The Impact of Property Reassessment on Housing Prices —Trade-offs between Tax Fairness and Housing Equity*

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Abstract

Property reassessment serves as a crucial mechanism to align assessed property values with market prices, ensuring fairness in taxation. However, such reassessments may inadvertently influence housing values, thereby impacting wealth distribution. Drawing on data from 19 Pennsylvania counties, this study investigates the effect of property reassessment on housing values. The paper examines two competing theories: the capitalization effect, which posits decreased housing values in affluent regions and increased prices in less developed areas, and the anchoring effect, which suggests more significant price hikes in affluent regions and broader disparities in housing prices. Employing a difference-in-differences approach and instrumental variable analysis, the study reveals that the anchoring effect prevails. On average, property reassessment leads to a 9% increase in housing values across counties, with a notable positive impact in high-priced regions and a negative effect in less affluent areas. This underscores that while reassessment enhances tax fairness, it also disproportionately benefits wealthier individuals and exacerbates geographical disparities in housing prices, running counter to goals of wealth equality.

Keywords—*Property reassessment, capitalization effect, anchoring effect*

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1 Introduction

Property assessment in the United States has long been criticized for its regressivity (Ross, 2012; McMillen & Singh, 2020; Avenancio-León & Howard, 2022). Previous studies have found that high-priced houses are more likely to be underestimated, leading to an inequitable tax burden between less developed and wealthy regions (Krupa, 2014; McMillen & Singh, 2020). Therefore, a regular property reassessment aimed at unifying the assessment ratio[1] within a jurisdiction is an important tool to correct the regressivity of property tax (Payton, 2012; Krupa, 2012; Hou et al., 2023). However, reassessment might unintentionally affect housing values and create unequal capital gains among house owners, resulting in unfairness (Yinger et al., 1988).

Property assessment might affect housing values in two ways. First, since the property tax bill is usually calculated as the product of assessed value and tax rate, changes in assessed value would affect the tax burden. Previous studies suggest that a higher property tax leads to lower housing prices as people would be less willing to live in regions with a heavier tax burden (Smith, 1970; Richardson & Thalheimer, 1981; Rosen, 1982; Gallagher et al., 2013; Livy, 2018). This mechanism is referred to as the *capitalization effect*. Second, the assessment itself may affect people's valuations and decision-making in the housing market. Behavioral economics theory suggests that people's judgment would be affected by initial information (i.e., anchor) presented to them (Mussweiler & Strack, 1999; Beggs & Graddy, 2009; Furnham & Boo, 2011). Previous evidence also suggests that listing price, previous sales price, or government-announced statistics would affect individuals' valuation of a given house (Northcraft & Neale, 1987; Scott & Lizieri, 2012; Palm et al., 2015; Chang et al., 2016). Therefore, an increase in assessed value could raise the market value of houses. This mechanism is referred to as the *anchoring effect*. Notably, the expected impacts of the capitalization and anchoring effects are in opposite directions. While a higher assessed value may push up house prices due to the anchoring effect, the corresponding higher property tax would reduce housing values. Therefore, there is theoretical ambiguity regarding the total effect of property assessment.

[1] Assessment ratio is defined as the ratio of assessed value and real market value.

To study the impact of property assessment, this paper examines county-wide reassessments over time in the state of Pennsylvania. The paper aims to identify the total effect of property reassessment on housing values and decompose the capitalization and anchoring effects. Understanding the separate impacts driven by different mechanisms is crucial. First, while the capitalization effect (i.e., the impact of the tax burden) is aligned with the equity goal (redistributing tax from low- to high-priced housing), the anchoring effect might widen wealth inequality (pushing up the values of high-priced housing more than the low-priced ones). Therefore, decomposing the capitalization and anchoring effects is crucial to understanding the tradeoff between taxation progressivity and wealth equality. Secondly, while reassessment would induce both capitalization and anchoring effects, some policies only affect one. For example, a change in tax rate only yields a capitalization effect, and the government's announced housing market statistics only produce an anchoring effect. The decomposition results of multiple mechanisms could generate insights into different policies.

The current study utilizes both between and within counties variation to examine the causal impact of property reassessment and to decompose the two channels. Particularly, a difference-in-differences (DID) framework with a dosage variable based on pre-treatment underestimation level (defined as the average assessed ratio at the census tract level) is applied. While the reassessment happened countywide, different regions within a county might experience heterogeneous effects. The goal of property reassessment is to align assessed value with market values. Therefore, regions that had been most underestimated would experience the most considerable increase in assessed value than those less underestimated. Additionally, reliance on a particular state law—which requires counties to reduce the nominal tax rate after a countywide reassessment—is employed to separate the capitalization and anchoring effects. Due to this state requirement, counties are required to perform two things together—reduce the nominal tax rate and reassess property value. While the change in nominal tax rate applies to all properties in the county, reassessment might produce heterogeneous effects within a county. This policy feature produces distinct and independent variations in property tax not solely driven by assessed value. This setting allows for the decomposition of the separate impact of assessed value (anchoring effect) and property tax (capitalization effect). Additionally, this paper incorporates DID with instrumental variable (IV) analysis to formally decompose and estimate the two channels.

The results suggest that property reassessment increases overall assessed value by 200%, with the most considerable surge in regions that had been most underestimated. Furthermore, the policy led to a significant increase in property tax in regions that had been most underestimated but a decrease in regions that were less underestimated. This pattern suggests that the policy improves tax equity by redistributing the tax burden. Finally, the policy leads to an overall 9% increase in housing values in the treated counties. While the top quantile most underestimated regions experience a 35% increase in housing price, the bottom quantile least underestimated regions see a 12% decrease in housing price. The pattern of within-county heterogeneous effects shows that the anchoring effect (predicts the effect to be stronger in more underestimated regions) might dominate the capitalization effect (predicts the effect will be negative in underestimated regions and positive in non-underestimated regions). Estimation from 2SLS results also aligns with this conclusion. While a 100% increase in assessed value leads to a 4.6% increase in housing prices, a 100% increase in property tax leads to a 2.9% decrease in housing prices.

The contribution of this paper could be summarized as follows: First, this paper contributes to the property assessment literature by simultaneously considering both capitalization and anchoring effects. While previous studies have investigated either the capitalization or anchoring effects driven by property (re-)assessment independently (Smith, 1970; Yinger et al., 1988; Cheung et al., 2022), none of them consider both effects at the same time. Since the two effects are in opposite directions, failing to consider either could bias the estimation toward zero. Furthermore, only when correctly evaluated, both policy mechanisms would provide insight into the potential trade-off of the policy (i.e., tax progressivity and wealth equality) and better inform future policy design.

Secondly, this study also speaks to the anchoring effect literature. Previous studies find that the credibility of the information sources affects the magnitude of the anchoring effect (Furnham & Boo, 2011; Dowd et al., 2014). Government, as an official agency, could be a powerful source of anchors. Previous studies have examined the anchoring impacts of government-announced regional land price statistics (Chang et al., 2016) and housing subsidies to low-income families (Arbel et al., 2014). However, the effect of property assessment might be even more potent because the government provides customized evaluation for each house. Furthermore, house owners might be actively engaged in the reassessment process as they might see the property assessors visit their homes and have the right to file an appeal for assessment, increasing the credibility of assessed results. This paper contributes to the literature on government-generated anchors by providing evidence of the impact of property assessment—a specific and customized anchor.

Finally, this study also contributes to the property tax capitalization literature. Despite a significant body of literature on this topic (Hilber, 2017), most still suffer from the empirical challenge that property tax variation usually leads to local revenue change, which may also affect housing value and confounds the estimation of the tax impact. This study utilizes Pennsylvania's specific revenue-neutral provision to overcome this challenge. While reassessment substantially redistributes the property tax burden within a jurisdiction, the provision requires that reassessment would not alter total local revenue. Utilizing this feature, this study can identify a clean causal estimate of the effect of the property tax burden on housing values.

2 Institutional Background

This paper investigates property reassessments in Pennsylvania, which offers several advantages for the present study. Firstly, Pennsylvania stands out as one of the few states without a mandatory state-level property reassessment requirement.[2] Consequently, there exists wide variation in the frequency and occurrence of countywide reassessments. As of 2024, the average time span between countywide reassessments is 26 years, ranging from 2 to 54 years. For counties that underwent reassessment since 2005 (i.e., the treatment group), the average gap from their last reassessment is 23 years (ranging from 4 to 59 years).

[2] There is some ambiguity regarding definitions of lacking compulsory state-level regular reassessment. According to various definitions, only six to nine states in the US have no state-level provision on property reassessment schedules (Higginbottom, 2010; Coffey et al., 2020; Hennen, 2022).

Secondly, Pennsylvania's constitution incorporates a uniformity clause that mandates tax jurisdictions to treat the same class of subjects uniformly.[3] This clause prohibits tax jurisdictions from categorizing properties into distinct groups (e.g., commercial or residential) and applying different tax rates or assessment procedures (Vogel, 2016). Consequently, counties cannot selectively reassess subcategories or regions of houses.[4] Additionally, Pennsylvania lacks rules mandating property reappraisal after sale.[5] This feature ensures that transaction prices have no immediate impact on assessed values, mitigating reverse causality concerns.

Lastly, Pennsylvania implements a specific revenue-neutral provision.[6] This provision mandates tax jurisdictions to decrease the property tax rate following a countywide reassessment, thereby ensuring that total taxes do not surpass the previous year's total. Consequently, while reassessment redistributes the tax burden across households, it does not alter local revenue. Policy statements from multiple counties indicate that reassessment typically increases taxes for some properties, reduces taxes for others, and leaves others unaffected (Cumberland County, 2010; Ulsh & Barr, 2010; WBK LLC, 2014; Hou et al., 2023; Lackawanna County, 2021). This provision enables our study to isolate the impact of reassessment on housing values without the confounding effects of changes in local public goods provision levels.

Countywide reassessment involves re-evaluating all properties within a jurisdiction to align assessed values with fair market values. Between 2005 and 2021, 23 out of 67 Pennsylvania counties underwent countywide reassessments. Counties may initiate reassessment for various reasons. In some cases, court orders drive reassessment.[7] In others, reassessment is a policy decision made by the government. While the adoption of these policies may correlate with county-specific char-

[3] Article 8, §1. https://www.legis.state.pa.us/cfdocs/legis/LI/consCheck.cfm?txtType=HTM&ttl=00&div=0&chpt=8

[4] For instance, the state court has deemed some partial reassessments, targeting specific property types within a county, unconstitutional (Haider, 2022).

[5] For example, in California, properties are re-appraised upon changes in ownership. In some Kentucky counties, assessed values automatically adjust to the sales price after a transaction.

