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## Taxing Homeowners Who Won't Borrow

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# Taxing Homeowners Who Won't Borrow

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# Taxing Homeowners Who Won't Borrow

## Abstract

Using high-frequency administrative data covering millions of US homeowners, I document three novel facts about homeowner responses to property tax increases driven by rising home values. First, non-migrating homeowners cut consumption, exhibit financial distress, and do not borrow against their higher home values. These responses run contrary to the predictions of frictionless models, in which homeowners should borrow to avoid costly adjustments. Second, heterogeneity analysis shows that consumption responses do not vary by liquidity, consistent with savings target behavior. In contrast, distress responses are concentrated among liquidity-constrained homeowners. Many homeowners report being debt averse and therefore unwilling to borrow in order to avoid illiquidity and distress. Third, tax hikes induce migration—partly by displacing illiquid homeowners—but do not accelerate neighborhood change. A simple welfare framework reveals that the largest costs of property taxes arise from financial distress among liquidity-constrained homeowners.

JEL-Codes: H200, G510.

Keywords: property taxes, housing, household finance.

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# 1 Introduction

Property taxes represent the predominant tax on housing wealth worldwide and raise over \$600 billion annually in the US. By definition, these *ad valorem* taxes are levied as a share of home value, meaning that rising home values lead to property tax hikes. Although housing wealth is illiquid by nature, homeowners should be able to borrow against their increased home value in order to pay increased taxes. Indeed, the ability and desire to borrow against wealth is a central feature of many economic models of consumption, saving, and housing markets.

However, there is a widespread policy concern that when home values rise, accompanying tax hikes “can be unaffordable for those who are house-rich but income-poor,” causing financial hardship, displacing homeowners, and accelerating neighborhood change.<sup>1</sup> Anecdotes of homeowners facing hardship because of newly unaffordable property taxes are a mainstay of media coverage.<sup>2</sup> In addition, recent evidence in other settings reveals important frictions that can prevent homeowners from borrowing against their housing wealth (Ganong and Noel 2023; Bernstein and Koudijs 2024). If such frictions also affect homeowner responses to property taxes, then property taxes may impose sizable welfare costs by forcing homeowners to make costly adjustments.

This study analyzes homeowner responses to typical year-to-year property tax increases using a nationwide sample of millions of US residential property records linked to credit bureau, mortgage servicing, and address history data. This linkage offers two key advantages. First, these high-frequency data allow me to apply a quasi-experimental event study design to estimate impacts on a wide range of welfare-relevant outcomes, including consumption, financial distress, migration, and home investment. Second, rich information on the characteristics of homeowners, including measures of credit utilization and access, enable an assessment of whether homeowners are willing and able to borrow against their housing wealth.

The first part of this study documents average impacts of tax increases. I find that among non-migrating homeowners, a \$100 property tax hike reduces auto consumption by \$14, increases mortgage delinquency rates by about 1%, and reduces mortgage borrowing by \$19 (an indication of further reductions in consumption). This behavior is puzzling; even if property tax increases were not accompanied by increases in wealth, homeowners should prefer to avoid delinquency.<sup>3</sup> Although property purchase and sales data confirm that the tax increases I study are coupled with large increases in home value, these impacts are quantitatively very similar to the impacts of mortgage payment shocks that are unrelated to changes in home value (Di Maggio et al., 2017). This similarity further suggests that homeowners do not draw on their housing wealth when responding to property

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<sup>1</sup>Quotation from Langley and Youngman (2021), who summarize recent policy efforts to address property tax affordability.

<sup>2</sup>This coverage is succinctly exemplified by the headline of a *New York Times* article entitled, “As Property Values Rise, Homeowners Feel Pinch” (Lyman, 2006). Similar narratives appear in articles entitled “Georgia Lawmakers Consider Measures to Curb Soaring Property Taxes as Home Values Rise” (*Fox News*; Associated Press 2024) “How a Pandemic Boom Led to a ‘Property Tax Mess’ in Colorado” (*New York Times*; Chen 2024), and “Montana’s Real Estate Bonanza Turns Political as Property Taxes Soar” (*Washington Post*; Brulliard 2024).

<sup>3</sup>Because delinquency triggers a 5% late fee in most mortgage contracts, missing mortgage payments is dominated by other forms of borrowing. In addition, prolonged delinquency ultimately results in foreclosure and eviction.

taxes. In addition to conducting a broad range of robustness exercises in the administrative data, I collect survey responses from 2,000 US homeowners that corroborate the estimated consumption, distress, and borrowing responses.

The second part of this study analyzes mechanisms by estimating heterogeneous responses to property taxes. In particular, I distinguish between credit supply and credit demand factors that deter borrowing. In principle, it is possible that homeowners face limited credit supply because they do not possess enough housing wealth to secure additional borrowing; however, I find that impacts on consumption and distress are similar across homeowners with different levels of home equity. An alternative explanation is that even homeowners with ample home equity are unable to secure a loan, resulting in illiquidity. Consistent with this explanation, impacts on financial distress are concentrated among homeowners who have less access to borrowing (e.g., who exhibit high levels of credit card utilization and who have low credit scores).

Although credit supply factors can explain the increases in financial distress, they cannot explain (a lack of) heterogeneous consumption responses. In particular, I find that homeowners with both ample home equity and access to liquidity exhibit reductions in consumption. I corroborate this finding using the homeowner survey, in which durable consumption reductions are similar across self-reported measures of liquidity. These patterns are consistent with savings target behavior, which is widespread among homeowners in other settings (Bernstein and Koudijs, 2024).<sup>4</sup>

Moreover, credit supply factors also cannot explain why homeowners do not generate additional liquidity for themselves before they become distressed, as would be predicted by a model with precautionary motives. I use the homeowner survey to evaluate whether credit demand factors underlie this absence of precautionary borrowing. The survey reveals the presence of preference-based debt aversion that deters borrowing: 77% of respondents say they would not borrow against their homes even if they had difficulty paying property taxes, and 67% would rather skip bills than take out a second mortgage. Of those who would not borrow against their homes, the majority (69%) would not do so because they feel uncomfortable being in debt. In contrast, a minority of respondents cite credit supply (11%), or a lack of knowledge (4%) as reasons for not borrowing. Debt aversion also makes homeowners reluctant to take up government-provided borrowing in the form of tax deferrals. Such deferrals are offered in thirty-one states; however, even in places where eligibility criteria are broad, take-up of property tax deferrals tends to be extremely low. In the survey, 41% of respondents say that they would never take up a zero-interest deferral, of which 61% provide the rationale that they would not want to feel like they were in debt.

The puzzling finding that already-mortgaged homeowners exhibit debt aversion can be rationalized through mental accounting behavior, in which households differentiate debts based on type and purpose (Prelec and Loewenstein, 1998). As observed in the sociology literature, “Taking on debt can be a moral good or a moral bad. A good debt allows a middle-class person to care for her family by ensuring that basic needs are met or by securing (and investing in) home ownership”

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<sup>4</sup>In principle, models where home value increases do not have wealth effects (e.g., Sinai and Souleles 2005) could explain the reductions in consumption; however, I find similar consumption responses by leverage and age, contrary to the predictions of such models.

(Wherry, 2016). This distinction can explain why debt-averse households tolerate mortgage debt to purchase a home but not to pay taxes and finance current consumption.<sup>5</sup>

One implication of these findings is that illiquid homeowners, even when they have ample home equity, bear a greater burden from property taxes. This is readily apparent when examining differential responses by demographic characteristics, which shows that single-headed homeowners, Black homeowners, and homeowners with lower incomes and with lower-priced homes experience substantially larger distress impacts from property taxes. This finding represents a novel channel through which these groups bear a disproportionately high burden from property taxation, exacerbating already-higher tax burdens among these groups.<sup>6</sup>

In the third part of this study, I analyze the migration impacts of property taxes, which are a key area of policy concern and a popular objection to property taxes. I find that a \$100 tax increase leads to a 1.1% increase in home sales after 12 months, and a 0.95% increase in the rate of distressed sales (i.e., foreclosures and short sales). This increase in distressed sales, which are generally precipitated by illiquidity (Ganong and Noel, 2023), implies that many of the homeowners who are induced to move due to property taxes are not indifferent between moving and staying, and may therefore experience sizable welfare costs from being induced to move.

Although the impacts on distressed sales validate the concern that property taxes displace homeowners, I find little evidence that property taxes accelerate the pace of neighborhood change. To analyze the characteristics of moves induced by property taxes, I leverage address history data and instrument for migration using tax increases. I find that tax-induced movers downgrade to substantially lower-quality neighborhoods (e.g., lower house prices, rents, and incomes). However, in contrast to typical concerns about replacement by wealthier in-migrants, movers are replaced by residents from lower-quality neighborhoods. Although in-migrants tend to be younger and from outside the community, they appear to be demographically similar in terms of household size and race/ethnicity. These findings suggest that the welfare costs of displacing homeowners may be partly offset by welfare gains among in-migrants, who may have a high valuation of moving into the newly-available properties.

The estimated impacts on home sales carry two additional implications. Distressed sales create well-documented negative house price spillovers (Campbell et al., 2011), indicating the presence of negative externalities from tax increases. In addition, while transacting a property often generates substantial expenditures which can stimulate aggregate economic activity (Best and Kleven, 2018), I find a net reduction in home investment, and the tax-induced consumption reductions outweigh plausibly-sized increases in moving expenditures.

Lastly, I embed the empirical estimates of consumption, distress, migration, and home investment impacts into a formula for the marginal value of public funds (MVPF) of a one-year tax

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<sup>5</sup>Moreover, even many second mortgages could be labeled as good debt, since second mortgages are often used for making investments and paying down other debts (Canner et al. 2002), and for financing higher education (Lovenheim 2011; Amromin et al. 2016).

<sup>6</sup>See, e.g., Avenancio-León and Howard (2022); Berry (2021); Amornsiripanitch (2020); Ihlanfeldt and Rodgers (2022); Nathan et al. (2020).

increase. This approach carries the advantage of avoiding assumptions about the specific nature of homeowner borrowing frictions. These calculations reveal that the welfare costs of consumption responses are modest for the average homeowner, in contrast to relatively large welfare costs arising from creating financial distress among liquidity-constrained homeowners.

The finding that homeowners do not borrow against their housing wealth has important implications for theories of property tax incidence. Since at least [Smith \(1776\)](#) and [George \(1879\)](#), influential economists have believed that taxes on immobile land and property are more efficient than other taxes because they minimally distort incentives.<sup>7</sup> Starting with [Tiebout \(1956\)](#), [Mieszkowski \(1972\)](#) and [Hamilton \(1975\)](#), whether *ad valorem* property taxes entail any efficiency costs has been the subject of a long-running debate.<sup>8</sup> My findings reveal new economic costs that occur because homeowners do not borrow, and that exist regardless of whether taxes on land and property distort incentives. This finding is also relevant for more recent research on property tax incidence ([İmrohoroğlu et al. 2018](#); [Löffler and Siegloch 2021](#)). Most relatedly, [Brockmeyer et al. \(2022\)](#) document that welfare losses from property taxes are higher for illiquid homeowners in Mexico. I find that such welfare losses occur even when property taxes are accompanied by increases in home prices, in large part by inducing constrained homeowners to move.

