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Capitalization of Property Tax Incentives: Evidence From Philadelphia

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Abstract

In 2000, Philadelphia enacted an abatement policy that exempted new development from property taxes for 10 years. This policy provides an ideal natural experiment to test property tax capitalization because it creates contemporaneous intra-jurisdiction tax variation within a finite and known duration. Consistent with theory, the tax benefits are initially capitalized fully into home prices. However, as abatements near expiration, the benefits become *overcapitalized* in home prices. This paper also finds that escrow payment shocks cause delinquencies for owners of homes with expiring abatements.

Keywords: housing · tax incentives · property tax · real estate · mortgages · payment shock

JEL Classification: D12 · G41 · G51 · H71 · R21 · R31 · R38 · R51

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1. Introduction

U.S. homeowners pay $330 Billion annually in property taxes.[1] If fully capitalized into home prices, these taxes decrease the value of the housing stock by around 20% or $10 Trillion.[2] The extent to which home prices reflect property tax differentials also has significant ramifications for the fairness and efficiency of property taxes and the allocative efficiency of locally financed public services. If property taxes are fully capitalized, home prices immediately reflect any changes to the tax, and the costs or benefits accrue to the current owners. This can be problematic for the Tiebout (1956) mechanism of foot voting as homeowners cannot escape the effects of fiscal changes by moving. Consequently, substantial empirical literature exists on property tax capitalization, starting with Oates (1973), well summarized by Yinger, Bloom, and Boersch-Supan (2013), and more recently by Sirmans, Gatzlaff, and Macpherson (2008).

Many studies use tax variation over time or among jurisdictions to estimate the degree of capitalization. This approach can make it difficult to separate the effects of different levels of taxes from the effects of the services the taxes finance. Other studies avoid this problem by using intra-jurisdictional tax variation from a change or discrepancy in assessment practices. These studies are necessarily sensitive to assumptions about whether the change is anticipated and how persistent the new practices are expected to be. Additionally, all studies must translate differences in home prices to a capitalization rate by dividing by the net present value of any tax differences. Recent work by Giglio, Maggiori, and Stroebel (2015) and Giglio et al. (2021) shows that homeowners assign significant value to cash flows far into the future. As a result, estimated capitalization rates can be extremely sensitive to the assumed discount rate. Unsurprisingly, empirical studies have come to varied conclusions about property tax capitalization. Some studies, such as Palmon and Smith (1998); Moulton, Waller, and Wentland (2018); and Schwegman and Yinger (2020) found full or nearly full capitalization. The most common finding is partial capitalization as Rosen (1982), Gárate and Pennington-Cross (2023), and others demonstrate. Other studies, such as Brasington (2001), even find zero or negative capitalization.

Philadelphia's property tax abatement policy, which exempts new development from prop-

[1]Source: 2022 American Community Survey

[2]Based on a real discount rate of 3% and a (post capitalization) market value of approximately $40 Trillion. Source: Federal Reserve Financial Accounts of the United States

erty taxes for 10 years, provides an ideal natural experiment to test capitalization. The city entitles abated and unabated properties to the same services, so comparing such properties avoids the issue of unobserved differences in services. Furthermore, buyers and sellers should know the tax benefit's duration, which is short enough that the present value is not particularly sensitive to the discount rate. Additionally, because such simple rules govern the abatements, differential assessment practices or the simultaneity between effective tax rates and home prices is not a concern. Using the tax variation that the abatement policy creates also adds to the existing literature by measuring capitalization in the unique setting of a property tax incentive and offering insights into the effectiveness of such programs.

CoreLogic transaction data is used in a difference-in-difference model to estimate the abatement premium and degree of capitalization. The point estimate for abatement tax benefit capitalization into new construction price is 100.6%. This result is consistent with full capitalization, and with theory assuming efficient markets. It agrees with Palmon and Smith (1998), who report capitalization using a natural experiment and assuming the persistence of differential taxation. This paper extends the finding to the context of a tax incentive.

This paper adds a new result to the current literature by estimating how the degree of capitalization evolves over the period of tax benefits. These findings offer unique insights into how the market capitalizes an expiring tax benefit whose duration is known with certainty. Interestingly, the empirical results show that the price premium amortizes slower than the tax benefits. Consequently, the benefits are significantly overcapitalized in home prices for abatements nearing expiration. For example, in year 9, buyers still pay a 6.7% premium despite the theoretical premium being only 1.8%. This finding may not be surprising considering the numeracy required to calculate the present value of a stream of tax benefits and the low levels of financial literacy that Lusardi and Mitchell (2014) and others document. Several specific behavioral economics mechanisms may explain this finding. These hypotheses are explored in some detail.

One possible explanation for overcapitalization as the benefit approaches expiration is the high salience of current taxes relative to future taxes. Studies; including Chetty, Looney, and Kroft (2009); Cabral and Hoxby (2012), and Gindelsky et al. (2023), show consumer sensitivity to the relative salience of taxes, including property taxes. Another closely related mechanism is inattention to abatement expiration. This mechanism is consistent with

Bradley (2017), who found buyer inattentiveness to the temporary nature of tax provisions. MLS listings data demonstrate the high salience of abatements, even as they near expiration. The listings' text also suggests inattention to abatement expiration.

As additional evidence that inattention may drive overcapitalization, this paper shows that escrow payment shocks at abatement expiration increase mortgage delinquency. A model using GSE and CoreLogic data estimates abatement expiration increased 30+ day delinquency by 71 basis points, or 38% percent. While the effect of payment shocks due to rate resets on mortgage delinquency is well studied, e.g., deRitis, Kuo, and Liang (2010) and Ambrose, LaCour-Little, and Huszar (2005), this finding adds to the literature by showing significant effects even from a planned increase in property tax-driven monthly payments. Currently, the most similar finding is Anderson and Dokko (2008), who find that property tax timing can drive delinquencies for mortgages without escrow accounts. Other possible mechanisms driving the overcapitalization exemplify the findings of Genesove and Mayer (2001) and Leung and Tsang (2013), who conclude that loss aversion shapes home seller behavior, and Northcraft, Neale, et al. (1987); Clapp, Lu-Andrews, and Zhou (2020); and Zhou, Clapp, and Lu-Andrews (2021), who show the importance of price anchoring.

Section 2. of this paper gives background on Philadelphia's abatement policy. Section 3. derives the theoretical premium. Section 4. explains the empirical estimation strategy. Section 5. reviews the data used in estimation. Section 6. presents the initial full capitalization results. Section 7. shows the overcapitalization in the abatements' later years and discusses mechanisms that may drive this phenomenon. This discussion includes the results about expiring abatements and mortgage delinquency. Lastly, Section 8. concludes and considers the policy implications.

2. Background on the Unique Tax Policy

Since 2000, the City of Philadelphia has provided a 10-year exemption from property taxes on the value of newly constructed or significantly improved[3] properties. The owner of a newly constructed property pays taxes on only the value of the underlying land for the first

[3]Improvements qualify if completed under a City-issued construction permit and increased the property's assessed value.

10 years.[4] The goal of the policy is to stimulate development. For build-to-sell properties, the policy should accomplish this goal by increasing the initial sales price developers receive.

Philadelphia's Office of the Controller reported that as of 2017, there were 14,345 active abatements for a total of \$6.67 billion in abated value, or 6.6% of all assessed value. With Philadelphia's 1.4% property tax rate, this translates to an aggregate annual tax benefit of \$93 million, which is 2.2% of total city tax revenue. The average abatement amount was approximately \$465,000, with considerable variation. Table 1 provides additional statistics about abatements by type (new construction versus improvements), property types, and property value.

Table 1: Abatement Statistics

	Number of Abatements	**Abated Value (\$ Billions)**	**Annual Tax Benefit (\$ Millions)**	**Avg. Abated Value (\$ Thousands)**
Abatement Type				
New Construction	9,659	4.70	65.8	487
Improvement	4,686	1.97	27.6	420
Property Type				
Hotels and Apartment Buildings	1,448	2.10	29.4	1,450
Condominiums	5,448	1.99	27.9	365
Single-Family Homes	6,956	1.72	24.1	247
Commercial	324	0.74	10.4	2,284
Abatement Value				
Abatement $>$ \$1 Million	647	3.11	43.5	4,807
Abatement $\leq$ \$1 Million	13,698	3.56	49.8	260
Total	**14,345**	**6.67**	**93.4**	**465**

Notes: Selected abatement statistics from Office of the Controller (2018) which uses Philadelphia Office of Property Assessment data from 2017.

The tax policy applies equally to residential, commercial, and industrial properties. There are no special requirements, limits, or restrictions. Abatements are granted at the property level and are automatically transferred to the new owner if the property is sold. The empirical analysis in this paper examines only new construction abatements, which constitute 67% of all abatements and 70% of abated value. This paper also focuses on residential properties, which make up 98% of all abatements and 89% of abated value.

[4] On January 1, 2022, a reformed abatement policy went into effect, which phases out the tax benefits over the 10-year abatement period. However, this analysis focuses on the original policy and uses data from before the reform.

While this policy may not be unique, similar programs in other cities tend to be less generous or have numerous restrictions and requirements. For example, the Baltimore city government grants a nontransferable exemption for 50% of the value of new construction and specific improvements, which phases out over five years. New York City's program comes with many requirements, such as creating affordable units, and it does not apply to properties in many areas of the city, including all of Manhattan.

Philadelphia's abatement policy's scale and simplicity make it ideal for studying the effects of tax incentives designed to boost development and homebuyers' reactions to those programs. Specifically, this paper examines how the tax benefit is capitalized into the prices of recently built residential properties.

3. Theoretical Abatement Premium

An abatement's benefits should be fully capitalized into an asset price premium if the market is informationally efficient. The abatement premium is the size of this price increase as a percentage of unit value. The theoretical premium is simply the present value of the discount in tax payments. It also serves as the denominator when calculating the capitalization rate. This section explains how the theoretical premium is calculated and shows that it is insensitive to assumptions about discount rates and tax increases.

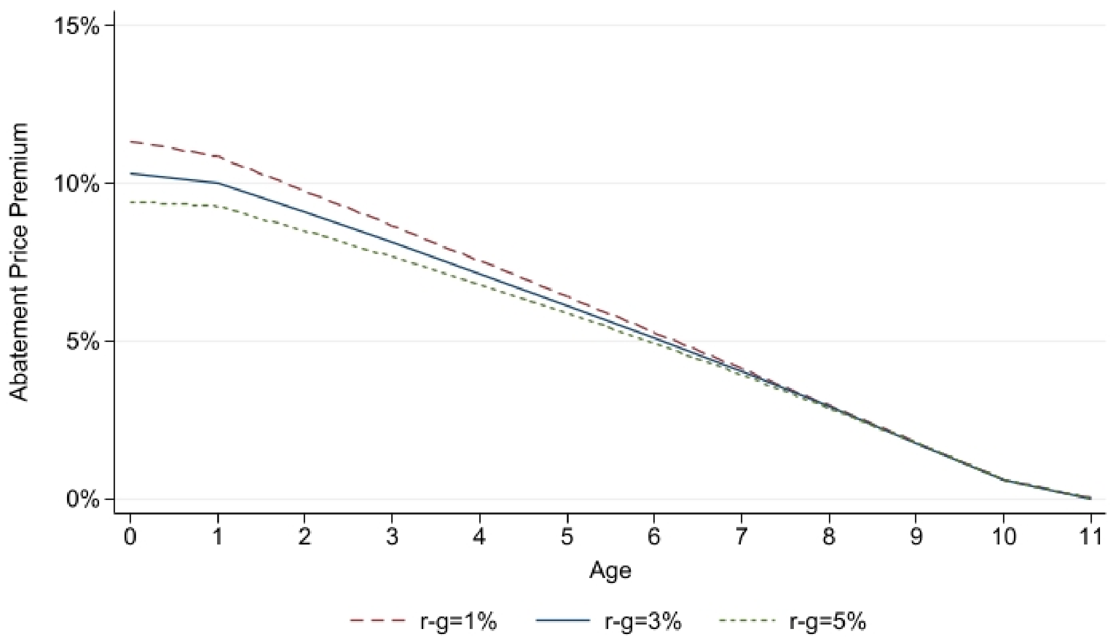
Let τ be the tax rate, and E represent the fraction of value exempted from taxation. The yearly benefit from the abatement (expressed as a fraction of home value) is τE. Let π_α denote the abatement premium for a home of age $\alpha \leq 10$. The abatement premium is defined as the premium paid for an abated home over an equivalent unabated home expressed as a percentage of pre-abatement value. Let r be the appropriate discount rate, g the expected growth in taxes, and i index the years of remaining abatement. Then, the theoretical abatement premium for an age α home is given by equation (1).

$$\pi_\alpha = \sum_{i=1}^{10-\alpha} (1 - r + g)^{i-.5} \tau E \tag{1}$$

The Philadelphia Office of Property Assessment attributes 85% of the assessed value of homes to the structure, with the remaining 15% attributed to the land for all property types. Consequently, newly constructed homes receive an 85% property tax discount. The tax rate is about 1.4%. If r-g = 3%, the initial abatement premium $\pi_0 = .103$. This means that a newly constructed and abated home should sell for 10.3% more than an equivalent unabated home based on the expected discounted present value of the abatement.