[6] Title 53, §8823. https://www.legis.state.pa.us/cfdocs/legis/LI/consCheck.cfm?txtType=HTM&ttl=53&div=0&chpt=88

[7] For instance, Washington County conducted a reassessment in 2017 following a court decision prompted by two school districts' lawsuit against the government for underestimating certain property values (McCune, 2016). Other reassessments in Allegheny, Carbon, Erie, and Lebanon counties were similarly triggered by court orders.

acteristics, the exact timing of adoption may involve uncertainty, given the prolonged process of negotiation and debate.[8]

The reassessment process varies across counties. In some counties, property assessment offices conduct reassessments, while in others, governments outsource this work to private companies specializing in property appraisal.[9] Although reassessment techniques may differ, the process generally involves collecting real estate transaction prices and property condition information (e.g., building age, lot size, exterior condition). New assessed values are typically based on neighborhood average prices adjusted for property characteristics.

3 Theoretical Framework

Two theories can explain how property assessment affects housing prices. The first theory is the capitalization effect—property assessment determines the property tax and is incorporated into housing prices when potential buyers account for future costs. Section 3.1 delves into this perspective. The second mechanism is the anchoring effect—the assessment itself signals the government's judgment on the values of the property and affects market actors' valuation. Section 3.2 discusses this phenomenon.

3.1 Capitalization Effect

Tiebout's (1956) model suggests that people could "vote with their feet" to find a local community with the most efficient bundle of taxation and public goods provision (Banzhaf & Walsh, 2008). A branch of the literature empirically tests Tiebout's model by examining how property tax burdens are "capitalized" into housing values. They find a negative relationship between property tax and housing prices (Oates, 1969; Richardson & Thalheimer, 1981; Rosen, 1982; Palmon & Smith, 1998). The underlying logic is that the higher the cost (tax burden), the lower people are

[8] For instance, in Philadelphia, property reassessment was proposed in the 1980s, remained under debate in the 2000s, was reintroduced in 2012, and eventually took effect in 2014 (PEW, 2012).

[9] For example, many counties collaborate with 21st Century Appraisals, Inc.

willing to pay to live in a place. Understanding the capitalization effect is crucial for policymakers because it implies how people weigh public goods provision and the tax cost they need to bear.

Previous studies usually utilize variations in the tax rate to examine the capitalization effect. Some studies use cross-sectional comparisons between tax jurisdictions with different tax rates (Richardson & Thalheimer, 1981; Palmon & Smith, 1998; Livy, 2018), while others use tax rate changes to study the impact of property tax (Oliviero & Scognamiglio, 2019; Elinder & Persson, 2017; Høj et al., 2018). However, previous studies have not agreed on the magnitude of the capitalization effect (Hilber, 2017). The estimated level of capitalization ranges from null to over 100%. One reason for the inconsistent finding might be due to the lack of consensus on the discount rate of how to convert future tax burden into present value. Another explanation might arise from the empirical challenge of identifying the causal effect of property tax. Property tax revenue might determine local public goods provision, which also affects housing values. Therefore, the estimation of the property tax capitalization effect might be confounded by local expenditure.

Some studies overcome the challenge by turning to the intra-jurisdictional difference in tax burden driven by property assessment. For example, Ihlanfeldt & Jackson (1982) utilize variations in tax burden due to assessment error to examine the capitalization effect. They focus on the case in St. Louis, Missouri, where some houses are more underestimated than others due to assessment practices. They find that a one-dollar reduction in tax burden due to assessment error leads to a 22-dollar increase in market values. Given a 5% discount rate and 40-year time horizon, the estimation yields 130% of full capitalization. However, their results might be confounded by the fact that assessment error is not random. Recent studies find that high-priced houses are more likely to be underestimated than low-priced houses (Krupa, 2014; McMillen & Singh, 2020). Hence, the negative relationship between assessment error and house price might be due to the assessment process rather than the capitalization effect.

Some other studies utilize property reassessment, which generates sharp variations in assessed value to examine the impact of property tax. For example, Yinger et al. (1988) utilize several countywide reassessments in Massachusetts to investigate the capitalization effect. They use houses with transaction records before and after the reassessment to examine the relationship between effective property tax rate changes and housing value changes. They find a 15% to 30% capitalization—far lower than full capitalization. However, they ignore the anchoring effect of the assessed value itself. Houses that experienced a significant increase in the effective tax rate (therefore, should have a significant negative capitalization impact on house values) might experience a more substantial positive anchoring effect. Hence, the anchoring effect might offset the capitalization effect and cause a downward bias in the estimation.

Overall, while previous studies have not agreed on the magnitude of the capitalization effect, most evidence suggests a negative relationship between property tax and housing values. Due to the revenue-neutral provision in Pennsylvania, the reassessment might not change the average level of property tax but merely redistribute the tax burden within the jurisdictions. Specifically, houses that have been most underestimated are likely to experience an increase in property tax (therefore, a negative capitalization). In contrast, places that have been least undervalued are likely to experience a decrease in property tax (therefore, a positive capitalization).

3.2 Anchoring Effect

Due to cognitive limitations, humans usually make decisions based on limited rationality (Simon, 1955). People's judgments are commonly affected or even biased by the initial information they are exposed to, which is referred to as the anchoring effect (Furnham & Boo, 2011; Battaglio Jr et al., 2019). Previous studies find substantial evidence of the anchoring effects both when the anchor is arbitrary (such as respondents' phone numbers) or contextually related (such as expert valuations) (Furnham & Boo, 2011; Bystranowski et al., 2021). In addition, evidence suggests that the anchoring effect not only exists when people are asked to evaluate a number (Northcraft & Neale, 1987; Kaustia et al., 2008; Scott & Lizieri, 2012) but also affects their decisions in the real market (Simonson & Drolet, 2004; Bergman et al., 2010; Li et al., 2021).

Understanding the anchoring effect and evaluating how this mechanism could work via policy delivery is crucial. Public policy not only yields effects via the policy tool itself (such as regulations or subsidies) but also affects people through the information the government provides. For example, Arbel et al. (2014) find that the government's discount rate on public housing would affect residents' future decisions and willing-to-pay prices when they purchase a house. Ho (2016) also finds that government subsidies to firms to encourage them to hire fresh college graduates would bias firms' evaluations of the salary of their new employees, lowering the start wage for new grads. Hence, policymakers should be aware of the potential anchoring effects of the policy to avoid unintended or even undesired impacts.

Previous studies identify several mechanisms of the anchoring effect (Furnham & Boo, 2011). The first is the anchoring-and-adjustment process. This approach suggests that people are aware that the anchor does not imply the true value, but they will approach the true value by making adjustments away from the anchor (Epley & Gilovich, 2006). The second mechanism is selective accessibility. This approach suggests that people treat the anchor as a proposed hypothesis and use the information to test whether the anchor is true (Mussweiler & Strack, 1999). Finally, the anchor might affect judgment because it serves as a cue for accurate information (Wegener et al., 2010).

Hence, assessed values affect people's judgment both when people believe the assessment represents the fair market value or not. For example, the assessed value might serve as a lower bound to create a floor for the market price (anchoring-and-adjustment), or potential buyers might require more evidence from the house owners or the real estate if the listing price is too far away from the anchor (selective accessibility). Besides, people may also believe that the assessed value implies the actual market value and adjust their judgment.

Empirical evidence finds a strong anchoring effect on house price valuation. For example, a lab experiment finds that an arbitrary anchor (the phone numbers of the respondents) might affect participants' evaluations of a property value (Scott & Lizieri, 2012). The anchoring effect on house prices has also been found in the real world. For example, Shie (2019) and Bracke & Tenreyro (2021) find that historical sales prices (of the neighborhood or identical houses) would affect real sales values (even when accounting for the house fixed effect). Besides, Chang et al. (2016) also finds that government-announced statistics on average regional land values have an anchoring effect on the willing-to-pay price of potential house buyers.

Few studies have examined the anchoring effect of property assessment. One exception is Cheung et al. (2022), which uses New Zealand data to study the time series relationship between assessed value and house prices. They apply the Granger causality test and conclude that a 1% increase in assessed value leads to a 0.94% rise in housing value. In addition, they find the anchoring effect to be most substantial when the government has just completed a reassessment. However, their empirical strategy only deals with the lead and lag effect between the assessed value and house price but does not account for other endogeneity, such as the macroeconomic environment affecting both variables. Moreover, they do not consider the capitalization effect due to the change in property tax, so their estimation of the anchoring effect might be biased.

This paper expects that the assessed value will positively affect actual market value. Since the countywide reassessment usually raises assessed value for all properties, there would be an overall increase in house value caused by the reassessment. In addition, regions that experience a more substantial change in assessed value should also experience a larger positive effect.

4 Data and Sample

4.1 Data

This paper utilizes county administrative record data on property characteristics, historical assessment, and transaction records.[10] Based on data availability, this study only includes 19 out of 67 counties in Pennsylvania in the analysis.[11] The sample period is from 2005 to 2021. Table 1 demonstrates the counties included in the analysis. The sample consists of 8 counties in the treatment group (having conducted countywide reassessments from 2005 to 2021) and the remaining 11 counties in the control group (having never conducted countywide reassessments in the sample

[10] Some data are publicly available on the county website, while others require purchase or subscription for access to the records.

[11] While most of the counties provide data on the current assessment and the most recent transaction records, few of them provide historical records over a long enough period.

period).

The county property characteristics dataset includes property details such as lot size, year of construction, or garage type, historically assessed values, and property transaction records (date and price). Property tax is imputed using the assessed values, homestead exemption rules, and nominal tax rates.[12]

4.2 Sample

The level of observation in this study is each property transaction. In other words, this paper exclusively includes properties with transaction records because the housing value would remain unobserved for properties not involved in transactions. It's important to note that the same property might appear in the sample multiple times, although it may or may not be present in both the pre- and post-treatment periods. This setup implies that the analysis regarding the impact of property reassessment on assessed value and property tax should not be construed as a reflection of the population's average treatment effect. Instead, the estimates solely represent the treatment effect on properties that have undergone transactions. Additionally, I exclude transactions between two parties with the same last name, trade between government agencies, and transactions with a sales price below $1,000. The rationale for this sample selection is to exclude "non-genuine" transactions.