Shedding light on the frictions that deter borrowing offers a novel contribution to the literature studying homeowner responses to property taxes. The analysis of these frictions is made possible by the new linkage to credit bureau and mortgage survey data, which contains measures that were unavailable in prior studies documenting impacts of property taxes on consumption and financial distress. These studies typically relied on surveys ([Surico and Trezzi 2019](#); [Brockmeyer et al. 2022](#)), aggregate data ([Hayashi 2020](#)), or more limited administrative data ([Anderson and Dokko 2016](#)). This study also departs from prior work by assessing the extent to which tax increases are accompanied by increases in housing wealth, a key point for interpretation.<sup>9</sup> In addition to elucidating mechanisms, the high-frequency data and quasi-experimental research design allows for improved estimates of homeowner responses, which often differ markedly from those in prior work.

The finding that tax increases coupled with house price growth induce constrained (i.e., non-indifferent) homeowners to migrate offers an important contribution to prior work on property tax-induced migration ([Shan 2010](#); [Martin and Beck 2018](#); [Fraenkel 2021](#)). A second contribution of this study is to analyze characteristics of movers, which is enabled by the address histories that track households across moves. My findings on migration contrast with many studies in the large literature on gentrification and mobility, which has typically found mixed evidence of displacement

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<sup>7</sup>In *The Wealth of Nations*, Smith writes, “Both ground-rents, and the ordinary rent of land, are a species of revenue which the owner, in many cases, enjoys without any care or attention of his own. Though a part of this revenue should be taken from him in order to defray the expenses of the state, no discouragement will thereby be given to any sort of industry.”

<sup>8</sup>The “benefits view” holds that property taxes are a perfectly efficient payment for local amenities ([Tiebout 1956](#), [Oates 1969](#), [Hamilton 1975](#)), while the “capital tax view” predicts that property taxes inefficiently distort the allocation of mobile capital ([Mieszkowski 1972](#), [Zodrow 2001](#)).

<sup>9</sup>Moreover, documenting the role of borrowing frictions lends new interpretation to prior studies documenting the impacts of property taxes on other outcomes, such as labor supply ([Zhao and Burge, 2017](#)), and property tax delinquency ([Waldhart and Reschovsky 2012](#); [Bradley 2013](#); [LaPoint 2022](#)).



and little evidence of downgrading (Ellen and O’Regan 2011a; Ding et al. 2016; Brummet and Reed 2019; Baum-Snow et al. 2019; Dragan et al. 2020). These contrasting findings suggest that tax-induced displacement to lower-quality neighborhoods may be counterbalanced by voluntary moves to higher-quality neighborhoods.

The remainder of this paper proceeds as follows. Section 2 introduces a conceptual framework for homeowner responses to property taxes. Section 3 describes the administrative data. Section 4 analyzes the relationship between tax increases and home value increases. Section 5 presents the empirical strategy. Section 6 analyzes average consumption, borrowing, and distress responses. Section 7 elucidates mechanisms by analyzing heterogeneous impacts and survey responses. Section 8 analyzes migration. Section 9 conducts welfare analysis. Section 10 concludes.

## 2 Conceptual Framework

I formalize the welfare-relevance of borrowing frictions using the marginal value of public funds (MVPF) as a metric for the economic costs of property taxes (Hendren and Sprung-Keyser, 2020). Specifically, this framework illustrates how credit constraints, liquidity constraints, and savings targets can exacerbate the welfare costs of property taxes. Prior work has found that these frictions are widespread among homeowners in other settings (Ganong and Noel 2023; Bernstein and Koudijs 2024).

### 2.1 Setup

Consider an agent who lives for three periods and derives utility from housing consumption  $h$  and non-housing consumption  $c$ . In period 0, the agent chooses housing consumption for a price  $p_0$ . At the beginning of period 1, the stochastic house price  $p_1$  is realized, after which the agent allocates non-housing consumption to periods 1 and 2. In addition, the agent must pay property taxes  $\tau$  in period 1. For simplicity, I assume that the interest rate is zero. This environment yields the following value function and budget constraints:

$$\begin{aligned}
 V(A_0) &= E[v(h) + u_1(c_1) + u_2(c_2)] & (1) \\
 \text{s.t. } A_0 &= p_0 h + A_1 \\
 A_1 &= c_1 + A_2 + \tau p_1 h \\
 c_2 &= A_2 + p_1 h \\
 A_2 &\geq \underline{A} \text{ (borrowing constraint)}
 \end{aligned}$$

In the above, expectations are taken over house prices that are uncertain in period 0, during which the agent commits to a certain level of housing consumption using initial endowment  $A_0$ . Intuitively, period 1 models the period of time during which a homeowner has chosen a certain level of housing consumption and faces uncertain changes in property tax payments due to house price fluctuations,

while period 2 captures the period of time after which a homeowner has sold her home and has converted her housing wealth into liquid wealth.

In a frictionless environment, property taxes reduce consumption uncertainty. For plausibly low levels of property taxes  $\tau$ , the agent responds to an increase in house prices  $p_1$  by increasing period 1 consumption (and borrowing by choosing a lower value for  $A_2$ ). Since property taxes are a fraction of home value, this implies that property taxes moderate the extent to which uncertainty in house prices translates into uncertainty in consumption. Formally, differentiating the agent's optimized value function with respect to  $\tau$  and dividing by the marginal utility of income yields the following expression for an agent's (negative) willingness to pay for a \$1 expected increase in property taxes:

$$-WTP = \frac{E\left[\frac{p_1 h}{E[p_1 h]} \cdot u'_1(c_1)\right]}{E[u'_1(c_1)]} = 1 + cov\left(\frac{p_1 h}{E[p_1 h]}, \frac{u'_1(c_1)}{E[u'_1(c_1)]}\right) \quad (2)$$

The covariance term is negative in this environment because higher house prices correspond to greater wealth, which lowers marginal utility. The negative sign implies that property taxes partly insure against consumption uncertainty.

However, the presence of borrowing frictions undoes the insurance value of property taxes. For example, suppose the borrowing constraint  $A_2 \geq \underline{A}$  binds, implying that the agent is liquidity constrained in period 1. In this case, the functional form of Equation 2 remains unchanged; however, the sign of the covariance term is reversed. This reversal occurs because the agent no longer increases her period 1 consumption in response to an increase in house prices. Consequently, consumption is lower when house prices are higher because property taxes are higher. Savings target behavior carries similar implications. If the agent targets  $A_2 = \underline{A} < \underline{A}$ , the covariance term remains positive, although it is smaller in magnitude than in the case of liquidity constraints because the level of period 1 consumption is higher. This implies that the welfare costs of property taxes depend on the presence of borrowing frictions.

Three points are worth noting. First, any deterrent to borrowing can increase welfare costs. For example, the covariance term in Equation 3 becomes more positive in the presence of an extra utility term that discourages dissaving, which can be interpreted as a form of debt aversion. Second, the absence of wealth effects from house price increases (as in [Sinai and Souleles 2005](#)) carries implications that are similar to those of borrowing frictions. Formally, if one were to replace the period 2 budget constraint with  $A_2 = c_2$ , housing becomes a consumption good rather than a store of wealth, and therefore house price changes carry no wealth effects. Since house price changes do not motivate consumption smoothing, such changes only add to the uncertainty of period 1 consumption through variable property taxes. Third, the dependence of welfare costs on borrowing distinguishes property taxes from income taxes, which provide insurance value against income uncertainty regardless of borrowing frictions because income taxes are levied in the same period as the cash flow ([Varian 1980](#), [Cremer and Gahvari 1995](#)).

## 2.2 Moving Costs

In practice, homeowners have the option to move, allowing them to adjust their housing consumption and property tax burden. Enriching this environment to allow moving demonstrates that the welfare implications of moving also depend on the presence of borrowing frictions. Suppose that after  $p_1$  is realized, agents have the option to pay a fixed moving cost to move and choose a new level of housing consumption  $h_1$ . Under certain regularity conditions, this environment generates behavior in which households do not move within a range of price realizations  $p_1 \in [p_L, p_H]$ , and move otherwise (Chetty and Szeidl, 2007).

In the absence of optimization frictions, changes in property taxes may affect the probability of moves but have no first-order effects on welfare because marginal homeowners are indifferent between moving and staying. However, this is not necessarily true in the presence of borrowing frictions. For example, suppose that for a sufficiently high realization of  $p_1$ , the borrowing constraint  $A_2 \geq \underline{A}$  becomes binding. If households must maintain a certain minimum level of consumption in order to stay in their homes (e.g., mortgage payment), there can exist a level of house prices  $p_c \in [p_L, p_H]$  above which liquidity-constrained households are forced to move. These households are not indifferent between moving and staying, meaning that a marginal increase in property taxes lowers  $p_c$  and generates non-negligible welfare costs. See Appendix C for a formal discussion.

## 2.3 Marginal Value of Public Funds

To derive an expression that captures the economic costs of property taxes, I compute the MVPF of a marginal increase in property taxes  $\tau$ .<sup>10</sup> To parameterize the net fiscal costs of a tax increase, I assume that property taxes are levied by a government that balances its budget in expectation, such that  $R = \tau E[p_1 h]$ . Dividing agents' willingness to pay for a marginal increase in  $\tau$  by the net cost to the government yields the following expression:

$$MVPF = \frac{1 + cov\left(\frac{p_1 h}{E[p_1 h]}, \frac{u'_1(c_1)}{E[u'_1(c_1)]}\right) + \frac{\partial \phi}{\partial \tau} (M + E)}{1 + \varepsilon_h} \quad (3)$$

In the above,  $\varepsilon_h$  denotes the elasticity of housing with respect to property taxes,  $\phi$  denotes the likelihood that the agent is induced to move, and  $M$  denotes net moving costs. As discussed above, these moving costs are only non-zero when the agent is liquidity constrained and forced to move. In practice, forced moves among liquidity-constrained homeowners often take the form of distressed home sales (i.e., foreclosures and short sales). Prior work has documented that forced home sales entail negative house price externalities (e.g., Campbell et al. 2011). Accordingly, the term  $E$  captures these externalities onto other agents, which is reflected in those agents' willingness to pay to avoid these externalities (i.e.,  $E \equiv \frac{\sum_{k \neq i} WTP_k}{E[p_1 h]}$ ). See Appendix C for detailed derivations.