The true value for r-g is unknown. From 2000–2020, the average 30-year mortgage rate (accounting for points and fees) was 5.3%.[5]. Meanwhile, national home prices rose by about 4.0% per year and Philadelphia home prices by about 4.9% per year from 2000–2020.[6] This implies that r-g may be 1% or lower. On the other hand, there is considerable inertia in Philadelphia tax assessments, as discussed by Hou et al. (2021). This means the annual growth in assessed value may be negligible for the first 10 years. It follows that the appropriate value of r-g may be closer to the ≈5% financing rate. The theoretical abatement premium is fortunately not terribly sensitive to the value of r-g because of the finite length of the abatement. If r-g = 1% or 5%, $\pi_0 = .113$ or .094 respectively. In all cases, the theoretical abatement premium gradually decreases until age 11, where $\pi_{11} = 0$. This is illustrated in Figure 1.

Figure 1: Theoretical Abatement Price Premium



Notes: Theoretical amortization path of the abatement price premium with various growth-adjusted discount rates. The r-g values 1%, 3%, and 5% correspond to initial premiums of 11.3%, 10.3%, and 9.4% respectively.

[5]Source: Freddie Mac
[6]Source: FHFA Home Price Indices

Philadelphia property taxes are paid annually, so the theoretical calculation assumes that, on average, there is half a year between each sale and the next payment. Taxes are paid in the first quarter of each year, suggesting that most sales of properties during an abated year have already received that year's tax benefit. However, buyers are usually asked to reimburse sellers for a prorated share of prepaid taxes. This means sales prices will include a premium for the remaining portion of that year's tax benefit. Consequently, this analysis assumes that, on average, the premium should reflect half of the current year's tax benefit. This leads to the kinks observed in Figure 1.

4. Identification Strategy

The empirical abatement premium is estimated using a difference-in-difference model with property-level fixed effects. This section explains the intuition behind this identification strategy, gives the stochastic specification used to estimate the premium, and presents and tests the model's assumptions. Then, the model is adapted to measure the abatement's effect on mortgage delinquencies.

To illustrate the intuition of the identification strategy, let $P_{i,t,\alpha}$ be the price of home i of age α at time t.

$$lnP_{i,t,\alpha} = \gamma_t + \theta_i + \mu_\alpha + \pi_\alpha + \varepsilon_{i,t} \tag{2}$$

Here, the parameter of interest is π_α, the abatement age effect. γ_t measures local market prices at time t, θ_i reflects the value of immutable characteristics of the home, μ_α is a universal age effect, and $\varepsilon_{i,t}$ is an error term. The universal age effects may include ordinary linear deprecation, non-linear depreciation, and any special age effects for newly constructed properties unrelated to the abatement.

The market inflation effects γ cannot be identified separately from linear depreciation when using a property fixed effects or repeat sales model. This is because the change in age is perfectly collinear with the change in sale date, as shown by Harding, Rosenthal, and Sirmans (2007). This is not a concern for the hypothesis being tested here. The term γ_t is replaced with γ_t^*, the price inflation net of linear depreciation, and the term μ_α is replaced with μ_α^* which contains only non-linear age effects.

$$lnP_{i,t,\alpha} = \gamma_t^* + \theta_i + \mu_\alpha^* + \pi_\alpha + \varepsilon_{i,t} \tag{3}$$

Measuring the true abatement premium requires disentangling the universal age effects μ_α^* from the abatement effects π_α. Separate identification requires data from newly constructed homes that are not subject to the abatement policy. Philadelphia properties built before the enactment of the abatement policy in 2000 are one possible source of unabated properties. However, the available data goes back only to 1980, and construction activity was very low in Philadelphia in the 80s and 90s. Consequently, there are few observations of young but unabated properties in the Philadelphia sales data, making it difficult to separate abatement premiums from universal age effects.

Data from the neighboring counties is added to estimate the premiums for each age separately. Specifically, the estimation uses data from Bucks, Chester, Delaware, and Montgomery counties in Pennsylvania and Burlington, Camden, and Gloucester counties in New Jersey as control properties. Note that data from neighboring counties is only used to separately identify universal new construction age effects and the abatement effects. The source of tax variation remains the intra-jurisdictional variation due to the abatement policy. Stated differently, no assumptions about the tax rates or public services in the other jurisdictions need to be made. The only assumption is that these jurisdictions do not preferentially tax new development, which they do not.

The identification comes from comparing the price-age profiles of abated and control properties as they evolve over the age ranges during which abated properties receive tax benefits. The difference is attributed to the amortizing abatement premium.

Appendix A contains three robustness checks that test the appropriateness of using properties from neighboring counties as controls. Figure 13 plots the estimation results using homes in other major cities rather than the surrounding counties as controls. Figure 14 plots the estimation results using only properties in ZIP codes bordering Philadelphia or separated from the city by one ZIP code. Finally, Figure 15 shows results only for row homes, which are common both in Philadelphia and the control counties. All three sets of results are qualitatively similar to the preferred specification.

4.1 Property Fixed-Effect Stochastic Specification

The above model is the basis for identification in the stochastic specification as shown in equation (4).

$$lnP_{i,t} = \theta_i + \sum_{\ell} \sum_{t} \gamma_{\ell,t} I_{\ell,i} * Year_t + \sum_{\alpha \leq T} \mu_\alpha Age_{\alpha,i,t} + \sum_{\alpha \leq 10} \pi_\alpha Abat_i * Age_{\alpha,i,t} + \epsilon_{i,t} \tag{4}$$

As before, μ_α is the universal age effect, and π_α is the abatement age effect. $I_{\ell,i}$ is a location indicator variable at the ZIP code level, and $Abat_i$ is an indicator variable for abated properties. $Year_t$ is a year dummy variable and $\gamma_{\ell,t}$ reflects the local market effect at location ℓ at time t. Similarly, $Age_{\alpha,i,t}$ is a set of dummy variables equal to 1 if the property was α years old in year t and 0 otherwise.

The assumption that age effects and non-linear deprecation end after T years can be relaxed in various ways. The simplest and most flexible way is to increase the number of universal age effects, as these non-parametrically capture any deprecation up to age T. To allow fully non-parametric depreciation, $T = \infty$ with one age omitted as a base case. However, this makes the age and year dummies perfectly collinear. To prove this result, let Y be a vector of year values with one year omitted and Γ_i the vector of year dummies. Similarly, let A be a vector of all but one possible property age and M_i the vector of age dummies. In this case, $Y'\Gamma_i = A'M_i$ for all i, as both equal the number of years elapsed between sales. This is easily remedied by omitting either a second age dummy or a second year dummy. Once this is done, $Y'\Gamma_i \neq A'M_i$ for those observations where the two sales happen at the base ages/years. These observations will have either their linear deprecation or market appreciation normalized to be 0, with the opposite parameters adjusted to compensate. This means the trendline of universal age effects is not identified separately from the trendline of price appreciation, but this does not pose an issue for identifying the abatement premium.

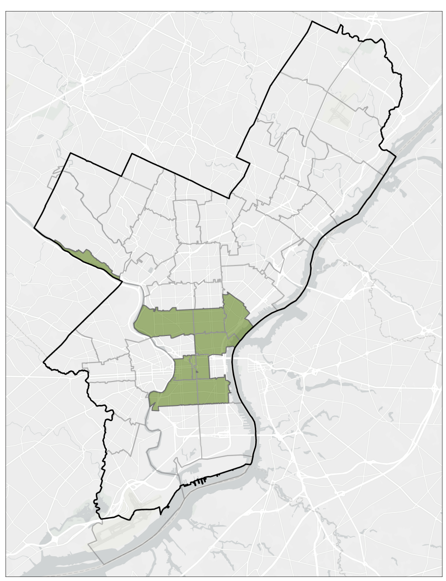
The data period of 1980–2023 includes the enactment of the policy period and a rapid increase in construction. Properties and lots developed soon after the introduction of the policy may be systematically different from those developed later. As a robustness check, Figure 16 in Appendix A contains estimation results for properties built from 2000 to 2007 as the only abated properties. These results are qualitatively similar to the preferred specification.

Different types of homes may have systematically different depreciation rates or age effects. For example, single-family homes on large lots may depreciate slower due to the value of the land. This can bias the estimated abatement premiums if certain types of properties are disproportionately abated. This is accounted for by adding additional controls for property type interacted with the Age_α indicators. Note that including ZIP code specific $\gamma_{\ell,t}$ already allows for different (linear) depreciation rates in each ZIP code.

4.2 Localized Price Trends

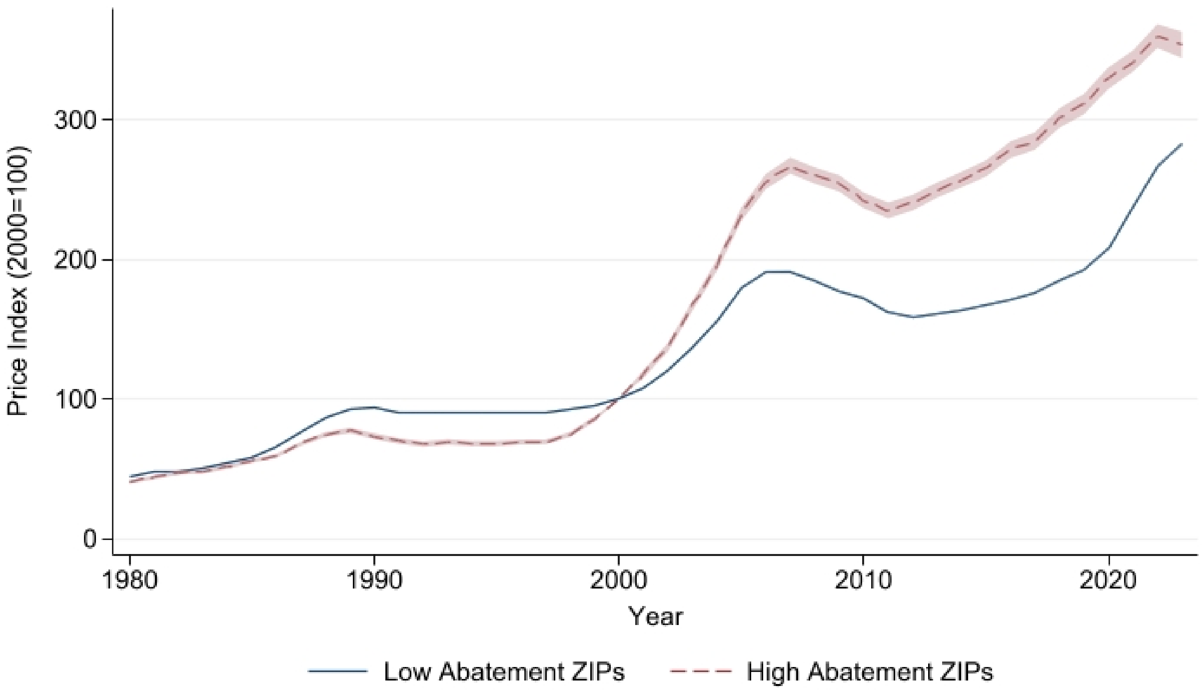
Abated properties may be disproportionately built in areas where prices are rising more quickly. Absent controls for local price trends, this would violate the parallel trends assumption, and the estimated abatement premiums would be biased downwards as the market price inflation offsets the premium amortization. The top 10 ZIP codes by abatement concentration are mapped in Figure 2. Together, these 10 ZIP codes account for nearly 70% of all abated properties in the data. Abated properties are concentrated near Center City and Northwest Philadelphia. Annual price indices for these 10 ZIP codes and the other areas in the dataset are plotted in Figure 3. Areas with high abatement concentration had more rapid price appreciation both immediately before and after the policy enactment. ZIP code-specific market prices $\gamma_{\ell,t}$ account for this.

Figure 2: High Abatement ZIP Codes



Notes: Top 10 ZIP codes by abatement concentration are shown in green. Source: CoreLogic data.

