwise, the property is considered owner-occupied.
[13] The parcel level tax data only allow us to identify the owner of a property, who are not necessarily the current occupants of the property. The tax data do not allow us to track the mobility of individuals/households over time reliably, so we use the CCP data to assess this.

CCP data consist of an anonymized 5 percent random sample of U.S. consumers in a major credit bureau's total population of eligible individuals, as well as consumers in each sampled individual's household. This sample is constructed by selecting consumers with at least one public record or one credit account currently reported and with one of five numbers in the last two digits of their Social Security numbers (SSNs) (see details in Lee and van der Klaauw, 2010).[14] The CCP data report the credit characteristics for sample members quarterly beginning in 1999. The CCP data allow us to study residential mobility, because the CCP data include census geography identifiers based on census boundaries associated with each consumer's credit file. By identifying whether an individual has moved across neighborhoods, a "mover" is defined in this study as an individual who lives in a different census tract at the end of the first quarter of a year than where he or she lived one year earlier. Consistent with earlier literature, we focus on the moving decisions of elderly homeowners, proxied by residents between 55 and 84 years old with outstanding residential mortgages, as well as longer-term residents (five or more years) with outstanding residential mortgages.

3.5 Descriptive Statistics

Figure 3 illustrates some of the unique features of the property taxation system in Philadelphia by showing the trends in average assessed values, tax amounts, and tax delinquency rates in gentrifying neighborhoods and in the adjacent low-income neighborhoods that did not experience gentrification before 2013. The average assessed values changed very little before the AVI, with an average increase of 42.9 percent during 2004–2013 in gentrifying neighborhoods but only an average increase of 10.3 percent in nongentrifying neighborhoods. The concentration of new construction home, which are required to undergo reassessments, in gentrifying neighborhoods likely explain the observed differences. The assessed values, however, jumped sharply in 2014 when the city reassessed all properties under the AVI, with a much larger increase in gentrifying neighborhoods. Property taxes increased slightly before 2013, but the increase was mainly attributable to small increases in the property tax rate. After adopting the

[14] The CCP data do not include actual SSNs. Equifax uses SSNs to assemble the data set, but the actual SSNs are not shared with researchers. In addition, the data set does not include any names, actual addresses, demographics (other than age), or other codes that could identify specific consumers or creditors.

AVI, property taxes rose substantially in gentrifying neighborhoods, but there was almost no change in nongentrifying neighborhoods. These figures suggest that the adoption of the AVI allowed for the realization of the actual differences in assessed values and tax amounts between gentrifying and nongentrifying neighborhoods. The trends for property sales and residential mobility in gentrifying and nongentrifying neighborhoods look generally similar, and we discuss this in more detail when evaluating the parallel assumption in the next section.

Descriptive analysis confirms that the assessed value of single-family, owner-occupied properties in Philadelphia jumped sharply in 2014 when the city reassessed all properties under the AVI (Table 3). There was a larger increase in the assessed values for properties in gentrifying neighborhoods: The increase of $115,998 in the average assessed value, or a 306.8 percent increase, in gentrifying neighborhoods was larger than the increase of $44,325 in average assessed value, or a 205.0 percent increase, in nongentrifying neighborhoods. Property taxes also rose more substantially in gentrifying neighborhoods after the AVI, with an increase of 57.4 percent from 2013 to 2014, compared with a slight decrease of 0.3 percent in nongentrifying neighborhoods. The biggest jumps in property taxes were concentrated in gentrifying neighborhoods where housing prices had soared in the past decade but had also been gentrifying in previous decades (*continued gentrification*), with an average property tax increase of 76.9 percent in neighborhoods with continued gentrification. In neighborhoods undergoing intense gentrification, the increase in the tax amount ($1,042) was larger, but the percent change (42.9 percent) was smaller, because the average property tax amount was higher in these neighborhoods before the AVI, which is likely due to higher levels of new construction in these intensely gentrifying neighborhoods prior to 2014.

The average tax delinquency rate had been between 15 percent and 20 percent before 2013 in gentrifying neighborhoods. In nongentrifying neighborhoods, the tax delinquency rate was much higher, at about 30 percent, during the same period. There was a substantial increase of 2.9 percentage points in the delinquency rate from 2013 to 2014 for owner-occupied properties in gentrifying neighborhoods (the 2013 mean was 12.3 percent). Those neighborhoods experiencing more intense levels of gentrification generally experienced larger increases in property tax delinquency rates — an increase of 5.0 percentage points (from 4.9 percent to 9.9 percent) in

neighborhoods experiencing intense gentrification and an increase of 3.2 percentage points (from 10.4 percent to 13.6 percent) in neighborhoods undergoing continued gentrification. In contrast, tax delinquency rates in nongentrifying tracts declined slightly (an average decrease of 0.8 percentage point), although they were still at a relatively high level of 26.6 percent in 2014. There was a decline in sales transactions after the AVI, with a larger decrease in the volume of property sales in gentrifying neighborhoods.

About 48.5 percent of single-family, owner-occupied properties in gentrifying neighborhoods received homestead exemptions in 2014, and the share was similar (49.6 percent) in nongentrifying neighborhoods. However, the share of properties receiving other exemptions or abatements was much higher in gentrifying neighborhoods than in nongentrifying neighborhoods (22.9 percent in gentrifying neighborhoods versus 6.5 percent in nongentrifying neighborhoods). Because gentrifying neighborhoods had more new construction and experienced larger increases in property values in general, it is not surprising that more homeowners in gentrifying neighborhoods qualify for gentrification protection programs.