In Equation 3, the economic costs of property taxes consist of three components. First, the

<sup>10</sup>By definition, the MVPF of a tax increase for agent  $i$  is given by  $MVPF \equiv \frac{WTP_i + \sum_{k \neq i} WTP_k}{\text{Net Cost}}$ . Note that the inclusion of willingness to pay for agents  $k \neq i$  allows for the MVPF to capture externalities from agent  $i$ 's behavior.

elasticity term in the denominator captures the extent to which property taxes generate efficiency costs by distorting the tax base. This term resembles a standard inverse elasticity rule for taxation. Second, the covariance term in the numerator captures the relationship between stochastic home prices and marginal utility of consumption, the sign of which depends on the presence of borrowing frictions like liquidity constraints and savings target behavior. Third, moving costs and externalities associated with forcing liquidity-constrained homeowners to migrate generate additional welfare costs. Thus, this expression illustrates how the welfare costs of property taxes depend on the extent to which homeowners are willing and able to borrow against their housing wealth to generate liquidity to smooth consumption and avoid forced moves.

**Implications for Empirical Analysis** This framework motivates an empirical analysis of whether borrowing frictions affect homeowner responses to property taxes, with a particular focus on three outcomes: consumption, financial distress, and migration. The welfare relevance of consumption and migration is directly reflected in Equation 3. Although financial distress is not explicitly represented in Equation 3, analyzing financial distress (e.g., mortgage delinquency) serves to test for the presence of liquidity constraints and to identify the occurrence of forced moves (Ganong and Noel, 2023). Moreover, financial distress itself is a welfare-relevant outcome because it can be extremely costly for homeowners (Diamond et al., 2020). In the remainder of this study, I estimate homeowner responses to property taxes and evaluate the extent to which these responses reveal borrowing frictions. In Section 9, I apply the MVPF formula to quantify the welfare implications of the empirically observed responses.

## 3 Data

I use a series of linked administrative data sources to measure homeowner responses to tax increases. This section describes the data sources and key demographic and outcome variables. Appendix D provides additional details on the data sources and sample construction.

### 3.1 Primary Data Sources

Analyzing how homeowners respond to property taxes requires linking tax changes to measures of consumption, borrowing, and distress, as well as to relevant homeowner characteristics (such as those that indicate the presence of credit constraints). To measure property tax changes, I use a nationwide panel covering millions of US residential properties derived from the records of local government property assessor and recorder offices and assembled by ATTOM, a private data provider. This data source, henceforth referred to as the property data, contains annual property tax bills and assessments of taxable value. The property data also contain property transactions, including home sales and mortgage loans. Records of home sales include the sale price of the property, and a flag indicating whether the sale was a foreclosure or short sale.

I construct key consumption and distress outcomes as well as measures of borrowing constraints using credit bureau records from Equifax linked to mortgage servicing records from McDash/Black

Knight Financial Services (also known as CRISM). The credit bureau records contain individual-level outcomes reported by lenders and are used to generate consumer credit reports. These data include monthly information on both primary and secondary mortgages, credit cards, auto loans, and loan delinquency. The mortgage servicing records contain characteristics of the mortgage, such as original property value and loan amount, as well as monthly payment amounts, unpaid principal balances, and monthly tax and insurance payments. The credit bureau and servicing records cover between 60% and 80% of mortgages depending on the year, starting in 2005 (Gerardi et al., 2023).

I measure sales and migration responses using a combination of two datasets. First, the property data contain records of home sales. Foreclosure sales are readily identified from administrative documents that are captured by the property data, and short sales are identified using a proprietary algorithm developed by the data provider. Second, I use address histories to identify the location of households after a home sale. The address histories are comprised of a panel of individual addresses spanning 2006 to 2020. This panel was constructed by Infogroup, a private firm that collects address information on US residents from a variety of sources, including real estate transfers, voter registration files, and telephone directories. The Infogroup data also contain information about the year in which the homeowner moved into the property, and measures of homeowner age and race/ethnicity, which I use for heterogeneity analysis.

To measure impacts on home investment, I use records of building permits assembled by Buildfax. Homeowners wishing to make major improvements to their property (e.g., addition of a new room) typically must file a permit with the local government. These filings contain the date of the permit request, the estimated permit cost, and the address of the property.<sup>11</sup>

I analyze heterogeneous effects of property taxes by income, race/ethnicity, and family composition using data from the Home Mortgage Disclosure Act (HMDA) data. HMDA requires mortgage lenders to disclose certain information about new mortgage loans, including the self-reported race and ethnicity of loan applicants, the number of individuals applying for the mortgage, and borrower income. These data capture the near-universe of mortgage originations during the study sample.

Records in each of these datasets were linked by the Fisher Center for Real Estate and Urban Economics at the UC Berkeley Haas School of Business. Individuals in the credit bureau and mortgage loans in the mortgage servicing data are linked to mortgages in the property data using a k-nearest neighbor algorithm which links records by original loan balances, property sale prices, and distress events (e.g., foreclosures). The address history data are linked to the property data by homeowner name and address. The permits data are linked to the property data by address. Lastly, the HMDA records are linked to the property data by matching on mortgage origination year, Census tract, dollar amount, and lender name.

### 3.2 Sample Restrictions and External Validity

I make several sample restrictions throughout my analysis, which is designed to analyze homeowner responses to typical year-to-year property tax increases. For my main analysis, I restrict to tax

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<sup>11</sup>Data provided by Buildfax. More information on the permit data can be found at <http://www.buildfax.com>.

increases among properties that are owner-occupied for at least three years and that were assessed between 2010 and 2019. Note that tax decreases, which I analyze separately, are both less informative about the presence of borrowing frictions like credit constraints, and are typically not the subject of affordability concerns in policy discourse. The sample time period largely excludes variation in property taxes resulting from the preceding housing crisis. I also exclude California from the sample because property assessments in California generally do not reflect increases in house prices due to Proposition 13.

I construct three analysis samples, each of which draws on a subset of the linked datasets to analyze a given set of outcomes.

**Financial Behaviors Sample** First, I construct a sample to analyze consumption, borrowing, and delinquency responses, which I refer to as the financial behaviors sample. These outcomes are contained in the credit bureau and mortgage servicing data, which also list owner-occupancy status. Outcomes in these data are measured at the mortgage level, and cease to be recorded starting six months after a borrower pays off their mortgage. To construct a balanced panel, I restrict to tax increases where the mortgage was not paid off in a two-year window around the tax increase.

In addition, I restrict the financial behaviors sample to homeowners who pay their property taxes in monthly installments with their monthly mortgage payment, an arrangement referred to as escrow. Escrow payments, which are used by about four-fifths of mortgaged homeowners (Corelogic, 2017), are arranged by mortgage servicers and allow homeowners to pay their property taxes and insurance in monthly installments together with their mortgage principal and interest payments. Since escrow payments are updated once a year to reflect changes in property tax bills, this restriction allows me to identify the precise month in which these homeowners face increases in their property tax payments. I analyze non-escrow homeowners as a robustness exercise.<sup>12</sup>

These sample restrictions yield 4.9 million property tax increases (loan-years) in the financial behaviors sample, for which I observe outcomes in the 12 months before and after the increase and which are merged with the credit bureau and mortgage servicing data. Table 1, Panel A presents summary statistics for this sample. The average homeowner has a property tax bill of \$3,358 that increases by \$171 in the following year. Moreover, the majority of homeowners in the sample have substantial amounts of home equity (\$81 thousand on average).

Although this sample represents a relatively small share of the roughly 75 million owner-occupied housing units in the US during this period (U.S. Census Bureau, 2024), the sample appears representative along observable characteristics. In Appendix Table A1, I compare mortgaged homeowners in the 2015 American Housing Survey (AHS) to the analogous homeowners in my financial behaviors sample. Homeowners in the two samples appear similar across a range of observable characteristics, including property tax amount, property value, homeowner age, and tenure length. Additional external validity exercises in Section 6 (e.g., analysis of homeowners not paying property taxes through

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<sup>12</sup>Note that identifying the timing of tax increases is less straightforward for homeowners that pay property taxes directly to the government, because many governments have multiple property tax due dates. For the analysis that does not restrict to homeowners who pay taxes through escrow, I use the tax bill issuance month as the event month. Property tax due dates are typically between one and four months after the bill issuance date.

escrow) offer further reassurance that the sample restrictions do not substantially limit the external validity of the analysis. Note that the majority of the reduction in sample size arises is due to the merges required to observe outcome and demographic variables. Appendix D.1 discusses the impact of each sample restriction in detail, and Appendix Figure A1 provides a visual illustration.

**Migration Sample** The second analysis sample captures property sales, homeowner moves, and home investment. This sample does not require the linkage with the servicing records and enables analysis of a substantially larger number of homeowners. Outcomes in this sample are measured in the property records, permit records, and address histories. In contrast to the financial behaviors sample, the migration sample includes homeowners who sell their home or pay off their mortgage. To focus on owner-occupants, I restrict to properties where the owner listed in the property data matches the occupant listed in the address history data. For this sample, I define event time around the property tax bill issuance month, and therefore restrict to properties for which this month can be observed.<sup>13</sup> These restrictions yield a sample of 39 million tax increases. Table 1, Panel B presents summary statistics for the migration sample. Overall, homeowners in this sample are slightly older and longer-tenured than those in the financial behaviors sample. This difference reflects the inclusion of homeowners who have been in their home long enough to pay off their mortgage.

**Repeat Sales Sample** Third, I construct a sample of repeat property sales to analyze the correlation between tax increases and home value increases. This repeat sales sample consists of properties for which a purchase and sale price can be observed (i.e., ownership spells).<sup>14</sup> I restrict to ownership spells of properties that were first assessed in 2010 or later, and with at least three years between the first and last tax bills. I restrict to owner-occupied properties, defined using the address history data. I also drop properties that were purchased or sold in a distressed sale because prices for these sales may not reflect actual property value. Table 1, Panel C provides summary statistics for the 372 thousand ownership spells in the repeat sales sample. During this time period, homeowners experienced substantial increases in home value: the average difference between purchase and sale prices is \$60,236. This home value appreciation was accompanied by an average \$949 increase in annual property taxes, computed as the difference between the first and last property tax bills.

### 3.3 Key Outcome and Demographic Variables

Together, the analysis datasets allow me to analyze a broad range of outcomes, including monthly payments, consumption, borrowing, financial distress, investment, home sales, and migration.

I measure the impact of property tax increases on monthly payments (the first-stage analysis) in the financial behaviors sample using the dollar value of the property tax and insurance payment (i.e., escrow payment) that is due in a given month. Following Di Maggio et al. (2017), I measure auto consumption as the difference in total auto balances between any two months in which auto

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<sup>13</sup>Local governments are sometimes delayed in issuing tax bills, and issue them later than the statutory deadline. In order to reduce noise from late issuances, I define the actual tax bill issuance month for each county-year using the month in which tax bills begin to be reflected in escrow payments. See Appendix E.1 for more details.