Figure 3: Price Trends: High vs. Low Abatement ZIP Codes



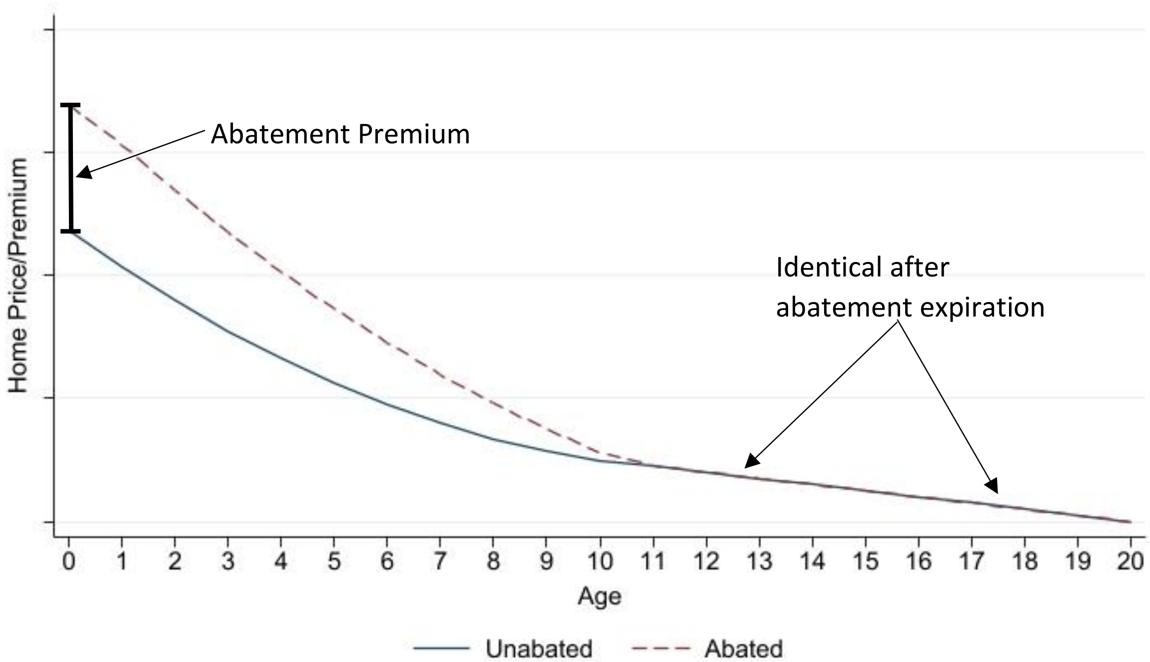
Notes: Repeat sale price indices for high and low abatement ZIP codes. Year 2000 is normalized to 100. High abatement ZIPs are the top 10 ZIP codes by abatement concentration. Low abatement ZIPs are all other ZIP codes in Philadelphia and surrounding counties. The shaded areas represent 95% confidence intervals. Source: CoreLogic data 1980–2023.

As a robustness check, Figure 17 in Appendix A contains estimation results using Census tract level price controls rather than ZIP code level. These results are qualitatively similar to the preferred specification but may suggest slightly lower capitalization levels. Interestingly, this implies that while abated properties are disproportionately built in ZIP codes with rapidly rising prices, within ZIP codes, they are concentrated in tracts with more moderate price increases. This may result from supply effects or externalities caused by the abated properties themselves. Consequently, the ZIP code level price controls are used in the preferred specification.

4.3 Validating Identifying Assumptions

This identification strategy has two major identifying assumptions. The first assumption is analogous to the parallel trends assumption in a standard difference-in-difference model that requires treated and untreated units to follow the same trends prior to treatment. However, with newly constructed homes, there is no relevant pre-treatment period. Instead, the critical assumption is that abated and unabated properties of the same property type depreciate similarly after abatement expiration. The second assumption is that any differences in depreciation rates prior to expiration are due to the abatement amortization and not other inherent differences between abated and unabated properties. These assumptions are illustrated with stylized depreciation curves in Figure 4.

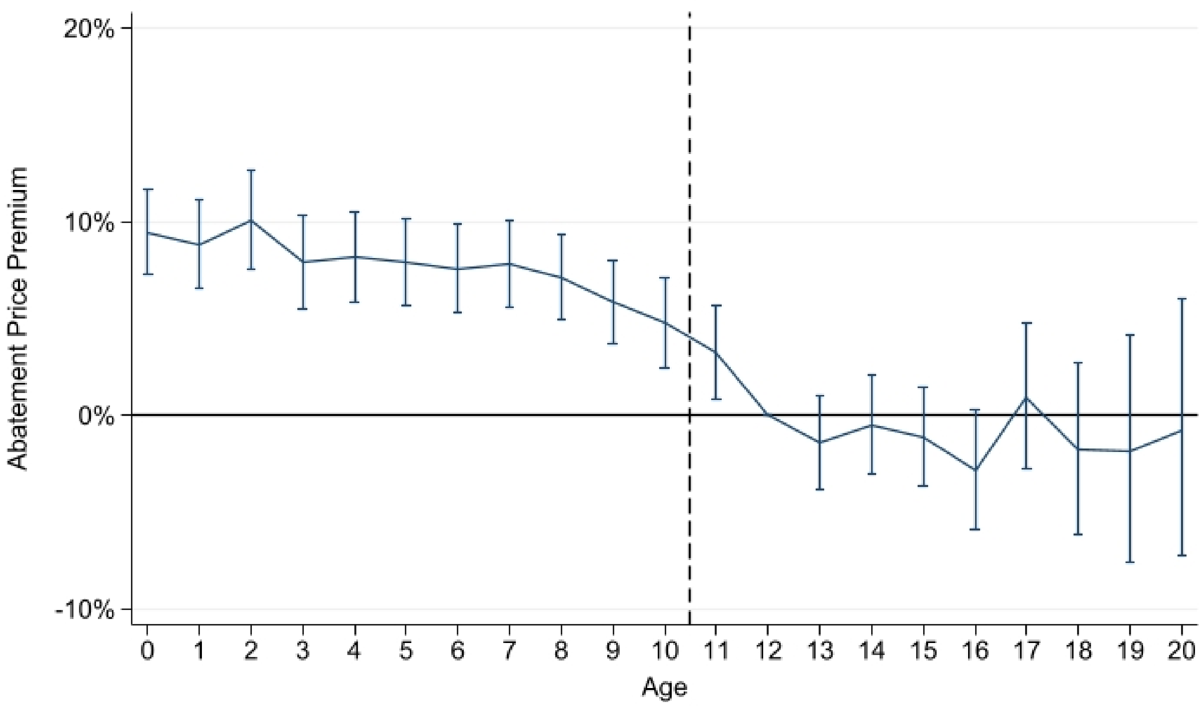
Figure 4: Stylized Depreciation Curves Abated vs. Unabated



Notes: Stylized illustration of two identifying assumptions. The distance between the curves is assumed to be the price premium paid for the abatement's tax benefits. The curves are assumed to be identical once the abatement has expired.

The assumption of similar depreciation after abatement expiration can be tested directly by examining how the difference between abated and unabated home prices evolves as the abatement ages out of existence. This is illustrated in Figure 5. After normalizing the age 12 premium to 0, the 95% confidence intervals for ages 12+ all contain 0, consistent with the identifying assumption. The null hypothesis that the age 12+ premiums are all jointly 0 (p=.606) cannot be rejected. However, the age 11 premium is significant, as is the hypothesis that the age 11+ premium are all jointly 0 (p=.005). Therefore, the final model specification allows for a premium at age 11. Reasons why the premium may persist at age 11 are discussed in Section 7.

Figure 5: Post-Expiration Parallel Trends Test



Notes: The age 12 premium is normalized to 0. The null hypothesis that the age 12+ premiums are all jointly 0 (p=.606) cannot be rejected. However, the age 11 premium is significant, as is the hypothesis that the age 11+ premiums are all jointly 0 (p=.005). Therefore, the final model specification allows for a premium at age 11. The vertical bars represent 95% confidence intervals. Source: CoreLogic data 1980–2023.

4.4 Estimation Strategy and Two-Way Fixed Effects Considerations

The baseline model uses property fixed effects. However, there is no reason the model cannot be estimated with a hedonic regression instead. The stochastic specification using a hedonic model is given by (5). Here, the property fixed effects are replaced by βX_i, where X_i is a vector of home characteristics, and β is the associated shadow prices.

$$lnP_{i,t} = \beta X_i + \sum_{\ell} \sum_{t} \gamma_{\ell,t} I_{\ell,i} * Year_t + \sum_{\alpha \leq T} \mu_\alpha Age_{\alpha,i,t} + \sum_{\alpha \leq 10} \pi_\alpha Abat_i * Age_{\alpha,i,t} + \epsilon_{i,t} \quad (5)$$

However, a hedonic regression requires correctly specifying the vector of home characteristics X. This may be especially important because abated properties may vary from others in various unobserved or observed but challenging to model ways. For example, lot size may be less significant for condos, which are disproportionately prevalent amongst abated properties.

Another possible approach is to use a repeat sales model. The stochastic specification using a repeat sales model is given by (6).

$$lnP_{i,t} - lnP_{i,s} = \sum_{\ell} \sum_{\tau} \gamma_{\ell,\tau} I_{\ell,i} * Year^*_{s,t} + \sum_{\alpha \leq T} \mu_\alpha Age^*_{\alpha,i,s,t} + \sum_{\alpha \leq 10} \pi_\alpha Abat_i * Age^*_{\alpha,i,s,t} + \epsilon_{i,s,t} \quad (6)$$

Here, $Year^*_{s,t}$ is a set of dummy variables equal to 1 in year t (the period the property was sold), equal to -1 in year s (the period of the previous sale), and equal to 0 in all other years. Similarly, $Age^*_{\alpha,i,s,t}$ is a set of dummy variables equal to 1 for the property's age in year t, -1 for the property's age in year s, and 0 otherwise.

The repeat sales model is mathematically similar to the property fixed effects approach, except it transforms the observations differently. The fixed effects estimator uses the within transformation, which is efficient under the assumption of i.i.d. errors. The repeat sales model uses the first difference transformation, which is efficient if the errors follow a random walk. The serial correlation of the estimated errors is moderately negative ($\rho = -.167$), indicating that the fixed effects approach may be preferable. Nevertheless, recent developments in the literature on using two-way fixed effects to estimate difference-in-difference models give reasons to prefer the repeat sales model. Goodman-Bacon (2021) showed that the DiD estimator is a weighted average of treatment effects with variance-based weights. These weights may not be intuitive or optimal if cross-sectional units have differing amounts of observations pre- and post-treatment. This would occur if an abated property sold multiple times after abatement expiration. This problem is solved with the repeat sales approach, as each repeat sale has exactly two observations. This is the same solution offered by a stacked DiD approach. However, unlike in a stacked DiD, a given sale can still act as a "pre" period for one age effect and a "post" period for another. The repeat sales approach is included as a robustness check. Theoretical advantages and disadvantages notwithstanding, the repeat sales model delivers very similar results. These are available in Figure 18 in Appendix A.

Finally, Sun and Abraham (2021) showed that the DiD estimator might be biased if the treatment effect is not constant over the life of the abatement. This poses an issue for estimating a single abatement premium or capitalization rate since each may vary over time and reinforces the need to estimate separate effects for each age of abatement so that each estimated effect is constant.

4.5 Testing for Effects on Delinquency

The estimation discussed above produces the new result that the abatement value is overcapitalized as it approaches expiration. This suggests the hypothesis that there is inattention to abatement expiration. One implication of the inattention hypothesis is that expiring abatements cause an increase in mortgage delinquencies. This hypothesis is tested in Section 7.2.2. The test applies a model similar to the one used to estimate the abatement price premium. The probability of loan delinquency is modeled as a probit function of a county-year effect, a universal age effect, and an age effect specific to abated properties. The model also includes additional controls for the original loan-to-value (LTV) ratio, credit score, debt ratio, loan age, origination year, occupancy type, mortgage type, mortgage purpose, property type, first-time home buyer status, and the logs of the property value and borrower income.

$$\Pr\left(dlq_{i,t}\right) = \Phi\left(\sum_{c}\sum_{t}\theta_{c,t}I_{c,i} * Year_t + \sum_{\alpha}\omega_{\alpha}Age_{\alpha,i,t} + \sum_{\alpha}\phi_{\alpha}Abat_i * Age_{\alpha,i,t} + \beta X_{i,t}\right) \tag{7}$$

$dlq_{i,t}$ is an indicator variable equal to 1 if loan i was 30+ days delinquent in month t. $I_{c,i}$ is a county level location dummy, $Year_t$ is a year dummy, and $\theta_{c,t}$ is the county-year effect. $Age_{i,t}$ is an age dummy. ω_α is the universal age effect. ϕ_α is the abatement-specific age effect. $Abat_i$ is an abatement indicator dummy equal to 1 if the property is in Philadelphia and built between 2000 and 2022. $X_{i,t}$ is the vector of controls with corresponding effects β. The delinquency model does not include a property or loan level fixed effect. Therefore, the full set of abatement-specific age effects can be included, and there is no restriction that loans on abated and unabated properties behave identically at any age. The model is estimated using loan-level monthly mortgage performance data with errors clustered at the loan level.

5. Data

5.1 Home Sales

Deed and tax assessment data from CoreLogic is used to estimate the abatement premium. The data covers the period from 1980 through September 2023. Tax assessment data contains information on the year the property was built and other home characteristics. When this is joined to transactions from the deed data, it is possible to know the property's age at the time of each transaction.

The analysis excludes all non-arms-length transactions and foreclosure sales, properties built before 1901, properties that sold more than once within 12 months, properties that sold only once during the data period, and properties that gained or lost more than 100 log points in value (adjusted for county-level market prices) between two successive transactions. This leaves 9,272 transactions of abated properties (defined as Philadelphia properties built 2000–2021[7]), 354,849 transactions of older Philadelphia properties, and 1,286,059 transactions from properties in the neighboring counties. Table 2 contains summary data for the properties and transactions in each of these groups.