3.6 Identification Assumptions

There are important assumptions for the DID approach used in this study. The parallel trend assumption, which assumes parallel trends prior to the treatment, is the most critical to ensure internal validity of DID models. One way to assess this identifying assumption is to look at the trends in outcomes leading up to the adoption of the AVI in 2013. The descriptive charts (Figure 3) based on gentrifying and nongentrifying neighborhoods suggest that the trends for neighborhoods in the treatment group and for those in the control group are quite similar for most outcome variables (assessed value, property tax, and tax delinquency) during the pre-2014 period. The trend for assessed value and property tax is not surprising, since there were no citywide reassessments during the 2010–2013 and 2014–2018 periods. The trends in the mobility of elderly and longer-term residents were less parallel but still similar, likely because of the relatively small sample and the rare incidence of residential moves. The only exception is that there was a slightly larger increase in property sales in gentrifying neighborhoods in 2013, possibly driven by the anticipation of the adoption of the AVI.

A better way to assess the parallel trend assumption is to conduct falsification tests for other periods, based on the idea that the effects of gentrification we identified based on the exogenous policy shock in 2014 would not exist in the pre- or post-treatment periods. To do this, we repeat the regression models for each two-year episode during the study period, from 2009–2010 to 2017–2018 for the property tax outcomes (assessed value, tax amount, property sales, and tax delinquency), and for each four-year episode, from 2008–2011 to 2015–2018, for the residential mobility outcome.[15] If we find a significant effect in periods before 2013 or after 2014, it suggests that there were some unobserved characteristics between the treatment and control tracts that potentially yielded biased estimates. The results are shown in Figure 4. The points represent the estimated coefficients of the interaction term, and the vertical bars are the 95 percent confidence interval of the coefficients.

In general, the estimated "treatment" effects are either insignificant or slightly different from zero during the pre-event or post-event years for assessed value, property tax, and residential mobility. The standard errors for the effects on assessed value and property tax are quite small because most of the properties were not reassessed in most years except 2014. As expected, there was a much larger change in both assessed value and property tax from 2013 to 2014, as well as a significant increase in property tax amount from 2015 to 2016 because of the increase in the tax rate. We find a similar pattern for the mobility rates of elderly and longer-term homeowners, with no significant pre-trend for elderly residents. The pattern for tax delinquency is slightly more nuanced. The estimated "treatment" effects for tax delinquency were significantly less than zero for two of the years before 2013 (2010 and 2012), but the magnitude of the change was much smaller (relative to that in 2014).

There was, however, a larger increase in property sales in gentrifying neighborhoods in the two years before the AVI (2012 and 2013), suggesting a pre-trend in property sales before the AVI. Results suggest that some property sales in the short period before 2014 in gentrifying tracts could have been driven the adoption of the AVI. As a robustness check, we reran the baseline

[15] Owing to data constraints (the lack of historical data needed to identify longer-term homeowners), the pre-trend analysis for longer-term homeowners is only available for the post-2012 periods.

regression by excluding the two years immediately before and after the AVI. The results on property sales are qualitatively consistent, although the magnitude of the interaction term becomes smaller (-0.3 percentage point, instead of -0.6 percentage point using the full sample). In other words, with one exception (property sales), compared with the control tracts, the gentrifying tracts generally had no systemic difference in the trend of assessed values, property taxes, tax delinquencies, and the mobility of elderly and longer-term homeowners in the years before the policy shock in 2014. Further, results based on the sample that are unlikely to suffer the pre-trend problem suggest the results still hold qualitatively for property sales as well. Overall, the pre-trend analysis supports the idea that the effects of gentrification found in this paper were mainly due to the exogenous policy shock in 2014.

4. Empirical Results

This section summarizes the regression results of the effects of gentrification and the effectiveness of tax relief programs. The gentrification effect is captured by the coefficient for the interaction variable (*GENTRIFY*AVI*), representing the change in the value of the corresponding outcome measure post-AVI of being in a gentrifying neighborhood. The coefficient of the three-way interaction variable, *GENTRIFY*EXEMPTION*AVI*, captures the effect of tax relief programs on properties in gentrifying neighborhoods after the AVI. Because we are unable to link the DOR tax abatements and exemptions data to the CCP data on residential mobility, the analysis of the effectiveness of tax relief programs focuses only on gentrification's effects on tax delinquencies, property sales, and property taxes. As defined earlier, the control group generally refers to the properties in the nongentrifying tracts within a half-mile of any gentrifying neighborhood.

4.1. Effects of Gentrification on Assessed Values and Tax Amounts

Regression results provide consistent evidence that gentrification leads to a significant increase in the assessed value and the tax amount of residential properties in Philadelphia (Table 4). Gentrification leads to an increase in assessed value of $71,673 (about 189.6 percent of the 2013 mean) and an increase of $540 in the tax amount (about 57.6 percent of the 2013 mean), relative

to the low-income tracts that did not experience gentrification. The increase of $540 is lower than expected (an increase of $71,673 in assessed value should lead to an increase of $960 in the tax amount, based on the 2014 tax rate of 1.34 percent), which is likely explained by the existence of various tax relief programs that are not fully captured by this model.

The results also show that both assessed values and tax amounts increase significantly in neighborhoods of any type of gentrification relative to nongentrifying tracts. The increase in assessed values and tax amounts is much larger in neighborhoods undergoing intense gentrification or continued gentrification. For example, gentrification leads to an increase of $1,045 in the tax amount in neighborhoods experiencing intense gentrification, compared with an increase of $794 in neighborhoods with continued gentrification and an increase of $361 in neighborhoods with weak/moderate gentrification. While these amounts may not seem particularly high, these increases are substantially larger than what residents were paying in the previous year, and prior work by Shan (2010) suggests that these incremental increases in property taxes can substantially increase the likelihood of outmigration for elderly residents.

4.2 Effects of Gentrification on Tax Delinquencies

As mentioned earlier, liquidity-constrained homeowners may become tax delinquent when the increase in the tax amount is significant enough that it is challenging for them to make timely payments on property taxes. Regression results suggest that gentrification does lead to an increase in the probability of tax delinquency by an average of 4.1 percentage points (see Table 5) — the mean delinquency rate was 12.3 percent in gentrifying neighborhoods in 2013. Neighborhoods with intense gentrification have the largest increase in tax delinquency rates, with an increase of about 6.1 percentage points, compared with 3.8 percentage points for continued gentrification neighborhoods and 4.2 percentage points for weak/moderate gentrification neighborhoods. The results suggest that a more intense level of gentrification leads to a larger increase in the probability of tax delinquencies.

