Property Taxes and the Great Recession: the Role of Property Tax Limits

Thomas Brosy and Chiara Ferrero

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Abstract

We use newly collected data in 38 states on property tax rates, assessment values, and property tax levies between 2000 and 2016 to explore the impact of the Great Recession and falling housing prices on local property tax revenues. We specifically study the role of property tax limits on the tax base, and on the relationship between the property tax base and property tax revenues. Assessment limits reduced the average correlation between changes in home prices and assessed values by almost half, from about 0.65 to 0.36. We find an average elasticity between the property tax base and property tax levied of about 0.57, with larger changes in tax revenues in response to increases in assessed values (0.61) than decreases (0.47). This is evidence of the property tax being a "residual" tax, where policymakers offset changes in the tax base by adjusting the property tax rate in the opposite direction, with slightly more offsetting when the tax base declines. The combination of assessment and broad rate limits significantly reduced the ability of policymakers to do millage offsetting and pushed jurisdictions toward a rate-based system, with elasticities for both positive and negative shocks around 0.8. Levy limits had little effect on property tax revenue, but states with more stringent levy limits had slower property tax growth in response to positive shocks in the tax base, with an elasticity between 0.2 and 0.3. We present results in four states: California, Massachusetts, Michigan, and Texas to illustrate the interaction between housing markets and state property tax structures on local property tax revenues.

Keywords: [Property taxes, Property tax limits]

About the Authors

Thomas Brosy is senior research associate at the Urban-Brookings Tax Policy Center. His interests include property taxes, state and local taxes, federalism, corporate taxation, and international taxation. He can be contacted at tbrosy@urban.org.

Chiara Ferrero can be contacted at cferrero@umich.edu.

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Introduction

Property taxes are a bedrock of local governments and by far the main source of revenues, along with intergovernmental transfers, for cities, counties, and school districts. In 2012, property taxes represented 27 percent of total revenues for counties, 20 percent for municipalities, and 36 percent for school districts, but only 1 percent of state revenues.[1] Reliance varies widely across states and localities: in New Hampshire, property taxes made up 31 percent of all state and local tax revenue in 2012, but only 7 percent in Alabama. The structure and administration of property taxes also varies widely across, and sometimes within states. Most states have one or more property tax limits, which vary in their application, stringency, and scope. Property taxes are often viewed as a stable source of revenues, even during economic downturns, and as less volatile than other taxes like income or sales taxes, and potentially more predictable than transfers, especially counter-cyclical transfers.[2] By 2010, property taxes had held up remarkably well, but in many areas of the country, they declined between 2010 and 2013. In this study, we gather data on property tax revenues from counties and cities across 45 states to shed light on the impact of the housing crisis that plunged the country into the Great Recession.[3]

There is a long and rich literature discussing the relationship between housing markets and property tax revenues, and documenting the changes brought about by the Great Recession after 2008. Several factors explain the delayed decline in property tax revenues following the housing crash, as well as the heterogeneity in how severe the impact was on local property tax revenues. First, assessment and taxing practices often create lags of several years between changes in home prices and their reflection in real property taxable values. Second, the property tax is often seen as a "residual" source of revenue, meaning that policymakers estimate how much property tax revenue they need based on other sources of financing, and set tax rates accordingly. This means that taxing districts could raise tax rates in response to a decline in the base. Finally, many states impose limits and regulations on local governments, including assessment limits, rate limits, and levy limits. Assessment limits, which broadly serve to regulate changes in assessed values, can create a wedge between home values and their taxable assessed values. Rate limits may constrain

[1] US Census Bureau Annual Survey of State and Local Government Finances, 1977-2021 (compiled by the Urban Institute via State and Local Finance Data: Exploring the Census of Governments; accessed 25-Mar-2024 10:44), https://state-local-finance-data.taxpolicycenter.org.

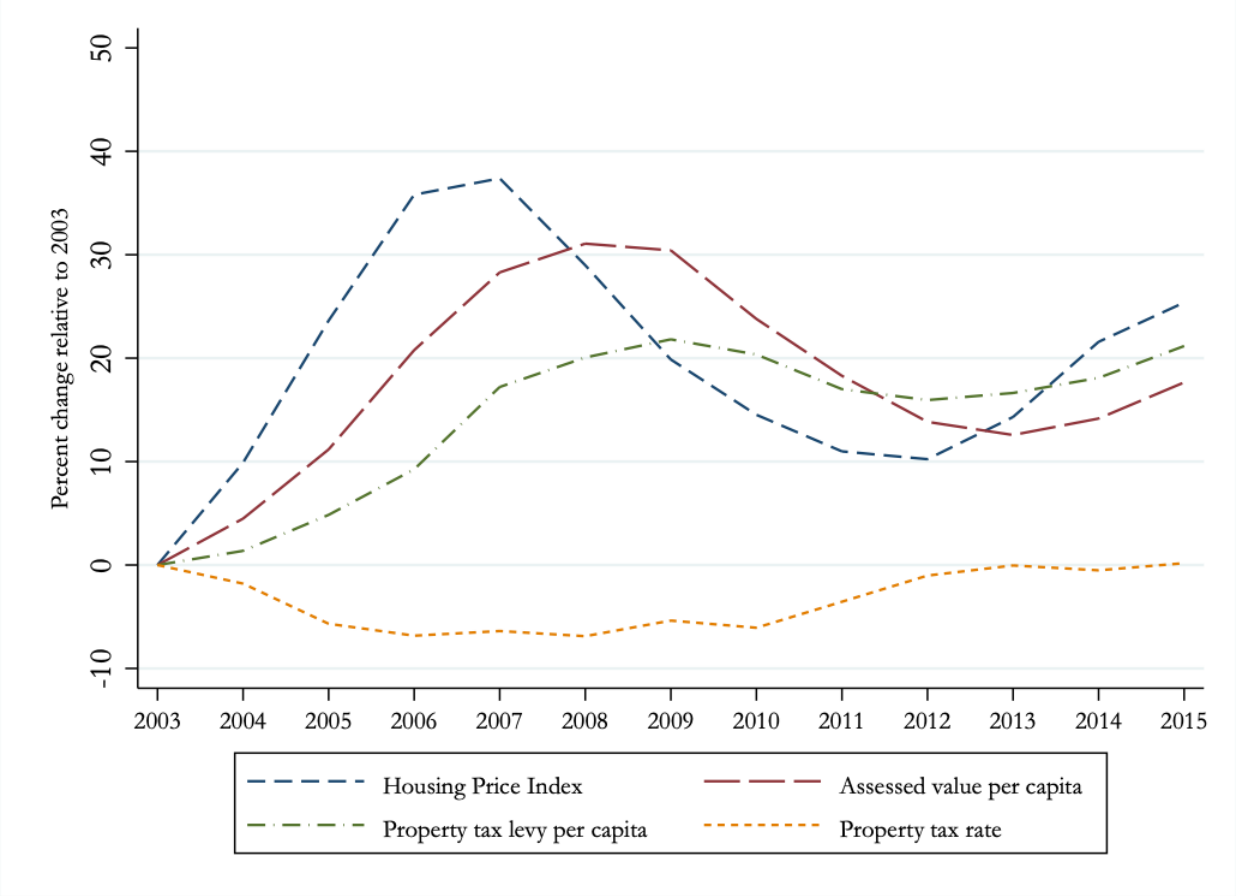
[2] Most federal aid to state and local government during economic crisis, such as the Great Recession, or the more recent COVID-19 pandemic are discrete in nature and part of federal aid packages. There are few automatic stabilizers in the form of federal transfers in the United States. State transfers may be more predictable, especially when they are formula-based, however state government may also be fiscally limited during economic downturns as well.

[3] Although we have data on 45 states, we use 36 states in the analysis, as some data is missing for some years or variables of interest in a handful of states.

the ability of taxing jurisdictions to offset a decline in assessed values by increasing the rate, and levy limits restrict the growth of property tax revenue.

To study the impact of the housing crisis on property taxes, we collected data (sources detailed in the data section) on the total property tax of all taxing districts within a county aggregated at the county level, as well as the total taxable assessed value at the county level, and the effective (or average millage) tax rate. We also collected and classified a variety of tax limits. This unique dataset allowed us to make several contributions. First, we document the average elasticity between home price indexes and taxable values and shed light on the role of assessment limits. As shown in Figure 1, assessed values rose slower than home prices and declined almost 3 years after home values peaked in 2007, while property tax revenues increased and declined much less than assessed values. Areas with frequent reappraisals (yearly or bi-yearly) and no assessment limits show a strong and significant relationship between recent changes in home values and the property tax base, with correlations of 0.7 or above, while states with broad assessment limits have a correlation closer to 0.4.

Figure 1: Changes in home values, assessed values, property tax levy, and property tax rate



Source: the home price index comes from the Federal Finance Housing Agency. Data on assessed values, property tax levies, and property tax rates were collected by authors. All results are weighted by the average county population.

Second, we collect data on the property tax structure across states and explore the role of property tax limits on tax rates and revenues between 2000 and 2016. Overall, we find that limits have a significant impact in shaping the path of property taxes, in particular when multiple limits are combined. When localities have both assessment and rate limits, changes in tax revenues are highly correlated to changes in the tax base, as stringent assessment limits push tax revenues to move closely with assessed values. We find that broad rate limits are associated with larger responses in tax revenues to both positive and negative shocks in the tax base, with a larger impact for negative shocks. Rate limits without assessment limits seem to slightly constrain millage offsets when the tax base declines. Levy limits tend to lower the growth of property tax revenues when the tax base goes up, although by a small margin and with a lot of variation, an indication that most levy limits were unlikely to be significantly straining before the Great Recession, and results are driven by a few stringent levy limits. The presence of a levy limit is also associated with smaller decline in taxes when assessed values decline, but we show that it is the absence of rate and assessment limits that matters, rather than the presence of a levy limit.

Third, we show that there is a strong and statistically significant correlation between positive and negative changes in the property tax base and tax revenues, where property tax revenue on average increases by 6 percent when the tax base goes up by 10 percent and declines by 4 percent when the tax base goes down by 10 percent. This means policymakers offset changes in the tax base by adjusting the tax rate in the opposite direction, with an average offset slightly higher for negative shocks to the tax base. The result is a much smoother trend in property tax revenues, with declining mill rates between 2000 and 2007, and rising mill rates after 2010. We also confirm previous observations in the literature that taxing jurisdictions varied widely in both the impact of the Great Recession on the tax base, and the jurisdictions' reactions. These results confirm prior findings in the literature on the relationship between home prices and property taxes, and on the response of policymakers to changes in the property tax base, but in a broader context. Although other papers have focused on specific states and used county-level data on assessed values, tax levies and millage rates, we add to the literature by using county-level panel data for the majority of US states and quantifying the role of limits in affecting these relationships. Our results are broadly in line with other findings and insights developed in the rich literature that looked at the Great Recession and its impact on property tax collections, as detailed in section 2. We add to the consensus that assessment limits severely restrict policymakers and when combined with rate limits can effectively apply a rate-driven system onto property taxation. Whether that reflects local preferences, or how other sources of revenues and the structure of state transfers alleviate or exacerbate these concerns are important questions for future research.

Finally, we present results for 4 states with very different property tax structures and housing markets (California, Massachusetts, Michigan, and Texas), which further highlight how the

interaction between specific property tax limits and housing markets impacted property tax collections and recovery after the Great Recession. In the next section, we discuss the basics of property taxation and property tax limits and review the literature. In the third section, we present our data collection, and mechanisms behind our estimation strategy. We show empirical results in section 4, and the last section concludes.

Policy background and literature review

Basics of property taxation

Property taxes revenues are composed mostly from taxation of residential, commercial, and agricultural real estate. The importance of commercial property taxes varies by jurisdiction and depends on factors such as available tax options and policymaker preferences. Residential properties are most commonly assessed based on comparable sales, with exemptions usually available for certain categories of homeowners and investors. Although market and assessed values are strongly correlated, there are several factors that can weaken that correlation, such as state-imposed limits on value increases, infrequent reappraisals, and disparities in valuation across neighborhoods, often disadvantaging minority, or lower-income areas.[4] Property tax systems may be budget-driven, setting rates based on needed revenue, or rate-driven, with a fixed tax rate and property tax revenue changing when assessed values increase or decrease.[5] Many governments fall somewhat in the middle, and aspects of the tax system or significant changes in the tax base or revenue needs can push governments toward one system or another.

Property tax limits

[4] As Bradley et al. (2023) shows, appraisal frequencies vary across states (see table 1 in the Appendix), with minimum reappraisal ranging from yearly to no minimum required. Many states that have long lags between reappraisals may still apply yearly adjustments based on inflation or other local factors between reappraisal periods. Many assessment limits also allow for full reappraisal when the property is sold or transferred. Most states implement ways to limit the variability of taxes paid across areas and use equalization methods to optimize horizontal equity for homeowners. However, recent research (Berry (2022), Howard and Avencio-Leon (2023)) highlights how assessment mechanisms can create wide disparities in valuation across and within neighborhoods. For example, homes in minority or lower-income neighborhood tend to be underassessed compared to homes in affluent neighborhoods.