Table 2: Transaction Data Summary

	Abated Philadelphia	Unabated Philadelphia	Neighboring Counties	Age $\leq$ 10, Year $\geq$ 2000	
				Abated	Control
Transactions					
N	9,272	354,849	1,286,059	6,871	88,051
Age $\leq$ 10	6,871	12,309	321,512		
Age > 10	2,401	342,540	964,547		
Average Price	\$504,303	\$130,590	\$208,828	\$496,729	\$345,507
Repeat Transactions					
N	5,157	220,120	824,513	4,834	63,262
Average ΔTime (years)	6.64	11.08	10.11	6.84	7.93
Average $\Delta \ln$ Price	0.145	0.519	0.367	0.142	0.175
Properties					
N	4,115	134,729	461,546	4,007	36,933
% Single-Family	10.4%	24.4%	75.6%	9.9%	58.8%
% Row/Town House	45.5%	65.9%	13.5%	45.6%	23.0%
% Condo	44.1%	9.8%	11.0%	44.5%	18.1%
N ZIP Codes	38	45	196		

Notes: Selected descriptive statistics for the filtered dataset. The neighboring counties used are Bucks, Chester, Delaware, and Montgomery counties in Pennsylvania and Burlington, Camden, and Gloucester counties in New Jersey. Source: CoreLogic data 1980–2023.

[7]Philadelphia properties built after 2021 are eligible for a less generous abatement and are excluded.

The considerable difference in the average price of abated and unabated properties (both inside and outside Philadelphia) is primarily due to differences in property age and time (all abated sales are after 2000). When the sample is restricted to only sales after 2000 of properties with age ≤ 10, the difference in average price shrinks significantly. Differences in ZIP code and property type can almost entirely explain the remaining differences. Some of the difference is also presumably due to an abatement price premium. Abated properties appreciate notably less between sales than unabated properties. This is expected because of the abatement premium that shrinks with age. The estimates in sections 6.1 and 7.1 separate this effect from other market forces. Abated properties also sell slightly more frequently than unabated properties. The frequency of abated home sales is discussed further in Section 7.2.3.

5.2 Mortgage Performance

Mortgage performance data is used to test the hypothesis that the payment shock resulting from abatement expiration is causing mortgage delinquencies. The data comes from the Mortgage Loan Integrated System (MLIS), which is a confidential regulatory dataset at the Federal Housing Finance Agency (FHFA) consisting of all loans acquired by the Government Sponsored Enterprises (GSEs) Fannie Mae and Freddie Mac. The tables and figures in this paper do not contain any confidential or personally identifiable information.

This analysis uses data from GSE loans originated since 2000 in the same eight counties used to estimate the abatement premium. Loans are excluded if they are missing information for any of the controls. Non-conventional loans such as balloon or construction loans are also excluded. Loans are included if they are observed in active status for at least one month. Of all the loans from these counties in the MLIS database, 77.5% meet these criteria.

Identifying newly constructed and abated properties requires knowing the year the property was built. This is accomplished by merging with the CoreLogic assessor data. 94.0% of the MLIS loans can be uniquely matched to the assessor records. The analysis excludes loans on properties built before 1900 or where the property was built or significantly modified after the loan's origination.

The data contains 84,355,458 monthly records for 1,503,358 loans from Philadelphia and the surrounding counties. Of these, 858,122 monthly records and 18,926 loans are for abated properties, defined here as being in Philadelphia and built between 2000 and 2021.[8] Table 3 contains summary statistics about the loans for unabated and unabated properties. Abated properties are much younger than non-abated properties. As such, they tend to be worth more and are purchased by more affluent buyers with stronger credit profiles. Therefore, abated properties tend to have lower delinquency rates.

Table 3: Mortgage Performance Data Summary

	Abated	Unabated
Home Value	$454,041	$308,967
Annual Income	$151,609	$110,266
Debt Ratio	.323	.340
Original LTV	.750	.719
Credit Score	755	738
Delinquency Rate	1.98%	3.89%
Single-Family	58.9%	81.4%
Condo	22.6%	4.1%
PUD	18.5%	14.4%
Cash-Out Refi	8.2%	26.5%
No Cash-Out Refi	34.2%	33.9%
Purchase	57.6%	39.6%
30 Year Fixed	78.5%	68.5%
15–20 Year Fixed	18.1%	28.6%
ARM	3.4%	2.8%
Primary Residence	88.6%	94.2%
First Time Home Buyer	30.1%	16.8%
N Loans	18,926	1,484,432
N Monthly Records	858,122	83,497,336

Notes: Selected descriptive statistics for the filtered dataset. Abated mortgages are those made on Philadelphia properties built between 2000 and 2021. Unabated mortgages are those on older Philadelphia properties or properties in the surrounding counties. Source: GSE and CoreLogic data 2000–2023.

[8] Philadelphia properties built after 2021 are eligible for a less generous abatement and are excluded.

6. Estimates of the Initial Capitalization

6.1 Results

Table 4: Estimated Initial Abatement Premium and Capitalization

	(1)	(2)	(3)	(4)	(5)
$Abat * Age_0$	.110***	.081***	.096***	.094***	.104***
	(.008)	(.008)	(.008)	(.011)	(.008)
Implied Capitalization	1.060***	.790***	.934***	.920***	1.006***
	(.073)	(.073)	(.071)	(.105)	(.075)
Property Fixed Effects	✓	✓	✓	✓	✓
$Year * ZIP$	✓	✓	✓	✓	✓
Age_α	0,1,...,10	0,1,...,∞	0,1,...,∞	0,1,...,∞	0,1,...,∞
$Abat * Age_\alpha$	0,1,...,10	0,1,...,10	0,1,...,10	0...11,13...∞	0,1,...,11
$Type * Age$			✓	✓	✓
N Transactions	1,650,177	1,650,177	1,650,177	1,650,177	1,650,177
N Properties	600,389	600,389	600,389	600,389	600,389

Notes: The estimated premiums are derived by exponentiating the $Age_\alpha * Abat$ coefficients and subtracting 1. Robust standard errors are shown in parentheses. $* = p < 0.05$, $** = p < 0.01$, $*** = p < 0.001$ Source: CoreLogic data 1980–2023.

Table 4 gives the estimated abatement price premiums for year 0 with corresponding capitalization rates from several variations of the stochastic specification in equation (4). The reported estimates are obtained by exponentiating the estimated π coefficients and subtracting 1. This gives the percent price premium associated with abated properties of the listed age. The reported robust standard errors are transformed using the delta method.

Column (1) is a baseline specification that estimates separate abatement premiums for ages 0–10 and includes universal age dummies for ages 0–10 as controls. Column (2) is similar but includes all possible age dummies, allowing for fully non-parametric depreciation by age. The estimated premiums in (2) are lower than in (1). This is expected if properties aged 11+ depreciate more quickly than older properties. For example, imagine an abated property sold at age 0 and again at age 20. The more flexible specification in (2) allows for more of the relative decrease in this property's price to be explained by aging rather than an amortizing abatement premium. Column (3) adds interactions between these age dummies and the property type (single-family, row/townhouse, or condo).

The specifications in columns (2) and (3) both estimate that a ≈4–5% abatement premium, significant at the 0.1% level, remains even at age 10. This can be seen in Table 5 in Appendix A and calls into question the assumption that abated and unabated homes depreciate similarly after the abatement expires. Column (4) relaxes this assumption by interacting the abatement indicator with all the age dummies except age 12. This is the parallel trends test specification presented in Figure 5. The null hypothesis that the age 12+ abatement premiums are all jointly 0 (p=.606) cannot be rejected at any level. However, the age 11 abatement premium is significant, and the hypothesis that the age 11+ premiums are all jointly 0 (p=.005) can be rejected at the typical significance level. Therefore, the preferred specification is column (5), which assumes that the depreciation rates are the same beginning in year 12. This allows some abatement premium to be present at age 11. However, the major conclusion that the abatement policy is initially fully capitalized into home prices is consistent with all specifications.

6.2 Estimating Capitalization

There are several options for translating the estimated premiums into measures of capitalization. The incentive to build is equal to the size of the initial abatement price premium. Therefore, the initial capitalization is most relevant from a policy perspective.[9] The preferred specification gives an estimated 100.6% capitalization rate. The 95% confidence interval for the degree of capitalization is 86.0%–115.2%. Taking account of the uncertainty in the discount rate by allowing r-g to be as high as 5% or as low as 1% expands the confidence interval to 78.6%–125.5%.

These estimates constitute reasonably strong evidence that property tax incentives are close to fully capitalized into new residential home prices, which has several implications. From a policy perspective, this means that the abatement policy does, in fact, incentivize development by increasing the price builders receive for new construction rather than rewarding the

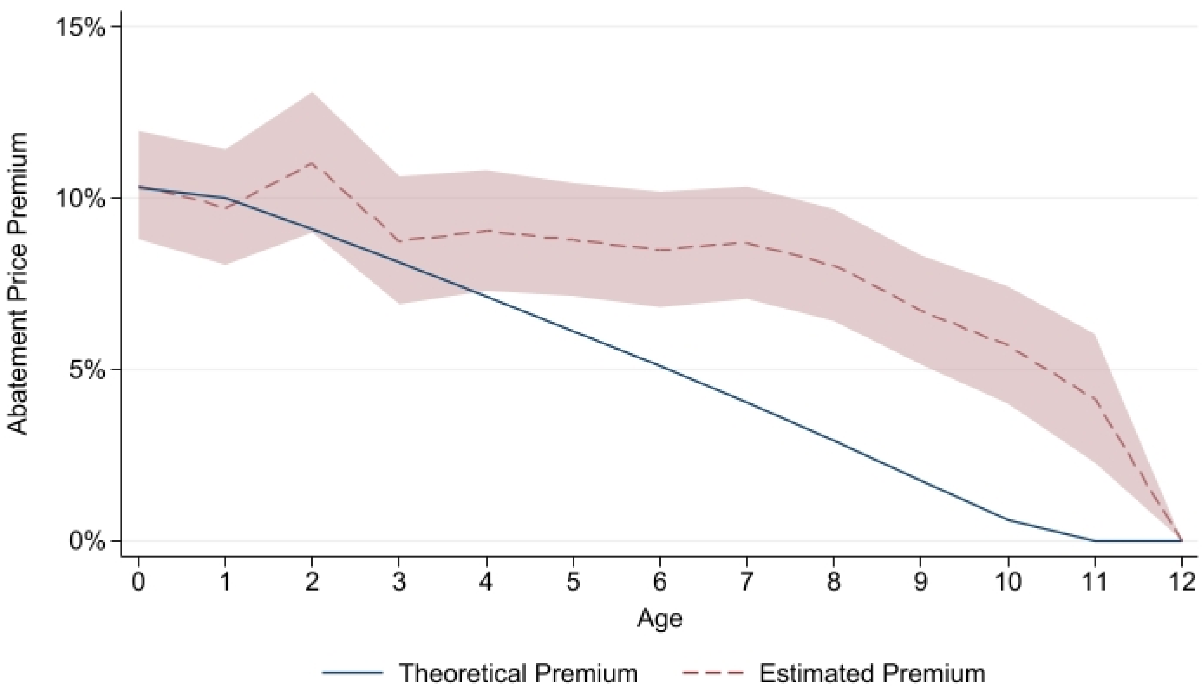
[9]For a more holistic look at capitalization, the $Abat * Age_\alpha$ terms can be replaced with the discounted abatement years remaining. In this case, the coefficient represents what buyers are willing to pay for a single year of tax benefits expressed as a percentage of home value. Since the average new construction is 85% abated, and the tax rate is 1.4%, full capitalization would mean a 1.19% premium for one year of benefits. Using this specification gives 75.1% capitalization with a 95% confidence interval of 64.3%–85.9%. However, this may be misleading for several reasons. The individual abatement age effects show that the abatement becomes overly capitalized in years 5–10 because the premium amortizes more slowly than expected. This represents a changing treatment effect of the discounted abatement years remaining. Goodman-Bacon (2021) shows how this can distort the DiD estimator. In this case, higher capitalization in years 5–10 may perversely decrease our estimate of the overall capitalization because some of our identification comes from the expected amortization between the initial abatement and sales in years 5–10.

buyers of these properties. Second, it is consistent with some previous estimates that find full capitalization of property taxes and inconsistent with only partial or no capitalization. Finally, given that this ideal natural experiment finds full capitalization, it suggests that any capitalization of inter-jurisdiction differences in property taxes results from homeowners in the higher tax jurisdiction valuing the public services financed by these taxes less than they value the additional tax they pay.

7. Estimates of Later Overcapitalization

7.1 Results

Figure 6: Estimated vs. Theoretical Abatement Price Premiums



Notes: Theoretical and empirical premiums for an abated home through the period of tax benefits. For ages 12 and older, the empirical premium is defined to be 0. The shaded area represents the 95% confidence interval. Source: CoreLogic data 1980–2023.

Figure 6 plots the estimated abatement premium from the preferred specification with 95% confidence interval against the theoretical premium. Table 5 in Appendix A gives the complete set of estimated abatement price premiums from several variations of the stochastic specification in equation (4).

While noisy, the initial abatement premium does appear to amortize over time. However, this amortization happens much slower than the theory would suggest. By age 5, the abatement tax benefits are significantly overcapitalized. At age 9, abated properties sell for a 6.7% premium even though the remaining tax benefits are only worth about 1.8% of the home value. Amortization speeds up at ages 10–12, but the reduction to 0 is not immediate. There are several possible explanations for the divergence of actual and theoretical premium rates over time.