Table 2 demonstrates the summary statistics of the sample in 2005 (the beginning of the sample period and also the pre-treatment period for all counties). Properties in the treated counties tend to be larger, as denoted by larger living areas and more rooms. They are also more likely to be single-family dwellings, have higher story levels, and are older. Properties in the treated counties also tend to be assessed at lower values, pay less property tax, and have lower sales prices. One notable observation is that while the properties in the treated counties have an average sales price 45% lower than the properties in the control counties, their average assessed value is 62% lower

[12] Though some counties have more complex tax formulas, such as elder citizens tax relief, this paper focuses on "what the property tax should have been" from the perspective of potential buyers rather than the current owner. Hence, using the "calculated tax" might be more suitable than using the "actually paid tax." Some counties also provide data on historical tax payments, which is used to check the differences between calculated and actually paid taxes.

than that of the control counties. This comparison implies that properties in the treated counties are more underestimated than those in the control group.

One concern is that the selected counties included in the analysis might not be generalizable to the whole of Pennsylvania. Table A1 in Appendix A compares the counties included and excluded in this study using the American Community Survey (ACS).[13] The comparison shows no substantial differences between the counties with better or more limited data availability.

5 Empirical Strategy

This paper's primary goal is to identify the causal effect of property reassessment and to decompose the capitalization and anchoring effects. The challenge in decomposing these two effects arises from the fact that property tax is typically a function of assessed value and nominal tax rate, making it difficult to isolate the variation of property tax from assessed value.

To address this challenge, this paper conducts a stagger difference-in-differences (DID) analysis with a dosage variable accounting for within-county variation. Further, this study utilizes the DID as an instrumental variable (IV) to formally decompose the sole impact of assessed value (anchoring effect) and property tax (capitalization effect). The following sections discuss the empirical strategy in detail.

5.1 Stagger DID with a Dosage Variable

This study utilizes both between-county and within-county variation. The between-county variation comes from the context that different counties adopted the countywide property reassessment at different timings, and some of which never adopted the policy (in the sample period). In addition, within the treated counties, property reassessment can produce heterogeneous impacts on different properties within counties. The aim of reassessment is to align assessed values with real market

[13] The ACS data is an annual survey conducted by the Census Bureau, which includes information on self-reported housing values, property tax paid, and property characteristics. This study uses property tax paid divided by the tax rate of the corresponding tax jurisdictions to impute the property assessed value. The main limitation of the ACS data is that the housing value variable is self-reported and does not necessarily imply the actual market value.

prices, and the degree of underestimation of property values varies within a county. Regions with greater underestimation experience a substantial increase in property assessment, while those with lesser underestimation undergo only a mild impact.

To calculate the level of underestimation, I use the average assessment ratio within a census tract, represented by the formulas:

$$\begin{cases} AssessRatio_{ij} = \frac{AssessedValue_{ij}}{MarketValue_{ij}} \\ AvgAssessRatio_j = \frac{\sum_{i=1}^{n_j} AssessRatio_{ij}}{n_j} \end{cases} \tag{1}$$

The assessment ratio ($AssessRatio_{ij}$) of individual houses i in census tract j is the ratio of assessed value to real market value. A ratio of one indicates full alignment between assessed and market value, while a ratio below one signifies property underestimation, with lower ratios indicating more severe underestimation. The average assessment ratio represents the mean of individual assessment ratios at the census tract level, which is logical because county governments rely heavily on transaction records from nearby regions to conduct property assessments.

Appendix Figure A1 illustrates the variation in the level of underestimation in each treated county before policy implementation, highlighting substantial variation. For example, in Blair County, the average assessment ratio at the census tract level ranges from 0.15 to 0.4, while in Perry County, this variation extends from 0.85 to 1.

In addition, this study leverages Pennsylvania's revenue-neutral provision. This provision necessitates counties to simultaneously adopt two policies—property reassessment (directly affecting assessed value and indirectly affecting tax burden) and a reduction in the nominal tax rate (solely impacting tax burden without affecting assessed value). While changes in assessed value can have both anchoring (direct) and capitalization effects (indirect via property tax), changes in the nominal tax rate exclusively result in the capitalization effect.

Combining these two features—(1) both between- and within-county variation and (2) distinct variations in assessment value and property tax—this paper decomposes the capitalization and anchoring effects by examining how the treatment effect varies within a county. The logic of this decomposition is illustrated in Figure 1. Regions with the most substantial underestimation are likely to experience a strong increase in assessed value after countywide reassessment, while regions with less underestimation will experience either no change or a minor increase. The revenue-neutral provision ensures that the average property tax remains constant, but there may be a redistribution of the tax burden within the county. Regions with the strongest increase in assessed value are likely to experience the most significant rise in property tax, while regions with no or minimal changes in assessed value may experience reduced tax payments due to the reduction in nominal tax rates.

Moving to the impact on housing prices, the anchoring effect is directly associated with the change in assessed value. Consequently, regions with the most underestimation will experience the most substantial increase in housing prices. Conversely, the capitalization effect is directly linked to changes in property tax, meaning that regions experiencing the most significant changes in property tax will have the strongest capitalization effect. Since capitalization moves in the opposite direction to tax changes, regions with the most underestimation, witnessing the greatest increase in property tax, will experience the most substantial decrease in housing prices.

The anchoring and capitalization effects act in opposing directions, and their relative strengths determine the pattern of the overall impact on housing prices. If the anchoring effect dominates the capitalization effect, regions with the most underestimation (strongly positive anchoring effect and strongly negative capitalization effect) will experience a more significant increase in total housing prices than regions with less underestimation (weak to null anchoring effect and strongly positive capitalization effect). Conversely, if the capitalization effect dominates the anchoring effect, regions with the most underestimation will experience a drop in total housing prices, while regions with less underestimation might see an increase.

To formally examine the impact of property reassessment, this study incorporates the concept of dosage measurement into a stagger difference-in-differences (DID) framework to examine the policy effect. Specifically, I compare the change in outcomes of interest in the treated and untreated counties in the pre and post-policy period. In addition, I utilize the variation of policy intensity within the treated counties to evaluate the heterogeneity within a county. This paper estimates the following equation:

$$Y_{ijt} = \alpha_0 + \beta_k \sum_{k=1}^{5} Policy_{jt} \times Quantile_{ij}^{k} + X_{ijt} + \theta_j^{*} + \delta_t \times Quantile_{ij} + \varepsilon_{ijt} \tag{2}$$

In this equation, Y_{ijt} represents the outcomes of house i in county j at time t. The first-stage outcomes include the log assessed values and the log property tax. The final outcome of interest is log housing prices. $Policy_{jt}$ is a dummy variable indicating whether the policy has been implemented in county j at time t, remaining as one after the policy is implemented. It denotes the combined effect of property reassessment and nominal tax rate reduction. $Quantile_{ij}^{k}$ is a series of dummy variables indicating the level of underestimation in the pre-treatment period. I define quantiles based on the average assessment ratio at the census tract level (as estimated from equation [1]), grouping properties into five quantiles. The first quantile represents the regions with the highest assessment ratio, i.e., the least underestimated, while the fifth quantile represents the regions with the lowest assessment ratio, i.e., the most underestimated. X_{ijt} is a vector of house characteristics, including log living area, number of rooms, bedrooms, full baths, half baths, land usage type, dwelling type, story of the house, basement type, and age of the property. θ_j^{*} represents geographical region fixed effects, accounting for county-by-municipality-by-school district fixed effects to better consider the geographical factor. δ_t represents time fixed effects, including year-by-month fixed effects, interacted with the quantile variable for comparison between properties in treated counties and control counties with the same level of underestimation. ε_{ijt} is the error term.

The key parameters are β_k, which denote the impact of the policy change in regions of each quantile of underestimation. When the outcome is assessed value, a higher quantile (more underestimated regions) should experience a stronger increase than the lower quantile. When the outcome is property tax, the highest quantile (most underestimated regions) should experience the largest increase, while the lowest quantile (least underestimated regions) might experience a decrease. The pattern of the impact on housing prices is unknown and would be determined by the competition between anchoring and capitalization effects.

The identification assumption of the DID framework is that the houses in the treated and untreated counties would have shared the same trend in the outcomes of interest in the absence of the policy. Figure 2 demonstrates the existence of the common trend in the treated and untreated counties prior to the reassessment. Also, as the specification includes a dosage variable, the assumption is that houses with different levels of dosage (various levels of pre-treatment assessment ratio) would also have shared the same trend. Figure 3 reassures this assumption by demonstrating the common trends across regions with different dosages prior to the policy.

5.2 Two-stage Least Squares Estimation

The preceding section provided the conceptual framework for decomposing the anchoring and capitalization effects. To formally estimate the magnitudes of these effects, this paper utilizes the Two-stage Least Squares (2SLS) approach. The instrumental variables (IVs) employed here are $Policy_{jt} \times Quantile^k_{ij}$, which serve as IVs to estimate the impact of assessed value and property tax on housing prices. The estimation process involves two stages. First, equation (2) is used to predict log assessed values and log property taxes. Subsequently, these predicted values are utilized in the following equation:

$$\begin{aligned} \ln(HousePrice_{ijt}) = \alpha_0 + \gamma_1 \ln(\widehat{PropertyTax}) + \gamma_2 \ln(\widehat{AssessedValue}) \\ + X_{ijt} + \theta^*_j + \delta_t \times Quantile_{ij} + \varepsilon_{ijt} \end{aligned} \tag{3}$$

Here, $\ln(\widehat{AssessedValue})$ and $\ln(\widehat{PropertyTax})$ are the predicted values derived from equation (2). The key parameters of interest are γ_1 and γ_2. Specifically, γ_1 represents the causal impact of property tax on house prices when the assessed value is held constant, while γ_2 signifies the causal impact of assessed value on house prices when property tax remains fixed.

This equation is over-identified, featuring two endogenous variables ($AssessedValue$ and $PropertyTax$) and five instrumental variables ($Policy_{jt} \times Quantile^k_{ij}$). A crucial concern lies in whether the instrumental variables offer enough independent variations for the two endogenous variables. As depicted in Figure 1, policy impacts on assessed value and property tax exhibit different patterns of within-county variation. While the change in assessed value is generally positive but varies across regions, the change in property tax may either be positive or negative, depending on the region. This pattern generates independent and distinct impacts on the changes in assessed value and property tax, aiding in the isolation of variations for instrumental variable analysis.

6 Empirical Results

6.1 Graphical Evidence

Figure 2 illustrates the trend in outcomes of interest in both treated and control counties over time. Following policy implementation, the treated counties witnessed a substantial surge in assessed value (refer to Figure 2a). On average, assessed values increased by roughly 200%, resulting in values that were triple their original levels. This pattern aligns with the trend observed where the pre-treatment assessment ratio was only one-third. Conversely, there is no significant difference in average property tax between the treated and control counties (refer to Figure 2b), at least in the first couple of years after the policy implementation. This trend aligns with the revenue-neutral provision. Furthermore, the treated counties experienced a slight increase in housing prices, approximately between 5% to 10%, compared to control counties (see Figure 2c). This pattern persists over time.