[5] Budget-driven governments usually estimate the amount of property tax revenue needed after considering other sources of revenues, the available tax base (total taxable assessed values) and set the tax rate accordingly. For example, in New York, school boards and municipal policymakers decide a budget in May and using the value of assessed property in March that year, set the tax rate equal to the total levy needed divided by the net taxable value of property. This mechanism is what stands behind the view of property tax as a "residual" tax, or a tax that is determined once all other variables in the budget are set. On the other hand, rate-driven systems rely on a fixed tax rate and property tax revenue changes when assessed values increase or decrease (rate-driven systems are common for other taxes like income taxation).

Property tax limits are widely used in the United States, as all states except for Hawaii, New Hampshire, Tennessee, and Vermont have adopted one or a combination of property tax limits. Limits are usually applied to increases in assessed values, tax levies or rates with the aim to regulate property tax revenue, avoid significant increases in a taxpayer's property tax bill, and create restrictions on local policymakers. The features and administration of limits vary widely by state, with some states also imposing broader limits on total revenues and expenditures of local governments (e.g., Colorado). A handful of states, typically in the South, have enacted the concept of Truth in Taxation, which requires local governments to notify and sometimes consult taxpayers of new budgets that would increase taxes more than an allowed amount (e.g. jurisdictions in Texas must notify taxpayers of any increase beyond the previous year's budget, and require voter approval to raise property tax revenue by more than 8 percent – excluding new construction.)

The share of states with some limits has not changed significantly in the last few years, as fewer new limits have been established since the early 2000s. Coincidentally, most of the states that introduced a limit after 2000 were not included the analysis because we could not find the relevant data on tax levies and assessed values.[6] Although property tax limits are often popular with taxpayers, as they can keep property taxes low for existing homeowners or avoid unexpected or unwarranted increases in property taxes, an increasing amount of attention has been devoted in the literature to the effects that limits have on equity (such as the impact of assessment limits and reappraisal rules on horizontal equity) and on the resilience of local finances to economic shocks.

Rate limits

Tax rate limits may be applied at the jurisdiction level, or on the tax rate that homeowners pay on their property. They are often expressed in maximum millage rates and can apply different maximum rates for different levels of government. In some cases, states may have an overall maximum effective tax rate on the fair market value of a property, and a handful of states restrict millage growth.[7] Many states exclude certain taxing jurisdictions from the cap, such as school districts (e.g., Alabama) or exclude revenues when the tax revenues are earmarked for debt servicing.[8] Some states allow local governments to put the budget up for a vote which overrides the tax limit (e.g. Louisiana or Michigan).

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[6] For the few limits that were introduced between 2000 and 2016, we code the limit as existing only for years after their implementation in 2005, Maine, Wisconsin and Nevada introduced a levy limit. In 2006, Pennsylvania introduced a levy limit and South Carolina an assessment limit. Florida introduced a new rate limit in 2007, and an assessment limit on non-homestead properties in 2008. Minnesota had a levy limit, but it was ineffective between 2009 and 2011, and implemented a new limit in 2014. New York introduced a levy limit in 2012, while Arizona introduced an assessment limit in 2012 and a rate limit in 2015.

[7] For example, Massachusetts' Proposition $2\frac{1}{2}$ restricts total levy to 2.5 percent of the fair market value. But since Massachusetts assesses property at 100 percent of the full and fair cash value, this is equivalent to a 2.5 percent effective tax rate limit.

[8] Arizona's 10 mill rate limit does not apply to property tax revenue earmarked for debt service.

The stringency of rate limits varies broadly, and rate limits are more likely to bind when assessed value are stagnant or fall, but the relationship with economic cyclical fluctuations is murkier. Declining economic conditions are not always associated with stable or declining housing prices, and a short-lived decline in the housing market may only be reflected in assessed values when the economy has otherwise rebounded. Thus, rate limits may be more stringent in the rebound period, and particularly constraining during prolonged counter-cyclical periods, with a sustained decline in housing values, as experienced during the Great Recession. In each state, we estimated the overall rate limit as an effective tax rate on taxable assessed value, adjustment for local assessment ratios. Figure A2 in the appendix maps rate limits and highlights which states have broad rate limits, that apply to all jurisdictions, or at the property level.

The stringency of rate limits can also depend on the presence of other local restrictions, such as assessment limits. Highly constraining assessment limits unsurprisingly increase the likelihood of rate limits binding, even in pro-cyclical periods, as any budget with property tax revenue growing faster than assessed values increases the rate. If there are more instances of faster revenue growth compared to the tax base than slower revenue growth, the rate will gradually converge toward the limit over time. For example, California is notorious for its 2 percent maximum assessment limit introduced by proposition 13, and a 1 percent tax rate limit. As a result, many jurisdictions in California have a mill rate very close to or at the limit.[9]

Levy limits

Levy limits are usually formulated as a limit on the growth rate of the aggregate levy at the jurisdiction level. Sometimes, the levy limit is on the growth rate of individual property owners' tax obligations. The most common type is capping maximum property tax revenue growth at the taxing jurisdiction limit.[10] Levy limits almost always include exceptions for growth and new construction.

Just like rate limits, levy limits may be stringent, but when not combined with other limits they are usually seen as potentially less constraining than rate limits since they are not affected by declines or increases in the tax base. They vary widely in how much they allow in property tax levy growth, from the 2.5 percent increase in Massachusetts, regardless of inflation, to New Mexico or Colorado, where the limit is capped at inflation and growth.[11] Figure A2 in the appendix maps levy limits by the allowed growth rate. We also classify levy limits as stringent,

[9] Some limit on the maximum amount of property taxes paid on an individual's property value can be expressed as rate limits, such as California's maximum 1 percent rate, but we categorize them as rate limits.
[10] For example, Proposition 21/2 in Massachusetts restricts the growth rate of levy to 2.5 percent of the previous' year levy, with exceptions for new construction.
[11] The levy limit is higher in Colorado, but the TABOR amendment generally restricted the growth of government more severely, and we code TABOR as a strict levy limit.

with a growth rate of 5 percent or less on all taxing jurisdictions, and most stringent, as a growth rate of 3 percent or inflation.

Levy limits are most likely to bind when local jurisdictions that operate mostly under a budget-driven system move toward increased property tax reliance, when the cost of public expenditures rises faster than inflation, when the tax base grows quickly, and more generally limit the ability of local government to significantly expand. A consequence of levy limits could be the unwillingness to temporarily provide property tax relief when the tax base declines - policymakers may be unable or unwilling to offset the decline by raising the tax rate, and increasing revenue back up in the future could be difficult with strict levy limits.

Assessment limits

Assessment limits vary in their application and put constraints on the growth of taxable assessed values. The most stringent type of assessment limit caps the increase in the assessed value of a property. For example, proposition A in Michigan limits the growth rate of taxable value of a property by 5 percent or the rate of inflation, whichever is less. Often, the law allows uncapped reassessment when the property is sold or transferred, as is the case in Michigan, California, or Florida. Rarely, assessment limits apply to total assessed values.[12]

Many states have assessment limits that are restricted to a small subset of homeowners or unlikely to bind. Bradley et al. (2023) categorize these limits as "other assessment limit" compared to the "traditional" assessment limit in place in states like California or Michigan.[13] In the context of this study, we only consider broad assessment limits, and their potential role on property taxes during and after the Great Recession. We define as broad assessment limits "traditional" assessment limits as in California, and strict assessment limits that apply to total assessed values as in Oregon.

Literature review

Our paper contributes to the literature on property taxation, focusing on the relationship between home prices and the property tax base, policy makers' ability to set policy instruments such as the millage rate, and the role of limits.

[12] In Oregon, Measure 50 passed in 1997 cut tax rates and introduced a permanent tax rate on most levies.
[13] From Bradley et al. (2023): "Other states apply maximum capped growth rates that are unlikely to bind (e.g., Minnesota's since-eliminated Limited Market Value Law, which had a cap equal to the greater of 15 percent or 25 percent of the change in market value), apply to only a small subset of homeowners (e.g., Arkansas) or exclusively to primary residences (e.g., the District of Columbia, Maryland), do not trigger taxable value uncapping as a result of changes of ownership (e.g., Arizona, Oregon), apply only to certain localities as a local option (e.g., Georgia, Illinois, New York), apply only to aggregate taxable values (e.g., Colorado, Iowa), or merely stipulate phasing in of property reassessments (e.g., Connecticut, Montana)."

The performance of local governments finances during the Great Recession has been studied widely, including by Langley (2014), who finds that property tax revenues started declining in 2010 and that the effect on local finances varied widely by entity, and Chernick et al (2012) who predicted in 2012 that revenue per capita would decline by 3.5 percent on average over 4 years. Other studies have focused specifically on the role of policy makers' reactions to the Great Recession. Skidmore and Scorsone (2011) focus on Michigan and study how localities change expenditures due to fiscal stress, not focusing instead on other mechanisms such as changes in tax rates. Dye and Reschovsky (2008) instead analyze changes in state aid and whether local governments responded by raising tax rates, finding that school district increased tax rates by $0.23 for a dollar decrease in state aid on average. While these studies focus on the overall finances of local governments, others such as Dadayan (2012) hone in on property taxes, finding that, while property tax collection remained stable during and immediately after the Great Recession, they started declining by the end of 2010.

The relation between house prices changes and property tax collection has been explored in Lutz (2008) where the elasticity of property tax revenues with respect to house prices is estimated to be around 0.4, and the timing of adjustment of the property tax base following a change in house prices to be around 3 years. The elasticity is comparable to what is obtained in our analysis with a back of the envelope calculation, using the overall coefficient of 0.64 from column 2 of table 3 of the correlation between house prices and assessed values, and the coefficient of 0.57 of the correlation between assessed values and property tax levies (table 4). Lutz, Molloy, and Shan (2011) provide evidence on how assessed values respond to changes in property values, and how tax revenues respond to changes in house prices using state-level panel data and individual states case studies. They find weak evidence of the effect of decline in house prices on property tax revenues and argue that the lag between market and assessed values changes and millage offset can explain this result.

The role of policy makers in offsetting tax base changes with the millage rate is taken into consideration by Doerner and Ihlanfeldt (2011), who find an asymmetric effect, where a rise in home prices lead to higher revenues, but a decline in market values had little effect on tax collections. Alm et al. (2011) instead analyze the impact of declining property values on local government revenues and using school districts in Georgia, they show that policymakers offset declining home values by increasing the millage rate. Ihlanfeldt et al. (2014) use panel data for cities and counties in Florida to estimate the elasticity of the millage rate and local expenditures with the property tax base. They find a long run potential elasticity between -0.136 and -0.670 for a decrease in the tax base. This is in line with the results presented in Table 4, where the elasticity between a decrease in assessed value and the tax levy is estimated to be between –0.40 and –0.58. Ross and Yan (2013) use data from cities and counties in Virginia to estimate the change in levies following changes in assessed values and find evidence that the property tax is not set fully residually, but that there is some increase in levies after a mass reappraisal.

Cromwell and Ihlanfeldt (2015) focus on Florida and look at millage rate and expenditure adjustments following lower transfers and a decline in property tax base during the crisis. They find that local policymakers both cut expenditures and offset the decline in the tax base by raising millage rates, and that the response varied in part due to the monopoly power of local governments, or the degree of competition with other neighboring localities. In our paper, we study how assessed values, levies and mill rates change in response to a change in property values and focus on how property tax limits affect these interactions.

Examples of efforts to categorize and study property tax limitations include Paquin (2015), Mullins (1995), Sapotichne et al. (2015), Maher and Deller (2013) and Bradley et al. (2023). Amongst others, Dye and McGuire (1997) and Preston and Ichniowski (1991) studied the effectiveness of property tax limitations. At the state level, Poterba (1994) evaluates the role of tax and expenditure limitations, and fiscal institutions. He finds that states with higher restraint are typically correlated with faster fiscal adjustment using data from the late 1980s. Our paper relies on data gathered by Paquin (2015), Bradley et al. (2023) and the Lincoln Institute of Land Policy to evaluate how the presence of rate limits and levy limits has impacted the change in property tax revenues after the Great Recession. Increasing attention is being devoted in the literature to the effect that tax limitations have on the erosion of the tax base overall, and on the distortionary effects that limits and rules related to reappraisal may produce. Berry (2021) and Avenancio-Léon and Howard (2022) are two examples of recent research focusing on assessment and reappraisal values and shedding light on limitations of the methods used in assessment. Bradley et al. (2023) develop a measure of tax policy risk and find that the presence of limits can increase exposure of households to greater risk and subsequent financial distress.