The effect of gentrification on the new delinquency rate is quite consistent, with a larger increase in the new delinquency rate for properties in neighborhoods with more intense levels of

gentrification (an increase of 1.6 percentage points in tracts with intense gentrification, compared with 1.0 percentage points for continued gentrification neighborhoods and 0.8 percentage points for weak/moderate gentrification neighborhoods). It should be noted that the delinquency rates in neighborhoods undergoing intense gentrification were substantially lower than other neighborhoods pre-AVI (Table 3). The sharp increase in delinquency rates, accompanied by the largest absolute changes in the assessed values and tax amounts, is expected to impose greater financial burdens for homeowners in these neighborhoods.

Overall, the significant increase in property taxes for homeowners in gentrifying neighborhoods is consistent with our contention that the larger increase in property taxes in gentrifying neighborhoods leads to a higher risk of tax delinquencies. While homeowners can choose to tolerate the increased property taxes and other expenses because of the improved amenities and opportunities in gentrifying neighborhoods, gentrification could force homeowners to become delinquent on tax payments if the increase in tax amount is significant enough for liquidity-constrained homeowners.

Tax delinquencies, however, may also be inflated by an unusual number of high-value property assessment appeals in Philadelphia: When a homeowner is unsatisfied with a significantly higher assessment, they may stop paying the full amount of property tax and file an appeal for a reassessment, which could have driven up delinquency rates — at least in the short term. We identified a sample of more than 4,000 likely appeals by comparing assessed values of the properties in 2015 and 2016 with the corresponding 2014 values.[16] We find these residents are more likely to become current on tax payments after the assessed values are adjusted, as confirmed by the data: These homeowners' tax delinquency rate dropped from 30.2 percent in 2014, which was double the average of 15.1 percent of all properties in gentrifying neighborhoods, to 10.7 percent in 2015, likely because their appeals had been approved and led to a reduction in their assessed values. When we exclude these likely appeals from the sample, the estimated gentrification effect on tax delinquencies is slightly smaller but remains

[16] If the assessed value of the property was adjusted downward after 2014, we assume the homeowner had appealed for reassessment and successfully adjusted the assessed value downward. Although this is an imperfect measure, it should capture the portion of the homeowners who are more likely to enter delinquency owing only to inaccurate or unfair assessments, instead of liquidity constraints.

statistically significant (an increase of 4.0 percentage points instead of 4.1 percentage points at the aggregate level). Therefore, the results suggest the large number of property assessment appeals contributes to the increased tax delinquency rate in gentrifying neighborhoods. The magnitude of the gentrification effects becomes smaller, but the major conclusions nonetheless hold when we exclude these likely appeals.

4.3 Post-AVI Residential Mobility and Home Sales

The results on tax delinquencies are informative and shed light on the financial burdens that gentrification imposes on homeowners, but tax delinquencies do not necessarily mean that the resident moves away. Increases in property taxes could force vulnerable homeowners with liquidity constraints, such as those elderly homeowners relying on fixed incomes and having insufficient liquid assets, to move out. We also suspect, however, that increased property taxes could reduce the demand for properties in gentrifying neighborhoods, thus suppressing the number of transactions and reducing the moving rates of homeowners in these neighborhoods. Unfortunately, because the DOR tax data cannot be linked directly to the CCP data on residential mobility, we are unable to test if tax delinquencies lead individual households to move out of their homes explicitly. Instead, we focus directly on the effect of the adoption of the AVI on residential mobility of elderly and longer-term homeowners in gentrifying neighborhoods to test if increased property taxes and subsequent delinquencies bear out on observed outmigration rates. Since we are unable to control for tax relief programs using the CCP data, the coefficient of the interaction variable, *GENTRIFY*AVI,* captures both the effect of gentrification and tax relief programs that target properties in gentrifying neighborhoods, such as LOOP.

The regression results suggest that the probability of moving within five years after the adoption of the AVI for elderly residents (ages 55–84) in gentrifying neighborhoods does not change significantly (a slight decrease of 0.4 percentage point but statistically insignificant) after the adoption of the AVI (Table 5). There is also no significant evidence in support of a higher rate of mobility for longer-term homeowners after the adoption of the AVI, although the sign of the interaction term is positive (1.3 percentage points but statistically insignificant).[17] As a

[17] The CCP sample size is too small to allow us to run the regression for different gentrification categories.

robustness check, we reran the residential mobility regressions for all elderly residents and all longer-term residents, to include those homeowners who have paid off their mortgages (and inevitably some older and longer-term renters). The results are qualitatively consistent in terms of the sign and significance of the coefficients, although the magnitude of the effects becomes smaller, likely because the property tax increase only has an indirect and possibly smaller effect on renters than homeowners. In other words, there is no significant evidence that the sharp increase in property assessments in gentrifying neighborhoods increased the outmigration of elderly and longer-term homeowners at the aggregate level.

Although this finding seems to contradict Shan's (2010) finding that elderly homeowners respond to increased property taxes by moving to more affordable housing or housing with lower property taxes, several other studies find that the outmigration rates of homeowners from gentrifying neighborhoods are not significantly higher than those from nongentrifying neighborhoods (Ding et al., 2016; Martin and Beck, 2018). There are several reasons that may explain these findings. First, studies have provided evidence that tax relief programs that provide tax breaks for homeowners living in the same house for a long time, like Proposition 13 in California, have created a lock-in effect on housing choice and residential mobility (Wasi, White, Sheffrin, and Ferreira, 2005; Ferreira, 2010). In Philadelphia, many elderly and long-term homeowners are able to stay likely because of the tax relief provided by LOOP and other programs, which we evaluate in the next subsection.