Figure 3 shifts the focus to within-county variation. The left panel presents the results for treated counties. The most underestimated region (solid line) experienced a more pronounced increase in assessed value than the least underestimated region (dotted line) (see Figure 3a). This pattern of change in assessed value then influences the change in property tax. The most underestimated region (solid line) experienced the most significant increase in property tax, while the least underestimated region (dotted line) saw a decrease (see Figure 3c). Since counties conducting reassessments simultaneously reduce the nominal tax rate, regions with modest increases in assessed value may experience a decrease in their property tax. Figure 3e demonstrates the change in housing prices, with the most underestimated region (solid line) experiencing a more substantial increase in housing prices compared to the least underestimated region (dotted line).

A potential concern is that the heterogeneous effects within counties might be driven by different time trends associated with the pre-treatment underestimation levels. The right panel of Figure 3 addresses this concern by examining the patterns in control counties. The results suggest that there are no heterogeneous time trends over time regarding the change in assessed value and property tax (see Figure 3b and Figure 3d). For housing values, the most underestimated regions experienced a slight decrease in housing values compared to the least underestimated regions (see Figure 3f). The trends in the control group serve as a counterfactual for the variation in regions with different underestimation levels in the absence of the policy. This pattern suggests that the increase in housing values in the most underestimated regions in the treated counties is not driven by these properties having faster growth rates that are not triggered by the policy.

6.2 DID Results

Table 3 presents the estimates of the policy impact on the outcomes of interest using equation (2). In Panel A, I examine the impact on the log assessed value. I gradually introduced different sets of covariates to test for robustness. The preferred specification in column (4), which includes all covariates, suggests that property reassessment leads to a significant increase in assessed value. Specifically, it results in a 164% increase in the bottom quantile (least underestimated) regions and a substantial 227% increase in the top quantile (most underestimated) regions. The magnitude of the treatment effect increases as the level of underestimation rises. These estimations remain robust across various specifications.

In column (5), we substitute $Policy \times Q_1$ with $Policy$. In this setting, the coefficient of $Policy$ represents the baseline policy impact in the least underestimated regions, while the remaining coefficients on $Policy \times Q_k$ examine the difference in the treatment effect in regions at other quantiles compared to the bottom quantile. The estimation reveals that all differences are statistically significant, except for the second quantile. Column (6) eliminates the interaction terms between $Policy$ and quantile dummies, focusing solely on estimating the overall policy impact. Consistent with the findings in Figure 2a, the policy increases assessed value by approximately 200%.

Moving to Panel B of Table 3, I estimate the impact on property tax. The results in column (4) show that the policy, a combination of reassessment and a reduction in the nominal tax rate, reduces property taxes in the least underestimated regions (bottom quantile) while raising the tax burden in the most underestimated regions (top quantile). Column (5) highlights statistically significant heterogeneous effects within-county. Column (6) reports an overall positive impact of the policy, with tax payments increasing by 26% after the policy implementation. Notably, as seen in Figure 2b, this pattern is more driven by changes occurring later, not immediately following the policy. Furthermore, it's worth noting that the sample includes properties sold on the market, not the entire population, suggesting that the pattern could be driven by that properties with increased property taxes may be more likely to be sold (possibly because homeowners cannot afford the tax).

In Panel C, I examine the impact on housing prices. Column (4) reveals that the policy leads to a decrease in housing prices in the least underestimated regions (bottom quantile) and an increase in other higher quantiles (more underestimated) regions. The impact on housing prices increases as we move to higher quantiles. Specifically, while the third quantile experiences a 9% increase in the housing price, the top quantile shows a 35% increase in housing price. Column (5) demonstrates statistically significant heterogeneous impacts, except for the second quantile. Column (6) indicates that, overall, the policy increases housing prices in the treated counties by 9%.

In summary, the impacts on assessed value and property tax align with the theoretical framework presented in Figure 1. The evaluation of heterogeneous impacts on housing prices shows a stronger positive impact in more underestimated regions, consistent with the scenario where the anchoring effect dominates the capitalization effect.

This paper also delves into the equity implications of the policy outcomes. The observed pattern indicates that regions characterized by underestimation experience the most substantial increase in housing prices. Given that these regions often tend to be high-priced areas, this outcome suggests that the policy could exacerbate disparities in housing values between high- and low-priced regions. To formally test this relationship, we refer to Table A2 in Appendix A, which replaces the quantile denoting underestimation level with pre-treatment housing price levels. The results indicate that the top quantile (the most affluent regions) experiences a notable 17% increase in housing values. In contrast, the middle quantile sees a more modest 10% increase, while the bottom quantile (the least affluent regions) shows a statistically insignificant 8% decrease in housing prices. The variations in these heterogeneous effects are statistically significant.

6.3 2SLS Results

Table 4 formally examines the separate impacts of assessed value and property tax using equation (3), with equation (2) as the first stage. I incrementally include different sets of covariates to test for robustness. The preferred specification in column (4) suggests that a 100% increase in assessed value leads to a 4.6% increase in housing prices, holding property tax constant. This estimation aligns with the results that the policy increases assessed value by 200% and leads to an overall increase in housing values by 9%. Furthermore, a 100% increase in property tax results in a 2.9% decrease in housing prices, holding the assessed value constant. This decomposition is consistent with the implications in the previous section, which suggest that the anchoring effect dominates the capitalization effect.

The estimation of the impact of assessed value is statistically significant, but the estimation of the impact of property tax is not significant. However, the estimates remain fairly robust across different specifications. The lack of significance in the property tax impact could be attributed to the 2SLS estimation not having enough independent variation of property tax that is isolated from the assessed value.

6.4 Robustness Checks

One concern with conventional DID involving staggered treatment timing is the potential for biased estimates when there are heterogeneous and dynamic effects across treated units and timing (Baker et al., 2022). To address this issue, the study conducts a robustness check by estimating the treatment effect for each treated cohort separately. In each estimation, the treatment group is compared only to the never-treated group without including early or later-treated groups as controls. Subsequently, the estimates from multiple cohorts are aggregated and weighted by the number of observations in each cohort. Standard errors are obtained using a bootstrapping method. Specifically, the process involves resampling observations with replacement within the census tract cluster and repeating the analysis 1,000 times. Table A3 in Appendix A reports the results of this practice. The estimates are quite consistent with the main results.

To decompose different mechanisms, this paper combines the DID with 2SLS to examine the separated impacts of property tax and assessed value. The assumption of using a DID estimator as an IV first-stage is that the policy would only affect the house price via the change in property tax burden and assessed value (exclusion restriction). One potential violation of the assumption is that the policy may change local spending. Though the specific revenue-neutral provision in Pennsylvania requires the tax jurisdiction to keep the tax revenue at the same level after the reassessment, the government could still vote to raise the tax rate after the policy. This paper examines the validity of the assumption by examining the effect of policy reform on local revenue and spending. Table A4 reports that the policy has no significant effect on revenue and spending at the county, municipality, and school district levels.

Another concern is that the change in property tax burden might affect the supply and demand in the real estate markets. Hence, the change in house price might be confounded by the composition effect rather than entirely driven by capitalization and anchoring effects. This paper examines the concern by evaluating the impact of policy on the likelihood of transactions. Table A5 estimates the change in the number of property transactions in each census tract after the policy implementation. The results suggest that property reassessment does not change the number of transactions in the treated county, and the change in transactions is also not associated with the pre-treatment underestimation level or housing price.

7 Discussion and Conclusion

This paper examines the impact of property reassessment on housing prices in the context of Pennsylvania. Utilizing administrative data on property assessment and transactions, this study tracks samples over a 17-year period, conducting comprehensive analyses to assess the effects of property reassessment. Employing a DID approach, considering both between- and within-county variations and complemented by a 2SLS model, this paper further dissects the mechanisms underlying anchoring and capitalization effects.

This paper unveils three pivotal findings. Firstly, the policy of property reassessment in Pennsylvania has made a significant impact on aligning assessed values with actual market prices, leading to an enhancement of equity in property taxation. Notably, reassessment has resulted in the most substantial increase in assessed values in regions that were initially most underestimated. In contrast, the least underestimated regions have experienced relatively mild increases in assessed values. Consequently, property reassessment significantly corrects the regressivity of property tax by redistributing the tax burden from the least underestimated regions to the most underestimated ones.

Secondly, the impact of this policy has extended to housing prices, particularly concerning the degree of underestimation in different regions. Notably, the policy has significantly boosted housing prices in the most underestimated regions (the top quantile, typically wealthier areas) by 35%. Conversely, the least underestimated regions (the bottom quantile) experienced a minor decline in housing prices, around 9%. These effects have consistently grown stronger as the level of underestimation increased, highlighting the dominance of anchoring effects over capitalization effects.

Finally, the 2SLS results reinforce these findings. Specifically, a 100% increase in assessed value leads to a 4.6% increase in housing prices, holding property tax constant. This is consistent with the observed 200% increase in assessed value and an overall increase in housing values by 9%. In contrast, a 100% increase in property tax results in a 2.9% decrease in housing prices, reinforcing the dominance of anchoring effects over capitalization effects. The estimation aligns with the theory expectations, with a positive anchoring effect and negative capitalization effect. Furthermore, the anchoring effect (impact of assessed value itself) is more pronounced than the capitalization effect (impact of property tax itself when holding assessed value constant).

These results not only illustrate the impact of property reassessment but also underscore its implications for equity in the housing market. Regions characterized by previous underestimations have witnessed the most substantial increases in housing prices. Since these areas typically comprise higher-priced regions, the policy has inadvertently exacerbated disparities in housing values between high- and low-priced regions. The evidence indicates a significant 17% increase in housing values in the most affluent regions (top quantile), compared to a less pronounced 10% increase in the middle quantile. In contrast, the least affluent regions (bottom quantile) experienced a statistically insignificant 8% decrease in housing prices. Overall, the results suggest that while property reassessment improves tax equity, it unintentionally widens wealth inequality by bestowing house owners of high-priced housing with more significant capital gains and by broadening the gap in housing prices across different regions.

While these findings shed light on the consequences of property reassessment in Pennsylvania, there are important considerations and limitations to acknowledge. The specific context of Pennsylvania, characterized by infrequent property reassessments, may differ significantly from other jurisdictions with more regular reassessment practices. Therefore, the generalizability of these findings should be approached with caution.