7.2 Mechanisms and Additional Results

7.2.1 Relative Salience

One possible reason for the overvaluing of soon-to-expire abatements is that the current tax bill is much more salient than future taxes. Here, "salience" is defined as the ease of calculating the amount and timing of the tax bills. Several studies have shown that households react more to higher salience taxes. Chetty, Looney, and Kroft (2009) show that buyers respond more to sales taxes included in sticker prices than those imposed at checkout. Cabral and Hoxby (2012) and Gindelsky et al. (2023) show that homeowners are more attentive to property taxes paid out of pocket than those paid via escrow.

There are several reasons why current taxes are more salient to buyers. The current or most recent tax bill populates the expected tax amount used by real estate websites, agents, and loan documents. Consequently, the current annual abatement is used to calculate expected monthly payments, which lenders and buyers routinely use to determine mortgage pricing and availability. Meanwhile, estimating future tax bills requires predicting future tax rates and appraised value. In the case of an abated property, this estimate also requires knowing the rules of the abatement policy and the years of abatement remaining. If buyers are more responsive to the highly salient current tax bill, then much of the abatement premium would be due to the low initial tax burden, which remains constant until the abatement expires. This disparity in salience would magnify any present bias or hyperbolic discounting by buyers.

There is evidence that sellers attempt to exacerbate and capitalize on this phenomenon. MLS listing data, provided by CoreLogic, shows 47% of listings for Philadelphia properties aged 6–10 mention "abatement" in their description. This is slightly higher than the 42% of listings for Philadelphia properties less than 6 years old that mention "abatement." Figure

7 contains excerpted screenshots from listings of 6–10 year old properties in Philadelphia. These listings demonstrate that the presence of an abatement is often a significant selling point, even for older abatements.

Figure 7: Sample Listings For Abated Properties Age 6–10

minimal way. This home is just steps from Manayunk's Main Street, and public transit. 4 YEARS LEFT ON TAX ABATEMENT! Do not miss out on the chance to call this property home!

This home is conveniently located in the heart of Center City Philadelphia with easy access to Penn University, CHOP, Fitler Square, Schuylkill River Park, bike path and dog park, highways and 30th Street Station. 2 1/2 YEAR TAX ABATEMENT remaining.

provides great sunlight and views of the neighborhood. 2424 East Letterly is a true gem. Many years remaining on the real estate tax abatement, and a carefree luxury lifestyle is here and ready for you. Schedule a tour, today!

unique media room, gym, or play area. If you are looking for a home with a wide floor plan and high ceilings, great natural light, quality construction, two car garage parking, and a tax abatement in a great neighborhood, this is one property that you don't want to miss.

** NEW PRICE IMPROVEMENT** PRIME Temple University location in one of the most desirable blocks for student housing. Rare duplex offering 6 BR/4 BA for each unit. Tax abatement remaining. Typical rent roll $6900/month. Very well designed and highly desirable floor-plan with large and even-

home make this a must-see. Schedule your showing for this beautiful home! Nearby Porcos Porchetteria, On Point Bistro, Cafe Ynez, Dockside Brewery, and more. Short walk to Graduate Hospital and Rittenhouse Square. Buyers are responsible for confirming remaining years on tax abatement.

Notes: Screenshots from listings of age 6–10 properties in Philadelphia. Source: Zillow.com Retrieved on December 11, 2020.

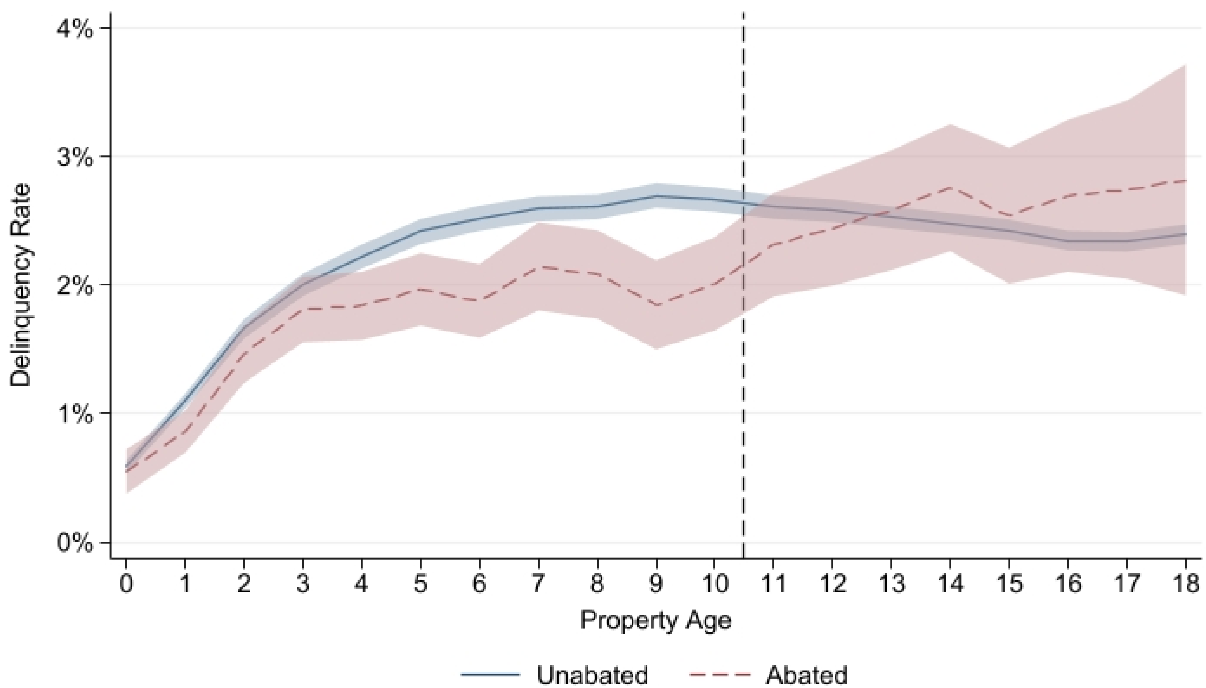
7.2.2 Inattention and Delinquency

Not only is the current tax bill more salient, but buyers may be unaware of the temporary nature of the low tax bill or the precise number of years it will remain low. This would be consistent with Bradley (2017), who found that buyers are inattentive to tax increases that occur when assessment-capped homes are sold in Michigan. Bradley finds that buyers pay a premium for homes with below-market assessments even though they themselves will not be taxed based on that assessment. The Philadelphia listing data also suggests that sellers seek to exploit this inattention to abatement expiration. While some listings mention the time remaining on the abatement, many either do not mention or contain only vague language about expiration.

Mortgage performance data provides additional evidence of this inattention. If buyers are not fully aware of the time remaining on a home's abatement, they will treat expiration as a payment shock. The size of the payment shock can be large. A borrower with an 80% LTV

30-year loan and no assessment growth will receive a payment increase equal to about 23% of the principal and interest payment. Significant assessment growth over the study period means some shocks are significantly larger. The literature on payment shocks, including deRitis, Kuo, and Liang (2010), finds that they result in higher mortgage delinquency rates. One implication of the failure to anticipate a payment shock is that mortgage delinquencies could rise. This could be true even if owners of abated properties are generally less likely to be delinquent due to their relative affluence. To test the relation between the payment shock and delinquency, Figure 8 plots the 30+ day delinquency rate by property age for abated and unabated properties.

Figure 8: 30+ Day Delinquency Rate by Abatement Status and Property Age

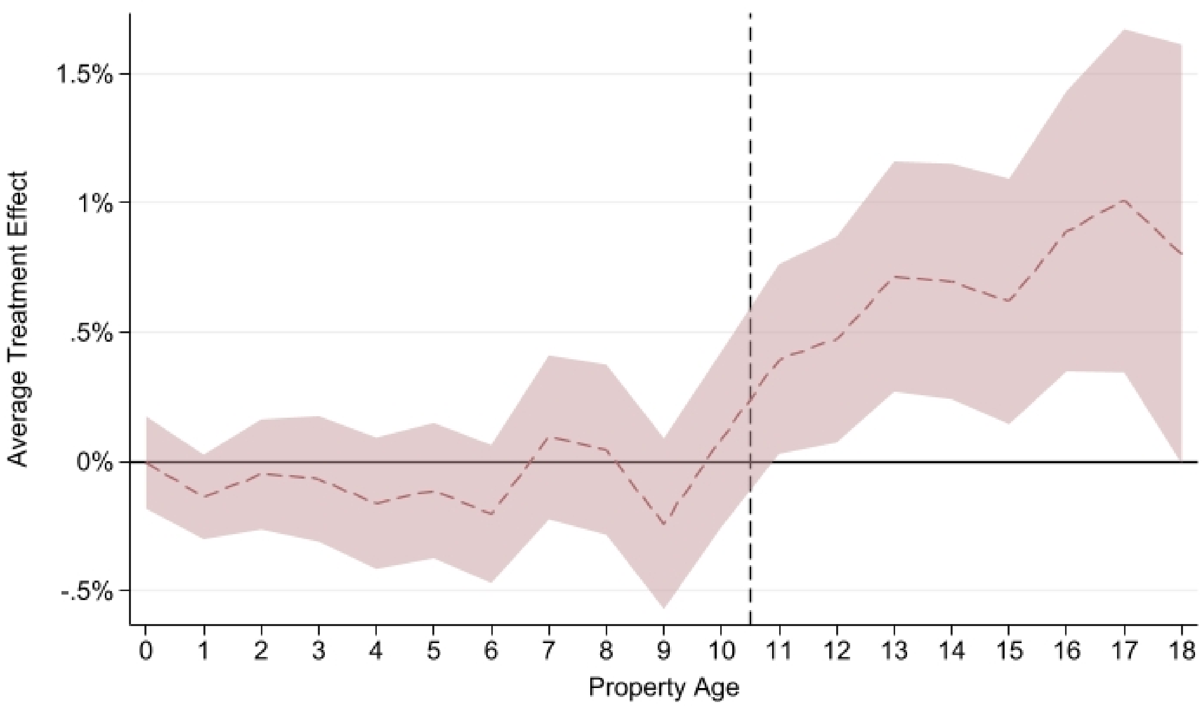


Notes: Observed delinquency rates for abated and unabated properties by property age. The shaded areas represent 95% confidence intervals accounting for sampling error. Source: GSE and CoreLogic data 2000–2023.

Delinquencies appear to be less common for loans on abated properties with active abatements, perhaps due to lower escrow payments. After 10 years, abatements expire and this trend begins to reverse. By age 13, loans on formerly abated properties are likelier to be delinquent. However, to get an accurate estimate of the size of these effects, it is important to control for loan characteristics and economic conditions. This is particularly true because abated properties were at most 9 years old during the last recession. This is done using the probit model described by equation (7).

The abatement-specific age effect (with 95% confidence interval) is plotted in Figure 9. The effect reported is the average treatment effect on the treated (ATT) expressed as the percentage point (pp) increase or decrease in the probability of being delinquent at each age. The full list of variables and estimated coefficients can be found in Table 6 in Appendix A.

Figure 9: Abatement Effect on Delinquency



Notes: ATT for the $Age_\alpha * Abat$ coefficients. The shaded area represents the 95% confidence interval. Standard errors are calculated using the delta method and clustered at the loan level. Source: GSE and CoreLogic data 2000–2023..

From ages 0 to 10, abatements appear to have virtually no effect on delinquency. The ATT averages less than 7 basis points (bp) for these years, and none of the effects are statistically significant. Around age 11, monthly escrow payments increase because of the increased tax bill. This is associated with an increase in delinquencies. At age 13, the ATT is a 71 ($\pm$ 45) bp increase in delinquency. This translates to a 38% rise in delinquent loans and is equivalent to the impact of a 25-point drop in credit score. Past age 13, the estimated ATT loses precision fairly rapidly as fewer cohorts of abated properties have reached these ages. Consequently, it is unclear if the increase in delinquency continues to grow, plateaus, or dissipates.

The delinquency effect may be surprising, given that the timing and size of the tax increase should be known well in advance. However, it is consistent with deRitis, Kuo, and Liang (2010), who find similar reactions to payment shocks due to the foreseeable expiration of a teaser rate and payment shocks due to less predictable market rate movements. They conclude that borrowers are not fully informed about the temporary nature of the teaser rate. Similarly, the increased delinquencies for properties with recently expired abatements are evidence of borrower inattention to the expiration of the tax benefits. It stands to reason that these borrowers were also inattentive to the upcoming expiration when they were buyers, causing them to overpay for abatements with few years of remaining benefits.