Second, it is also possible, as mentioned earlier, that the sharply increased property taxes for properties in gentrifying neighborhoods have suppressed both demand for housing and the volume of transactions in these neighborhoods, making it more difficult for vulnerable homeowners to sell their properties after the AVI, even when they want to do so. The regression results on property sales confirm that the probability of sales of existing properties decreases in gentrifying neighborhoods after the adoption of the AVI (about 0.6 percentage point lower on average, with an even larger decrease in neighborhoods with intense gentrification or continued gentrification). Third, given Philadelphia's history of weak enforcement for tax-delinquent properties, the risk that vulnerable homeowners are formally forced from their homes is likely to be lower in Philadelphia than in other cities. Of course, the outmigration of long-term

homeowners is rare, and that outmigration may occur following a longer time period after the adoption of the AVI, as financial burdens accumulate. All these factors help explain why there is no discernible difference in the mobility rate of elderly and longer-term homeowners.

4.4 Effects of Tax Exemptions and Abatements

We ran a set of three-way DID regressions to compare the effectiveness of exemptions in preventing tax delinquencies for homeowners in gentrifying neighborhoods (Table 6). Regression results suggest that LOOP and the 10-year tax abatement program are effective in reducing the risk of tax delinquency for properties in gentrifying neighborhoods (about 2.1 percentage points lower in aggregate delinquency rate and 0.8 percentage point lower in the new delinquency rate). Different from the homestead exemption, these exemption and abatement programs provide greater tax relief on average for properties in gentrifying neighborhoods: a reduction of about $566. When we focus on properties that are likely to benefit only from LOOP, the regression results on tax delinquencies are quite consistent, while the magnitude of the effect on tax amounts is slightly smaller (a reduction of $462, instead of $566 in the baseline model).[18] Therefore, these programs are more effective than homestead exemptions in preventing tax delinquencies for homeowners in gentrifying neighborhoods. In addition, properties already enrolled in these tax relief programs are less likely to enter appeal-induced tax delinquencies because the homeowners enjoying significant tax relief have little incentive to file appeals for property reassessments. These findings help explain why we do not observe higher rates of outmigration among elderly and longer-term homeowners, many of whom are more likely to be protected by these tax relief programs.

Properties receiving homestead exemptions, however, generally experience a slightly larger increase in the tax amount ($259) and the tax delinquency rate (4.0 percentage points) in gentrifying neighborhoods, relative to those in nongentrifying neighborhoods. In other words,

[18] The DOR data do not distinguish LOOP from the property tax abatement program. But according to the AVI, properties that had received 10-year tax abatements are ineligible for LOOP, which was adopted in 2014. Properties that did not benefit from any exemptions or abatements until after 2014 could serve as a better proxy of LOOP properties, since the exemption program in which they enrolled is more likely to be LOOP (except those newly receiving 10-year abatements after 2014).

homestead exemptions are less effective than LOOP in reducing tax amounts and the risk of tax delinquencies in gentrifying neighborhoods. The results are as expected, since homestead exemptions provide almost the same level of relief (up to $400) for all homeowners, regardless of the assessed values of the properties. A largely fixed amount of tax relief, thus, provides relatively greater relief for owners of lower-value properties, which are more likely to be located in nongentrifying neighborhoods. Therefore, homestead exemptions are expected to be less effective in protecting homeowners in gentrifying neighborhoods.

Overall, because of various abatement and exemption programs adopted along with the AVI, especially LOOP, designed to mitigate sharp increases in tax amounts for long-term homeowners, rising assessed values do not necessarily lead to tax delinquencies or outmigration. While tax delinquencies are not necessarily something to be avoided at all costs in the Philadelphia context, we believe tax delinquency still serves as an early indicator of potential displacement, especially for more vulnerable homeowners. The new addition of LOOP helps reduce the risk of tax delinquencies in gentrifying neighborhoods. The results suggest that well-targeted policies could significantly mitigate the negative consequences of gentrification for homeowners.

4.5 Robustness Checks

We conducted additional analyses using different control groups, with data aggregated at the neighborhood level instead of the property level and with different subsamples, to discern how sensitive the results are to some of our analytical decisions. For the sake of brevity, we only discuss general patterns here. When we expand the control group to owner-occupied properties in all nongentrifying neighborhoods, instead of those in adjacent neighborhoods, gentrification's effect on tax delinquencies is still significant, but the magnitude becomes slightly smaller. Gentrification's effects on the mobility of elderly homeowners and longer-term homeowners are quite consistent as well (Table A1).[19] When the unit of analysis is a census tract instead of an

[19] When we use the owner-occupied properties in all nongentrifiable neighborhoods as the control group, gentrification's effects on new delinquencies, property sales, and the residential mobility of elderly homeowners are consistent, although the magnitude of the effects becomes slightly smaller. But results suggest tax delinquencies are

individual property, the results are quite consistent, both in terms of the sign and the significance of gentrification's effects. We also tried a shorter study period (two years before and after the AVI) for the tax delinquency and residential mobility analysis, and gentrification's effects remain quite consistent.

Further, we conducted analysis using alternative gentrification measures, including the Freeman (2005) measure, which is less conservative than ours, and the Ellen and O'Regan (2011) measure, which identifies generally similar tracts to be gentrifying as our measure (Table A2). The results are qualitatively consistent, although the magnitude of gentrification's effects on tax delinquencies becomes smaller, likely because our gentrification measure relies on significant changes in housing prices in addition to socioeconomic changes of the residents there, whereas Ellen and O'Regan's (2011) measure relies solely on income changes and Freeman's (2005) measure includes tracts with any increase in housing values along with demographic changes.