<sup>14</sup>I link repeat sales of properties using the algorithm in Kermani and Wong (2021), described in Appendix D.2.

balances increase by more than \$5,000. This approach to measuring auto consumption assumes that a one-month increase in auto loan debt of more than \$5,000 represents a car purchase.

I focus on two primary measures of borrowing. The first measure is the balance of junior-lien mortgage loans, which includes closed-end second mortgages and home equity lines of credit (HELOCs).<sup>15</sup> These loans are secured by home equity and therefore represent borrowing against housing wealth. The second measure is the total balance of credit cards, which represents the most common form of unsecured borrowing.

I analyze two primary measures of financial distress. The first is an indicator that a homeowner's mortgage is 30 or more days past due, which is recorded in the mortgage servicing data. The second is the total balance of past-due loans, which is reported in the credit bureau data. Note that total past-due balances have the advantage of capturing delinquencies on multiple types of loans, including both credit cards and mortgages, but represent a lower bound on delinquency because not all delinquencies are reported to credit bureaus.<sup>16</sup>

To measure home sales, I construct an indicator that a property has been sold in the last 12 months, and an indicator that a property has been sold in a distressed sale (i.e., foreclosure or short sale). To analyze migration, I use the address histories to identify the next address of a homeowner whose property has been recorded as sold in the property data. By following a homeseller to their next address, I am able to construct variables that capture changes in neighborhood quality (e.g., the difference in median Census tract income between the two addresses). To measure investment, I define an indicator that a home improvement permit has been filed in the last 12 months.

I leverage several demographic variables to conduct heterogeneity analysis. I define single-headed homeowners as those who have one applicant on the HMDA mortgage application, and couples as those with two applicants. I measure homeowner income using the total household income reported to the lender at loan origination, measured in the HMDA records. I use age recorded in the address history data, which is reported in bins of approximately 5-year increments. I compute a numeric value for age by taking the midpoint of each bin. To measure race/ethnicity, I leverage the HMDA data that captures the self-reported race and ethnicity of homeowners. Since the HMDA data can only be merged with a subset of properties, I also use race/ethnicity imputed from name and geographic location in the address history data. In Appendix D.3, I assess the extent of measurement error in age and race/ethnicity in the address address history data.

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<sup>15</sup>Closed-end second mortgages offer borrowers a fixed amount of credit while HELOCs offer a rotating line of credit. Junior-lien mortgages are taken in tandem with primary mortgages and are backed by the borrower's property but carry a lien on the property that is subordinate to that of the primary mortgage. These loans carry relatively low interest rates—historically around 6% per year and therefore lower than 15-25% for credit cards—but require homeowners to pay fixed costs of 2-5% of the loan amount. Homeowners can also extract home equity using cash-out refinance loans. Cash-out refinances allow borrowers to refinance their primary mortgage and to borrow more than the outstanding balance of the original loan. Because a cash-out refinance leads to the termination of the primary mortgage, which is the unit of observation in the credit bureau and mortgage servicing data, I analyze cash-out refinances using an alternative sample construction discussed in Appendix E.3, which reveals patterns consistent with those in the credit bureau data.

<sup>16</sup>For example, comparing delinquencies that appear in the mortgage servicing data to those in the credit bureau data implies that only about half of mortgage delinquencies are reported to credit bureaus.



### 3.4 Survey of Homeowners

To complement the analysis of administrative data, I designed and conducted a survey of US homeowners. This survey was fielded between September and November 2019 and collected responses from 2,000 homeowners over the age of 18 across the US. The sample of respondents, who were identified by Qualtrics, were designed to be roughly representative of the sample of US homeowners by age, gender, race, and location. Surveys were completed electronically using Qualtrics’ online platform. Appendix F presents additional details on the survey methodology.

The survey instrument elicits a broad range of attitudes and behaviors associated with property taxes, as well as homeowner demographics. To complement the measure of consumption based on car purchases in the administrative data, the survey asks respondents, “Suppose that next year your yearly property tax bill increases by \$500. How would you pay for this?” Homeowners can report multiple (non-exclusive) margins of adjustment, including reducing durable consumption (“big-ticket items like cars, home improvements, or appliances”), non-durable consumption (“basic necessities like food or heat”), credit card and mortgage borrowing, borrowing from friends and family, and skipping bills. The full survey instrument is presented in Appendix G.

Appendix Table A2 provides summary statistics for the survey sample. Compared to demographic statistics from the 2013-2017 American Community Survey (ACS) 5-year estimates, respondents are somewhat more educated, more female, and less likely to be employed. Accordingly, I reweight the observations to match ACS demographic shares in terms of age, sex, race/ethnicity, education, and employment. I presented unweighted estimates in the Appendix, which are generally very similar to the weighted estimates.

## 4 Variation in Property Taxes and Home Values

The welfare framework in Section 2 applies to increases in property taxes that are coupled with increases in home values. Accordingly, my empirical analysis requires variation in property taxes that is tied to home values. This section describes the sources of typical year-to-year variation in property tax bills, and estimates the correlation between tax increases and home value increases.

In principle, there are three factors that cause a property’s tax bill to change from one year to the next: changes in the assessed value of a property, changes in the tax rate, and changes in tax exemptions like tax credits for elderly homeowners. In practice, changes in assessed value account for the bulk of the variation. Specifically, 69% of the overall variation in tax increases can be accounted for by controlling for changes in the assessed value (as well as county, purchase year, and baseline assessed value), which rises to 84% when restricting to places with linear tax schedules (Appendix Table A3).<sup>17</sup> In turn, about 89% of the variation in changes in assessed values can be explained by controlling for a straightforward set of property characteristics: property type, number of bedrooms, number of bathrooms, and deciles of lot size and square footage.<sup>18</sup>

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<sup>17</sup>As an example of a non-linear tax schedule, owner-occupants in Indiana can deduct the less of \$45,000 or 60% of the property’s assessed value.

<sup>18</sup>Note that an increase in an individual’s taxes typically does not correspond one-for-one to increases in property

Although these correlations indicate that much of the variation in property taxes is deliberately tied to changes in home values through the process of setting assessed values, the magnitude of the relationship between tax increases and home value increases is *a priori* uncertain. On one hand, the magnitude may be larger than these correlations suggest because changes in tax rates and exemptions may also be positively related to home values if policymakers adjust rates and exemptions in response to local economic conditions. On the other hand, imperfections in the property assessment process can attenuate the relationship between home values and assessed values. Note that disentangling the three factors behind tax increases is not necessary for inferring the presence of borrowing frictions; rather, the relevant object is the average relationship between tax increases and home value increases.

While there has been much work studying the accuracy of the *level* of assessed values relative to the level of market values (Ihlanfeldt and Jackson 1982, Ihlanfeldt 2004, Hodge et al. 2017), there is relatively little research quantifying the relationship between *changes* in property taxes and home values. Important differences between the accuracy in levels and in changes may arise because setting a property’s value following its purchase may be done simply using its purchase price; however, tracking the subsequent evolution of value is challenging in the absence of an observable transaction price. I overcome this challenge by using the repeat sales sample, which consists of a set of properties where both purchase and sale prices are observed.

The ideal comparison between changes in property taxes and changes in home values adjusts for the fact that a home value increase represents an increase in the *stock* of value, while the resulting increase in property taxes represents an increase in the *flow* of tax obligations. For example, at a tax rate of 1.4% (the mean in the sample), a property that increases linearly in value by \$100 over 10 years will accrue an extra \$7.15 of property tax payments (i.e.,  $\sum_{t=0}^{10} \$100 \times 1.4\% \times t = \$7.15$ ).

I use to repeat sales sample to approximate this ideal comparison. First, I compute the difference in purchase and sale prices of a home, which captures the increase in the stock of home value. Second, I measure the accumulated increase in property tax payments by interpolating linearly between the first and last tax bills. Specifically, I compute the accumulated increase in tax payments as  $\frac{1}{2}(tax_1 - tax_0) \times (year_1 - year_0 + 1)$ . This assumption avoids requiring measuring all property tax payments between purchase and sale, which is not possible for many properties due to missing years of data. When directly comparing the two, I annualize both objects by dividing by the length of the ownership spell (i.e., the time between property purchase and sale) for convenience.

I find that property tax increases are tied to large increases in home values. Figure 1, Panel A plots the relationship between changes in property taxes and home values among ownership spells in the repeat sales sample. To parallel the empirical strategy in Section 5, I residualize by purchase and sale year, county, and ventiles of assessed value at purchase, such that these estimates compare properties that experienced different changes in property taxes, but were bought and sold in the same years and the same location, and were of similar sizes. On average, a \$1 accumulated increase

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tax-funded amenities, as can be the case with aggregate levels of taxation across jurisdictions (Brueckner, 1982). Since house price growth usually varies within jurisdiction (e.g., county), total revenues can remain relatively stable even when some homeowners face substantial tax hikes.

in property taxes corresponds to a \$7.5 increase in home value. Since this comparison accumulates the flow of property tax increases to ensure comparability with the increased stock of home value, this finding confirms that the average increase in property taxes is accompanied by a much larger increase in home value.<sup>19</sup>

The relationship between increases in taxes and home values varies across US states, which is to be expected given that property tax policies and systems of property assessment vary greatly. Figure 1, Panel B illustrates this variation by plotting estimates by state. Consistent with an important role played by property assessment policies, Appendix Figure A2 shows that counties in which assessments are more accurate and are conducted more frequently feature larger correlations between tax increases and home value increases. Yet even in places that exhibit lower correlations, average tax increases correspond to large increases in home value.

One caveat of this exercise is that it compares changes in home values and taxes that occur over the span of an ownership spell. Ideally, for the purpose of interpreting responses to year-to-year changes in property taxes, one would wish to estimate the change in expected home values arising from a one-year change in property taxes, holding current home value fixed. Since it is not possible to precisely observe yearly changes in home values between purchase and sale, the repeat sales sample may miss short-term variation in property taxes that is less correlated with longer-term home value growth. Nonetheless, this exercise serves as useful confirmation that increases in property taxes are generally associated with large increases in home values.

## 5 Empirical Strategy

My empirical strategy analyzes responses to typical year-to-year increases in property taxes. Enabled by the high-frequency administrative data, I implement a quasi-experimental research design that estimates impacts in the months after homeowners face newly increased payments. Specifically, I estimate regressions of the following form:

$$y_{it} = \alpha_i + \gamma_{s(t),g(i)} + \sum_j \beta_j \mathbb{1}\{s(t) = j\} \Delta T_i + \varepsilon_{it} \quad (4)$$

In Equation 4,  $y_{it}$  denotes an outcome of interest measured in calendar month  $t$  for homeowner  $i$  facing a tax increase in a given tax year (tax year subscripts are omitted for clarity).  $s(t)$  denotes time relative to the month of the tax increase.  $\Delta T_i$  denotes the one-year dollar change in annual property taxes.  $\beta_j$  represent the event study coefficients, capturing the impact of a \$1 increase in property taxes on the outcome of interest. I cluster standard errors at the level of  $i$  (i.e., mortgage/property).