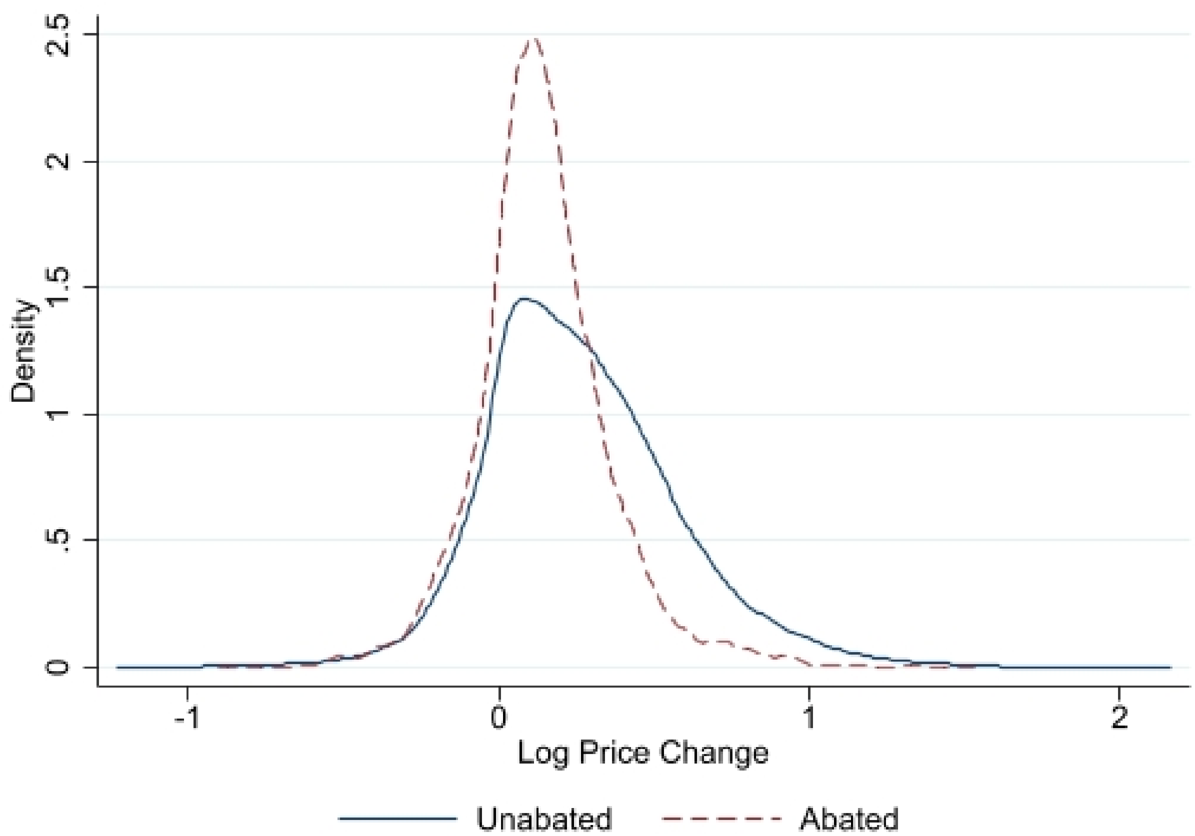
7.2.3 Price Anchoring and Loss Aversion

Another possible explanation for the overvaluation of older abatements is price anchoring. Here, "price anchoring" means insufficient adjustment away from an anchor price towards the true market value. Northcraft, Neale, et al. (1987) showed the importance of anchor prices in real estate transactions with an experiment using different listing prices. Beggs and Graddy (2009), Clapp, Lu-Andrews, and Zhou (2020), and others have shown how previous sales prices can similarly serve as an anchor price. If this is the case, the initial full abatement price premium may be carried forward via higher reference prices. Anchoring may occur not only in a behavioral sense for buyers and sellers but also in a mechanical sense for pricing models that do not account for the expiring abatement. This may be especially important given the prevalence of tools like Zillow's "Zestimate" feature and their role in expectation setting.

Sellers may also exhibit loss aversion, meaning they may be particularly motivated to avoid selling at a nominal loss. Abated properties, particularly those with expired or soon-to-expire abatements, are likelier to face a nominal loss due to the amortization of the tax benefits. Genesove and Mayer (2001), Anenberg (2011), and others show that sellers facing a nominal loss list their homes at higher prices, keep their homes on the market for longer, and ultimately receive a higher selling price than they otherwise would. This could explain some of the inflated premiums for older abated properties with soon-to-expire benefits.

Leung and Tsang (2013) showed that the combination of these two mechanisms causes price dispersion to be pro-cyclical. Since abated homes have an amortizing premium, one can conceptualize them as being in a market with less robust price inflation. This would mean the distribution of price gains for abated properties should have less variance than the distribution for unabated properties. Indeed, the distributions of price changes in Figure 10 show that the lower average appreciation of abated properties comes mainly from a lower propensity for large gains rather than a higher propensity to sell at a loss. This would be consistent with price anchoring and loss aversion disproportionately inflating the subsequent sale prices of abated homes.

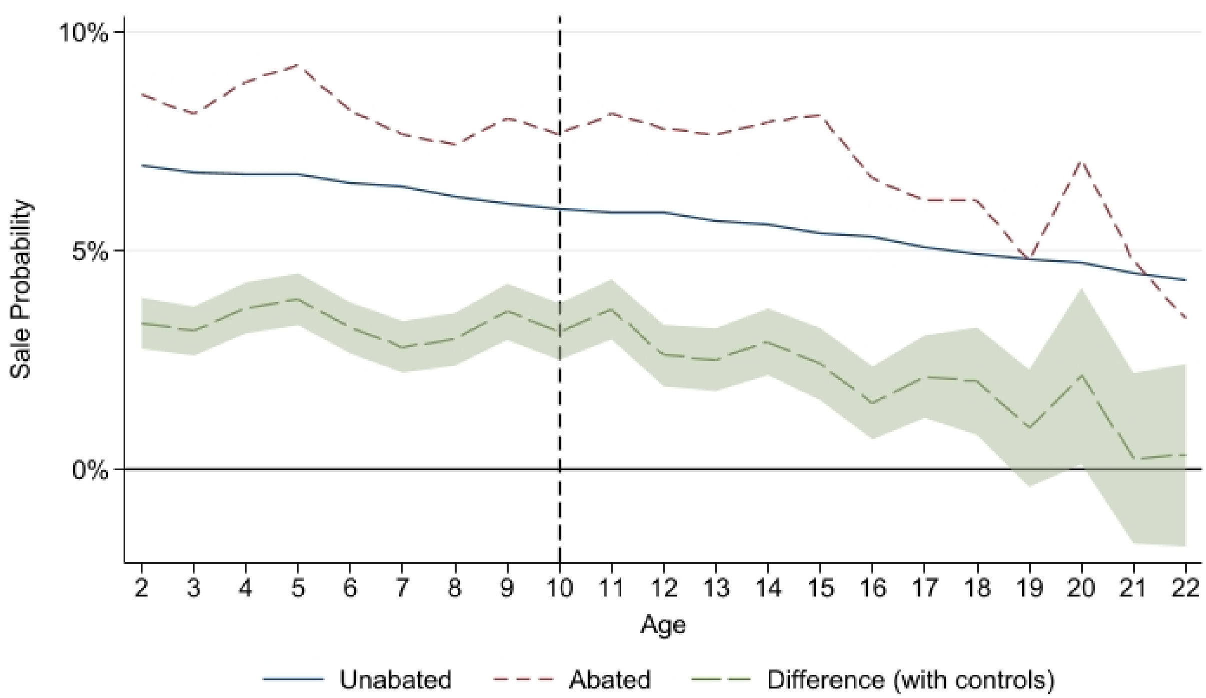
Figure 10: Price Change Distribution For Abated and Unabated Properties



Notes: Distributions of log price change for successive home sales of abated and unabated properties. To allow comparison between abated and unabated properties, only sales since 2000 are included. Source: CoreLogic data 2000–2023.

This loss aversion also raises the possibility that sales of older abated properties may be positively selected. Abated properties with below-average idiosyncratic price appreciation may be less likely to sell than identical unabated properties if the amortizing abatement would cause a nominal loss. Consequently, sales of older abated properties may be favorably selected towards those with more price appreciation. To investigate this possibility, Figure 11 shows the observed proportion of abated and unabated properties sold at each age and the difference between these probabilities after controlling for location, year, and property type. Abated properties are likelier to sell early in their lifetimes, perhaps due to developers looking to capture the full abatement subsidy. This higher propensity to sell lessens as the property ages. However, the trend shows no discontinuity at the time of abatement expiration. In fact, major convergence between the probabilities of resale does not occur until after age 14. Therefore, it appears that the measured overcapitalization does not arise due to selection bias.

Figure 11: Probability of Sale by Age For Abated and Unabated Properties



Notes: Observed probability that abated and unabated homes sold at each age and the difference between the abated and unabated probabilities after controlling for location, property type, and year. The shaded area represents the 95% confidence interval. Source: CoreLogic data 1980–2023.

7.2.4 Other Mechanisms

The abatement policy may also incentivize builders to build homes that depreciate quicker so that more housing services are delivered during the abated period. In this case, some of the measured abatement premium would actually be from other quickly deprecating features. This would manifest as continued comparatively rapid depreciation for abated properties even after the abatements expire. The parallel trends test in Figure 5 shows no evidence of this, but the hypothesis cannot be ruled out entirely. The final possible explanation is measurement error. Looking at listings, there are a small number of cases where the advertised years of abatement remaining exceed the number suggested by the year the property was built, suggesting that some properties have more years of abatement remaining than they appear to in the data.

7.3 Deductibilityy of Property Taxes

While Philadelphia's property tax rate has been close to 1.4% during the study period, the deductibility of property taxes for federal income taxes means that the effective rate is lower for homeowners who itemize. A small homestead exemption also lowers the effective rate for owner-occupiers. Because of this, the tax benefits may be modestly *over* capitalized even in sales of newly constructed properties.

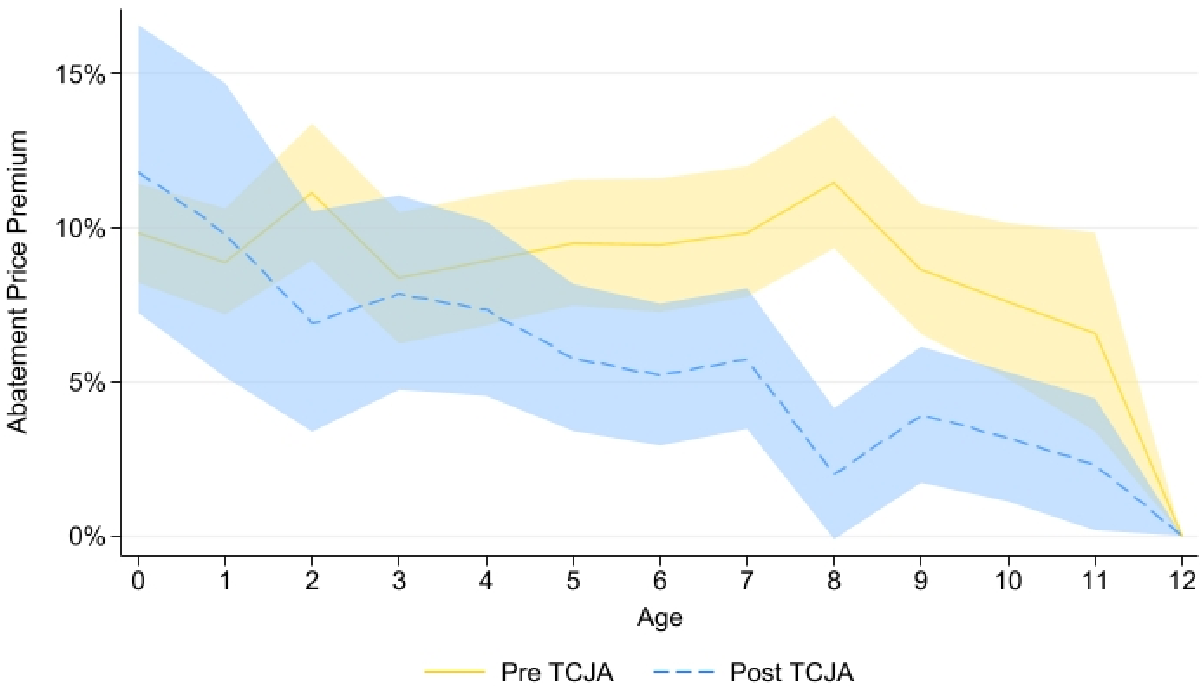
The Tax Cuts and Jobs Act (TCJA) significantly reduced the deductibility of property taxes beginning in 2018. The law doubled the standard deduction, greatly reducing the number of low- and middle-income filers who itemize. It also capped the deduction for state and local taxes (SALT) at $10,000. Consequently, most remaining itemizers receive little or no additional deduction for their property taxes.[10]

In theory, these changes should increase the value of abated properties by increasing the effective property tax rate that would otherwise have to be paid. Figure 12 shows the estimated abatement premiums before and after the implementation of the TCJA. Indeed, the initial capitalization increased from 95.5% pre-TCJA to 113.9% post-TCJA. However, limited data means this difference is not statistically significant (p=.372). Interestingly, the overcapitalization for age 6–10 properties appears to have disappeared post-TCJA. This is likely unrelated to the law and may result from market participants learning how to value

[10] Philadelphia imposes a local income tax of about 3.8% in addition to Pennsylvania's 3.07% tax, meaning the SALT deduction is completely used by income taxes after ≈ $145,000 in income.

short-term tax benefits. Figure 16 in Appendix A also shows that the overcapitalization of soon-to-expire abatements was worse for properties built before 2008.