In our paper instead, we study how property taxes features affect tax collection and its countercyclicality for homeowners and municipalities during episodes of property values downturns. While other papers focusing on state-specific studies use county-level data on assessed values and millage rates, this paper is the first to our knowledge to use county level panel data for the majority of US states to look at both the relationship between house prices and assessed values, and assessed values and tax levies and tax rates, emphasizing the role of limits in affecting these relationships.

Data and mechanism

Property tax data

We collected data on local property tax rates, assessed values and property tax levies in 45 states in the United States between 1990 and 2018.[14] In some states (Idaho, Indiana, Maryland, North

[14] We do not have any data available for the state of Alaska, Hawaii, Oklahoma, South Carolina, South Dakota, and Washington D.C. The start and end date of the panel vary by state. The exact variables and years available in each state is reported in table 1.

Carolina, Pennsylvania, Rhode Island, West Virginia), we only have the mill rate, so they are excluded from the analysis. We are also missing data on tax revenues in Kentucky. All remaining states have data for at least two of the three variables mentioned.[15] To our knowledge, there is no comparable database that aggregates historical local property tax data.[16]
We gathered our data from three main sources: state annual reports, state tax administration institutions - through their website or direct contact - and the Lincoln Institute of Land Policy. The Lincoln Institute of Land Policy collects data on the features of local tax systems and raw property tax rate data from most states. We transcribed the data obtained from the three sources above and restructured it to have a consistent and comparable series across states.

Table A1 reports the data collected in each state, as well as years covered. Most states report aggregate tax levy, mill rate and assessed values at the county level. However, some states only report data at the taxing jurisdiction level (e.g., school district, municipality, etc.). In those cases, we aggregated the available data at the county level. This method can lead to slightly skewed averages in either directions depending on whether smaller jurisdictions have lower or higher tax rates. The column "Aggregated" reports whether we aggregated data from lower jurisdictions to get county-level variables. When both are available, we relied on the data reported directly at the county level in the original source. In addition, states may differ in how information on property tax is delivered. For states that only report the tax base (assessed values) and total levy, we estimate an effective average mill rate for all properties.[17] When available, we collect assessed values for residential property and total property. Many states only report total real estate and personal property. We provide more details on the data gathering and cleaning process in the appendix.

Note that in the paper, we refer to tax levies, tax revenues, or tax collections interchangeably. It is important to notice that the data we collected is on taxes levied. In other words, it is based on the local government's budget, and represents what the constituents owe. This is not the same as tax collections if there is some level of tax delinquency. Unfortunately, data on both the taxes levied and the taxes collected is not always available for every state, and thus our results should be interpreted only regarding taxes levied. Although taxes collected typically do not deviate

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In Indiana, Maryland, North Carolina, Pennsylvania, Rhode Island, and West Virginia, we only have data on the mill rates, so they are not included in the analysis. In the analysis, we also exclude states with missing data in the middle of the period of observation. Arkansas has missing tax levy data between 2005 and 2016, Idaho has missing data in 2010-2011 and 2013-2016, New Hampshire has missing data in 2005-2006 and 2008-2009, and Vermont has missing data between 2012 and 2016.

[15] We typically have full panels between the start and end date of data available at a state, except for three states (NH, ID, KY) which have some missing years.

[16] The Census of Government collects data on spending and revenue from all levels of government every five years, as well as yearly for states, and large counties and municipalities. However, it does not contain information on tax rates and assessment values.

[17] Some jurisdictions tax classes of property differently (e.g., commercial, residential, and industrial). Other jurisdictions use different assessment ratios. For example, residential property is assessed at 20 percent of the estimated market value, while commercial property is assessed at 40 percent of the market value.

substantially from the taxes levied[18], this may be a concern after the Great Recession, as more homeowners became delinquent. This may bias our results if policymakers expected higher delinquency and adjusted their budgets and the tax rate accordingly. While this may be an issue at the county, and perhaps state level, we do not believe this issue to be systemic and large enough to substantially change our national estimates.

Throughout the analysis, when we refer to assessed value, we typically mean real estate value, which combines commercial and residential properties. This excludes public utilities, agricultural land, or the value of natural resources in certain areas. Although we use a residential property index, residential and commercial values are typically correlated over time, and commercial properties lost value during the Great Recession and recovered along residential property afterward (the decline in office value after 2019 from the switch to remote work could break that correlation). However, our price index captures the value of residential real estate, which implies that there is some measurement error on the combined value of commercial and residential property. To avoid clerical errors in the raw data, changes driven by data formatting, missing entries, or other state or county-level specific variation in reporting or measuring data, we exclude yearly changes above a 50 percent increase or below a 25 percent decrease.[19]

Other data

We collected two measures for local property values. The first home price index is issued by the Federal Housing Finance Agency (FHFA). The FHFA index is computed using sales prices and appraisal values for mortgages bought or guaranteed by Fannie Mae and Freddie Mac. Small counties with few transactions are typically missing from the data. The number of counties covered was 1435 in 1990, and 2412 after 2000. The sample is consistent throughout our estimation period (2000-2016). A second housing price measures comes from Zillow.[20] Zillow separates its price index into three category: low-tier, mid-tier, and high-tier. Mid-tier represents the typical home value in the 35th to 65th percentile range. Zillow data covers fewer counties than the FHFA index, so it is not our primary choice, but we leverage it to validate some results from the FHFA index.[21]

To compute per capita variables, we use demographic data at the county level (total population and share of the population by race and age groups) which comes from the Census and is based on revised intercensal estimates. We adjust all price-related variables (including the home price

[18] Anecdotal evidence suggests delinquency rates are overall small and below 1 % or between 1 and 3 % in most states. See https://www.corelogic.com/intelligence/buy-stories/property-tax-delinquency-varies-across-states.
[19] In the raw data, the drops smaller than -17 percent represents the bottom 1 percent of observations, while increases above 39 percent represent the top 1 percent of observations.
[20] Data from the FHFA can be found at: https://www.fhfa.gov/DataTools/Downloads/Pages/House-Price-Index.aspx.
[21] Top-tier ZHVI is the typical value for homes within the 65th to 95th percentile range for a given region, and bottom-tier ZHVI the typical value for homes that fall within the 5th to 35th percentile range. All data is seasonally adjusted.

index) for inflation in 2010 dollars using the GDP deflator provided by the Federal Reserve Bank of St. Louis. We use controls in some estimations. We get data from the National Historical Geographic Information System, which is based on the Census and the American Community Survey, on the share of population with a college degree, and the share of urban residents at the county level.[22] We also relied on the American Community Survey to estimate the average effective property tax rate on new homeowners between 2000 and 2005, to assess whether rate limits were binding or not (when the effective rate is significantly above the rate limit, we assume the limits are generally not binding). Data on unemployment rate comes from the Bureau of Labor Statistics. The main data source on state and local revenues and expenditures in the United States is the Census of Governments.[23] We use this data to compute the share that several sources of revenues represent at the county level, as localities may differ on how much they rely on revenue sources such as property taxes, other taxes, or intergovernmental transfers from states and the federal government. The Census of Governments data only covers all jurisdictions every five years, in years ending with '02 or '07. The Annual Survey of State and Local Government Finances covers all years but limits the sample to state level finances, and large cities and counties. As a result, we cannot compute yearly changes in sources of revenues for all local jurisdictions.

Summary statistics

Table 2 presents the average population weighted summary statistics. Between 2000 and 2016, the average yearly change in home values (adjusted for inflation) was 2.4 percent, the average change in assessed values per capita and property tax levy per capita was 4.2 percent and 4.4 percent, respectively, and the average change in the property tax rate was 0.44 percent.[24] All four variables had a high level of variation. Between 2000 and 2008, both the average change in home value as well as the change in assessed values and property tax revenues were unsurprisingly higher – 4.5 percent for the former – and 6 and 5.7 percent respectively for the latter, while the average change in the rate was close to zero. Between 2009 and 2016, the average change in home values was about zero, with a large degree of variation, as some areas recovered quickly, while others had long lasting declines. The average change in assessed values and tax revenue was smaller, 2.3 and 2.9 percent respectively, and there was an average annual increase in the tax rate of 0.8 percent.

These simple statistics highlight the widespread variation in how the Great Recession impacted housing markets, and by extension property taxes, and how quickly some areas recovered. Figure A1 in the appendix shows the change in real terms of assessed values and property tax levy per

[22] Census population data: https://www.census.gov/data/tables/time-series/demo/popest/2010s-counties-detail.html
[23] Census of government data: https://www.census.gov/programs-surveys/cog.html
[24] The data in some states covers a shorter period or does not include specific variables, see table 1 for which years and variables are available in each state.

Table 2: Summary statistics

Years 2000-2016 – Yearly change in percent

	Mean	Median	SD	1st	5th	95th	99th
Housing Price Index	2.41	2.32	5.57	-11.81	-5.98	11.52	19.29
Assessed value per capita	4.17	2.98	7.36	-13.51	-5.14	17.22	30.79
Property tax levy per capita	4.36	3.68	6.71	-13.11	-4.76	15.65	26.93
Property tax rate	.44	.16	5.9	-18.19	-9.02	9.1	19.28
			Years 2000-2008				
							99th
Housing Price Index	4.52	3.87	5.22	-7.41	-2.15	13.82	21.86
Assessed value per capita	6.01	4.64	7.3	-9.08	-2.29	19.16	33.94
Property tax levy per capita	5.71	5.04	6.56	-11.13	-2.77	16.94	27.49
Property tax rate	.1	.07	5.99	-18.58	-9.98	8.64	17.8
			Years 2009-2016				
Housing Price Index	.07	.11	4.98	-13.62	-7.91	7.97	13.12
Assessed value per capita	2.3	1.57	6.94	-16.13	-7.35	14.47	26.66
Property tax levy per capita	2.92	2.36	6.56	-14.41	-6.46	13.35	26.19
Property tax rate	.78	.24	5.79	-17.77	-7.74	9.51	20.75

capita between 2008 and 2015. Some states have very homogeneous changes across counties, especially in the Northeast and some states in the Midwest. Nevada, Arizona, and Florida were particularly severely impacted, while states like California, Texas, Georgia, Michigan, or Wisconsin showed high variation across counties.

Mechanism

Property taxes equal assessed values times the property tax rate $R^p = A \times \tau_m$. We can write the change in property taxes as

$$\Delta R^p = \tau_t \Delta A + A_{t+1} \Delta \tau$$

where the first term captures the impact of the change in assessed values on tax revenues, holding the tax rate constant, which we define as the *value effect*. The second term captures the impact of the change in the tax rate, given the new assessed values, which we define as the *rate effect*. When a local government operates under a rate-system, the rate effect represents policy choices, while the value effect represents the mechanical impact of a change in assessed values on tax collections.

When the system is budget-driven, the rate is decided based on the property tax revenue needs, so the dependent variable is the tax rate, and it follows that the rate change is:

$$\Delta \tau = \frac{1}{A_{t+1}} \Delta R^p + R_t \Delta \frac{1}{A}$$

The first term reflects the change in revenue needs holding assessed values constant, or the *budget effect*, while the second term is the mechanical impact of the change in assessed values on

the tax rate, holding tax revenues constant, the *value effect*. In this instance, the change in tax revenue is a policy choice, while the change in assessed value is the mechanical effect.

Practically, many governments operate a mixed system, where the revenue needs are chosen considering the impact on the rate and across taxpayers. Similarly, policymakers in a mostly rate-driven system may adjust the rate downward or upward based on estimated revenue needs.

We can also use this specification to explore the role of limits. First, levy limits put a cap on ΔR^p, which binds if the desired change in revenue by policymakers is larger than the limit. A levy limit also puts an upper bound on $\Delta\tau$. Rate limits put a cap on $\Delta\tau$, and create an upper bound for $\Delta\tau$. Effectively, rate and levy limits are two sides of the same coin, but with potentially very different implications depending on the change in assessed values. When assessed values go up as fast or faster than revenue needs, rate limits are less likely to bind, as the same rate with a higher tax base raises more revenues. But when assessed values go down or grow too slowly, rate limits are more likely to bind, as higher rates are necessary to maintain or increase property taxes. A potential effect of levy limit is the reluctance of policymakers to maintain stable or lower property taxes during economic downturns, because of the expected inability to increase them in the future.

Assessment limits are not binding when the market value of real property goes down, but they may have had an impact on how the property tax base fared after 2008. For example, places with strict assessment limits can have a large wedge between market values and assessed values, lowering the downside potential of assessed values as market values fall. Strict assessment limits may also make rate limits more likely to bind if policymakers wish to raise property tax revenues given a rise in assessed values.

Because of the complex nature of the relationship between assessed values and property tax collections, we view these estimates as descriptive in nature, rather than causal estimates.