In order to address the identification issues associated with staggered treatment designs (Call-

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<sup>19</sup>In addition, the blue line in Figure 1 holds fixed the change in property assessments by additionally residualizing by 1 percentage point bins of changes in assessed value between purchase and sale. Controlling for changes in assessed value yields a flatter relationship between home values and taxes, implying that changes in taxes due to tax rates or exemptions are positively correlated with changes in home values, but less so than changes in assessed value.

away and Sant’Anna 2021, Goodman-Bacon 2021, Sun and Abraham 2021), Equation 4 uses a set of event time fixed effects  $\gamma_{s(t)}$ , rather than calendar time fixed effects  $\gamma_t$ , an approach which is made possible by the availability of a continuous regressor. The resulting estimation does not use already treated units as controls for not-yet-treated units, a source of bias in the presence of treatment effects that vary over time. Instead, the estimation treats each set of homeowners within groups  $g(i)$  (which denote interactions with the event time fixed effects) as experiencing a simultaneous increase in property taxes (i.e., at event time  $s = 1$ ). The baseline specification for  $\gamma_{s(t),g(i)}$  interacts event time with county, year, and ventiles of assessed value calculated within state-year. Therefore, this approach compares homeowners in the same year and county, with homes of similar values, but who face differently sized property tax increases.

This approach entails two identification assumptions. First, it assumes that within groups  $g(i)$ , homeowners with small increases in property taxes represent a valid counterfactual for the potential outcomes of homeowners with large increases in property taxes, a standard parallel trends assumption. Second, the use of a continuous treatment variable requires the assumption that the average change in potential outcomes across all homeowners is the same as the average change for homeowners that actually experienced a given tax change (Callaway et al., 2021).<sup>20</sup> Intuitively, this assumes that homeowners who have different doses of the treatment are comparable in terms of their latent potential treatment effects. I provide empirical support for this assumption in Section 6 by demonstrating that homeowners who experience different doses of tax increases are similar along pre-treatment observables, and that restricting comparisons to more similar homeowners does not meaningfully alter the results.

## 5.1 Predicting Property Tax Increases

Although most of the variation in property taxes is exogenous from the perspective of the homeowner (as indicated by Appendix Table A3), this is not generally true for properties that are sold or improved. In many cases, selling or improving a property triggers an assessed value update that can affect the following year’s property tax bill.

Accordingly, to analyze migration and home investment outcomes (and to probe the robustness of the baseline empirical approach), I isolate variation in property taxes that is unaffected by homeowner behavior. To do so, I predict tax increases for each property and year using changes in taxes for nearby properties. For each nearby property, I compute a tax shock by dividing the year-to-year tax change by the property’s assessed value. I construct a predicted tax increase using the leave-out-mean of this tax shock, calculated within groups of properties with similar property features in the same neighborhood. To construct groups of nearby properties, I first group properties into cells of property type (e.g., single-family, condominium), Census tract, deciles of square footage, number of bathrooms, number of bedrooms, and deciles of property lot size. If

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<sup>20</sup>Formally, this “strong” parallel trends assumption requires that  $E[y_{it}(\delta) - y_{i,t-1}(0)] = E[y_{it}(\delta) - y_{i,t-1}(0)|\Delta T_i = \delta]$ , where  $\delta$  denotes a certain dose of  $\Delta T_i$  (Callaway et al., 2021). A sufficient (but not necessary) condition for this assumption to be satisfied is if  $\Delta^T$  is as good as randomly assigned within groups  $g(i)$ .

there are an insufficient number of similar properties to compute a leave-out mean for a given property, I compute the leave-out predicted shock within groups of property type, Census block, quintiles of assessed value, and occupancy status. See Appendix E.2 for more details.

The predicted increase in property taxes is highly correlated with actual increases in property taxes. With the baseline set of controls (county, year, and property size), the coefficient derived from regressing actual tax changes on predicted tax changes is 0.81 (Appendix Table A3, Column 8). Although this large coefficient confirms that these tax shocks are effective in predicting actual tax increases, they also entail a non-negligible amount of measurement error. Therefore, my primary approach uses the actual tax shocks when analyzing the financial behaviors sample, which restricts to homeowners who do not sell their home (Sections 6 and 7) and uses the predicted tax shocks when analyzing the migration sample (Section 8).

## 6 Effects of Tax Increases on Consumption, Borrowing, and Distress

I begin my analysis of homeowner responses to tax increases by confirming that my research design isolates the timing of payment increases among homeowners who pay property taxes in monthly installments. Figure 2, Panel A plots event study coefficients from Equation 4, which estimates the time path of payments around the month in which payments are scheduled to reflect the tax increase. Around this month, a \$1 increase in annual property taxes results in a sharp increase in monthly payments of about 8 to 9 cents (i.e., \$0.96 to \$1.08 per year). Having confirmed that this design isolates the precise timing of tax payment increases, the remainder of this section examines homeowner consumption, borrowing, and delinquency responses.

**Consumption** Homeowners sharply reduce their auto consumption in response to a tax increase. Figure 2, Panel B indicates that a \$1 increase in property tax payments is associated with an \$0.137 reduction in auto consumption over a 12-month period.

In frictionless models, homeowners should not exhibit this reduction in auto consumption after a tax increase. Since these tax increases are coupled with increases in home value, homeowners should instead internalize increases in home value as a wealth effect that offsets the tax hikes. Even if there are no wealth effects, the payment increase is highly predictable. Homeowners receive multiple notifications many months in advance, both from the local taxing authority and from their mortgage servicer about the tax increase.

Extrapolating auto consumption to total consumption illustrates the magnitude of this deviation from frictionless behavior. Di Maggio et al. (2017) estimate the relative sensitivities of auto sales growth and total consumption growth to state-level Bartik shocks, and extrapolate using the estimated ratio of 2.3:0.7.<sup>21</sup> This ratio extrapolates to an overall MPC of about 0.93, which would imply that increases in property taxes pass through nearly one-for-one into decreases in consump-

<sup>21</sup>Since car purchases account for about 4.5% of overall household consumption, an increase of \$X in monthly car expenditure can be extrapolated to a consumption response of  $\Delta(c_t)$  using the formula  $\Delta(c_t) = \frac{1}{0.045} \times \frac{0.7}{2.3} \times \$X$ .

tion. Through the lens of the conceptual framework in Section 2, this finding suggests that the vast majority of homeowners behave as if they are borrowing constrained, or as if home value increases entail no wealth effects. This finding by itself indicates that property taxes entail additional welfare costs by exacerbating consumption uncertainty, regardless of the reason that homeowners do not take increases in home values into account (e.g., credit constraints, wealth effects, behavioral frictions).

Consistent with homeowners not internalizing any accompanying wealth increases, the estimated impacts on auto consumption are nearly identical to the long-term auto MPC of \$0.136 estimated by Di Maggio et al. (2017) following adjustable-rate mortgage resets, which are unrelated to changes in home values. In contrast, these findings differ markedly from prior estimates of the impacts of property taxes using survey-based or aggregate measures of consumption.<sup>22</sup>

**Borrowing** In theory, homeowners can borrow or dissave in response to a property tax increase in order to finance both current consumption and higher property tax payments; however, homeowners appear to *reduce* borrowing after a tax increase. Figure 2, Panel C presents results for second mortgage balances, and Panel D presents results for credit card balances. Second mortgage balances decline by about \$0.19 for every \$1 increase in property taxes. There is no statistically significant change in credit card balances, and I reject increases in credit card balances of more than \$0.04.

One potential explanation for the reduction in borrowing is that they reflect foregone consumption (i.e., expenditures that would be financed by borrowing on second mortgages). Consistent with this explanation, Appendix Figure A3 illustrates that increases in second mortgage borrowing are strongly correlated with home improvement behavior. Using second mortgages to finance major expenditures like home improvements requires significant logistical planning, which can also explain why the reductions in borrowing begin several months before the tax increase, in contrast to the apparent lack of anticipation in the auto consumption response.

**Financial Distress** Property tax increases lead to persistently higher rates of financial distress. Figure 2, Panel E presents impacts on an indicator that a homeowner is 30 or more days delinquent on their mortgage. A \$100 increase in annual property taxes increases the delinquency rate by 0.08 percentage points, an increase of about 1%. Panel F analyzes impacts on the total amount past due on loans that appears on a homeowner’s credit report, and shows that a \$1 increase in monthly property tax payments results in about \$0.07 in past due balances after one year.

The increase in financial distress is sharp and persistent, with elevated increases in distress lasting for at least one year following the tax increase. Hypothetically, if property taxes were to merely induce a temporary reshuffling of finances (for instance, if homeowners needed to adjust automatic payments), then the time path would exhibit a reversion to prior levels of distress within a few months; however, there is no such reversion. As with the consumption responses, these distress

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<sup>22</sup>Specifically, Surico and Trezzi (2019) use surveys of Italian homeowners following a property tax reform and estimate a vehicle MPC of 0.61. Hayashi (2020) finds that a \$1,000 reduction in median property taxes from 2008 to 2009 increases ZIP-level car purchases by 10%. Applying this effect size to mean auto consumption in my data implies an MPC of 0.44. Both MPCs are well outside of the 95% confidence interval of my baseline estimates.

responses are similar in magnitude to those estimated in the context of adjustable-rate mortgage payments (Di Maggio et al. 2017); however, they are substantially larger than prior estimates of the impacts of property taxes (Hayashi, 2020).<sup>23</sup>

In standard models without credit constraints, increases in property taxes created by increases in housing wealth should not generate financial distress. Even if a tax increase were not associated with an increase in housing wealth, there are many reasons homeowners should wish to avoid costly delinquency: mortgage delinquency typically triggers a 5% late fee and thus represents a very costly form of borrowing (i.e., one with an annualized interest rate of 60%); prolonged delinquency ultimately results in foreclosure and eviction; and missed payments on all types of loans are included in borrowers' credit reports and thus visible to potential lenders and employers. In light of prior research documenting the importance of illiquidity for mortgage delinquency (Ganong and Noel, 2023), these findings imply that property taxes create financial distress because homeowners are illiquid and either unable or unwilling to draw on their housing wealth.

In the remainder of this section, I conduct robustness exercises and return to the question of why homeowners are illiquid and do not draw on their housing wealth in Section 7.

## 6.1 Robustness

Several additional exercises provide further interpretation of the observed responses and support the internal and external validity of the research design.

**Alternative Measures of Consumption and Borrowing** The primary administrative measure of consumption pertains to leveraged auto consumption, which captures a relatively narrow slice of total consumption. Corroborating the finding that homeowners reduce consumption in response to tax increases, Appendix Figure A4 shows that 47% of surveyed homeowners report that they would cut spending on durable consumption, and 26% report cutting spending on basic necessities in response to a hypothetical \$500 tax increase. Moreover, only 3% report that they would borrow against their home equity. In addition, a complementary measure of consumption in the administrative data is home improvement permits, which can be interpreted as a measure of housing consumption. Results presented in Section 8 reveal large reductions in permitting behavior.