Figure 12: Abatement Premiums Before and After the TCJA



Notes: Premiums for an abated home through the period of tax benefits before and after the implementation of the TCJA in 2018. These premiums are estimated by interacting the abatement age dummies with pre- and post-TCJA dummies. The implied age 0 capitalization pre-TCJA is 95.5%. Post-TCJA, this increases slightly to 113.9%. The difference between these estimates is not statistically significant (p=.372). The shaded areas represent 95% confidence intervals. Source: CoreLogic data 1980–2023.

8. Conclusion

Philadelphia's abatement policy offers an ideal natural experiment to estimate the capitalization of property taxes. The best estimate is that the tax benefits are 100.6% capitalized into the prices of newly constructed homes with a 95% confidence interval of 86.0%–115.2%. This result is consistent with studies that estimate the full capitalization of property taxes. The finding of increased mortgage delinquency for properties with newly expired abatements raises questions about the role of underwriting and disclosure for these mortgages. Local lenders likely lack the sophistication to underwrite loans on abated properties differently, while large national lenders likely ignore idiosyncratic local policies such as Philadelphia's property tax abatement. Current standard disclosures mention the possibility of tax increases due to reassessment but not from expiring abatements. Additional disclosure in loan documents and purchase agreements may better inform future borrowers.

Because the abatement terminates after 10 years, a further new test of capitalization over time is possible. Tests show that the capitalization rate rises over the life of the abatement as the premium amortizes more slowly than expected. Evidence exists for various potential causes, including buyer inattention to abatement expiration. The fact that expiring abatements lead to an increase in mortgage delinquency reinforces the evidence for this mechanism. Other possible explanations are the relative salience of current vs. future taxes and persistent premiums due to price anchoring and loss aversion.

While this paper is not intended to assess the overall effectiveness of Philadelphia's abatement policy, understanding the initial degree of capitalization in this specific case has policy implications. The Philadelphia abatement policy is intended to incentivize development by increasing the price developers receive for new construction. Suppose the benefits were less than fully capitalized, so the initial abatement premium was less than the present value of the tax benefits. In that case, the incentive to develop is lessened, and the policy instead provides a subsidy to the residents of abated properties. This paper shows that the abatement mechanism does indeed raise the price of new construction by the present value of the benefits.

Furthermore, the results of this paper demonstrate some likely effects of the reform to Philadelphia's abatement policy, which went into effect on January 1, 2022. The reformed policy phases out the tax benefit over the 10-year life of the abatement rather than fully abating the value of the new development for 10 years. This change should ameliorate the overpayment for homes with soon-to-expire abatements because current tax amounts will be more in line with future property taxes. The change should also lessen the effect that expiring abatements have on delinquencies. Finally, to the extent that the market overemphasizes current taxes when setting the *initial* abatement premium, the benefit phase-out will help Philadelphia incentivize more development per dollar of foregone revenue.

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A Appendix

Table 5: Estimated Abatement Home Price Premiums

	(1)	(2)	(3)	(4)	(5)
$Abat * Age_0$	.110***	.081***	.096***	.094***	.104***
	(.008)	(.008)	(.008)	(.011)	(.008)
$Abat * Age_1$	.082***	.061***	.089***	.088***	.097***
	(.008)	(.008)	(.008)	(.012)	(.009)
$Abat * Age_2$	.097***	.079***	.102***	.101***	.110***
	(.011)	(.010)	(.010)	(.013)	(.010)
$Abat * Age_3$	.066***	.055***	.080***	.079***	.087***
	(.009)	(.009)	(.009)	(.012)	(.010)
$Abat * Age_4$	.063***	.055***	.083***	.082***	.090***
	(.009)	(.009)	(.009)	(.012)	(.009)
$Abat * Age_5$	.057***	.053***	.080***	.079***	.088***
	(.008)	(.008)	(.008)	(.011)	(.008)
$Abat * Age_6$	.050***	.051***	.076***	.076***	.085***
	(.008)	(.008)	(.008)	(.012)	(.009)
$Abat * Age_7$	.050***	.055***	.079***	.078***	.087***
	(.008)	(.008)	(.008)	(.011)	(.008)
$Abat * Age_8$	.042***	.051***	.072***	.071***	.080***
	(.008)	(.008)	(.008)	(.011)	(.008)
$Abat * Age_9$	.030***	.043***	.060***	.058***	.067***
	(.008)	(.008)	(.008)	(.011)	(.008)
$Abat * Age_{10}$	.022*	.037***	.050***	.048***	.057***
	(.009)	(.009)	(.008)	(.012)	(.009)
$Abat * Age_{11}$				.032**	.041***
				(.012)	(.010)
Property Fixed Effects	✓	✓	✓	✓	✓
$Year * ZIP$	✓	✓	✓	✓	✓
Age_α	0,1,...,10	0,1,...,∞	0,1,...,∞	0,1,...,∞	0,1,...,∞
$Abat * Age_\alpha$	0,1,...,10	0,1,...,10	0,1,...,10	0...11,13...∞	0,1,...,11
$Type * Age$			✓	✓	✓
N Transactions	1,650,177	1,650,177	1,650,177	1,650,177	1,650,177
N Properties	600,389	600,389	600,389	600,389	600,389

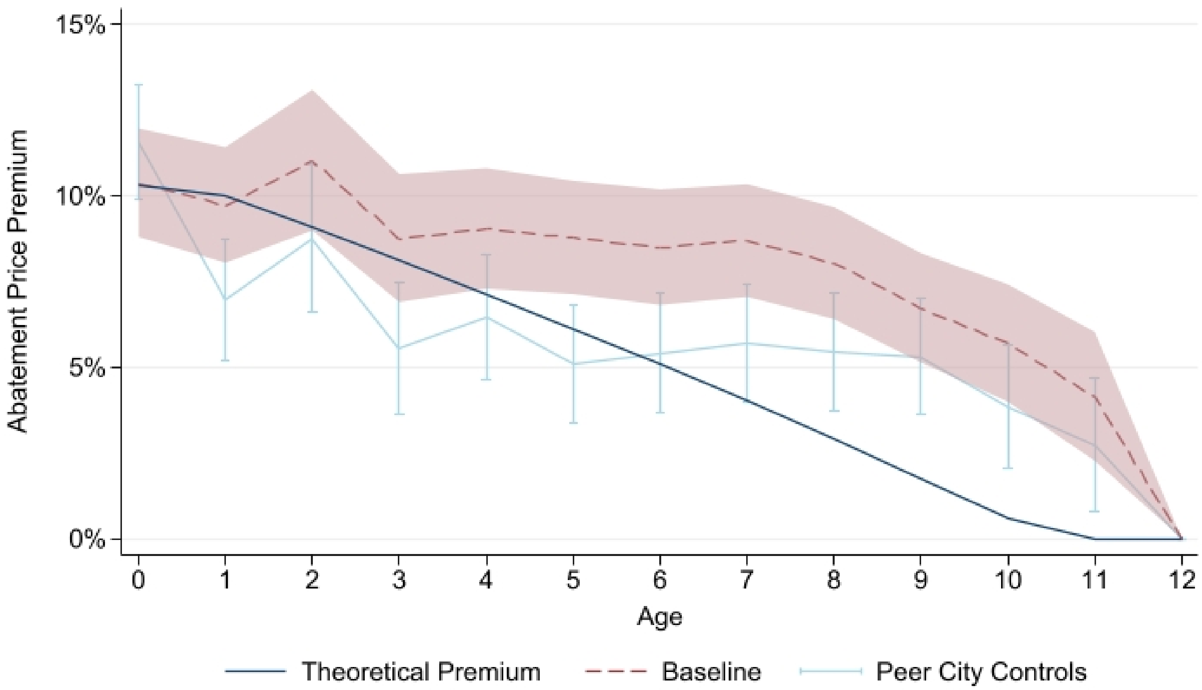
Notes: Columns (1)–(5) are defined the same as in Table 4 in Section 6.1.The empirical premiums are derived by exponentiating the $Age_\alpha * Abat$ coefficients and subtracting 1. Robust standard errors are shown in parentheses. $* = p < 0.05$, $** = p < 0.01$, $*** = p < 0.001$ Source: CoreLogic data 1980–2023.

Table 6: Delinquency Probit Model Coefficients

Variable	Coefficient	Variable	Coefficient
$Abat * Age_0$	-.003	Log Home Value	.128***
	(.061)		(.006)
$Abat * Age_1$	-.062	Log Income	-.225***
	(.039)		(.005)
$Abat * Age_2$	-.016	Debt Ratio	.371***
	(.034)		(.017)
$Abat * Age_3$	-.018	Credit Score*100	-.659***
	(.033)		(.003)
$Abat * Age_4$	-.042	Original LTV	1.015***
	(.035)		(.015)
$Abat * Age_5$	-.029	Loan Age	.066***
	(.035)		(.003)
$Abat * Age_6$	-.054	Single-Family	Omitted
	(.037)	Condo	-.093***
$Abat * Age_7$	.023		(.010)
	(0.04)	PUD	-.057***
$Abat * Age_8$	.011		(.007)
	(.042)	Cash-Out Refi	Omitted
$Abat * Age_9$	-.064	No Cash-Out Refi	-.077***
	(.047)		(.005)
$Abat * Age_{10}$	.022	Purchase	-.076***
	(.045)		(.005)
$Abat * Age_{11}$	.099*	30 Year Fixed	Omitted
	(.044)	15-20 Year Fixed	-.163***
$Abat * Age_{12}$	.114*		(.005)
	(.046)	ARM	-.003
$Abat * Age_{13}$	.167***		(.011)
	(.047)	Primary Residence	Omitted
$Abat * Age_{14}$	.156***	Second/Vacation	.078***
	(.047)		(.022)
$Abat * Age_{15}$	.151**	Investment	.143***
	(.053)		(.008)
$Abat * Age_{16}$	.212***	First Time Home Buyer	-.056***
	(.057)		(.006)
$Abat * Age_{17}$	.239***		
	(.068)	Property Age FE	✓
$Abat * Age_{18}$	.182*		
	(.082)	Origination Year FE	✓
$Abat * Age_{19}$	.200*		
	(.101)	Year * County FE	✓
$Abat * Age_{20}$	.144		
	(.119)		

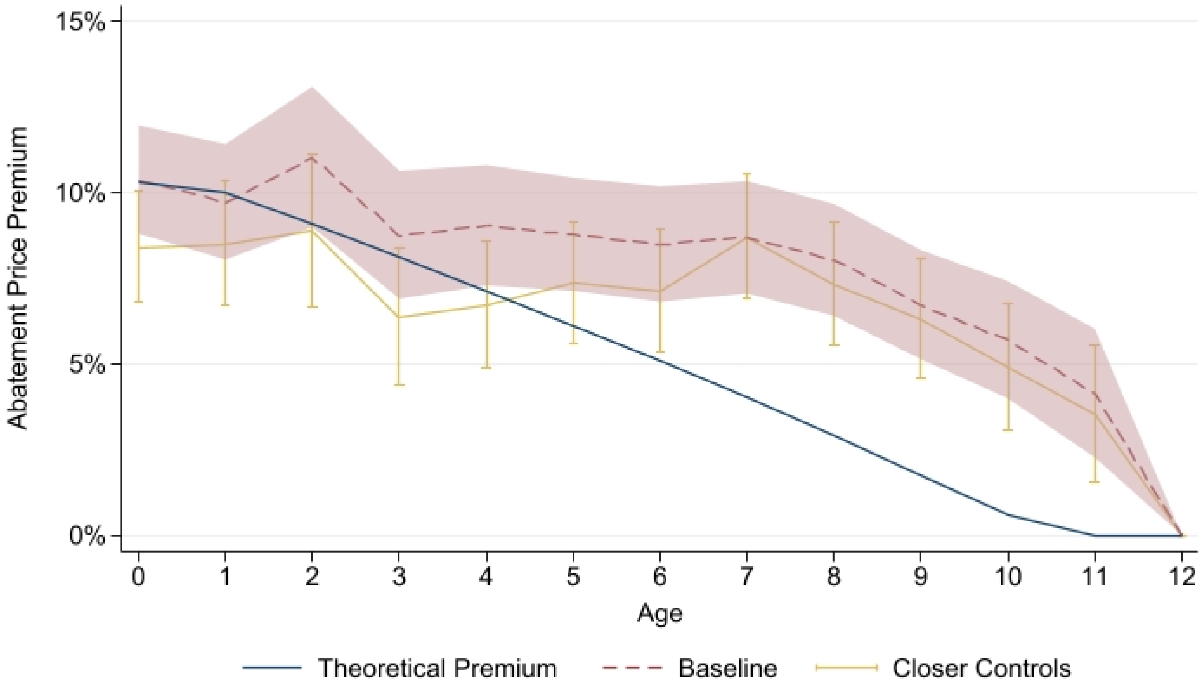
Notes: Standard errors derived using the delta method and clustered at the loan level. $* = p < 0.05$, $** = p < 0.01$, $*** = p < 0.001$ Source: GSE and CoreLogic data 2000–2023.