Finally, we tested the relationship between changes in property tax assessments and tax delinquencies and various demographic variables often associated with gentrification to assess if there are similar relationships to what we find with our gentrification measures. As Table A3 shows, the changes in property assessment values, tax amounts, and delinquency rates are highly correlated with the various demographic variables often associated with gentrification. The Spearman correlations suggest that changes in property assessments, tax amounts, and tax delinquencies from 2013 to 2014 are positively correlated with changes in home values, rents, percent share of whites, percent of college educated, and median incomes from 2000 to 2013, and they are negatively correlated with changes in poverty rates. While there is no clear consensus in the research on how to best operationalize gentrification for assessing a large number of neighborhoods, these relationships suggest that our findings should hold even if alternative measures of gentrification that rely on other neighborhood indicators are used.

5. Conclusion

shared between nongentrifiable and gentrifying neighborhoods, which could be explained by a similar level of increase in assessed values in nongentrifiable neighborhoods.

The contention that gentrification displaces long-term homeowners by increasing their property taxes has received renewed attention from policymakers and scholars in recent years. Although the hypothesized causal relationship and mechanism between gentrification, property taxes, and displacement is straightforward, there is limited evidence for such a link. This study sheds light on whether and how gentrification increases the risk of tax delinquencies and displacement of vulnerable homeowners by increasing their property tax liability. This study also demonstrates the effectiveness of several gentrification protection programs in mitigating the negative effects of gentrification.

The empirical results of this study confirm that gentrification increases the risk of delinquency on property tax payments under a tax system in which property assessments more accurately reflect the market price of the property. Gentrification, accompanied by increased property values, leads to increased property taxes, causing more homeowners to become delinquent on their tax payments on average. By freezing or lowering tax amounts, programs that provide greater relief for long-term residents lower the delinquency risk for homeowners.

There has been no sign yet that older or longer-term homeowners in gentrifying neighborhoods in Philadelphia are more likely to experience residential displacement. This is likely because well-targeted gentrification relief programs reduced tax amounts and the likelihood of tax delinquency, which contributes to mitigating a larger-scale departure of vulnerable homeowners in these neighborhoods, at least in the short term. Fewer sale transactions in the gentrifying neighborhoods as a result of increased property taxes may also help explain observed lower mobility rates. More studies, however, are still needed to track whether the higher tax delinquency rates in gentrifying neighborhoods will force more disadvantaged homeowners to move out in the long term. Nonetheless, while many homeowners manage to stay in their homes, they may sacrifice other basic needs to make property tax payments in order to stay in their home. Thus, in the longer term, they may still face the risk of having to sell their home or ending up in tax foreclosure. It is important that tax relief programs continue to be implemented and well-targeted and that there are expanded efforts to increase take-up rates to help mitigate such negative outcomes.

Nonetheless, this study is based on data from one city that has a number of distinct features, so the results may not necessarily be applicable to areas with significantly different market conditions and property tax systems. Our findings on the effectiveness of the tax relief programs, however, provide useful lessons for other cities facing the spread of gentrification and concerns about residential displacement and for designing policies that protect homeowners and policies that can potentially protect renters from displacement. As a case study, this empirical research contributes to debates on gentrification and residential displacement by shedding new light on the effects of gentrification on homeowners and the effectiveness of several innovative gentrification relief programs. The results can help researchers and policymakers understand the complicated relationship between gentrification, property taxes, and residential displacement for designing programs to prevent the negative consequences of gentrification.

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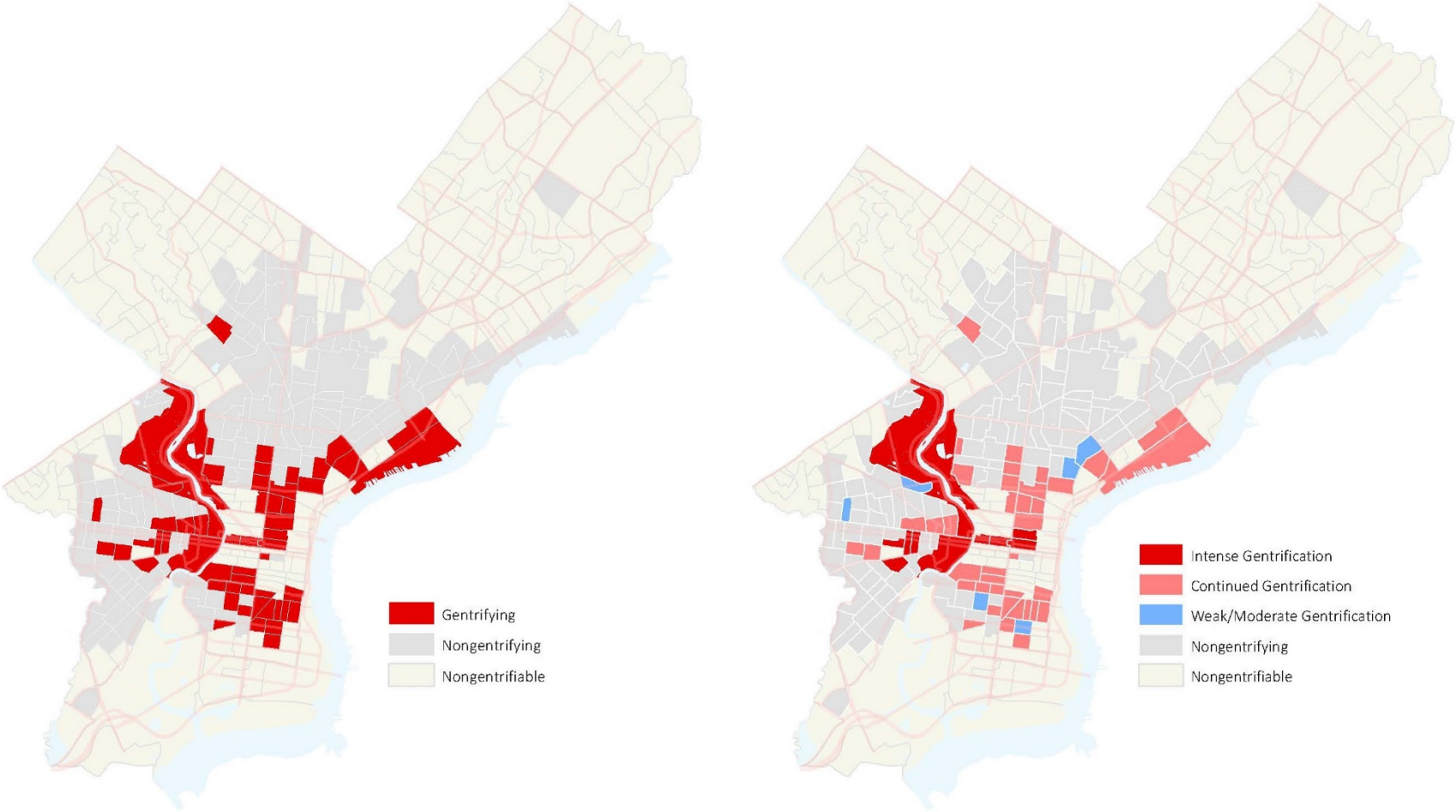