In conclusion, this study provides valuable insights into the impact of property reassessment on housing prices and tax equity. The evidence suggests that while property reassessment is effective in bringing property values in line with market prices, it can inadvertently exacerbate wealth inequalities by driving up housing prices in high-priced regions. The policy's implications extend beyond tax equity, affecting housing values across various regions. While the findings may be context-specific, they offer a nuanced perspective on the consequences of property reassessment for policymakers and researchers.

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Table

Table 1: List of Counties and Year of Countywide Reassessment

Treatment Group		Control Group	
County	Reform Year	County	
Blair County	2017	Bucks County	Susquehanna County
Erie County	2013	Cumberland County	Venango County
Indiana County	2016	Fulton County	Wyoming County
Lebanon County	2013	Lancaster County	
Luzerne County	2009	Lawrence County	
Perry County	2011	Lycoming County	
Philadelphia County	2014	Montgomery County	
York County	2006	Pike County	

Note: The treatment group is those counties that conducted countywide reassessment from 2005 to 2021. The control group is those counties that never conducted countywide reassessment from 2005 to 2021 (but might conduct reassessment before 2005 or after 2021).

Table 2: Summary Statistics in 2005

	Treatment Group	Control Group	Difference
Living area (square foot)	1.809	1.392	0.417***
	(8.370)	(1.577)	[0.034]
Number of total rooms	4.800	4.054	0.746***
	(3.161)	(3.782)	[0.022]
Number of bedrooms	2.433	2.373	0.060***
	(1.383)	(1.489)	[0.009]
Number of full baths	1.081	1.360	-0.279***
	(0.794)	(0.947)	[0.006]
Number of half baths	0.183	0.471	-0.288***
	(0.412)	(0.555)	[0.003]
Land usage type			
Residential	0.888	0.871	0.017***
	(0.315)	(0.335)	[0.002]
Commercial	0.054	0.042	0.012***
	(0.225)	(0.201)	[0.001]
Industrial	0.007	0.004	0.003***
	(0.081)	(0.062)	[0.000]
Agriculture	0.008	0.008	0.000
	(0.091)	(0.091)	[0.001]
Vacant Land	0.040	0.026	0.014***
	(0.196)	(0.161)	[0.001]
Dwelling type			
Single-family	0.675	0.572	0.103***
	(0.468)	(0.495)	[0.003]
Duplex or multi-family	0.177	0.190	-0.013***
	(0.381)	(0.393)	[0.002]
Condo or apartment	0.011	0.059	-0.048***
	(0.105)	(0.235)	[0.001]
Manufactured	0.007	0.006	0.001**
	(0.086)	(0.078)	[0.001]
Story			
One level	0.139	0.251	-0.112***
	(0.346)	(0.433)	[0.002]
One and half levels	0.033	0.059	-0.026***
	(0.179)	(0.236)	[0.001]
Two or more levels	0.649	0.530	0.119***
	(0.477)	(0.499)	[0.003]
Basement			
No basement	0.269	0.336	-0.067***
	(0.443)	(0.472)	[0.003]
Full basement	0.528	0.563	-0.035***
	(0.499)	(0.496)	[0.003]
Part basement	0.173	0.067	0.106***
	(0.378)	(0.250)	[0.002]
Age of property	61.236	41.046	20.190***
	(34.852)	(37.769)	[0.227]
Assessed value	43.618	116.727	-73.109***
	(176.170)	(427.225)	[2.155]
Property tax	3.723	4.292	-0.569***
	(27.698)	(29.678)	[0.179]
Sales price	165.987	294.539	-128.552***
	(666.034)	(976.810)	[5.355]
Number of counties	8	11	
Number of observations in 2005	63,799	43,916	
Number of observations in sample period	882,148	663,059	

Note: This table reports the summary statistics in 2005 (pre-treatment period). The treatment group is those counties that conducted countywide reassessment from 2005 to 2021. The control group is those counties that never conducted countywide reassessment from 2005 to 2021. Standard deviation in parentheses. Standard error in squared brackets.
$*p < 0.1, **p < 0.05, ***p < 0.01$

Table 3: Impact of Property Reassessment on Assessed Value, Property Tax, and Housing Price

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Log Assessed Value						
$Policy$					1.644***	1.902***
					(0.062)	(0.039)
$Policy \times Q_1$	1.619***	1.617***	1.653***	1.644***		
	(0.067)	(0.067)	(0.065)	(0.062)		
$Policy \times Q_2$	1.612***	1.611***	1.694***	1.667***	0.023	
	(0.066)	(0.066)	(0.065)	(0.061)	(0.074)	
$Policy \times Q_3$	1.916***	1.915***	1.911***	1.933***	0.289***	
	(0.061)	(0.060)	(0.057)	(0.057)	(0.080)	
$Policy \times Q_4$	2.038***	2.036***	1.991***	2.021***	0.376***	
	(0.061)	(0.061)	(0.058)	(0.055)	(0.074)	
$Policy \times Q_5$	2.322***	2.320***	2.281***	2.273***	0.629***	
	(0.076)	(0.076)	(0.074)	(0.069)	(0.086)	
F Statistics	503.180	502.573	498.088	503.174	503.174	2,352.59
Panel B: Log Property Tax						
$Policy$					-0.031	0.263***
					(0.081)	(0.035)
$Policy \times Q_1$	-0.092	-0.090	-0.030	-0.031		
	(0.091)	(0.090)	(0.092)	(0.081)		
$Policy \times Q_2$	-0.029	-0.028	0.079**	0.045	0.076	
	(0.041)	(0.041)	(0.036)	(0.040)	(0.078)	
$Policy \times Q_3$	0.239***	0.240***	0.254***	0.281***	0.312***	
	(0.043)	(0.043)	(0.039)	(0.046)	(0.088)	
$Policy \times Q_4$	0.412***	0.413***	0.380***	0.402***	0.433***	
	(0.035)	(0.035)	(0.032)	(0.035)	(0.080)	
$Policy \times Q_5$	0.666***	0.667***	0.647***	0.646***	0.677***	
	(0.053)	(0.053)	(0.047)	(0.051)	(0.089)	
F Statistics	52.974	53.112	57.066	49.580	49.580	57.763
Panel C: Log Housing Price						
$Policy$					-0.123***	0.090***
					(0.043)	(0.015)
$Policy \times Q_1$	-0.036	-0.034	-0.041	-0.123***		
	(0.043)	(0.043)	(0.035)	(0.043)		
$Policy \times Q_2$	-0.008	-0.007	0.009	-0.047	0.076	
	(0.047)	(0.047)	(0.040)	(0.044)	(0.063)	
$Policy \times Q_3$	0.104***	0.104***	0.077***	0.093**	0.216***	
	(0.037)	(0.037)	(0.029)	(0.037)	(0.065)	
$Policy \times Q_4$	0.183***	0.183***	0.130***	0.194***	0.317***	
	(0.034)	(0.034)	(0.028)	(0.031)	(0.056)	
$Policy \times Q_5$	0.330***	0.330***	0.275***	0.353***	0.476***	
	(0.042)	(0.042)	(0.035)	(0.041)	(0.064)	
F Statistics	17.053	17.106	15.115	20.956	20.956	34.594
Observations			1,545,207			
Geographical Region FE	√	√	√	√	√	√
Year FE	√	√	√	√	√	√
Year-by-Month FE		√	√	√	√	√
Property Covariates			√	√	√	√
Year-by-Month-by-Dosage FE				√	√	√

Note: This table reports the estimated coefficients $Policy \times Quantile_k$ from equation (2). The $Quantile$ denotes the level of underestimation in the pre-treatment period. Q_1 denotes the least underestimated regions, while Q_5 denotes the most underestimated regions. The outcomes of interest are log assessed value in Panel A, log property tax in Panel B, and log housing price in Panel C. Column (1) includes geographical region fixed effect (county-by-municipality-by-school district fixed effect) and year fixed effect. Column (2) includes year-by-month fixed effect. Column (3) includes property covariates, containing log living areas, numbers of rooms, bedrooms, full baths, and half baths, land usage type, dwelling type, story of the house, basement type, and age of the property. Column (4) includes year-by-month-by-dosage (quantile denotes underestimation level at census tract level). Column (5) substitutes $Policy \times Q_1$ with $Policy$ to capture the baseline. Column (6) examines the total treatment effect without considering within-county variation. Standard errors clustered at the census tract level are reported in parentheses. $*p < 0.1, **p < 0.05, ***p < 0.01$

Table 4: Impact of Assessed Value and Property Tax on Housing Price: 2SLS Results

	(1)	(2)	(3)	(4)
	Outcomes Variable: ln(Housing Price)			
ln(Assessed Value)	0.054***	0.055***	0.049***	0.046***
	(0.014)	(0.014)	(0.016)	(0.016)
ln(Property Tax)	-0.029	-0.031	-0.053	-0.029
	(0.099)	(0.099)	(0.102)	(0.109)
Observations	1,545,207			
Geographical Region FE	√	√	√	√
Year FE	√	√	√	√
Year-by-Month FE		√	√	√
Property Covariates			√	√
Year-by-Month-by-Dosage FE				√

Note: This table reports the estimated coefficients ln($Assessed\,Value$) and ln($Property\,Tax$) from equation (3) with equation (2) as the first stage. The outcomes of interest is log housing price. Column (1) includes geographical region fixed effect (county-by-municipality-by-school district fixed effect) and year fixed effect. Column (2) includes year-by-month fixed effect. Column (3) includes property covariates, containing log living areas, numbers of rooms, bedrooms, full baths, and half baths, land usage type, dwelling type, story of the house, basement type, and age of the property. Column (4) includes year-by-month-by-dosage (quantile denotes underestimation level at census tract level). Column (5) substitutes $Policy \times Q_1$ with $Policy$ to capture the baseline. Column (6) examines the total treatment effect without considering within-county variation. Standard errors clustered at the census tract level are reported in parentheses.
$*p < 0.1, **p < 0.05, ***p < 0.01$