Empirical analysis

Housing market and assessed values

We first evaluate how changes in home prices impact the tax base.[25] Because of the large heterogeneity in assessment rules and methods, we use a first-difference model. To capture the

[25] We find some large changes in absolute values in the data, which can be driven by clerical error in the raw data we rely on, changes in how the data is reported (e.g., from values in thousands to hundreds), and changes in assessment practices or assessment ratios.

lag between assessed values and home prices, we include lagged changes in home prices and estimate the following model:

$$\Delta \log NAV_t = \beta_1 \Delta \log HPI_{t-1} + \varepsilon_t \quad (1)$$

where NAV is the net assessed taxable value per capita, and HPI is the county level home price index.[26] We also present results with four lags to illustrate how the home price index is a lagging indicator for the real estate tax base, but do not add further lags to minimize the number of observations lost at the beginning of the sample. Assessed values for fiscal year 2010 would be calculated using home prices in 2009, so we expect little impact from the contemporaneous change in home values on assessed values. Estimating a first-differenced model controls for time-invariant county characteristics. We weight all results by the average county population. [27] When regressing on several lags, the sum of coefficients $\sum \beta_i$ reflects the correlation between previous changes in market values and current changes in net assessed values. We would expect it to be smaller than one for two reasons. First, it is an imprecise measure, built using recent transactions of residential homes, and may not accurately capture changes in the value of unsold homes or commercial real estate. Second, there are policies such as assessment limits or exemptions that lower the correlation between market value and taxable value. For example, homestead exemptions reduce the taxable assessed value of a home from its assessed value, and assessment limits may not apply to all properties similarly. Doerner and Ihlanfeldt (2011) find that the home values in Florida are strongly correlated with the tax base, but the correlation is stronger for non-homestead properties, and reflect new construction (the authors use number of parcels per capita). They also show that changes in home values are positively and statistically significantly correlated with other sources of revenues, such as federal grants or fines and fees.

[26] Note that there is no constant because the estimation is in first difference. In that context, a constant would imply constant growth in assessed value, regardless of the change in underlying market value.
[27] We use the average county population between 1990 and 2000 to estimate the weights. We cluster standard errors at the state levels.

Table 3: Home prices and assessed values

Dependent variable: Δ *Log real assessed value per capita*	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Baseline		Assessment limits				
						2000-2008	2009-2016
Δ Log Home price index (t-1)	0.47***	0.29**	0.66***	0.34***	0.65***	0.77***	0.58***
	(0.10)	(0.13)	(0.06)	(0.09)	(0.07)	(0.08)	(0.06)
Δ Log Home price index (t-1) x (Acquisition value assessment limit)			-0.29**	-0.10	-0.28**	-0.29*	-0.28*
			(0.14)	(0.20)	(0.13)	(0.15)	(0.14)
Δ Log Home price index (t-2)		0.22***		0.37***			
		(0.05)		(0.10)			
Δ Log Home price index (t-2) x (Acquisition value assessment limit)				-0.22*			
				(0.11)			
Δ Log Home price index (t-3)		0.05		0.15***			
		(0.04)		(0.03)			
Δ Log Home price index (t-3) x (Acquisition value assessment limit)				-0.05			
				(0.07)			
Δ Log Home price index (t-4)		0.08***					
		(0.02)					
Δ Log Home price index (t-1) x (Other assessment limit)					0.07		
					(0.10)		
Observations	29,566	28,954	29,566	29,208	29,566	14,748	14,818
R-squared	0.31	0.40	0.34	0.43	0.34	0.38	0.31

State-clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3, column one reports the results of regression (1). The coefficient $\beta_1 = 0.47$, implies that when home values go up by 10 percent, assessed values increase by 4.7 percent on average the following year. The distributed lag model in column (2) shows that each of the previous three lags in the change in home value have a precisely estimated impact on home values, with a combined total of 0.64, implying that when home prices go up by 10 percent, taxable values go up by 6.4 percent over time.[28]

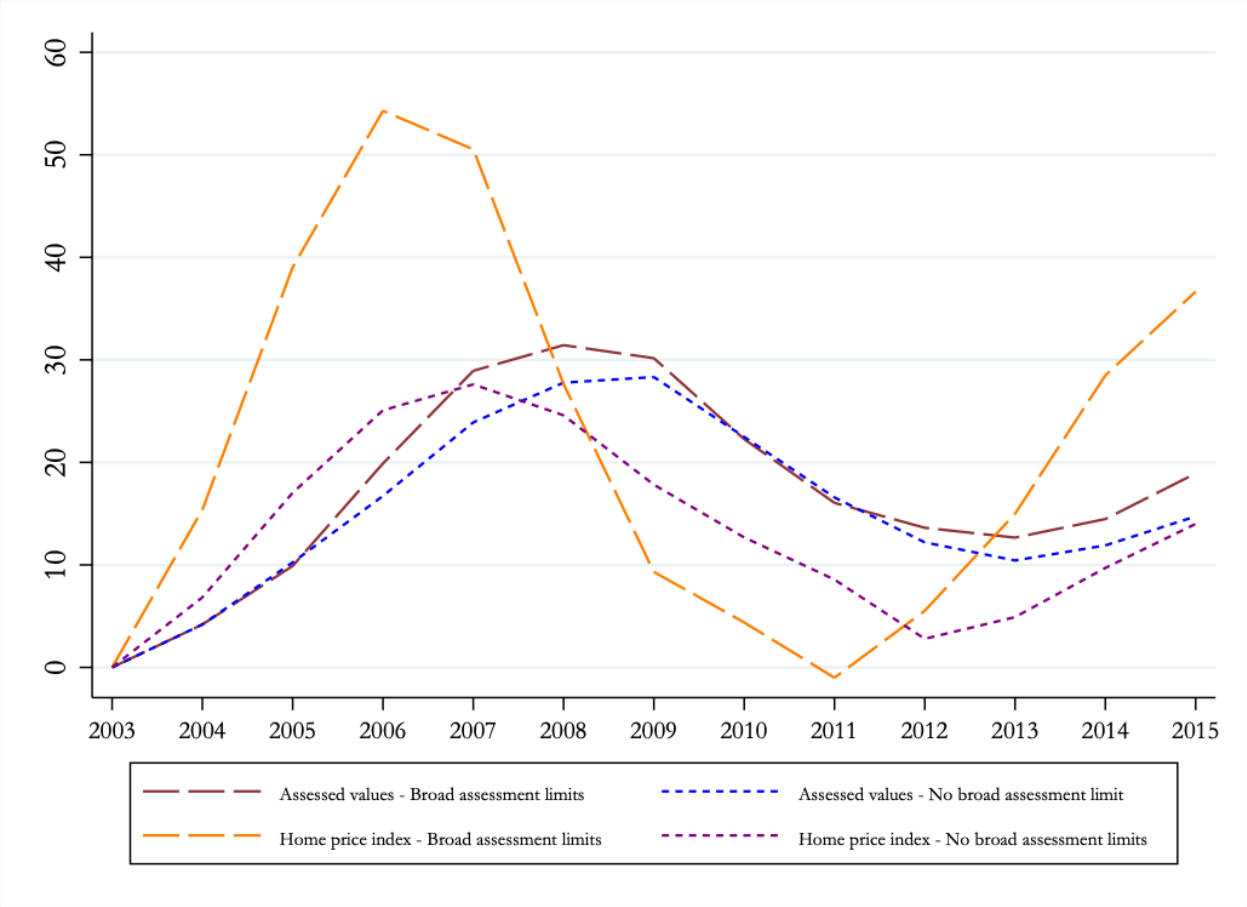
The role of assessment limits

Next, we evaluate to which extent assessment limits lower the correlation between home prices and assessed values. Figure 2 displays the average change in home values and assessed values weighted by population relative to 2003 in states with and without a broad assessment limit. In states without a broad assessment limit, there is a clear lag between home values and assessed values, by about 2-3 years, but the pattern looks very similar. In states with a broad assessment

[28] We also estimate this model using a home value price index by Zillow, which covers a smaller number of counties. We find a combined impact of 0.58, with similar coefficients.

limit, home prices are much more volatile than assessed values, which start to decline around 2010, roughly 4 years after the peak in home values.

Figure 2: Assessment limits and assessed values



Source: the home price index comes from the Federal Finance Housing Agency. Data on assessed values, property tax levies, property tax rates, and assessment limits were collected by authors. All results are weighted by the average county population.

We estimate equation (1) with an interaction term between the change in home values and whether the state has an assessment limit:

$$\Delta \log NAV_t = \sum \beta_t \Delta \log HPI_{t-1} + \sum \gamma_t \Delta \log HPI_{t-1} \times [Assessment\ limit = 1] + \varepsilon_t$$

In table 3, column (3), $\beta_1 = 0.66$, while the coefficient $\gamma_1 = -0.29$, which implies that when home values go up by 10 percent, assessed values go up by 6.6 percent the following years in areas without an assessment limit, and by 3.7 percent in areas with a traditional assessment

limit.[29] The same estimation with three lags (column 4) yields a similar qualitative conclusions, where the overall correlation is .86 in states without an assessment limit, and -.49 in states with a limit. The interaction coefficients are not statistically significant, however, indicating that the limits are not always binding, which is expected since they do not apply to new construction.[30]

We also test whether other types of assessment limits, which are unlikely to bind, have an impact (column 5) and find a small and statistically insignificant coefficient ($\gamma_1 = 0.07$), indicating that other types of assessment limitations are likely correlated with other properties of local tax systems, and are unlikely to significantly reduce the correlation between home values and taxable value.[31] Finally, we check whether the impact of assessment limits is different before 2008 and during and after the Great Recession. If assessment limits are binding in periods of home value growth, we would expect an even smaller correlation in states with strict assessment limits when home value falls, as taxable values could keep increasing as long as they are below market value or drop significantly less compared to market values. The correlation between lagged home values and the property tax base was lower between 2009 and 2016 than between 2000 and 2008 (0.58 and 0.7, respectively) in states without assessment limits, and 0.3 and 0.58, respectively, in states with assessment limits. The decline in correlation is larger in states with an assessment limit, as assessed values can keep rising as long as they are below a property's market value, even as home prices decline.[32]

Assessed values and property tax revenues

We now turn to how changes in taxable assessed values impact property tax levies. We estimate the following equation:

$$\Delta \log Levy_t = \alpha + \beta \, \Delta \log NAV_t + \varepsilon_t \qquad (2)$$

Where $\Delta \log Levy_t$ is the difference in log property tax revenue per capita.[33] As in our previous estimation, using first differences controls for time-invariant county characteristics, and all results are weighted by county population. With a rate-driven system, β should simply be equal

[29] An assessment limit that puts a cap on the maximum change in taxable value of a property within a defined period (typically a year).
[30] We followed Bradley et al. (2023) classification of broad and strict assessment limits, which can be found in seven states (California, Florida, Maryland, Michigan, New Mexico, Oklahoma, and South Carolina). However, we only have data on assessed values in four of these states (California, Florida, Michigan, and New Mexico). We also classify New York City as having an assessment limit.
[31] When estimating column 3 for states with high frequency minimum reappraisal, we find a small negative impact of other assessment limits (that includes Colorado, Georgia, Iowa, and Oregon) and a positive impact in other states with other assessment limits and lower minimum frequency reappraisal.
[32] We also test whether appraisal frequency impacts our estimates. We can't reject that coefficients in states with minimum yearly or bi-yearly reappraisals are the same as in states with less frequent minimum reappraisals. There are several reasons for this: many localities choose to reappraise at a higher frequency than the minimum required, it doesn't apply to new construction, and limits are much more important empirically.
[33] Because we use real per capita terms, we do not include a constant in the analysis, which would have assumed a constant rate of increase or decrease in property tax revenues, beyond adjustment for population or inflation.

to 1, since the rate is fixed, and the change in levy is perfectly correlated with the change in the tax base.[34] With a budget-driven system, β can vary since changes in the tax base are independent of changes in revenue needs. Theoretically, β can be negative if revenue needs increase when assessed values decrease.

We present the baseline results in table 4, column (1), where $\beta = 0.57$, which implies that on average, an increase in the tax base of 10 percent is correlated with an increase in tax revenues of 5.7 percent. To tease out whether there are asymmetric effects, we estimate:

$$\Delta \log Levy_t = \alpha + \beta_1 \log NAV_t * (\log NAV_t > 0) + \beta_2 |\Delta \log NAV_t| * (\Delta \log NAV_t < 0) + \varepsilon_t \qquad (3)$$

where we tease out the correlation between an increase and a decrease of the tax base on property tax revenues. We use the absolute value for negative changes, such that a negative coefficient for β_2 implies that there is a reduction in tax levy when assessed values go down. We find an asymmetric response, where the tax levy goes up by 6.1 percent when the tax base goes up by 10 percent, but only declines by 4.7 percent when the tax base goes down by 10 percent.[35] In columns (3) and (4), we find similar correlations when we estimate the model between 2000 and 2008 or between 2009 and 2016.