Figure 1. Gentrifying Neighborhoods in the City of Philadelphia (Left, Binary Measure; Right, Categorical Measure)
Sources: Authors' definition based on the 2000 census and 2009–2013 American Community Survey data; U.S. Census TIGER/Line Shapefiles.

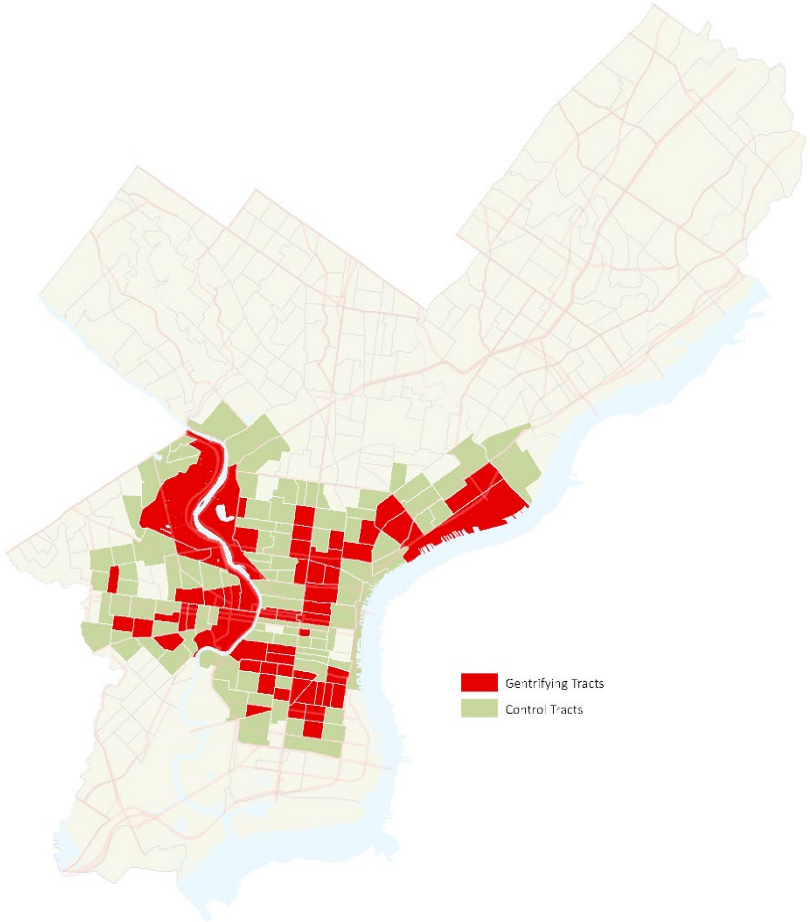

Figure 2. Gentrifying Neighborhoods in the City of Philadelphia and Adjacent Nongentrifying Neighborhoods (Within a Half-Mile)
Note: One gentrifying tract was dropped from the final analysis.
Sources: Authors' definition based on the 2000 census and 2009–2013 American Community Survey data; U.S. Census TIGER/Line Shapefiles.

Figure 3. Change in Average Assessments, Property Taxes, and Tax Delinquency Rates of Owner-Occupied, Single-Family Homes in Philadelphia by Neighborhood Gentrification Status Before and After the AVI (Gray Line)

Notes: Properties in gentrifying and nongentrifying neighborhoods are within a half-mile radius of the boundary of a gentrifying tract. Properties are single-family, owner-occupied homes with assessed values between $10,000 and $2,000,000. Sample size may vary slightly across different years. The gray line indicates when the AVI was implemented.

Source: Authors' calculations using data from the City of Philadelphia and CoreLogic Solutions, and data from the FRBNY/Equifax Consumer Credit Panel.

Figure 4. Falsification Tests: The Estimated Coefficients of the Interaction, Gentrify * Post

Source: Authors' calculations using data from the City of Philadelphia and CoreLogic Solutions, and data from the FRBNY/Equifax Consumer Credit Panel.

Table 1. Description of Categorical Gentrification Measure

	Categories	Tracts (n)	Explanation
Nongentrifiable		184	Has median income above citywide median income in 2000
Nongentrifying		131	Has median income below the citywide median income in 2000 and does not meet criteria for gentrifying from 2000–2013
Gentrifying		51	Has median income below the citywide median income in 2000; percent increase in rent or value above the median increase among city tracts; increase in percent of college-educated residents above the median increase among city tracts
	Weak/moderate gentrification	25	Gentrifying but not in the top quartile for rent or value in 2009–2013, not gentrifying pre-2000
	Intense gentrification	6	Gentrifying and in the top quartile for rent or value in 2009–2013, not gentrifying pre-2000
	Continued gentrification	20	Pre-2000 gentrification and gentrifying 2000–2013

Sources: Authors' calculations using data from the 1980, 1990, and 2000 censuses and the 2009–2013 American Community Survey.