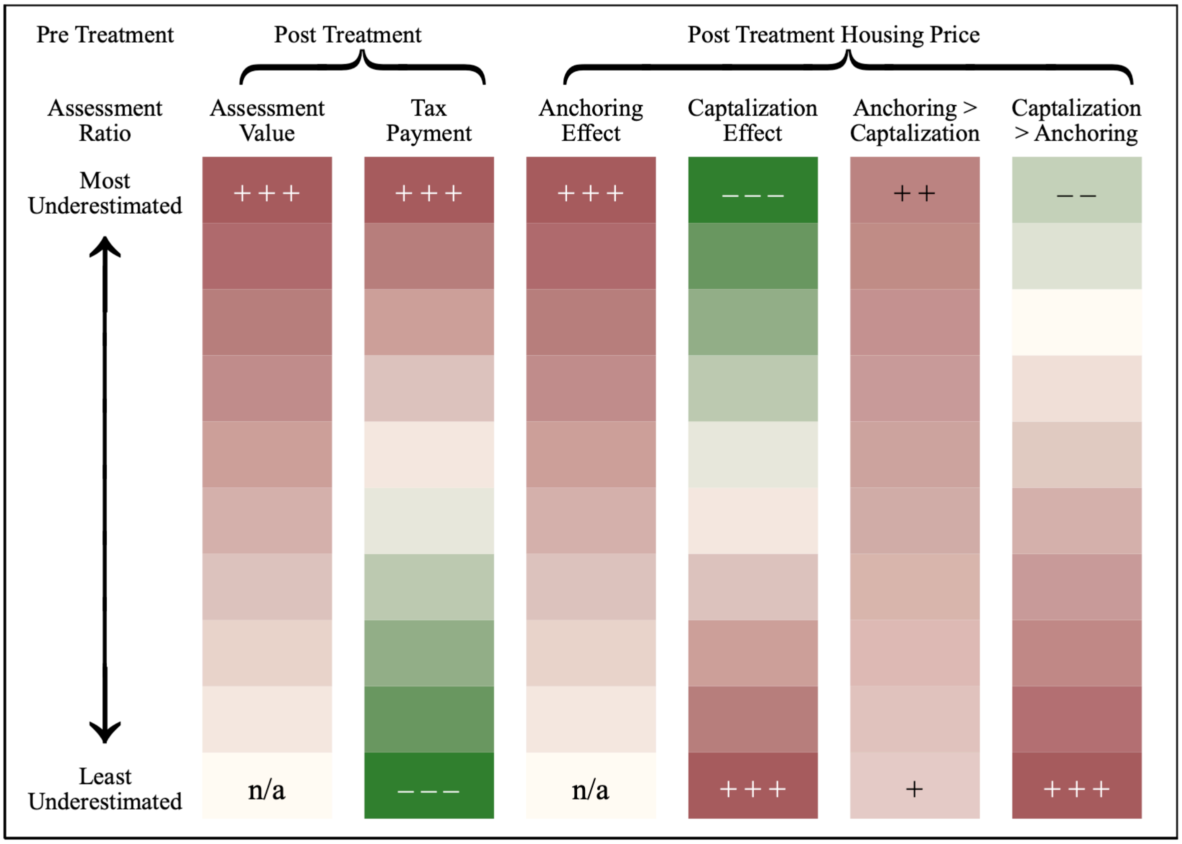
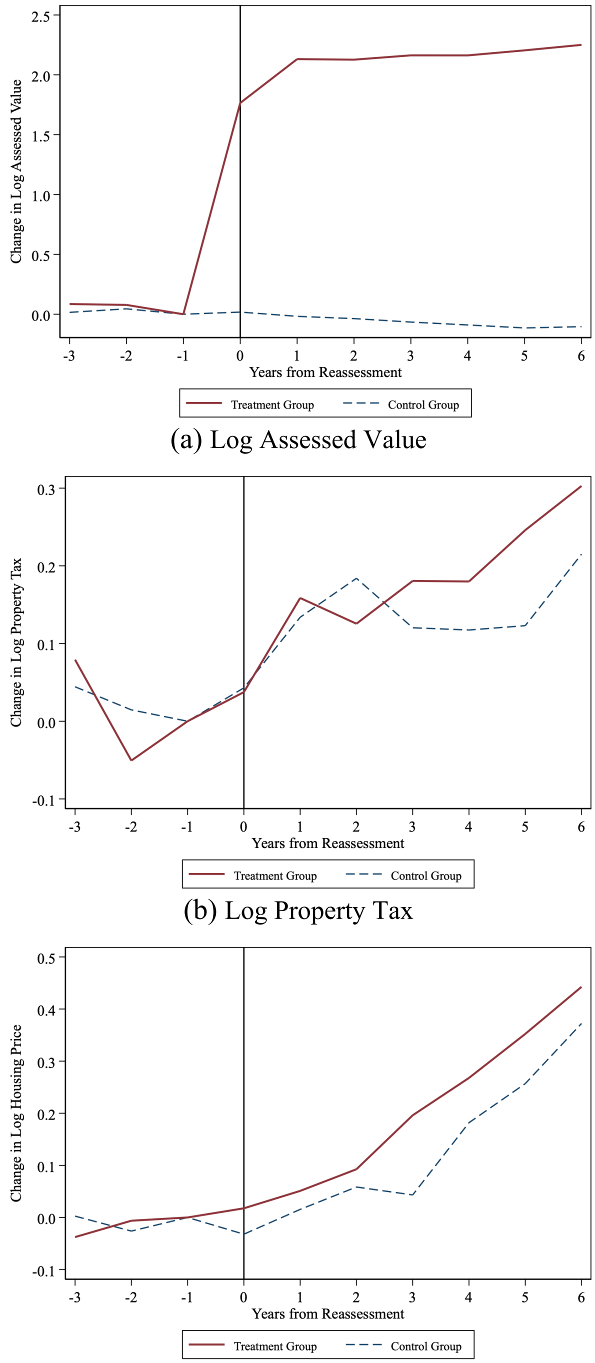


Figure 1: Logic to Decompose Capitalization and Anchoring Effect



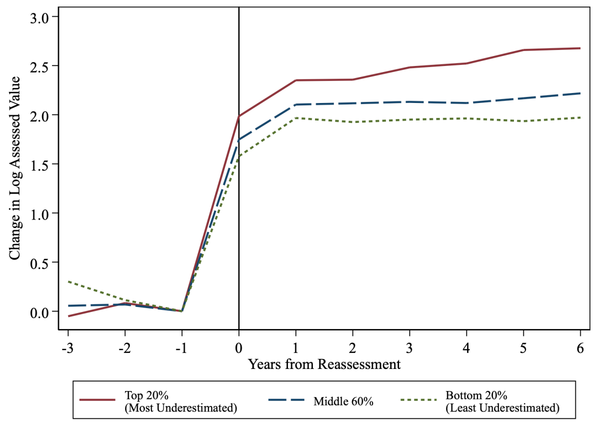
(a) Log Assessed Value

(b) Log Property Tax

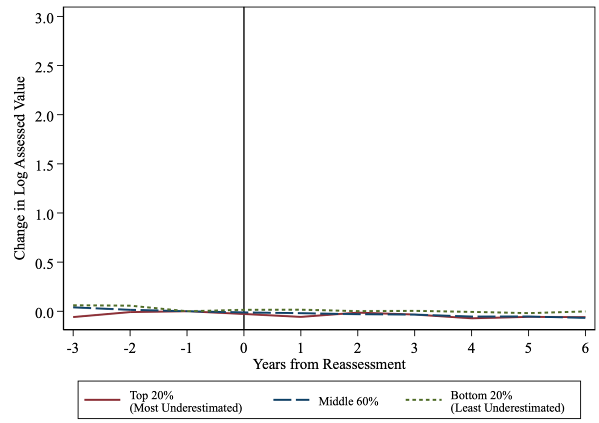
(c) Log Housing Price

Figure 2: Trend in Assessed Value, Property Tax, and Housing Price

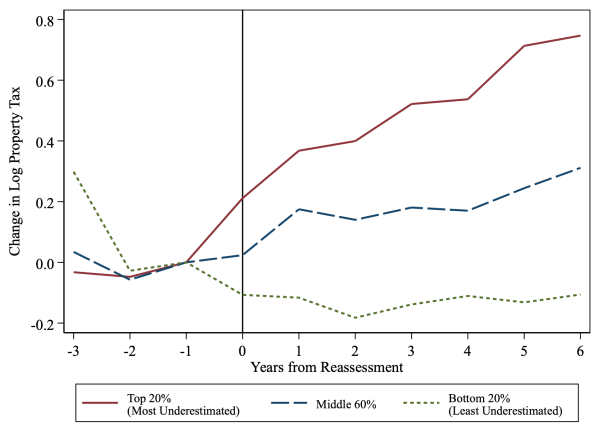
Note: This figure shows the trend in log assessed value (Figure 2a), log property tax (Figure 2b), and log housing price (Figure 2c), compared to the year prior to the county-wide property reassessment. I randomly assigned a pseudo reassessment year to each control county. The red solid line denotes the treated county, and the blue dashed denotes the control counties.



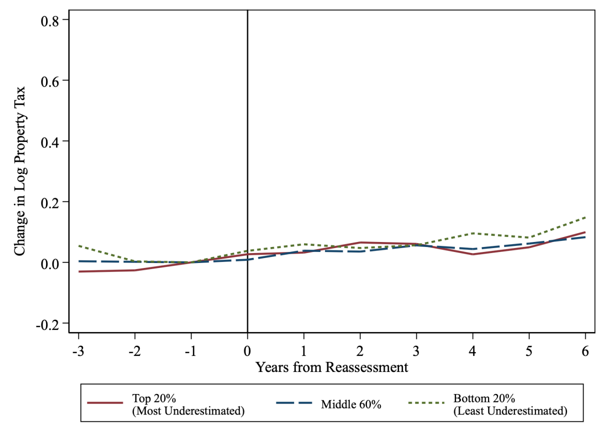
(a) Treatment; Log Assessed Value



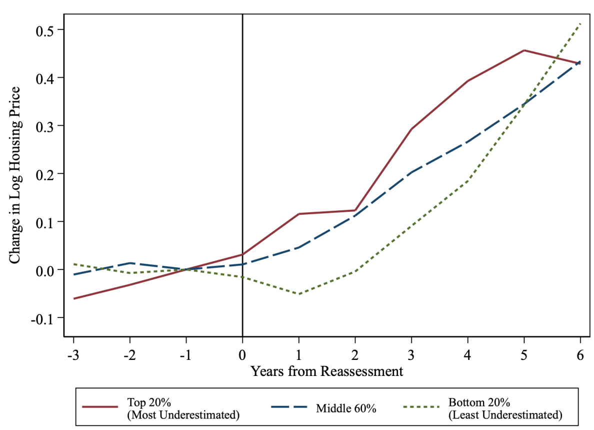
(b) Control; Log Assessed Value



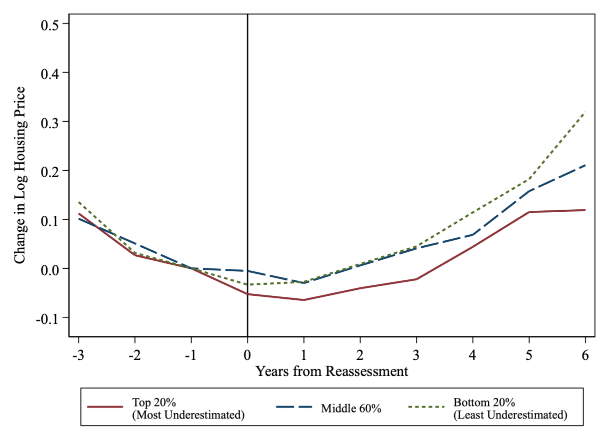
(c) Treatment; Log Property Tax



(d) Control; Log Property Tax



(e) Treatment; Log Housing Price



(f) Control; Log Housing Price

Figure 3: Trend in Assessed Value, Property Tax, and Housing Price by Pre-treatment Underestimation Levle

Note: This figure shows the trend in log assessed value (top panel), log property tax (middle panel), and log housing price (bottom panel) compared to the year prior to the county-wide property reassessment by the level of underestimation prior to the reassessment. The left panel shows the results in the treated counties and the right panel shows the results in the control counties. I randomly assigned a pseudo reassessment year to each control county. The red solid line denotes the quantile with the lowest pre-treatment assessment ratio (most underestimated), the green dotted line denotes the quantile with the highest pre-treatment assessment ratio (least underestimated), and the blue dashed denotes the remaining middle quantile.