Table 4: The impact of assessed values on property tax levies

Dependent variable: Δ *Log property tax levy per capita*	(1)	(2)	(3) 2000-2008	(4) 2009-2016	(5) With controls	(6)	(7)
Δ Log Assessed value per capita	0.57***						
	(0.07)						
Δ Log Assessed value per capita>0		0.61***	0.61***	0.65***	0.46***		
		(0.07)	(0.08)	(0.08)	(0.07)		
|Δ Log Assessed value per capita<0|		-0.47***	-0.40***	-0.48***	-0.58***		
		(0.09)	(0.10)	(0.09)	(0.08)		
Δ Log HPI (t-3)						0.33***	
						(0.02)	
Δ Log HPI (t-3)>0							0.42***
							(0.03)
|Δ Log HPI (t-3)<0|							-0.24***
							(0.04)
Observations	36,143	36,143	18,103	18,040	36,128	27,248	27,248
R-squared	0.44	0.44	0.45	0.44	0.48	0.22	0.24

State-clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

[34] Empirically we could find a coefficient slightly smaller than 1, if there is tax delinquency, if net assessed values do not fully incorporate some exemptions, or if there are different rates on different type of real property (e.g., commercial vs. residential) and their relative share in the tax base changes.
[35] We can reject the hypothesis that they are the same with a 5 percent significant level, using an F-test.

In column (5), we include county-level yearly changes in personal income, wage income, employment, and demographic characteristics, and the fraction of jurisdictions' own source of revenues over total revenues, sales and income taxes, charges, and governmental transfers at the county-level, estimated between 1990 and 2000. The correlation between a positive change in assessed value and tax revenue is now smaller, and the correlation between a negative change in the tax base and tax revenue is larger in magnitude. These results highlight how county-level structural and economic differences are correlated with both assessed values and revenue needs. In a rate-driven system, controls should have no impact, but in mostly budget-driven system, several factors impact the tax levy. For example, an area that is growing rapidly and has a higher share of working-age population is likely to see an increase in assessed values through increased construction or higher value homes. Population growth may increase other sources of revenues or reduce the cost of providing public services per capita because of economies of scale, which is consistent with a smaller $\beta_1$coefficient, as controls absorb some of that positive correlation. The reverse logic applies to areas with declining values, where it may become more costly to provide public services and there is a higher revenue need from property taxes, and controlling for those factors lead to a more negative coefficient β_2. In addition, previous research (e.g., Doerner and Ihlandfeldt, 2011) suggests that changes in home prices are correlated with changes in other sources of revenues, through a variety of channels. The elasticities we estimate encapsulate the correlation between property tax policy (i.e., the presence of mileage offsetting or lack thereof) and the tax base, also taking tax limits into account in the next section. We do not tease out how other sources of revenues, property tax structures, local preferences, or local costs of public goods interplay with each other in driving policy responses to changes in the tax base. Future research could add to the literature by investigating these additional channels.

Overall, we find evidence that taxing jurisdictions adjust their millage rate to smooth out changes in property tax revenues, whether there is an increase or decrease in the tax base. The rate adjustment seems to be larger on average for declines in the tax base, but we can't statistically reject that they are equal. To put these findings in perspective with previous elasticities in the literature, we estimate the change in log property tax revenues directly on the log change home price index lagged by three years. Our results are comparable with Lutz (2008), who finds an elasticity of 0.4 between 1996 and 2005, just a little above the average elasticity (0.33) of property tax revenues with respect to home values, and slightly below the elasticity of 0.36 we estimate for positive shocks only. Alm, Buchman and Sjoquist (2011) highlight the heterogeneity in how lower home values impacted property tax revenues and find that school districts in Georgia offset declines in the tax base by increasing the millage rate, with an elasticity around -.3. When estimating model (2) in Georgia only, we find an elasticity between the tax base and property tax revenue of .63, and a millage elasticity of -.37. We further provide evidence on the claim by Lutz, Molloy, and Shan (2011), that taxing jurisdictions frequently adjust the millage rate in the opposite direction of the change in assessed values. Our findings also more generally confirm Cromwell and Ihlanfeldt's (2015) argument that the impact of the Great Recession on local governments' budgets was delayed, mostly because of the lag between changes in home

values and taxable assessed values. Once controlling for the tax base directly, there is a statistically significant decline in tax revenues when assessed values decline. They report an elasticity between the millage rate and the property tax base of -.27 for cities in Florida, while we find a similar elasticity of -.25 for aggregated property tax revenues at the county level.[36] Next, we further explore the role of property tax limits, and other aspects of property tax structure on the relationship between the tax base and property tax collection.

Property tax limits and tax revenues

We start by looking at the impact of rate limits, which are most likely to bind when assessed values go down. Given the wide variation of rate limits, having a sense of how stringent they are is important. Measuring stringency is a complex task given their diversity, and the number of factors that can increase or decrease the likelihood of a particular rate limit being more or less strict. As in Bradley et al. (2023), we start by estimating the rate limit at the state level. When states have different limits across taxing jurisdictions, we simply add them up. We adjust for assessment ratios to have an effective rate on the assessed value (see figure A2 in the appendix).[37] Rate limits can take the form of a maximum effective rate at the property level, or a maximum mill rate in each jurisdiction. We define broad rate limits as limits that apply to all jurisdictions (e.g., Ohio has a 10 mill limit for cities, school districts and counties), or apply at the individual property (e.g., California 1 percent maximum effective rate).[38]

However, the effective rate limit is not necessarily a good indicator of stringency. In several states, the limit is not binding, or does not apply if the increase in the tax rate funds specific purposes like debt service or special education spending.[39] We use data from the American Community Survey to estimate the average effective tax rate on newly purchased homes between 2000 and 2010.[40] We find that in several states the average effective rate is much higher than the rate limit, an indication that the limit is generally not binding (e.g., Alabama, Georgia, Illinois, Ohio). However, going above these limits usually requires a vote, or earmarking for specific expenditures. In our context, it is unclear whether policymakers in jurisdictions with historically higher tax rates than the limit can as easily offset declines in the tax base as in other jurisdictions.

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[36] Cromwell and Ihlanfeldt used data between 1995 and 2011. Interestingly, we find a symmetric elasticity between the millage rate and increases and decreases in the tax base when restricting the analysis until 2010. When we use the full sample (2000-2106), and a positive impact of -.3, but .18 with a negative impact, an indication that millage offsetting in Florida was less prevalent after 2010.

[37] For example, Georgia imposes a maximum mill rate of 20 on school district and has an assessment ratio of 40, which means that the effective limit on assessed taxable value is 0.8%.

[38] We estimate some regression for limits with high or low rates and find no indication that the rate by itself impacts the elasticity between assessed values and property tax levy.

[39] Alabama imposes maximum mill rate for the statewide property tax and for cities and counties, but school districts have a minimum millage rate. In addition, residential properties have a maximum effective tax rate of 1 percent. In practice, the effective tax rate in Alabama is often much higher than the estimated maximum millage rate combining different limits across jurisdictions, highlighting the total millage limit is not binding.

[40] We use whether the respondent moved into their homes within the past two years as a proxy for a newly purchased home.

Two other factors that determine the stringency of rate limits are local property values and other types of limits. The same rate is more likely to bind in areas with lower property values since a higher rate is necessary to raise the same levy.[41] Rate limits in areas with strict assessment limits are usually more stringent, as governments need to raise the property tax rate whenever they wish to increase the levy beyond the growth in assessed values. That issue compounds over time, and unless the taxing jurisdictions increase their reliance on other sources of revenues or cut expenditures, the tax rate will slowly converge toward the limit. Figure A3 in the appendix plots the evolution of real per capita property tax revenue relative to 2003 in states with a broad rate limit and a strict assessment limit compared to states with a broad limit but no assessment limits and other states – highlighting different patterns.

Similarly, levy limits widely vary by their stringency and whether governments can override them under certain conditions or with a majority of the electorate. Appendix figure A2 shows the variation in the rate of growth allowed under the levy limit. We classified levy limits into stringent and most stringent. Most stringent levy limits have a maximum allowed growth rate at or below 3 percent or limited to inflation. States with a limit between 3 and 5 percent are classified as stringent. We exclude states where the limit does not apply to all jurisdictions or is not binding (the classification is shown in figure A2).[42] This is especially important in states with truth of taxation, a law where increases in tax levy above a certain threshold, often the previous' year levy plus inflation and taxes from new construction, automatically trigger notices to the taxpayers, public hearings, and sometimes referendums. Jurisdictions operating under a levy limit may respond very differently to changes in the tax base. First, a levy limit by itself does not put any restriction on millage offsetting, such that it is easy for policymakers to maintain tax revenue when the tax base declines. Second, if levy limits are associated with smaller effective property tax rates, and smaller increases in tax revenues when the tax base goes up, it may be politically easier for policymakers to increase tax revenue during economic downturns.

To have a sense of how the presence of different rate limits impacts the correlation between levy and assessed values, we estimate models (2) and (3) adding an interaction term between changes in assessed values and the presence of a limit. Table 5, column (1) shows that in states without a rate limit, an increase in 1 percent in the assessed value is associated with an increase in tax levy of about 0.35 percent in areas without a rate limit, but almost twice as large (0.67 percent) in

[41] Although the cost of public goods and public expenditures are likely higher in areas with higher home values, the relationship is unlikely to be linear, so that for the same amount of public spending adjusting for local cost of living, areas with low property values are more likely to need a higher property tax rate.

[42] For example, the levy limit in New York does not apply to New York City or school districts. In Virginia, the levy limit is 1 percent, but an increase above only requires public hearings, not a vote.

Table 5: Property tax levy and limits

Dependent variable: Δ Log property tax levy per capita	(1)	(2)	(3)	(4)	(5)	(6)
Δ Log Assessed value per capita	0.35***		0.63***		0.41***	
	(0.04)		(0.07)		(0.06)	
Δ Log Assessed value per capita>0		0.39***		0.69***		0.39***
		(0.05)		(0.07)		(0.05)
|Δ Log Assessed value per capita<0|		-0.21**		-0.52***		-0.44***
		(0.09)		(0.10)		(0.08)
Δ Log Assessed value per capita x (Any rate limit)		0.37***				
		(0.10)				
Δ Log Assessed value per capita>0 x (Any rate limit)		-0.44***				
		(0.13)				
|Δ Log Assessed value per capita<0| x (Any rate limit)	0.32***					
	(0.08)					
Δ Log Assessed value per capita x (More stringent levy limit)			-0.29***			
			(0.10)			
Δ Log Assessed value per capita>0 x (More stringent levy limit)				-0.34***		
				(0.09)		
|Δ Log Assessed value per capita<0| x (More stringent levy limit)				0.20		
				(0.13)		
Δ Log Assessed value per capita x (Acquisition value assessment limit)					0.37***	
					(0.08)	
Δ Log Assessed value per capita>0 x (Acquisition value assessment limit)						0.33***
						(0.10)
|Δ Log Assessed value per capita<0| x (Acquisition value assessment limit)						-0.41***
						(0.09)
Observations	36,143	24,149	36,143	36,143	36,143	36,143
R-squared	0.46	0.50	0.46	0.46	0.45	0.45

State-clustered standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

states with a rate limit. The asymmetric results indicate that the presence of a rate limit increases the correlation for both increases (0.39 without a rate limit and 0.76 with a rate limit) and decreases (-0.21 without a rate limit and -0.65 with a rate limit) in the tax base. While the larger decline in magnitude with negative shocks is consistent with rate limits binding when assessed values go down, the stronger correlation with positive shocks indicates other structural aspects of property taxation could be correlated with rate limits. For example, strict assessment limits combined with a rate limit may be binding even in times of home value growth, effectively creating a mostly rate-driven system, where the rate stays at or near the limit and changes in tax levy are highly correlated with changes in taxable values.

Columns (3) and (4) highlight the impact of a levy limit. The presence of a levy limit lowers the correlation between assessed values and tax revenues (from 0.63 to 0.34), consistent with the theory that levy limits force lawmakers to smooth out shocks in the tax base. Intuitively, when the tax base goes up, the limit is more likely to bind, and when assessed values go down, governments may be less willing to adjust levies downward for several reasons. First, strict levy

limits can create a "ratchet" effect any time revenues go down (or increase by much less than the maximum allowed growth), making it difficult for governments to get back to previous revenue levels. In addition, it is politically easier and less salient, as keeping the tax levy stable implies that the amount of property taxes paid by homeowners stay the same, even though the effective tax rate goes up. In the asymmetric regression, the correlation between a positive increase in the tax base in states without a levy limit is 0.69, and -0.52 for a decrease in the tax base, but only 0.35 and -0.32 in areas with a levy limit. The interaction term for positive shocks is precisely estimated and statistically significant, while the interaction with negative shocks is not, consistent with the theory. However, we cannot yet rule out other factors that may be correlated with levy limits and impact these results.