Table 2. Neighborhood Characteristics by Gentrification Category for Analysis Tracts

	Gentrifying	Nongentrifying
Initial Neighborhood Condition, 2000		
Total population (n)	175,368	307,409
Non-Hispanic white (%)	35.5	13.6
Non-Hispanic black (%)	48.3	72.7
Renters (%)	50.6	44.2
College educated (%)	14.8	8.7
Below poverty (%)	32.8	36.8
Median household income (2000 $)	21,406	20,091
Median rent (2000 $)	400	384
Median value (2000 $)	57,488	38,861
Change in Neighborhood Indicators, 2000–2013		
Change in total population (%)	3.8	–3.7
Change in non-Hispanic white (%)	22.4	–13.7
Change in non-Hispanic black (%)	–28.2	–9.7
Average percent change in median household income (%)	23.5	–11.1
Average percent change in renters (%)	–3.4	–8.7
Average percent change in college educated (%)	17.5	1.5
Average percent change in poverty rate (%)	–3.8	4.1
Average percent change in median rent (%)	39.3	14.2
Average percent change in median home value (%)	171.7	69.1
Tracts (n)	50	72

Note: Gentrifying and nongentrifying neighborhoods are within a half-mile radius of the boundary of a gentrifying tract only; tracts that have an extremely small population or no population were excluded.
Sources: Authors' calculations using data from the 2000 census and the 2009–2013 American Community Survey.

Table 3. Descriptive Statistics of the Study Sample

Variables	2013	2014	Absolute Change	Change (%)	Difference in Changes[a] (%)
Assessment ($)					
Gentrifying	$37,808	$153,806	$115,998	306.8%	101.8%
Weak/moderate	$27,875	$116,158	$88,283	316.7%	111.7%
Intense	$78,807	$299,054	$220,247	279.5%	74.5%
Continued	$50,940	$204,346	$153,407	301.2%	96.2%
Nongentrifying	$21,623	$65,948	$44,325	205.0%	
Property Tax ($)					
Gentrifying	$937	$1,474	$537	57.4%	57.7%
Weak/moderate	$810	$1,169	$358	44.2%	44.6%
Intense	$2,429	$3,472	$1,042	42.9%	43.3%
Continued	$1,030	$1,822	$792	76.9%	77.2%
Nongentrifying	$646	$643	-$2	-0.3%	
Tax delinquencies (%)					
Gentrifying	12.30%	15.16%	2.86%		3.64%
Weak/moderate	13.83%	16.39%	2.56%		3.33%
Intense	4.89%	9.89%	5.00%		5.78%
Continued	10.36%	13.56%	3.20%		3.98%
Nongentrifying	27.34%	26.56%	-0.78%		
New tax delinquencies (%)					
Gentrifying	2.70%	5.78%	3.08%		1.47%
Weak/moderate	3.06%	5.82%	2.76%		1.15%
Intense	1.06%	5.96%	4.89%		3.29%
Continued	2.23%	5.70%	3.47%		1.86%
Nongentrifying	4.82%	6.43%	1.61%		
Sales of existing properties (%)					
Gentrifying	6.33%	5.14%	-1.20%		-0.97%
Weak/moderate	5.18%	4.64%	-0.54%		-0.31%
Intense	5.74%	4.89%	-0.85%		-0.63%
Continued	8.27%	5.97%	-2.30%		-2.08%
Nongentrifying	2.99%	2.76%	-0.23%		
Homestead exemptions (%)					
Gentrifying	-	48.47%			
Nongentrifying	-	49.63%			
Other exemptions/abatements (%)					
Gentrifying	5.13%	22.90%	17.77%		12.76%
Nongentrifying	1.50%	6.51%	5.01%		
Properties (n)	89,712	89,712			

[a] Difference in changes represents the difference between the change of the corresponding group and the nongentrifying tracts.

Sources: Authors' calculations using data on property assessments and tax payment history from the Department of Revenue of the City of Philadelphia, CoreLogic Solutions data, and data from the FRBNY/Equifax Consumer Credit Panel.

Table 4. Summary of Gentrification's Effects on Property Assessments and Tax Amounts (Coefficients of the Interaction, *GENTRIFY∗AVI*, from Different Linear Regressions)

	Coefficient	Standard Error
Assessed value ($)		
Gentrification dummy	71,673.0***	334.1
Categorical gentrification variables		
Weak/moderate	43,957.4***	375.9
Intense	175,921.1***	1,510.0
Continued	109,081.1***	454.9
Tax amount ($)		
Gentrification dummy	539.6***	4.4
Categorical gentrification variables		
Weak/moderate	360.6***	5.2
Intense	1,044.6***	20.8
Continued	793.9***	6.3

Notes: ***, **, and * represent significance at the 0.001, 0.01, and 0.05 level, respectively. Based on the 2013 and 2014 data only; N=179,424 property years.
Sources: Authors' calculations using data on property assessments and tax payment history from the Department of Revenue of the City of Philadelphia and CoreLogic Solutions.

Table 5. Summary of the Gentrification Effects on Tax Delinquency and Residential Mobility (Coefficients of the Interaction, *GENTRIFY∗AVI,* from Different Linear Probability Regressions)

	Coefficient	Standard Error
Tax delinquencies		
Gentrifying	0.041***	0.002
Categorical gentrification variables		
Weak/moderate	0.042***	0.002
Intense	0.061***	0.009
Continued	0.038***	0.003
New delinquencies		
Gentrifying	0.009***	0.001
Categorical gentrification variables		
Weak/moderate	0.008***	0.001
Intense	0.016***	0.005
Continued	0.010***	0.001
Residential mobility		
Elderly residents (ages 55–84)	-0.004	0.005
Elderly homeowners (ages 55–84)	-0.010	0.013
Longer-term residents (5+ years)	0.006	0.004
Longer-term homeowners (5+ years)	0.013	0.010
Sales of existing properties		
Gentrifying	-0.006***	0.001
Categorical gentrification variables		
Weak/moderate	0.000	0.001
Intense	-0.015***	0.005
Continued	-0.014***	0.001

Notes: ***, **, and * represent significance at the 0.001, 0.01, and 0.05 level respectively; †=p<0.10. Based on the 2010–2018 data; N=807,122 property years for regressions on tax delinquency and property sales; the number of individual years for elderly residents, elderly homeowners, longer-term residents, and longer-term homeowners varies from 5,729 to 37,061.
Sources: Authors' calculations using data on property assessments and tax payment history from the Department of Revenue of the City of Philadelphia and CoreLogic Solutions, and data from the FRBNY/Equifax Consumer Credit Panel.