A Appendix

Table A1: Summary Statistics from American Community Survey (ACS) in 2005

	Sample Counties		Out of Sample	
	Treatment	Control	Treatment	Control
Property Characteristics				
Lot size (square foot)	59.903	64.408	62.762	64.477
	(26.835)	(28.370)	(27.378)	(29.173)
Number of total rooms	6.416	6.498	6.529	6.412
	(1.480)	(1.540)	(1.528)	(1.520)
Number of bedrooms	3.000	3.055	3.052	2.997
	(0.691)	(0.722)	(0.723)	(0.716)
Dwelling type				
Single-family detached	0.774	0.843	0.842	0.851
	(0.419)	(0.364)	(0.365)	(0.356)
Single-family attached	0.131	0.065	0.078	0.051
	(0.337)	(0.246)	(0.269)	(0.221)
Mobile	0.077	0.075	0.064	0.083
	(0.267)	(0.263)	(0.245)	(0.276)
Apartment	0.019	0.017	0.016	0.015
	(0.136)	(0.131)	(0.125)	(0.122)
Age of property	41.984	38.797	40.469	44.199
	(23.210)	(23.049)	(22.942)	(23.288)
Imputed assessed value†	45.866	65.869	46.605	35.829
	(58.066)	(68.373)	(57.634)	(42.209)
Property tax	1.776	2.156	2.129	1.661
	(1.254)	(1.652)	(1.725)	(1.336)
Self-reported value	136.107	180.692	159.483	124.426
	(105.690)	(160.507)	(137.179)	(123.024)
Household Characteristics				
Household income	60.113	64.285	61.649	56.267
	(52.102)	(57.723)	(55.380)	(50.596)
Household size	2.554	2.604	2.561	2.517
	(1.334)	(1.383)	(1.350)	(1.331)
Workers in family	1.580	1.567	1.567	1.525
	(0.915)	(0.914)	(0.919)	(0.922)
County Characteristics				
Population	319.985	128.274	348.155	139.553
	(423.998)	(130.844)	(439.327)	(184.800)
Number of parcels	141.718	70.506	148.879	64.335
	(191.462)	(56.801)	(159.659)	(62.894)
Nominal property tax rate	113.415	48.921	74.745	63.127
	(110.126)	(42.835)	(42.725)	(32.751)
Number of counties	8	11	11	37
Number of observations	26,989	33,130	33,005	112,187

Note: This table reports the summary statistics in 2005 using the American Community Survey (ACS) data. The treatment group is those counties that conducted countywide reassessment from 2005 to 2021. The control group is those counties that never conducted countywide reassessment from 2005 to 2021 (but might conduct reassessment before 2005 or after 2021). Standard deviation in parentheses.

† The imputed assessed values are calculated by dividing property tax payment by the nominal tax rate.

Table A2: Impact of Property Reassessment by Pre-treatment Housing Price Quantile

	(1)	(2)	(3)	(4)	(5)
Panel A: Log Assessed Value					
$Policy$					1.656***
					(0.064)
$Policy \times Q_1$	1.692***	1.690***	1.731***	1.656***	
	(0.067)	(0.067)	(0.068)	(0.064)	
$Policy \times Q_2$	1.761***	1.759***	1.827***	1.808***	0.153*
	(0.075)	(0.075)	(0.077)	(0.068)	(0.081)
$Policy \times Q_3$	1.953***	1.952***	1.957***	1.962***	0.306***
	(0.064)	(0.064)	(0.065)	(0.060)	(0.080)
$Policy \times Q_4$	2.032***	2.031***	2.020***	2.051***	0.395***
	(0.073)	(0.073)	(0.069)	(0.065)	(0.085)
$Policy \times Q_5$	2.026***	2.024***	1.948***	2.007***	0.351***
	(0.066)	(0.066)	(0.064)	(0.063)	(0.084)
F Statistics	463.241	462.786	463.407	462.867	462.867
Panel B: Log Property Tax					
$Policy$					0.063
					(0.052)
$Policy \times Q_1$	0.103**	0.105**	0.177***	0.063	
	(0.051)	(0.051)	(0.050)	(0.052)	
$Policy \times Q_2$	0.059	0.060	0.154	0.155*	0.092
	(0.097)	(0.096)	(0.101)	(0.086)	(0.087)
$Policy \times Q_3$	0.280***	0.281***	0.300***	0.308***	0.245***
	(0.040)	(0.040)	(0.040)	(0.042)	(0.062)
$Policy \times Q_4$	0.332***	0.334***	0.334***	0.404***	0.341***
	(0.050)	(0.049)	(0.046)	(0.048)	(0.067)
$Policy \times Q_5$	0.379***	0.380***	0.320***	0.361***	0.298***
	(0.043)	(0.043)	(0.041)	(0.049)	(0.068)
F Statistics	27.044	27.207	26.892	25.465	25.465
Panel C: Log Housing Price					
$Policy$					-0.077
					(0.052)
$Policy \times Q_1$	0.065	0.066	0.016	-0.077	
	(0.052)	(0.052)	(0.048)	(0.052)	
$Policy \times Q_2$	0.097**	0.099**	0.065	0.035	0.112*
	(0.048)	(0.048)	(0.044)	(0.042)	(0.067)
$Policy \times Q_3$	0.085**	0.086**	0.087***	0.097***	0.174***
	(0.033)	(0.033)	(0.029)	(0.034)	(0.066)
$Policy \times Q_4$	0.157***	0.157***	0.145***	0.189***	0.266***
	(0.032)	(0.032)	(0.027)	(0.032)	(0.065)
$Policy \times Q_5$	0.159***	0.159***	0.101***	0.167***	0.244***
	(0.037)	(0.037)	(0.030)	(0.037)	(0.070)
F Statistics	10.932	10.980	9.723	12.594	12.594
Observations			1,545,207		
Geographical Region FE	√	√	√	√	√
Year FE	√	√	√	√	√
Year-by-Month FE		√	√	√	√
Property Covariates			√	√	√
Year-by-Month-by-Dosage FE				√	√

Note: This table reports the estimated coefficients $Policy \times Quantile_k$ from equation (2). However, the analysis changes the construction of $Quantile$ to denote the housing price level in the pre-treatment period. Q_1 denotes the least affluent regions, while Q_5 denotes the most affluent regions. The outcomes of interest are log assessed value in Panel A, log property tax in Panel B, and log housing price in Panel C. Column (1) includes geographical region fixed effect (county-by-municipality-by-school district fixed effect) and year fixed effect. Column (2) includes year-by-month fixed effect. Column (3) includes property covariates, containing log living areas, numbers of rooms, bedrooms, full baths, and half baths, land usage type, dwelling type, story of the house, basement type, and age of the property. Column (4) includes year-by-month-by-dosage (quantile denotes pre-treatment housing price tier at census tract level). Column (5) substitutes $Policy \times Q_1$ with $Policy$ to capture the baseline. Column (6) examines the total treatment effect without considering within-county variation. Standard errors clustered at the census tract level are reported in parentheses.
$*p < 0.1, **p < 0.05, ***p < 0.01$

Table A3: Robustness Check: Cohort-by-cohort Analysis

	(1)	(2)	(3)
	ln(Assessed Value)	ln(Property Tax)	ln(Housing Price)
$Policy \times Q_1$	1.440***	-0.013***	-0.143***
	(0.004)	(0.004)	(0.006)
$Policy \times Q_2$	1.537***	0.048***	-0.030***
	(0.005)	(0.004)	(0.007)
$Policy \times Q_3$	1.714***	0.262***	0.096***
	(0.004)	(0.005)	(0.005)
$Policy \times Q_4$	1.813***	0.374***	0.204***
	(0.003)	(0.002)	(0.005)
$Policy \times Q_5$	2.041***	0.621***	0.384***
	(0.005)	(0.005)	(0.006)
Observations		1,545,207	

Note: This table reports the estimated coefficients $Policy \times Quantile_k$ from equation (2) but conducts the analysis separately by each cohort (treatment year) then aggregate the estimate by weighted by the sample size of each cohort. The $Quantile$ denotes the level of underestimation in the pre-treatment period. Q_1 denotes the least underestimated regions, while Q_5 denotes the most underestimated regions. The outcomes of interest are log assessed value, log property tax, and log housing price. All columns include the same covariates as Table 3 column (4). Bootstrap standard errors obtained from 1,000 times resampling within the census tract cluster are reported in parentheses.
$*p < 0.1, **p < 0.05, ***p < 0.01$