Finally, the interaction between changes in assessed values and the presence of a broad assessment limit shows results closely align with those looking at the presence of rate limits. However, every state that has a broad and potentially constraining assessment limit also has a rate limit, so we can only evaluate their impact jointly.[43]

We further investigate how the combination of limits affects estimated elasticities. In table 6, we present the total elasticity (combining the baseline impact and the interaction with limits) for states with different sets of limits.[44] The first column evaluates assessment and broad rate limits only while the second column includes most stringent levy limits (which we define as a levy limit on growth of 3 percent or less). States with only a broad rate or assessment limit do not differ substantially from states without either limit. However, states with both a broad rate and assessment limit have much larger elasticities (0.87 with respect to increases in the tax base, compared to 0.5 in other states and -0.73 with respect to decreases in the tax base, compared to -0.25 in other states). When incorporating levy limits, we find a smaller elasticity in absolute value (0.39 in states with only a levy limit compared to 0.56 to 0.88 in other states). This suggests that a levy limit is associated with smoother increases in tax levy following an increase in the tax base, as theory predicts. However, we cannot reject the null hypothesis that states without levy limits have the same elasticity as states with levy limits, highlighting that the limits may only be restrictive in specific counties and states and/or during specific periods of growth.

[43] We also estimate our model for rate limits that we do not characterize as broad, that is as applying to all levels of governments or at the property level. We find a smaller but not statistically different response to positive shocks in states with a broad limit and in states with a non-broad limit. However, the presence of assessment limits likely is driving many results. Removing states where we estimate the rate limit to be non-binding does not significantly alter the results. Similarly, we find similar elasticities when restricting the sample to the bottom or quarter half in terms of decline in assessed value between 2008 and 2013. We also estimate the model separately for states with and without Truth in Taxation. In states without Truth in Taxation and no rate limit, there is imperfect millage offsetting on average, and a decrease of 10 percent in the tax base is associated with a decrease of 3.2 percent in tax revenues. However, states that have both a broad rate limit and Truth in Taxation have stronger and symmetric responses to changes in the tax base, with an average elasticity of 0.68.

[44] Only Arkansas, Colorado, and NYC are classified as having broad assessment limits but no broad rate limits.

Table 6: Property tax levy and limit interactions

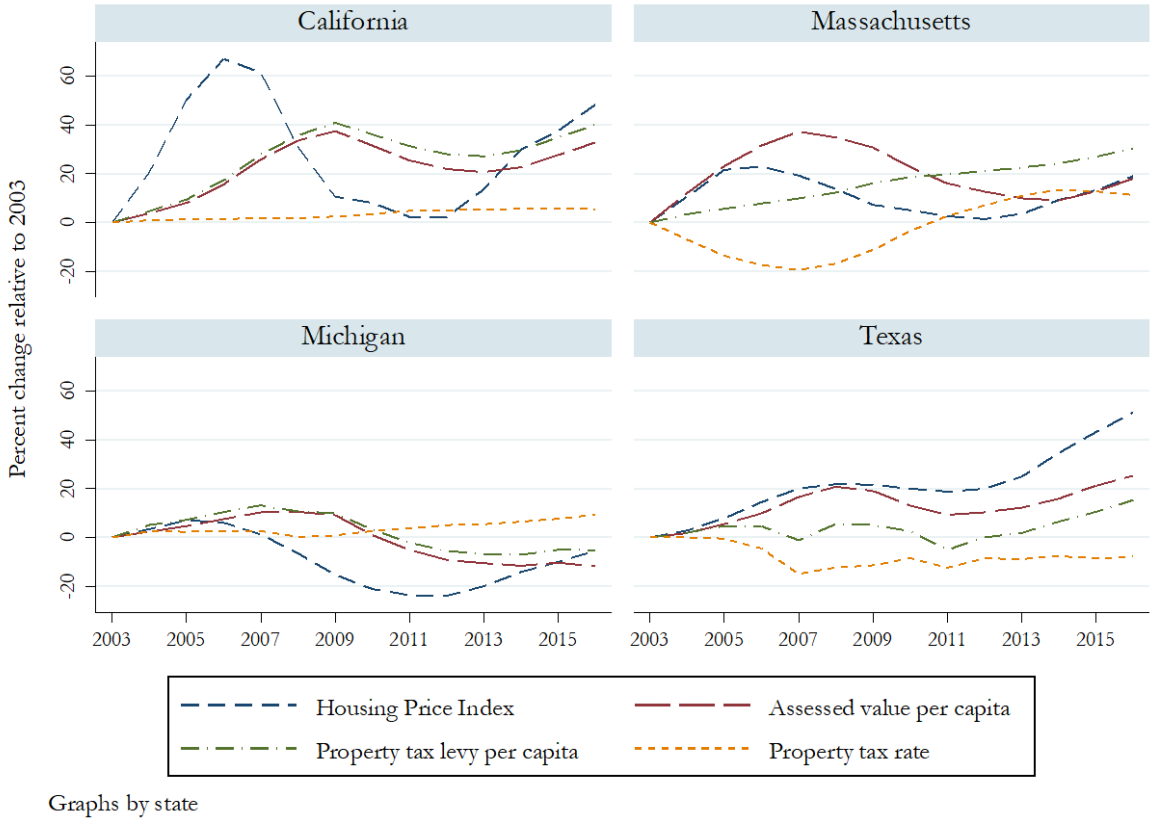
Dependent variable: Δ Log property tax levy per capita	Limits considered	
Full elasticity by type of limits in each state	Broad rate limits and assessment limits	Broad rate limits, stringent levy limits, and assessment limits
	NO limits	
Δ Log Assessed value per capita>0	0.50	0.59
	(0.06)	(0.06)
|Δ Log Assessed value per capita<0|	-0.25	-0.40
	(0.08)	(0.10)
	Rate limit but NO assessment limit	*Rate limit but NO assessment/levy limit*
Δ Log Assessed value per capita>0	0.54	0.56
	(0.14)	(0.12)
|Δ Log Assessed value per capita<0|	-0.44	-0.49
	(0.19)	(0.19)
	Assessment limit but NO rate limit	*Assessment limit but NO rate limit*
Δ Log Assessed value per capita>0	0.60	
	(0.17)	NA
|Δ Log Assessed value per capita<0|	-0.42	
	(0.21)	
	Rate limit AND assessment limit	*Rate limit AND assessment limit but NO levy limit*
Δ Log Assessed value per capita>0	0.87	0.88
	(0.14)	(0.15)
|Δ Log Assessed value per capita<0|	-0.73	-0.78
	(0.11)	(0.15)
		Rate and levy limit only
Δ Log Assessed value per capita>0		0.53
		(0.22)
|Δ Log Assessed value per capita<0|		-0.39
		(0.32)
		Levy limit only
Δ Log Assessed value per capita>0		0.38
		(0.12)
|Δ Log Assessed value per capita<0|		-0.24
		(0.15)

Robust standard errors in parentheses.

Case study

To illustrate the variation across states with different property tax structures and housing markets, we present detailed results for four states: California, Massachusetts, Michigan, and Texas.

Figure 4: State-specific outcomes



California is notorious for its proposition 13, which limits the growth of a property's taxable value to the lower of inflation or 2 percent and imposes a maximum effective tax rate of 1 percent on real property. Table 7 highlights how the assessment limit lowers the correlation between home values and taxable values. Although California does not have a levy limit, the assessment limit and low property rate limit can quickly create highly binding conditions over time. For example, even if a jurisdiction has a tax rate below 1 percent, every time it increases tax revenue over the rise in taxable value, the effective tax rate gets closer to the limit and imposes a fixed rate-driven system. By the early 2000s, the rate limit was likely widely binding, as shown in table 8, which finds a correlation of 1 between property tax revenues and taxable values. The coefficient associated with a negative shock is slightly smaller, which can be explained if some jurisdictions were able to slightly increase the tax rate or rely on special local taxes approved through referendum. Figure 4 shows that after 2009, the property tax levy

Table 7: Case study - home values and taxable assessed values

Dependent variable: Δ Log assessed value per capita	(1) California	(2) Massachusetts	(3) Michigan	(4) Texas
Δ Log Home price index (t-1)	0.04**	0.38***	0.02	0.74***
	(0.02)	(0.02)	(0.05)	(0.07)
Δ Log Home price index (t-2)	0.23***	0.45***	0.21***	0.22***
	(0.02)	(0.04)	(0.03)	(0.07)
Δ Log Home price index (t-3)	0.16***	0.24***	0.28***	-0.12*
	(0.01)	(0.04)	(0.02)	(0.06)
Observations	967	236	1,120	2,180
R-squared	0.74	0.87	0.57	0.29

County clustered standard errors in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

declines a bit less than taxable values, while the average mill rate increases slightly and then stabilizes around 2011/2012.

Massachusetts is another notorious state for its property tax limit, known as Proposition $2\frac{1}{2}$, which caps the maximum effective tax rate on a property to 2.5 percent, and limits the yearly growth of levies to 2.5 percent, excluding new construction. However, the rate limit is much higher than California, and there is no assessment limit. Table 7 confirms that the correlation between lagged changes in home values and taxable value is very high. As home prices and taxable values were rising, the tax rate was adjusted downward, and the growth of property taxes was slow and steady. After 2008, the state also saw a significant decline in real estate value and the tax base, however, the decline was fully offset by an increase in the tax rate. Table 8 shows that the millage offset was larger than necessary to maintain constant taxes, and the tax levy rose as the tax base eroded. Local governments may have been wary of not taking advantage of the yearly allowed increase of 2.5 percent since any missed opportunity compounds over time. The case of Massachusetts also highlights how a maximum effective tax rate without assessment limits and in an area with high economic growth, where jurisdictions can operate under a budget-driven system, and where the restriction depends on the difference between inflation and the levy limit, is very unlikely to be binding.

Quite the opposite to Massachusetts, Michigan is a fascinating example to illustrate how specific property tax limits can have long-lasting consequences. Local jurisdictions in Michigan do not impose sales or income taxes (except for Detroit and a couple of other cities) and are highly reliant on property taxes (including the state property tax that is transferred to local jurisdictions to fund education), transfers and charges. Michigan has had some of the highest property taxes in recent history, due to lower-than-average home values, a trend that was exacerbated by the Great Recession. Since 1978, the Headlee Amendment limits increases in the levy on the existing tax base to the rate of inflation. In 1994, Proposal A instituted a cap on the annual increase in the taxable assessed value for each property of the lesser of 5% or the rate of inflation, which is

Table 8: Case study - The impact of assessed values on property tax levies

Dependent variable: Δ Log property tax levy per capita	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	California		Massachusetts		Michigan		Texas	
Δ Log Assessed value per capita	1.00***		0.35***		0.81***		0.66***	
	(0.01)		(0.05)		(0.02)		(0.05)	
Δ Log Assessed value per capita		1.04***		0.47***		0.92***		0.68***
		(0.02)		(0.05)		(0.04)		(0.04)
|Δ Log Assessed value per capita<0|		-0.85***		0.37***		-0.78***		-0.58***
		(0.04)		(0.02)		(0.02)		(0.09)
Observations	986	986	236	236	1,162	1,162	4,065	4,065
R-squared	0.94	0.95	0.27	0.45	0.75	0.75	0.31	0.31
Separate regressions								
Δ Log HPI (t-3)	0.33***		0.38***		0.35***		0.35***	
	(0.01)		(0.07)		(0.02)		(0.07)	
Δ Log HPI (t-3)>0		0.49***		0.59***		0.28***		0.62***
		(0.01)		(0.08)		(0.06)		(0.09)
|Δ Log HPI (t-3)<0|		-0.15***		0.30***		-0.36***		0.57***
		(0.02)		(0.02)		(0.03)		(0.19)
Observations	967	967	236	236	1,120	1,120	2,151	2,151
R-squared	0.51	0.64	0.26	0.54	0.34	0.35	0.02	0.07

County clustered standard errors in parenthesis
*** p<0.01, ** p<0.05, * p<0.1

relaxed when the property is transferred. Michigan also has a rate limit of 15 mill, which excludes debt service, but voters can override the limit through referendum.

Figure 4 highlights the trends in home values and property taxes between 2003 and 2015. Unlike in most areas of the country, home values did not increase much until 2008, and went tumbling down afterward. By 2016, home prices – adjusted for inflation – were still below their 2003 level. Taxable values peaked in 2009 before dropping almost 20 percent in real terms by 2015, and property tax collections followed. The rate limit restrained quick adjustment of the tax rate to make up for the decline in the tax base, and the levy and assessment limit created a ratchet effect, locking in local governments at assessed values and tax levies at much lower levels than 2008. Table 9 illustrates the smaller correlation (about 0.5) between current taxable value and changes in home values over the previous 3 years. Table 8 presents the correlation between the tax base and property tax revenues, which is large for both positive and negative shocks.