**Alternative Measures of Distress** Increases in financial distress are also evident in alternative measures of distress, analyzed in Appendix Figure A5. Increases in property taxes produce a short-term increase in transitions into 30-day delinquency, and a more persistent increase in transitions from 30-day delinquency to 60-day delinquency. Property taxes appear to increase Chapter 13 but not Chapter 7 bankruptcy rates. Note that Chapter 7 bankruptcy is relatively rare in this sample,

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<sup>23</sup>Di Maggio et al. (2017) estimate that a 20% reduction in monthly mortgage payments reduces 60-day mortgage default by about 40%. Scaling my estimates by the average monthly payments and delinquency rates 12 months after the increase, my estimates imply a similar impact on 30-day delinquency of 29%, and on 60-day default of 42% (Appendix Figure A5). In contrast, these estimates are about twice as large as those in Hayashi (2020) who measures the impact of property tax cuts on mortgage default using legal filings initiated by lenders against delinquent borrowers. This measure of default may be subject to significant attenuation bias because it captures the decisions of lenders rather than borrowers, and filings do not mechanically follow borrower default.

possibly because Chapter 7 can force homeowners to sell their property. In addition, the increase in delinquencies occurs among the set of homeowners whose properties are listed for sale, measured in multiple listing services records merged to the financial behaviors sample by address. This finding suggests that housing market frictions exacerbate the impacts of property taxes on financial distress.

**Alternative Regressor** An alternative approach to parameterizing the event study is to normalize the tax increase as a percentage of annual housing costs (i.e., mortgage principal and interest plus taxes and insurance). Although the baseline regressor in levels is convenient for interpreting effects on dollar-valued outcomes (e.g., interpreting effects on consumption as an MPC), this alternative regressor offers a convenient scaling for binary outcomes. Appendix Figure A6 plots estimates of Equation 4 with the normalized tax increase, which yields patterns that are qualitatively very similar to the baseline estimates.

**Timing of Tax vs. Home Value Increase** To what extent do the observed patterns apply outside of the event study window? Since discrete tax increases are preceded by gradual increases house prices, it is possible that homeowners first increase consumption before cutting consumption in response to the tax increase. Such behavior would still imply that property taxes exacerbate consumption uncertainty, but would suggest that limited planning horizons are an important behavioral friction. To assess this possibility, Appendix Figure A7 extends the sample window to two years prior to the tax increase. Trends in consumption are relatively flat and the change in consumption in the two years prior to tax increase is not statistically distinguishable from zero. This pattern implies that homeowners do not increase consumption in response to accompanying home value increases prior to the baseline event window.

In addition, I analyze effects that occur further in the future by estimating effects 18 months after the tax increase in Appendix Table A4, Column 4. Note that extending the sample window forward entails more missed observations than extending backwards because the baseline sample requires homeowners to have lived in their homes for at least three years. The estimated 18-month impacts are very similar in magnitude as the 12-month impacts, and not statistically different.

**Smaller vs. Larger Increases** Are the observed responses driven by relatively large increases? If the responses are driven by larger increases, local governments may be able to mitigate the impacts of property taxes by smoothing increases over many years. To assess whether this is the case, I estimate specifications that include both linear and quadratic terms for tax increases. Appendix Table A5 presents the results of this estimation. I am unable to reject linear effects, even for mortgage delinquency which offers relatively high precision. In addition, my auto consumption estimates are very similar to those in Di Maggio et al. (2017), who study reductions in monthly payments of about \$900 on average. This similarity further suggests linear consumption responses, implying limited scope for policy to mitigate the impacts of property taxes by smoothing tax increases over time.

**Internal Validity: Endogenous Tax Increases** A potential threat to the baseline empirical strategy is if a large part of the variation in taxes is caused by homeowner behavior (i.e., reverse causality). For instance, major property improvements can induce tax assessors to increase their



valuation of the property. To assess whether this is the case, I estimate a version of Equation 4 that substitutes the realized tax increase with the predicted tax increase based on tax increases of nearby properties (described in Section 5.1). Appendix Table A4, Column 6 presents the effects estimated with the predicted increase. In support of the baseline empirical strategy, the estimated impacts on consumption, borrowing, and delinquency are similar to those estimated with the realized tax increase, albeit smaller and less precisely estimated, which is to be expected given that predicting tax increases entails measurement error.

**Internal Validity: Strong Parallel Trends** The use of a continuous regressor entails an assumption that homeowners that experience different doses of the treatment are comparable in terms of their latent potential treatment effects, also known as the strong parallel trends assumption (Callaway et al., 2021). In this setting, this assumption is plausibly satisfied because of the relatively modest variation in tax increases, coupled with the relatively narrow comparison groups. In support of this assumption, Appendix Table A6 presents correlations of the tax increase with baseline characteristics of homeowners. In the absence of controls, treatment dose is strongly related to a number of characteristics, like income, property value, credit score, and household composition; however, the inclusion of the baseline controls used for the analysis (i.e., year, county, and ventiles of assessed value) absorbs the bulk of these differences. In addition, the inclusion of finer controls (year, tract, percentiles of value, and property type) further reduces these differences, such that a \$1,000 increase in property taxes (the difference between the 0th and 98th percentiles of treatment dose) is associated with a change in homeowner characteristics of 0.08 standard deviations or less; yet estimated effects with these more granular controls yield magnitudes that are very similar to the baseline estimates (Appendix Table A4). Coupled with the modest differences in observable characteristics between different sizes of the tax increase, the robustness to finer controls suggests that violations of the strong parallel trends assumption are unlikely to meaningfully affect the baseline estimates.

**External Validity: Non-Escrow and Non-Mortgaged Homeowners** The baseline sample restricts to mortgaged homeowners who pay property taxes using mortgage escrow, because the timing of increased tax payments can be precisely measured for this group. Although these homeowners comprise about four-fifths of mortgaged homeowners (Corelogic, 2017), responses among homeowners who pay property taxes in a lump-sum directly to the government are of independent interest since these homeowners face a different payment structure.<sup>24</sup> I assess responses among these homeowners in two ways.

First, I construct a sample of homeowners in the administrative data and estimate event studies around the month that property tax bills are issued. Appendix Figure A8 shows similar consumption responses for homeowners paying property taxes in lump sum, but smaller delinquency responses.

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<sup>24</sup>For example, the financial shock of tax increases may be more severe when not spread out over monthly installments. In addition, property tax increases are more salient for homeowners paying taxes directly to the government, a group which exhibits better knowledge of their tax liability (Cabral and Hoxby, 2012). Lastly, lenders are more likely to require escrow payments for riskier borrowers, suggesting a certain degree of selection into escrow.

The smaller delinquency responses likely reflects two factors. First, lump-sum payers have more scope to pay their property taxes late while continuing to meet their mortgage payment. Second, riskier homeowners with higher loan-to-value ratios are more likely to be required by their lender to pay taxes through escrow, meaning that the difference in effect sizes is likely partly due in part to differences in selection into escrow payments. Consistent with the presence of selection, reweighting the sample of lump-sum payers to match the credit score distribution of escrow payers results in a moderate increases in estimated consumption and delinquency responses.

Second, I compare self-reported responses to tax increases in the survey of homeowners. Appendix Figure A4 presents responses for three groups: homeowners who pay property taxes (i) in monthly escrow payments along with their mortgage, (ii) in lump-sum payments but who have a mortgage, (iii) in lump-sum payments and who do not have a mortgage. In support of the external validity of the baseline analysis, responses are broadly similar, with only slightly smaller consumption responses among homeowners without a mortgage.

## 7 Heterogeneous Impacts of Tax Increases

The estimated impacts on consumption, borrowing, and financial distress imply that homeowners do not draw on housing wealth to respond to increased property taxes. This section sheds light on the mechanisms that deter homeowners from drawing on their housing wealth by estimating heterogeneous impacts of property taxes. Specifically, I estimate impacts of tax increases separately by subgroup and focus on 12-month impacts. When defining heterogeneity bins by time-varying variables (e.g., credit card utilization), variables are measured 6 months before the tax increase (i.e., event time  $t = -5$ ).

A plausible explanation for homeowners not borrowing is that they face limited credit supply. For example, homeowners can be credit constrained if they have insufficient amounts of home value to secure additional borrowing. To test for this type of credit constraint, I estimate heterogeneous responses by amount of home equity, measured using current loan-to-value ratio (CLTV). CLTV is defined as total first and second mortgage balances divided by current home value. In principle, homeowners with CLTV below 60% have ample home equity to secure additional borrowing; however, Figure 3 shows that impacts on consumption and distress are statistically indistinguishable and economically very similar across different levels of CLTV.

An alternative credit-supply explanation is that homeowners have ample housing wealth but are nonetheless credit- and liquidity-constrained. To test for the presence of such supply-induced liquidity constraints, Figure 3 compares homeowners without a home equity line of credit (HELOC) to those with a HELOC below 75% utilization. By definition, homeowners with a HELOC have immediate access to liquidity by borrowing against their housing wealth. Consistent with the presence of supply-induced liquidity constraints, these homeowners exhibit a relatively small increase in delinquency that is not statistically distinguishable from zero. Yet these liquid homeowners nevertheless exhibit seemingly large reductions in consumption, although these reductions are imprecisely

estimated because only a relatively small share of homeowners (around 6%) fall into this category.

Analyzing heterogeneity by access to credit card borrowing and by credit score offers a more statistically precise illustration of the role of credit and liquidity constraints. Figure 3 groups homeowners into those with credit cards with utilization less than 50%, and those who either have a credit card with utilization of more than 50% or who do not have a credit card.<sup>25</sup> As with HELOCs, this comparison reveals that homeowners with ample access to liquidity through credit cards exhibit small delinquency responses but similar consumption responses.

Comparing homeowners by their current credit score reveals similar patterns: delinquency responses are strongly concentrated among low-credit score homeowners, but consumption responses are very similar across levels of credit access (Figure 3). Note that credit scores are specifically designed to predict the likelihood of delinquency, meaning that they proxy for both current levels of financial distress and for credit access. I present further interactions of these heterogeneous responses in Appendix Figure A9, which shows that among homeowners with high credit card utilization and among subprime homeowners, delinquency responses are similar across different levels of home equity.

Together, these heterogeneous responses indicate that credit constraints create illiquidity and thus enable tax-induced financial distress, even when homeowners have ample amounts of home equity. However, credit-supply factors cannot explain why homeowners reduce their consumption, given that these reductions are nearly identical across different levels of home equity and credit access.