Table 6. Effectiveness of Tax Exemption/Abatement: Summary of Gentrification's Effects from Property-Level DID Regressions (Coefficients of the Three-Way Interaction, *GENTRIFY∗EXEMPTION*AVI,* from Different Linear Regressions)

	Other Exemption/Abatement		Likely LOOP Exemption		Homestead Exemption	
	Coefficient	**Standard Error**	**Coefficient**	**Standard Error**	**Coefficient**	**Standard Error**
Assessment ($)	13,871.3***	1,005.4	4,874.0***	1,094.9	-3,214.6***	675.0
Tax amount ($)	-565.5***	13.2	-462.0***	14.6	258.6***	8.8
Tax delinquencies	-0.021***	0.005	-0.021***	0.006	0.040***	0.004
New tax delinquencies	-0.008**	0.003	-0.008**	0.003	0.006***	0.002
Sales of existing properties	0.002	0.003	0.011***	0.003	-0.010***	0.002

Notes: ***, **, and * represent significance at the 0.001, 0.01, and 0.05 level, respectively. N=179,424 property years for regressions on assessments and tax amounts; N=807,122 property years for regressions on tax delinquency and property sales.
Sources: Authors' calculations using data on property assessments and tax payment history from the Department of Revenue of the City of Philadelphia and CoreLogic Solutions.

Appendix

Table A1. Robustness Check: Summary of Gentrification's Effects on Tax Delinquencies Using All Nongentrifying Neighborhoods as Control

	Coefficient	Standard Error
Tax delinquencies		
Gentrifying	0.026***	0.002
Categorical gentrification variables		
Weak/moderate	0.027***	0.002
Intense	0.045***	0.008
Continued	0.023***	0.002
New delinquencies		
Gentrifying	0.007***	0.001
Categorical gentrification variables		
Weak/moderate	0.006***	0.001
Intense	0.014**	0.005
Continued	0.008***	0.001
Residential mobility		
Elderly residents (ages 55–84)	-0.003	0.004
Elderly homeowners (ages 55–84)	-0.020†	0.012
Longer-term residents (5+ years)	0.004	0.003
Longer-term homeowners (5+ years)	0.002	0.008
Sales of existing properties		
Gentrifying	-0.003***	0.001
Categorical gentrification variables		
Weak/moderate	0.002*	0.001
Intense	-0.013***	0.004
Continued	-0.012***	0.001

Notes: ***, **, and * represent significance at the 0.001, 0.01, and 0.05 level respectively; †=p<0.10. N=1,253,287 for regressions on tax delinquency and property sales when using properties in all nongentrifying tracts as the control. The sample size for the residential mobility analysis varies for different regressions.
Sources: Authors' calculations using data on property assessments and tax payment history from the Department of Revenue of the City of Philadelphia and CoreLogic Solutions, and data from the FRBNY/Equifax Consumer Credit Panel.

Table A2. Robustness Check: Summary of Gentrification's Effects on Tax Delinquencies and Residential Mobility Using Alternative Gentrification Measures

	Our Measure		Freeman (2005)		Ellen & O'Regan (2011)	
	Coefficient	**Standard Error**	**Coefficient**	**Standard Error**	**Coefficient**	**Standard Error**
Tax delinquencies	0.041***	0.002	0.015***	0.001	0.011***	0.001
New delinquencies	0.009***	0.001	0.004***	0.000	0.004***	0.001
Residential mobility						
Elderly residents (ages 55–84)	-0.004	0.005	-0.005	0.003	0.000	0.005
Elderly homeowners (ages 55–84)	-0.010	0.013	-0.008	0.007	-0.024†	0.014
Longer-term homeowners (5+ years)	0.006	0.004	0.002	0.002	-0.001	0.003
Longer-term homeowners (5+ years)	0.013	0.010	0.003	0.005	-0.010	0.010
Sales of existing properties	-0.006***	0.001	-0.001	0.001	-0.005***	0.001

Notes: ***, **, and * represent significance at the 0.001, 0.01, and 0.05 level respectively; †=p<0.10. N=2,220,197 and 2,368,225 property years for regressions on tax delinquency and property sales using Freeman (2005) and Ellen & O'Regan (2011) measures, respectively. The sample size for the residential mobility analysis varies for different regressions.

Sources: Authors' calculations using data on property assessments and tax payment history from the Department of Revenue of the City of Philadelphia and CoreLogic Solutions, and data from the FRBNY/Equifax Consumer Credit Panel.

Table A3. Spearman Correlations Between Changes in Tax Assessments, Property Taxes, Tax Delinquencies from 2013 to 2014, and Measures of Neighborhood Change from 2000 to 2013

	Change in Property Value (%)	Change in Median Rent (%)	Change in Percent White (%)	Change in College Educated (%)	Change in Median Household Income (%)	Change in Poverty Rate (%)
Change in property assessments, 2013–2014 (%)	0.569***	0.192*	0.224*	0.311***	0.102	–0.131
Change in property tax, 2013–2014 (%)	0.679***	0.234**	0.300***	0.400***	0.193*	–0.207*
Change in tax delinquency rate, 2013–2014 (%)	0.541***	0.243**	0.225*	0.440***	0.258**	–0.215**

Notes: ***, **, and * represent significance at the 0.001, 0.01, and 0.05 level, respectively. N=122 tracts.
Sources: Authors' calculations using data on property assessment and tax payment history from the Department of Revenue of the City of Philadelphia and CoreLogic Solutions.