Table A4: Impact of Property Reassessment on Local Revenue and Expenditure

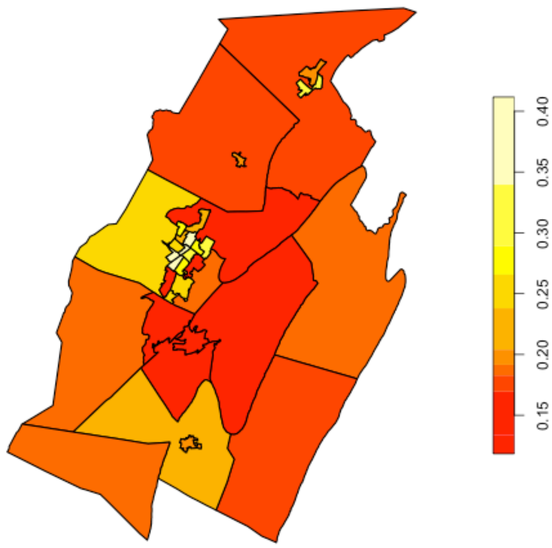
	(1)	(2)	(3)	(4)	(5)	(6)
	County		Municipality		School District	
Log Values:	Revenue	Expenditure	Revenue	Expenditure	Revenue	Expenditure
Panel A: All Counties						
Policy	-0.018	-0.016	-0.016	-0.022	0.014	0.018
	(0.028)	(0.034)	(0.013)	(0.014)	(0.009)	(0.011)
Observations	1,021	1,021	40,424	40,419	7,874	7,874
Panel B: Sample Counties						
Policy	0.007	-0.045	-0.031	-0.029	-0.002	-0.004
	(0.037)	(0.053)	(0.027)	(0.022)	(0.016)	(0.019)
Observations	275	275	11,263	11,261	2,392	2,392
Year FE	√	√	√	√	√	√
County FE	√	√				
Municipality FE			√	√		
School District FE					√	√

Note: The level of observation is county-by-year in Columns (1) and (2), municipality-by-year in Columns (3) and (4), and school district-by-year in Columns (5) and (6). The sample period is from 2006 to 2021 for county and municipality statistics and from 2006 to 2018 for school district statistics. Panel A consists of all counties in Pennsylvania. Panel B consists of counties included in the main analysis. This table reports the estimates of the effect of $Policy$ on log total revenue and expenditure at the county, municipality, and school district levels. The data of county and municipality comes from the Pennsylvania Department of Community and Economic Development (http://munstats.pa.gov/public/). The data on school districts comes from the Urban Institute (https://educationdata.urban.org/). Standard errors clustered at the county level are reported in parentheses.

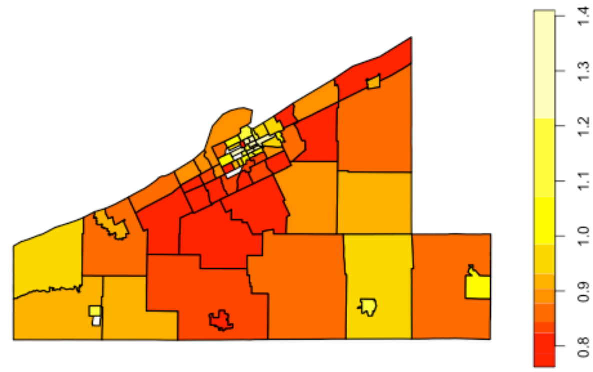
Table A5: Impact of Property Reassessment on Number of Transactions

	(1)	(2)	(3)	(4)	(5)
	Outcomes Variable: Number of Transactions				
	Overall	By Dosage		By Price Quantile	
$Policy$	0.687		-1.107		3.849
	(1.390)		(2.836)		(2.358)
$Policy \times Q_1$		-1.107		3.849	
		(2.836)		(2.358)	
$Policy \times Q_2$		1.336	2.443	-1.076	-4.925
		(3.236)	(4.303)	(3.841)	(4.595)
$Policy \times Q_3$		-0.788	0.319	-1.945	-5.794*
		(3.230)	(4.298)	(2.280)	(3.071)
$Policy \times Q_4$		0.945	2.051	1.764	-2.085
		(2.758)	(3.956)	(2.617)	(3.342)
$Policy \times Q_5$		3.949	5.056	0.848	-3.001
		(3.498)	(4.503)	(2.011)	(2.938)
Observations	22,860	22,860	22,860	22,860	22,860
Baseline Mean			60.78		

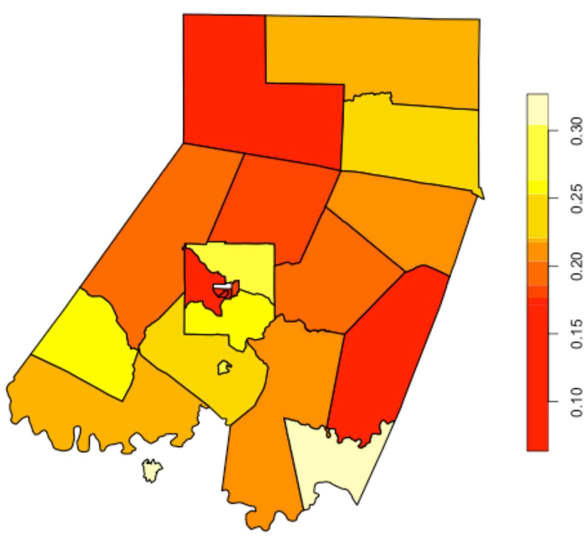
Note: The level of observation in this table is census-tract-by-year. This table reports the estimated impact of $Policy$ on the number of property transactions in each census tract in a given year. The baseline mean is the average number of property transactions in a census tract of the treatment group in the pre-treatment period. Column (1) reports the overall policy effect. Columns (2) and (3) report the effects by dosage variable (the quantile of the level of underestimation of assessment value). Columns (4) and (5) report the effects by price quantile prior to the policy effective. Standard errors clustered at the census tract level are reported in parentheses.
$*p < 0.1, **p < 0.05, ***p < 0.01$



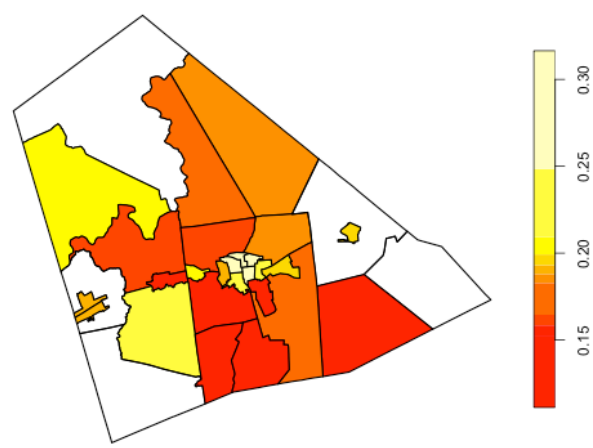
(a) Blair



(b) Erie



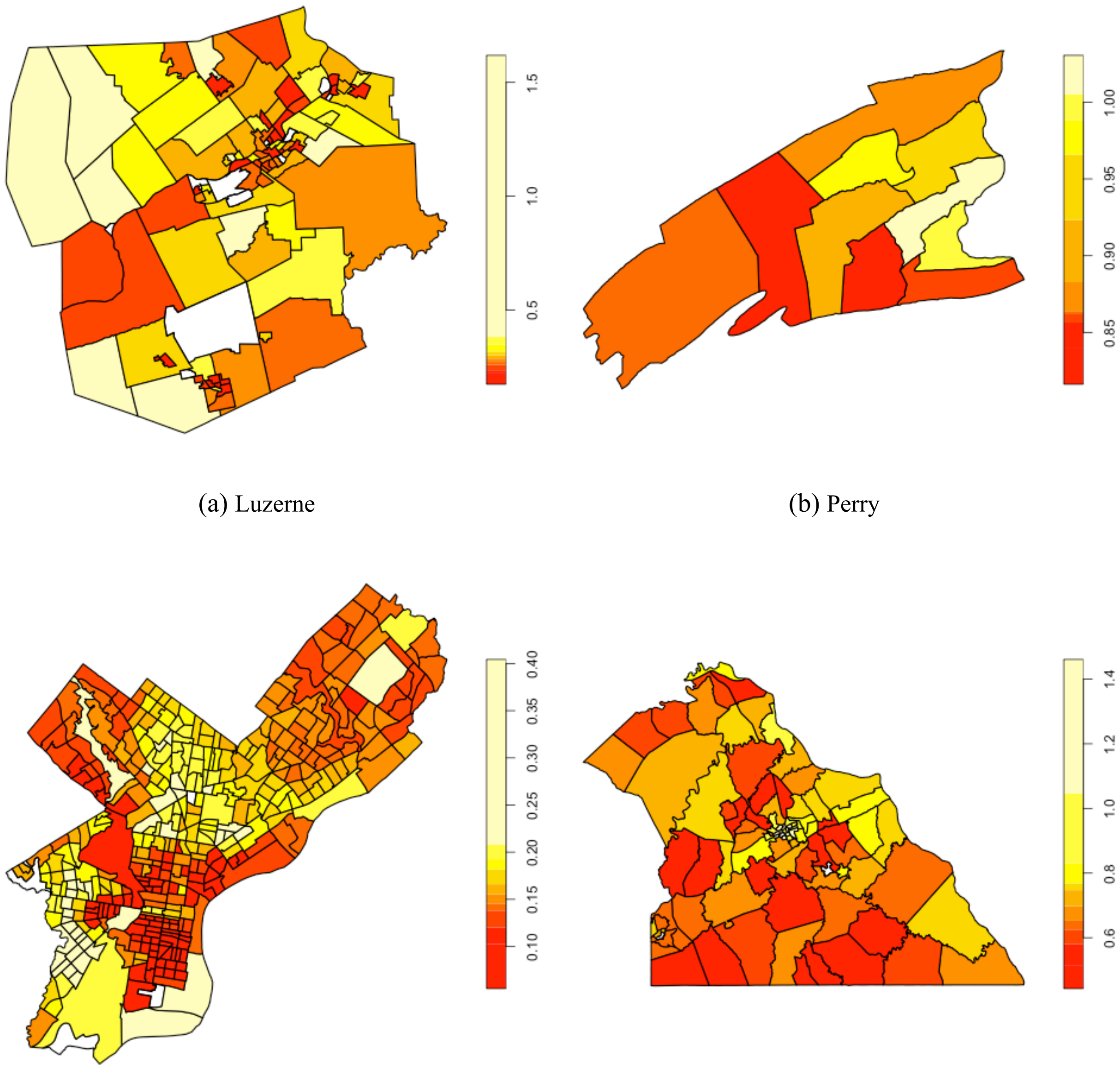
(c) Indiana



(d) Lebanon

Figure A1: Assessment Ratio in the Pre-treatment Period

Note: This figure shows the average assessment ratio (ratio of real market price and assessed value) at the census tract level in the pre-treatment period of each treated county. A dark red color stands for a lower assessment ratio (more underestimation), and a light yellow color stands for a higher assessment ratio (less underestimation). White color means no transaction data in that region.



(a) Luzerne (b) Perry

(c) Philadelphia (d) York

Figure A1: Continoued

Note: This figure shows the average assessment ratio (ratio of real market price and assessed value) at the census tract level in the pre-treatment period of each treated county. A dark red color stands for a lower assessment ratio (more underestimation), and a light yellow color stands for a higher assessment ratio (less underestimation). White color means no transaction data in that region.