An important implication of the finding that liquidity constraints lead to tax-induced financial distress is that the economic burden of property taxes is higher for groups of homeowners that tend to be illiquid. Figure 4 plots consumption and delinquency responses by demographic characteristics, namely family composition, self-reported race/ethnicity, age, income, and home value. While consumption reductions are similar across demographic categories, property taxes have a much larger impact on financial distress among homeowners who are more vulnerable to shocks, namely Black homeowners, single-headed homeowners, and homeowners living in lower-value houses or with lower incomes.

Part of these heterogeneous impacts may be due to a given dollar increase representing a larger shock for certain groups (e.g., lower-income vs. higher-income homeowners). To assess this, Appendix Figure A10 normalizes the tax increase by a share of mortgage payments, which reveals qualitatively similar but somewhat muted heterogeneity by homeowner demographics. However, it is worth noting that this normalization has little impact on the analysis of heterogeneity by access to credit and liquidity (Appendix Figure A11).

These findings add to recent studies documenting that bias in property assessments results in a higher incidence of property taxes on homeowners in lower-value properties and who identify as Black (Avenancio-León and Howard 2022; Berry 2021; Amornsiripanitch 2020; Ihlanfeldt and

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<sup>25</sup>As documented in Fulford and Schuh (2015), borrowers with utilization more than 50% tend to roll over balances month-to-month, and are therefore more limited in their access to liquidity through additional credit card borrowing.

Rodgers 2022; Nathan et al. 2020). The larger impacts on financial distress among these groups reveal a novel channel through which they bear a disproportionately high incidence of property taxation.

## 7.1 Why Do Liquid Homeowners Cut Consumption?

Standard credit supply frictions cannot explain reductions in consumption among homeowners with ample liquidity through credit access is puzzling, given that tax increases are coupled with larger increases in home values.

Responses to the homeowner survey, which elicits both liquidity and a broader range of consumption, corroborate this puzzling behavior. In the survey responses, I define illiquid homeowners as those who report having less than \$100 left over after paying regular expenses at the end of a typical month. Figure 5, Panel A presents responses to a hypothetical \$500 tax increase by self-reported liquidity status. Consistent with the consumption responses in the administrative data, the shares of liquid vs. illiquid respondents reporting reductions in durable consumption are quantitatively similar (47% vs. 53%, respectively) and not statistically different. Also consistent with the administrative data, increases in financial distress (reducing spending on basic necessities and skipping bills) are concentrated among illiquid homeowners, and almost no respondents report borrowing against their housing wealth.

One explanation for these puzzling consumption responses is that the tax increases may be accompanied by additional factors that nullify the wealth effects of home value increases. I consider three such factors. First, local increases in home values may be accompanied by increases in the cost of living, which could counteract any wealth effects. To test whether this is the case, I estimate Equation 4 with more granular geographic fixed effects. Intuitively, homeowners in the same neighborhood are likely to experience similar increases in the cost of living. Table A4, Columns 2 and 3 re-estimate the event study specification with ZIP code fixed effects and Census tract fixed effects. The estimated impacts on consumption, borrowing, and delinquency are similar to the baseline specification with county fixed effects, implying that differential changes in the cost of living do not drive the observed behavior.

Second, increases in future housing costs may counteract wealth effects from home value increases. In theory, the extent to which increases in rental obligations outweigh wealth effects depends on a homeowner's planning horizon (Sinai and Souleles, 2005). However, the reductions in consumption depicted in Figure 4 indicate nearly identical consumption responses by household composition, and Appendix Figure A8 presents similar reductions by age, both of which are likely to be correlated with planning horizon. Moreover, leverage should amplify consumption responses to house price movements (Berger et al., 2017). The absence of differential consumption responses by age, household size, and amount of home equity (Figure 3) suggest that the consumption reductions are not produced by wealth effects being dampened by increases in future expected rents.

Third, increases in property taxes may be insufficiently correlated with increases in home values to carry wealth effects. To test this possibility, I estimate impacts controlling for changes in assessed

value. If consumption responses are driven by tax increases that are less correlated with home value increases, including this control should yield larger reductions in consumption; however, Appendix Figure A8 reveals slightly smaller impacts on consumption. An additional test is to analyze heterogeneity by assessment accuracy. In places where properties are assessed less accurately, property tax increases should be accompanied by smaller wealth effects. I measure the county-level accuracy of assessments as the standard deviation of log assessment ratios for properties with an observed sale. Appendix Figure A8 presents respondents split by above- and below-median accuracy, and reveals very similar consumption responses. Therefore, consumption responses do not seem to be driven by an insufficient correlation between taxes and home value increases.

An explanation that does find support in the observed responses is savings target behavior. In theory, homeowners who maintain a savings target should be expected to increase consumption in response to tax decreases, whereas homeowners who face some other constraint that only discourages dissaving or prevents borrowing should not. Accordingly, I analyze consumption responses among a sample of homeowners who face tax decreases in Appendix Figure A12. Two important limitations of this exercise are that it involves a smaller sample and that tax decreases exhibit lower pass-through into reductions in monthly payments. The lower pass-through occurs because mortgage servicers are not legally required to refund escrow surpluses of less than \$50 until the following year, so tax decreases need not immediately reduce payments. To compare decreases to increases, I scale the estimated 12-month increase in consumption by the reduction in monthly payments. This calculation yields an MPC of 0.107, which is close to a similarly-scaled MPC of 0.118 for tax increases. This similarity is consistent with savings target behavior, which can also explain the lack of anticipatory consumption response prior to a highly predictable tax increase. Savings target behavior as an explanation for the puzzling consumption responses is also supported by recent work documenting widespread savings targeting among homeowners (Bernstein and Koudijs, 2024), and by a recent survey finding that 92% of homeowners would not increase consumption in response to an increase in the value of their homes (Christelis et al., 2021).

## 7.2 Explaining Illiquidity Among Property-Rich Homeowners

A second puzzle raised by the observed responses is that high-equity homeowners allow themselves to be illiquid and therefore vulnerable to financial distress. Particularly to the extent that homeowners have private information about their likelihood of becoming financially distressed in the future, a precautionary savings motive would dictate that homeowners should build up liquidity for themselves, possibly by extracting home equity before they become financially distressed and ineligible for additional credit.

Additional heterogeneity analysis underscores this puzzle. Appendix Figure A9 shows that homeowners who had high credit scores at mortgage origination but then had their credit scores fall to a subprime range exhibit similar distress impacts as those who had low credit scores throughout. Moreover, homeowners with high amounts of home equity and high credit card utilization but who maintain high credit scores exhibit non-negligible increases in distress. In both of these cases, it is

somewhat surprising that homeowners do not appear to take steps to generate liquidity before they become financially distressed.

Survey responses indicate that preference-based debt aversion is a key reason homeowners refrain from drawing on housing wealth, even when doing so could avoid financial distress. 77% of homeowners state that they would not consider taking out a second mortgage, even if they faced difficulty finding the money to pay property taxes (Appendix Table A7). Under these conditions, 67% of homeowners would rather skip bills than take out a second mortgage. Figure 5, Panel B shows that the majority of respondents (69%) indicate that the reason they would not take out a second mortgage is because they are uncomfortable being in debt. Only 33% refer to up-front fixed costs, only 11% indicate that they would not qualify for a loan, and only 4% indicate that they do not know how to take out a loan. Debt aversion is the key stated factor in this setting—homeowners report being sufficiently debt averse so as to prefer becoming financially distressed (i.e., skipping bills) over borrowing.

These findings suggest that a lack of credit demand precedes credit supply constraints among homeowners who later become liquidity constrained and financially distressed. In line with this interpretation, survey responses point away from credit supply and information frictions. When asked, 62% of respondents report that it would be easy or very easy to take out a second mortgage (Appendix Table A7). To test for information frictions, I conduct a randomized information treatment that provides a randomly selected set of respondents with additional information on home equity extraction. While the information treatment significantly increases the likelihood that respondents correctly answer a set of factual questions about second mortgages, the information does not meaningfully increase take-up of mortgage borrowing. This experiment is discussed in more detail in Appendix F.

In addition to creating homeowner illiquidity, debt aversion also inhibits the efficacy of a theoretically efficient policy solution for avoiding financial distress. Tax deferrals allow homeowners to postpone paying their taxes until they sell their home. Since these tax deferrals carry interest, they represent an implicit government loan to homeowners. Deferrals are theoretically appealing because they avoid negative shocks to liquidity due to property tax increases without creating substantial economic inefficiencies or reducing government revenue in the long run. Tax deferrals have already been implemented at scale: 31 states currently offer tax deferrals (Lincoln Institute of Land Policy, 2023). However, even in cases where eligibility criteria are relatively broad, take-up of property tax deferrals tends to be very low.<sup>26</sup>

To analyze the importance of debt aversion for tax deferrals, survey respondents are asked what they would do if offered the opportunity to defer property taxes with zero interest.<sup>27</sup> Appendix Table A7 shows that 41% of respondents indicate that they would never defer their property taxes,

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<sup>26</sup>For instance, the state of Washington allows homeowners with incomes less than \$57,000 to receive a partial property tax deferral at an interest rate of about 4% and elderly homeowners with low disposable income to receive a full property tax deferral at an interest rate of 5% (Washington Department of Revenue 2019). Despite broad eligibility criteria, only 572 homeowners in the state took up these deferrals in 2017 (Oline 2018).

<sup>27</sup>This proposition is not entirely unrealistic. Washington, DC offers a zero-interest tax deferral (Lincoln Institute of Land Policy and George Washington Institute of Public Policy, 2020).

while only 15% of respondents indicate they would defer their property taxes immediately. Figure 5, Panel C presents respondents' stated reasons for never deferring property taxes. Homeowners appear to also be debt averse in this context: 61% of respondents indicate that they would never defer their property taxes because they don't want to feel in debt. In standard economic models, the decision to reject a zero-interest tax deferral is equivalent to rejecting a zero-interest loan. Therefore, all homeowners should be willing to take up the tax deferral. According to respondents' stated reasoning, debt aversion prevents homeowners from taking on debt to pay their property taxes even in the absence of significant fixed costs or interest.

Debt aversion in this setting is surprising for several reasons. First, debt aversion is reported by a broad range of homeowners who are already indebted through their primary mortgages.<sup>28</sup> One potential explanation is mental accounting behavior in which households differentiate debts based on type and purpose (Prelec and Loewenstein, 1998). As observed in the sociology literature, "Taking on debt can be a moral good or a moral bad. A good debt allows a middle-class person to care for her family by ensuring that basic needs are met or by securing (and investing in) home ownership" (Wherry, 2016). Second, a large body of empirical work finds that house price increases lead to increases in mortgage borrowing (e.g., Mian and Sufi 2011; Cloyne et al. 2019). Good debt/bad debt accounting can also reconcile debt aversion with this finding, since second mortgages are most often used for making investments and paying down other debts (Canner et al. 2002), as well as for financing higher education (Lovenheim 2011; Amromin et al. 2016). Alternatively, it is also possible that these increases in borrowing are simply driven by homeowners who are not debt averse. Third, homeowners frequently resort to implicit borrowing through mortgage delinquency despite being debt-averse (about 7% are delinquent in a given month). Since delinquency typically triggers an automatic 5% late fee, it represents a highly costly form of borrowing (i.e. one with a 60% annualized interest rate); however, since it carries an urgent imperative to repay, the impact of short-term delinquency on wealth accumulation is likely modest.