Figure 13: Peer City Controls



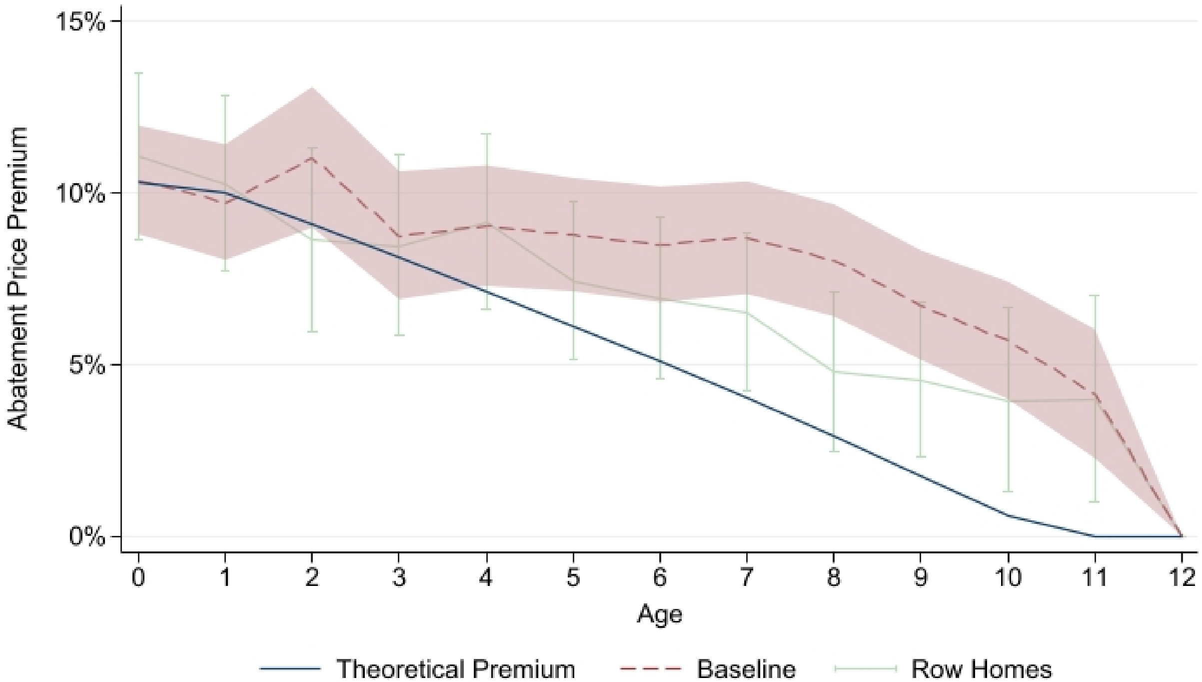
Notes: Premiums for an abated home through the period of tax benefits estimated using the theoretical, baseline empirical, and alternative control models. The alternative model uses properties from counties containing the cities identified as peer cities by Jones Lang LaSalle (2018) as controls rather than the surrounding counties. These counties are Allegheny, PA (Pittsburgh); Cook, IL (Chicago); San Francisco, CA; Suffolk, MA (Boston); and Washington, DC. Baltimore and New York were excluded as they each have limited abatement programs. The peer city control model gives an implied age 0 capitalization of 111.5% with a 95% confidence interval of 96.1%–126.9%. The error bars represent the 95% confidence interval. Source: CoreLogic data 1980–2023.

Figure 14: Adjacent ZIP Code Controls



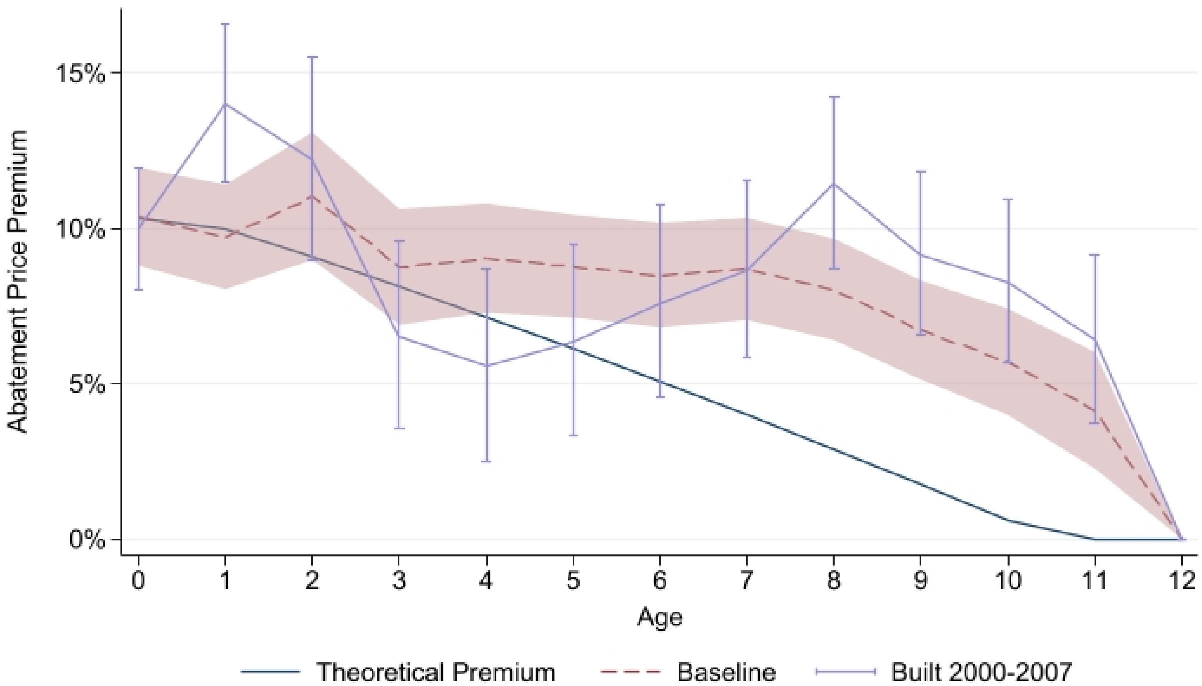
Notes: Premiums for an abated home through the period of tax benefits estimated using the theoretical, baseline empirical, and alternative control models. The alternative model uses properties in ZIP codes bordering Philadelphia or separated from the city by one ZIP code as controls rather than all properties in the surrounding counties. The peer city control model gives an implied age 0 capitalization of 111.5% with a 95% confidence interval of 96.1%–126.9%. The error bars represent the 95% confidence interval. Source: CoreLogic data 1980–2023.

Figure 15: Row Homes Only



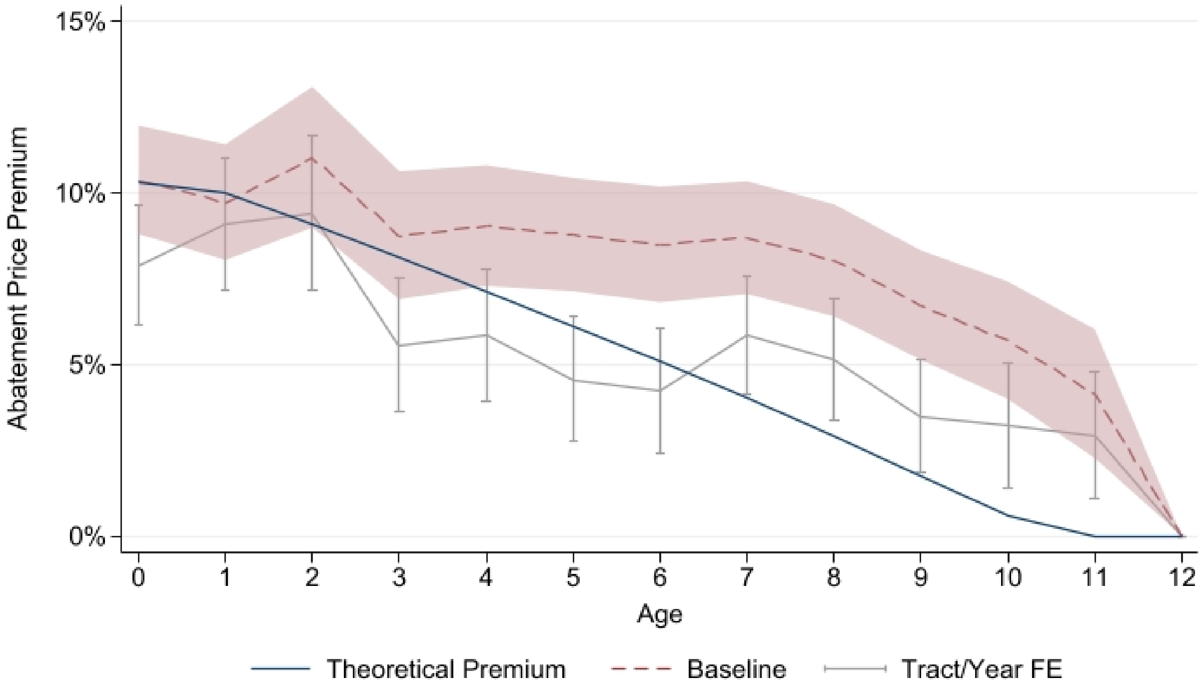
Notes: Premiums for an abated home through the period of tax benefits estimated using the theoretical, baseline empirical, and row home subsample models. In the subsample, only row/town homes are included in both the abated and control groups. Regression with the row home only sample gives an implied age 0 capitalization of 106.8% with a 95% confidence interval of 84.4%–129.1%. The error bars represent the 95% confidence interval. Source: CoreLogic data 1980–2023.

Figure 16: Abated Properties Built 2000–2007



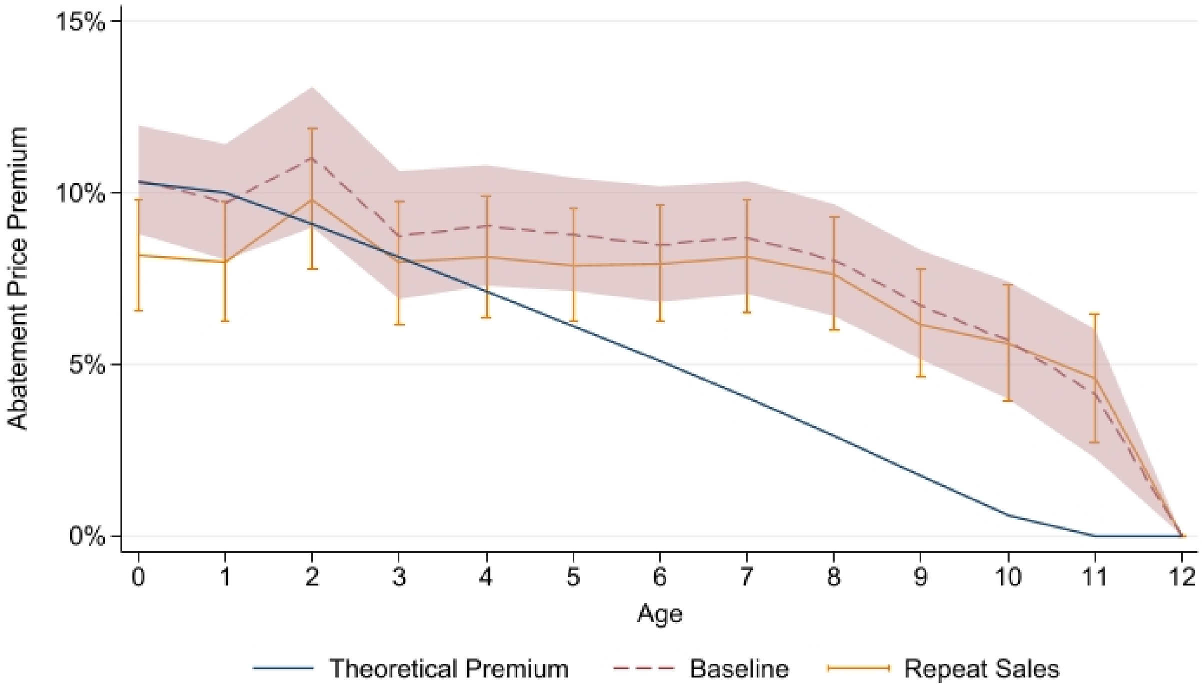
Notes: Premiums for an abated home through the period of tax benefits estimated using the theoretical, baseline empirical, and 2000–2007 subsample models. Abated properties built in 2008 or later are excluded from the 2000–2007 subsample. Regression with the 2000–2007 subsample gives an implied age 0 capitalization of 101.8% with a 95% confidence interval of 83.7%–119.9%. The error bars represent the 95% confidence interval. Source: CoreLogic data 1980–2023.

Figure 17: Tract×Year Fixed Effects



Notes: Premiums for an abated home through the period of tax benefits estimated using the theoretical, baseline empirical, and tract×year fixed-effect models. The tract×year fixed effects model replaces the ZIP-year dummies with tract×year dummies. The tract×year fixed-effect model gives an implied age 0 capitalization of 77.4% with a 95% confidence interval of 61.0%–93.8%. The error bars represent the 95% confidence interval. Source: CoreLogic data 1980–2023.

Figure 18: Repeat Sales Regression



Notes: Premiums for an abated home through the period of tax benefits estimated using the theoretical, baseline empirical, and repeat sales models. The repeat sales regression gives an implied age 0 capitalization of 80.0% with a 95% confidence interval of 64.6%–95.5%. The error bars represent the 95% confidence interval. Source: CoreLogic data 1980–2023.