Texas is another fascinating example of a state with many tax limits, but where the design and application of the limits still leaves room for local flexibility. Texas is also one of the states with the highest reliance on property taxes, which fund a large share of city, county, and school districts budgets. The structure of rate limits in Texas is complex and varies across jurisdictions and what type of spending the levy funds. However, a rate higher than the limit can be usually adopted by a majority vote of the electorate. Texas also caps the yearly increase in the taxable value of a primary residence to 10 percent, and the taxable value cannot exceed the estimated

market value. Texas operates under the concept of Truth in Taxation and has a levy limit, which mandates local jurisdiction inform taxpayers of proposed changes in the tax rate, as well as hold public hearings. If the proposed change is above a certain limit, it triggers a referendum. Until 2019, the maximum yearly rate increase that does not trigger a vote was 8 percent, meaning that taxing districts could apply a rate up to 8 percent higher than the rollback rate – the rate at which the levy in the new fiscal year is the same as the previous year, excluding new construction.

Unlike most areas of the country, Texas did not experience a large drop in home values after the Great Recession. Figure 4 shows a very small decline and stable values in real term between 2008 and 2012. However, the tax base fell slightly (the difference can be explained by the large number of counties with lower population that are not covered by the home price index).[45] Overall, Texas seems to operate under a mixed rate system, where millage adjustment is small and varies across jurisdiction and over time. Truth in taxation also implies that taxpayers are highly aware of an increase in the tax rate, even if the actual taxes collected on their property is unchanged. Taxing districts may have been less willing to fully offset declines in the tax base during a period of laggard economic growth.

Conclusion

Leveraging a database on total property tax levies and taxable assessed values of real property aggregated at the county level for almost 40 states, we analyze the relationship between assessed values and home prices, and between property tax revenues and assessed values. We show that changes in assessed values lag home prices, and that the correlation varies across states. A 10 percent increase in home values leads on average to a 6 to 7 percent increase in assessed values after 3 to 4 years. Infrequent mandatory reappraisal adds on average a small lag between home prices and the property tax base compared to more frequent mandatory reappraisal but has little impact. The presence of broad assessment limits significantly reduces the correlation between home values and assessed values. Other types of assessment limits, like local options or limits restricted to a small subset of property owners have no aggregate impact.[46] These findings are consistent across states and time periods.

We find an average elasticity between real assessed values per capita and real property taxes per capita of 0.57 between 2000 and 2016, further evidence of the property tax typically being a "residual" tax, where policymakers offset variations in the tax base by adjusting millage rates in the opposite direction. We find a stronger correlation for positive shocks (0.61) than for negative shocks (-0.47), indicating taxing districts intervene more for large declines than large increases

[45] We weighted all variables by county population.
[46] The only exception is New York City, which significantly impacts the results for New York state. We code assessment limits specifically for NYC.

in the tax base. Importantly, we find no evidence that these elasticities differed after the Great Recession. We document wide variation in responses across states and explore the role of property tax limits and property tax structure.

Rate limits, which are more likely to bind when the tax base goes down, are associated with a stronger correlation between assessed values and property tax revenues, for *both* positive and negative shocks to the tax base. A major driver of this result is the presence of assessment limits, which can make rate limits more stringent by restricting both the rate and the tax base. States with an assessment limit have much higher elasticities – above 0.85 for positive shocks and larger than -0.7 in magnitude for negative shocks – indicating that policymakers have little ability to offset negative shocks, and less or no need to offset increases in assessed values. Essentially, the combination of rate and assessment limits implies taxing districts are operating in a mostly rate-driven system. Caps on maximum effective tax rates, as in California or Massachusetts, are unlikely to be constraining when home values are increasing and in the absence of assessment limits.

Levy limits are associated with smoother changes in property tax revenues and a smaller correlation between the tax base and tax levy, for both positive and negative shocks, where the impact of negative shocks is mostly driven by rate limits. We find evidence that stringency significantly matters for levy limits, and more stringent limits are effective at capping upward swings in tax levies when the tax base increases. In the absence of broad rate limits, the relationship between lower assessed values and property tax revenues looks similar in states with and without levy limits. Overall, levy limits are associated with budget-driven systems, allowing policymakers flexibility under general constraints.

We show specific outcomes in four states with notorious but very different property tax structures: California, Massachusetts, Michigan, and Texas. Massachusetts, which operates under a levy limit of 2.5 percent in growth of total levy and a 2.5 maximum effective tax rates had slow but steady increases in real tax revenues between 2000 and 2016, with strong millage offsetting. California all but operated under a purely rate-driven system, as the assessment and rate limit of Proposition 13 severely constrained local governments. Michigan is an example of the uniquely constraining combination of more stringent assessment, rate and levy limits following a period a steep and rapid decline in home prices. The strain of the Great Recession on tax collections, including property taxes in Michigan, has been well documented: assessed values declined following plummeting home prices, with few millage rate adjustments to avoid a large decline in property tax revenues. As home prices started recovering around 2012, many taxing districts were stuck with much lower assessed values and revenues compared to before the crisis, and the inability to catch up because of the levy and assessments limits. Although Texas also operates under all three limits, none of them seem to be generally binding, allowing more local flexibility. However, Texas has a high reliance on property taxes, and operates under Truth of Taxation, making increases in tax levy more salient. We show that there is some decline in property tax

revenue right after the Great Recession, but not a break in the trend, as real property taxes per capita mostly stagnated in the few years before 2008. Texas is a great example of a mixed-system where local governments operate under a somewhat flexible budget-driven system, with limits and structures that can move it closer to a rate-driven system depending on economic conditions and jurisdictions.

The Great Recession was a once-in-a-lifetime housing crisis, which had broad ramifications on local economies and government finances beyond the housing market and property taxes. While most limits were introduced before 2000, many in the 1980s, following the property tax revolt in California that brought proposition 13, current surges in home values create uniquely new challenges for lawmakers, and some areas see renewed desires for new or more stringent limits (e.g., in 2023, lawmakers in Texas proposed lowering the maximum annual growth of taxable value of property from 10 to 5 percent). Our analysis and other findings in the literature show that limits can have unexpected effects on the cyclicality of tax collection for both policymakers and homeowners. More research on the role of property tax limits over time, as well as their relationship with local preferences, autonomy, and other sources of revenues, could shed light on how to improve how these important policies are designed.

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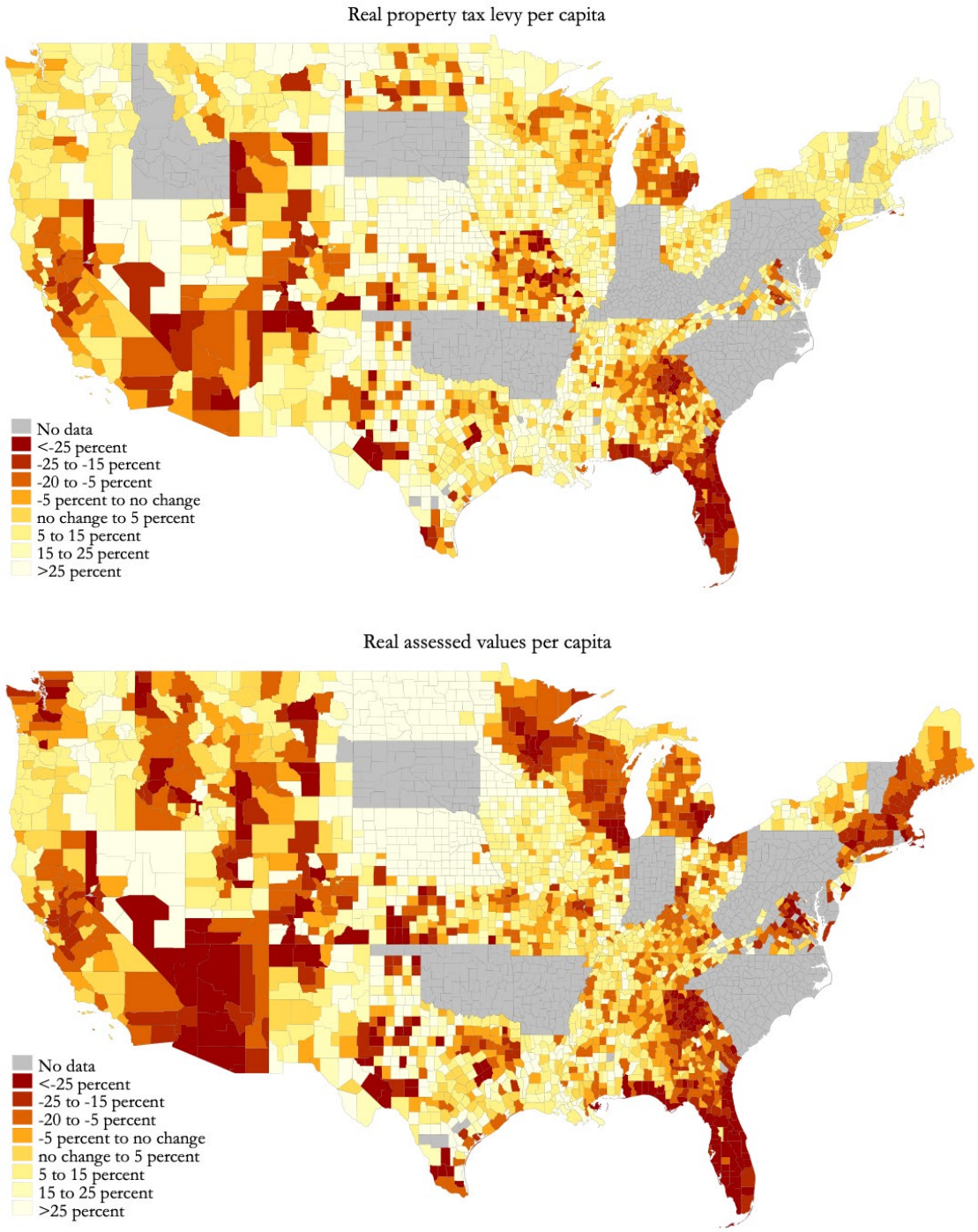
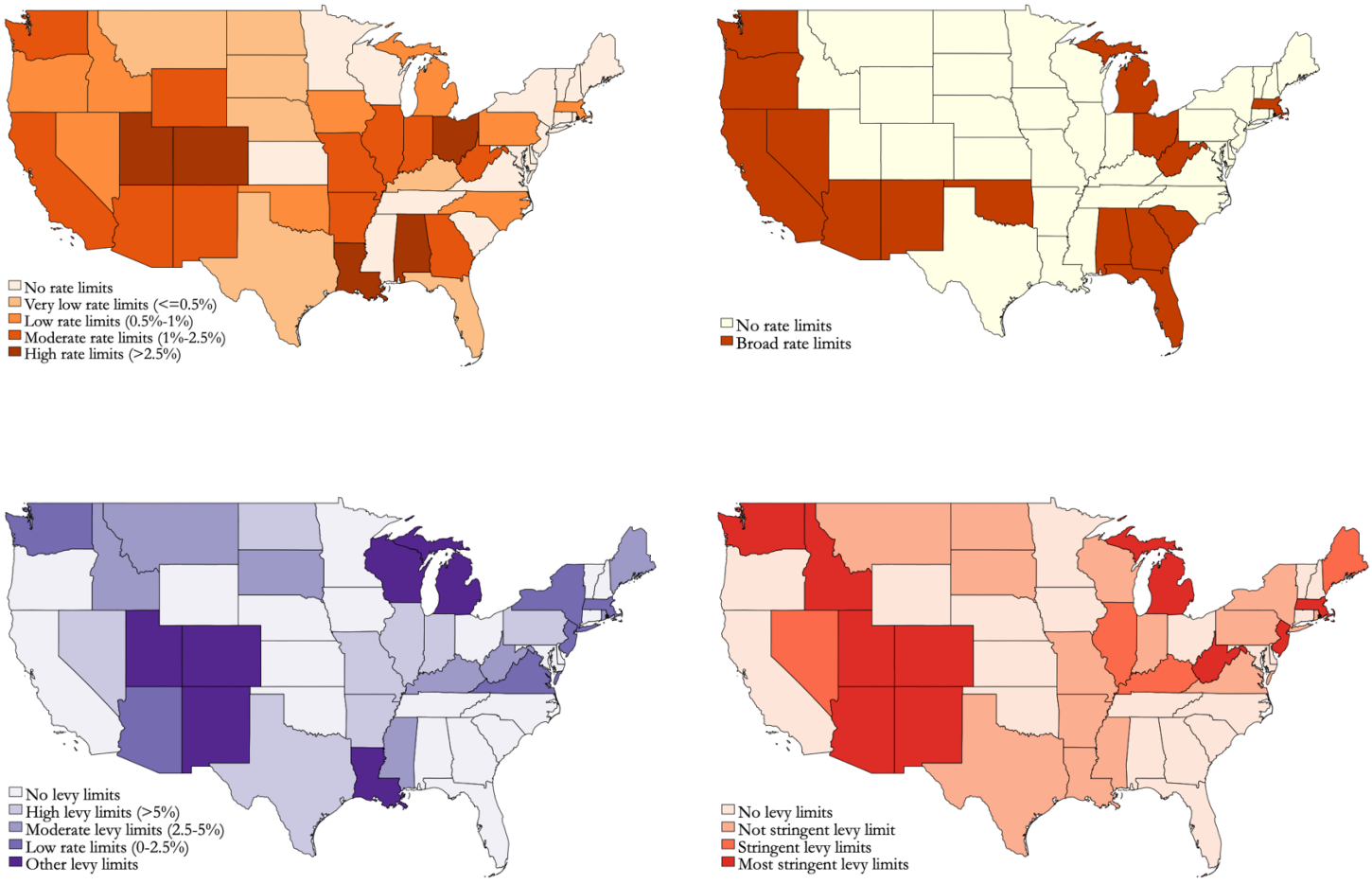
Appendix A

Figure A1: Changes in levy and assessed values per capita (2008-2015)



Note: Levy and assessed values per capita are in real terms, in 2015 USD.

Figure A2: Rate and levy limits by state



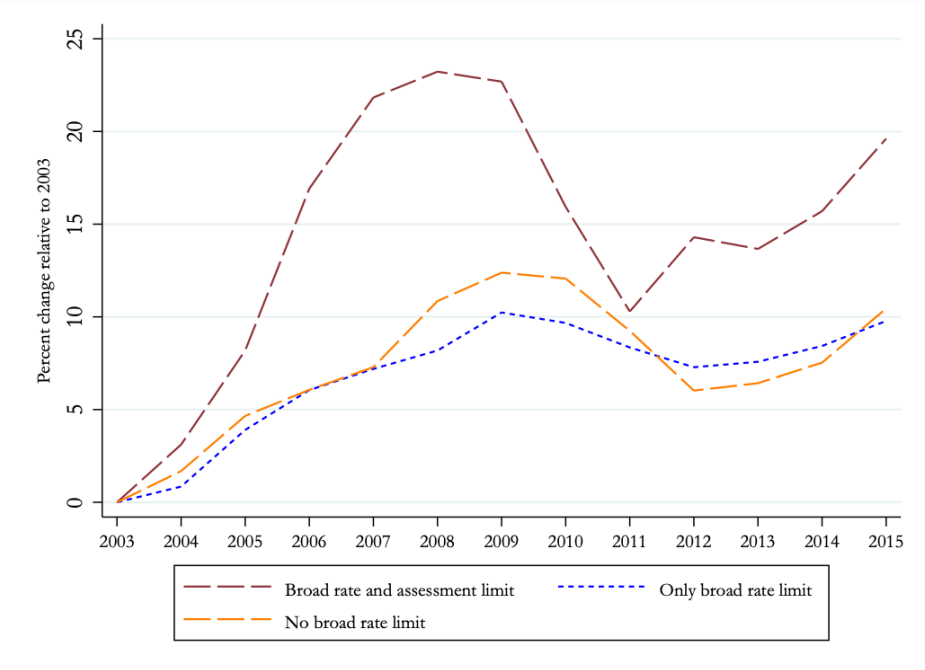
Note: The rate limits are adjusted for assessment ratio so that the effective rate is per $100 dollar of taxable assessed value. We classify broad rate limits as a maximum effective rate on individual property (e.g., 1 percent in California), or when there is there is a maximum rate limit for all local jurisdictions (e.g., Alabama).

The rate for levy limits typically excludes exceptions for new growth. "Other levy limits" include states that have automatic referendums when the levy exceeds the previous year's levy (usually with an adjustment for inflation) such as in Michigan or New Mexico or limited to the increase in assessed values (e.g., Wisconsin).

We define most stringent levy limits as a levy limit that has no exceptions other than through referendum, that is 3 percent or less, or limited to inflation. Stringent levy limits are limits with a rate between 3 and 5 percent.

Figure A3: Real property tax levy per capita

Percent change in real property tax levy per capita



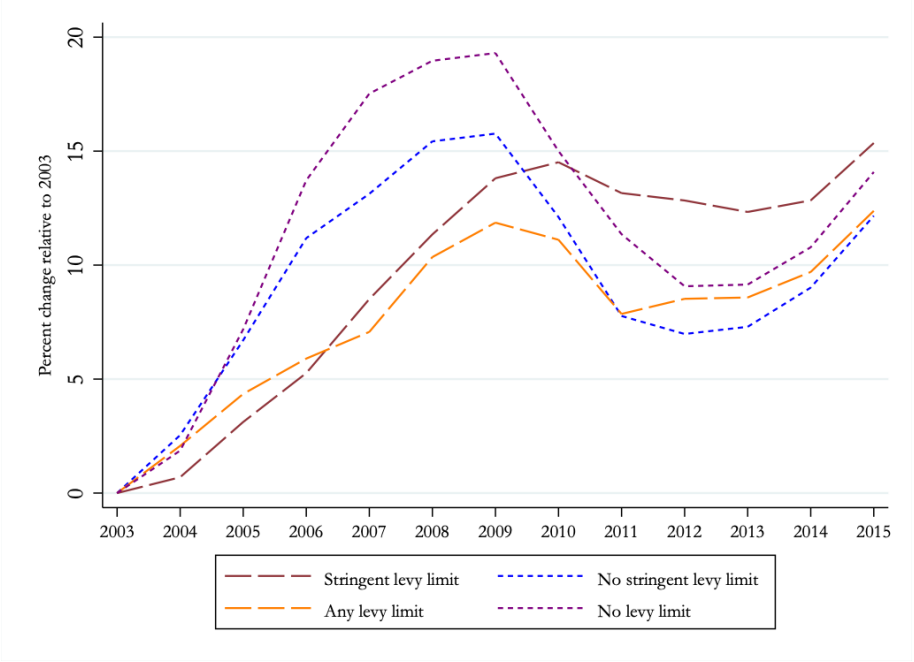


Table A1: Data collected by state

	Tax rate	Assessed taxable values	Property tax levy	Years available	Aggregated
Alabama	x	x	x	2000-2017	
Arizona	x	x	x	1999-2017	
Arkansas	x	x	x	2005-2018	
California	x	x	x	1998-2016	
Colorado	x	x	x	2001-2018	
Connecticut	x	x	x	1991-2017	x
Delaware	x	x	x	1996-2015	x
Florida	x	x	x	1999-2019	
Georgia	x	x	x	1994-2019	
Idaho	x	x	x	2001-2009	
Illinois	x	x	x	1990-2018	
Indiana	x			1998-2016	x
Iowa	x	x	x	1999-2016	
Kansas	x	x	x	1987-2018	
Kentucky	x	x	x	1999-2018	x
Louisiana	x	x	x	2002-2017	
Maine	x	x	x	2001-2016	
Maryland	x			2002-2016	x
Massachusetts	x	x	x	1981-2017	
Michigan	x	x	x	2004-2016	
Minnesota	x	x	x	2000-2017	
Mississippi	x	x	x	1995-2019	
Missouri	x	x	x	2000-2019	
Montana	x	x	x	1985-2015	
Nebraska	x	x	x	1997-2020	
Nevada	x	x	x	2000-2017	
New Hampshire	x	x	x	2001-2017	
New Jersey	x	x	x	1997-2017	x
New Mexico	x	x	x	2003-2020	
New York	x	x	x	2002-2018	
North Carolina	x			1991-2017	x
North Dakota	x	x	x	1997-2017	
Ohio	x	x	x	1990-2019	
Oklahoma		No data			
Oregon	x	x	x	2001-2016	
Pennsylvania	x			1988-2018	x
Rhode Island	x			2000-2017	x
South Carolina		No data			
South Dakota		No data			
Tennessee	x	x	x	2000-2017	
Texas	x	x	x	1999-2017	
Utah	x	x	x	2000-2019	
Vermont	x	x	x	2004-2012	
Virginia	x	x	x	1991-2017	x
Washington	x	x	x	2001-2019	
West Virginia	x			2003-2017	x
Wisconsin	x	x	x	1989-2018	
Wyoming	x	x	x	1998-2016	x

Note: The column Aggregated indicates whether the data was collected at the county level or for at the taxing district level, and then aggregated for all counties.

Table A2: Property tax structure (2010)

	Broad assessment limitation	Other assessment limits	Truth in taxation	Any rate limit	Broad rate limit	Any levy limit	More stringent levy limit	Appraisal frequency
Alabama				x	x			1
Arizona	x*		x	x	x	x	x	1
Arkansas	x	x		x				5
California	x			x	x			1
Colorado	x	x		x		x	x	2
Connecticut		x						5
Delaware			x					
DC		x						1
Florida	x		x	x	x			1
Georgia		x	x	x	x			1
Idaho				x		x	x	1
Illinois		x		x		x	x	4
Indiana				x				4
Iowa	x	x		x				2
Kansas								1
Kentucky			x	x			x	1
Louisiana				x		x		4
Maine							x	
Maryland	x		x					3
Massachusetts				x	x	x	x	5
Michigan	x			x	x	x		1
Minnesota								1
Mississippi						x		4
Missouri			x	x		x		2
Montana				x		x		2
Nebraska				x				1
Nevada				x	x	x		5
New Hampshire								5
New Jersey						x	x	
New Mexico	x			x	x	x	x	1
New York	x**	x				x		
North Carolina				x				8
North Dakota			x	x		x		1
Ohio				x	x			3
Oklahoma	x			x	x			1
Oregon	x	x		x	x	x		1
Pennsylvania				x				
Rhode Island								9
South Carolina	x				x			5
South Dakota				x		x		1
Tennessee			x					6
Texas		x	x	x		x		3
Utah			x	x		x	x	5
Vermont								1
Virginia			x				x	4
Washington				x	x		x	1
West Virginia				x	x	x	x	1
Wisconsin						x		5
Wyoming				x				1

Note: *(Arizona introduced the assessment limit in 2012 and we treat it as absent in previous year in the analysis)

** New York City and Nassau county have an assessment limit but not the rest of the state

Table A3: Property tax levy and limit interactions

Dependent variable: Δ Log property tax levy per capita	(1) Broad rate limits Assessment limit	(2) Broad rate limits Any levy limit	(3) Broad rate limits Stringent levy limit	(4) Broad rate limits Assessment limit Stringent levy limit
Δ Log Assessed value per capita>0	0.50***	0.52***	0.57***	0.59***
	(0.06)	(0.09)	(0.05)	(0.06)
|Δ Log Assessed value per capita<0|	-0.25***	-0.33*	-0.25**	-0.40***
	(0.08)	(0.18)	(0.11)	(0.10)
Δ Log Assessed value per capita>0 x (Rate and Assess limits)	0.37***			
	(0.13)			
|Δ Log Assessed value per capita<0| x (Rate and Assess limits)	-0.48***			
	(0.09)			
Δ Log Assessed value per capita>0 x (Rate limit only)	0.04			
	(0.13)			
|Δ Log Assessed value per capita<0| x (Rate limit only)	-0.19			
	(0.17)			
Δ Log Assessed value per capita>0 x (Assess limit only)	0.10			
	(0.16)			
|Δ Log Assessed value per capita<0| x (Assess limit only)	-0.17			
	(0.20)			
Δ Log Assessed value per capita>0 x (Rate and Levy limits only)		0.06	-0.18	-0.06
		(0.20)	(0.11)	(0.21)
|Δ Log Assessed value per capita<0| x (Rate and Levy limits only)		-0.15	-0.09	0.01
		(0.25)	(0.20)	(0.31)
Δ Log Assessed value per capita>0 x (Levy limit only)		-0.01	-0.24**	-0.21**
		(0.11)	(0.10)	(0.10)
|Δ Log Assessed value per capita<0| x (Levy limit only)		0.07	-0.06	0.16
		(0.20)	(0.13)	(0.14)
Δ Log Assessed value per capita>0 x (Rate limit only)		0.29*	0.25**	-0.03
		(0.14)	(0.11)	(0.10)
|Δ Log Assessed value per capita<0| x (Rate limit only)		-0.36*	-0.47***	-0.09
		(0.19)	(0.12)	(0.16)
Δ Log Assessed value per capita>0 x (Assess and rate limits)				0.29**
				(0.14)
|Δ Log Assessed value per capita<0| x (Assess and rate limits)				-0.38***
				(0.11)
Observations	36,143	36,143	36,143	36,143
R-squared	0.49	0.48	0.49	0.49

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1