Although my empirical setting does not allow me to fully elucidate the nature of debt aversion, the framework in Section 2 yields clear implications for welfare which do not depend on the micro-foundations of debt aversion. By being debt averse, homeowners place a constraint on themselves against drawing on their housing wealth. This constraint prevents them from converting housing wealth into liquidity, enabling property taxes to create financial distress.<sup>29</sup> As will be discussed in

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<sup>28</sup>Appendix Figure A13 presents correlates of debt aversion, and shows that debt aversion is not strongly correlated with a wide range of demographic characteristics, including employment status, income, home value, and gender. Unsurprisingly, homeowners who have already extracted home equity are less likely to be debt averse.

<sup>29</sup>Debt aversion represents a very different explanation for excess consumption sensitivity and homeowner illiquidity than those proposed in existing economic models. Previous work has focused on the role of large transaction costs (Chetty and Szeidl, 2007) and higher returns to illiquid wealth (Kaplan and Violante, 2014); however, survey responses indicate that neither of these factors is as important as debt aversion in this setting. The presence of debt aversion has meaningful implications for economic models of homeowner responses to housing wealth. In particular, debt aversion may be an important factor driving the excess sensitivity of consumption among liquid households (Olafsson and Pagel 2018; Kueng 2018; Baugh et al. 2021). My findings on debt aversion contribute new evidence to a growing body of empirical work that documents the role of debt aversion in other domains, such as reverse mortgages (Fornero et al. 2016; Davidoff et al. 2017; Hanewald et al. 2020), student loans (Callender and Jackson 2005, Field 2009), and financial choices in the laboratory and surveys (Meissner 2016, Caetano et al. 2019, Martínez-Marquina and Shi 2022;

the following section, this financial distress can lead to distressed home sales, an extremely costly outcome for homeowners.

## 8 Migration Effects

This section documents that in addition to inducing financial adjustments, property taxes induce homeowners to migrate. Analyzing migration requires two adjustments to my empirical strategy. First, I use variation in property taxes that is predicted using changes to similar nearby properties. These predicted tax increases, described in Section 5.1, avoid the reverse causality that can be created by the impacts of property sales on taxable value through the assessment process. However, using predicted tax increases appears to entail pre-trends in sales and investment outcomes. Accordingly, I include a linear trend between event times -15 and -3 in the event study specification.<sup>30</sup> This approach requires an additional identification assumption, which is that deviations from a linear trend reflect the causal impacts of property taxes. This assumption can be validated by assessing the closeness of the linear fit in the pre-event period. Intuitively, the closer that outcomes follow a linear trend prior to the tax increase, the more plausibly deviations from that trend after the tax increase can be attributed to the tax increase. Second, the migration sample does not include the credit bureau and mortgage servicing data, which I use to define event time in the financial behaviors sample. Therefore, I define event time according to the month in which the property tax bill is issued and analyze effects after 18 months. As before, the baseline specification includes fixed effects that interact county, assessor year, and ventiles of assessed value.

I find that property tax increases cause homeowners to sell their homes, both voluntarily and through distressed home sales (i.e., foreclosures and short sales). Figure 6 presents event study estimates that analyze impacts on the likelihood that a property is sold in any sale (Panel A) and in a distressed sale (Panel B). A \$100 increase in property taxes results in a 0.071 percentage point (1.7%) increase in annual home sales of any type and a 0.012 percentage point (1.5%) increase in annual distressed home sales after 18 months. These effects are highly robust to alternative specifications (e.g., ZIP code and property type fixed effects) presented in Appendix Table A8, which also shows that estimated effects after 24 months are similar to the 18-month effects.<sup>31</sup> In support of the identifying assumption, trends in the pre-period are highly linear.

The increase in distressed sales accounts for about one-sixth of the overall increase in sales. Since distressed sales are largely driven by illiquidity (Ganong and Noel, 2023), these results imply

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Colarieti et al. 2024). One interpretation of debt aversion among homeowners is that it represents a preference-based commitment device to save, which echoes recent work documenting demand for commitment devices to save (Ashraf et al. 2006, Beshears et al. 2015, John 2020) and to avoid borrowing (Allcott et al. 2022).

<sup>30</sup>Section 2 in the Online Appendix presents event study figures that do not impose a linear trend.

<sup>31</sup>The estimated migration impacts differ markedly from those in prior work. Shan (2010) uses survey data and variation in property tax relief programs and estimates that a \$100 increase in taxes results in a 0.73 percentage point (9%) increase in two-year mobility among elderly homeowners—substantially larger estimates than those derived from my administrative data. In comparison to responses to adjustable-rate mortgage payments, my estimates are somewhat smaller than the roughly 0.06 percentage point increase in foreclosures per \$100 increase in annual payments in Gupta (2019). One potential explanation for this difference is that Gupta (2019) analyzes a sample of mortgages originated between 2000 to 2010, a group which exhibited very high rates of distress during the Great Recession.



that a meaningful share of tax-induced moves occur among illiquid homeowners. This finding is particularly notable given the many costs associated with distressed sales, including elimination of housing wealth among above-water homeowners (Low 2022, Ganong and Noel 2023), negative house price externalities (Lin et al. 2009; Campbell et al. 2011; Anenberg and Kung 2014; Gerardi et al. 2015), and other adverse outcomes like higher rates of divorce (Diamond et al., 2020).

Impacts on home sales (and therefore migration) are concentrated among economically vulnerable groups. Figure 7 presents event study estimates that split the sample by terciles of Census tract income and share of non-Hispanic White homeowners in 2010. The estimated impacts on distressed sales are driven by homeowners in neighborhoods with the highest share of minorities and with the lowest incomes. Impacts on distressed sales are also larger for homeowners that are younger and have had shorter tenures at the time of the tax increase, consistent with lower levels of financial stability among younger homeowners, and higher rates of default early in tenure spells.

## 8.1 Do Property Taxes Accelerate Neighborhood Change?

A widespread concern among policymakers and the public is that in neighborhoods with rising house prices, incumbent residents unable to afford property taxes are replaced by wealthier in-migrants; that is, that property taxes accelerate ongoing gentrification (e.g., Wilding 2024; Rabb 2024). Yet empirical support for this concern is inconclusive. On one hand, observational comparisons of out-migration in gentrifying versus non-gentrifying neighborhoods has found limited evidence of displacement (e.g., Ellen and O’Regan 2011b, Ding et al. 2016, Martin and Beck 2018; Brummet and Reed 2019); on the other hand, recent work has documented that tax lien sales attract investment in luxury housing and amenities (LaPoint, 2022). To assess the validity of these concerns, I leverage my empirical design to isolate the impacts of property taxes on neighborhood change.

For this analysis, I use predicted property tax increases as an instrument for migration in the two years following the tax increase. If tax increases satisfy standard IV assumptions, the IV regression recovers a positive weighted average treatment effect of moving among compliers, defined as properties that would not have changed ownership in the first two years after the tax increase if they had received a smaller tax increase (Angrist and Imbens, 1994). This approach allows me to compare characteristics of both out-migrating and subsequent in-migrating households that were marginal to the tax increase, relative to characteristics of average migrants which can be estimated by analogous OLS regressions. This approach is enabled by the address history data, which is designed to follow migrating households from one location to the next. Appendix E.4 presents the estimating equation and discusses the accompanying assumptions in more detail.

I find that out-migrating homeowners who are induced to move because of tax increases move to neighborhoods of significantly lower quality. For this analysis, I draw on Census tract-level characteristics from the 2019 American Community Survey to measure the characteristics of the departure and arrival neighborhoods associated with a given move. Figure 8, Panel A compares characteristics of marginal and average moves for homeowners who are induced to leave, estimated by 2SLS and OLS, respectively. The first-stage F-statistic of the 2SLS regressions for out-migrants

is 25.9, confirming that the relevance assumption is satisfied. Figure 8 shows that the average migrant experiences very little change in average neighborhood rents, home values, income, and educational attainment. In contrast, marginal movers arrive to neighborhoods where median rents are 24 log points lower than those in the neighborhood from which they departed, and where median home values are 20 log points lower. Similarly, these neighborhoods contain residents with incomes that are 20 log points lower, poverty rates that are 4 percentage points higher, and college attainment rates that are 10 percentage points lower. These downgrades contrast with prior work documenting that on average, movers from gentrifying neighborhoods do not experience decreases in neighborhood quality (Brummet and Reed 2019; Dragan et al. 2020). The contrast between these two sets of findings suggests that in gentrifying neighborhoods, tax-induced moves to lower-quality neighborhoods may be counterbalanced by relatively voluntary moves to higher-quality neighborhoods.

At the same time, out-migrating homeowners are replaced by in-migrants who realize substantial improvements to neighborhood quality. Figure 8, Panel B presents estimates for in-migrants. In-migrants to properties that are vacated due to property tax hikes experience improvements in neighborhood home values, rents, and incomes of about 30 to 40 log points, as well as increases in average educational attainment and reductions in poverty rates. To contextualize these gains in terms of the overall distribution of neighborhood quality, Appendix Figure A14 plots effects scaled in percentiles of the distribution of Census tracts, and shows that marginal out-migrants experience reductions in neighborhood quality of 5 to 15 percentiles and are replaced by in-migrants who experience improvements of 15 to 30 percentiles. Although I am unable to directly measure the income or wealth of migrants themselves, these findings run counter to the concern that property taxes hasten gentrification by replacing incumbent residents with wealthier in-migrants. Rather, they suggest that property taxes may create vacancies for households who benefit from the opportunity to migrate to better neighborhoods, a positive externality.

In addition, Table 2 provides suggestive evidence that homeowners induced to move are replaced by in-migrants who transition from renting to owning. While out-migrants move to neighborhoods with similar homeownership rates, in-migrants tend to move from neighborhoods with a much higher share of renters. Specifically, marginal in-migrants experience a change in neighborhood homeownership rates of 20 percentage points (Column 1). Marginal in-migrants also appear to move from neighborhoods where the average age is about 4 years younger (Column 2). In addition, in-migrants are more likely to move from a multi-family to single-family home, whereas out-migrants are more likely to move from a single-family to a multi-family home (Column 3).

I find limited evidence that property taxes contribute to other changes in neighborhood demographics. Table 3 compares changes in the characteristics of the resident of a given property facing a tax increase. Although marginal (and average) out-migrants tend to be about 13 years older than their replacement, I am unable to reject no change in household size or race/ethnicity.<sup>32</sup> This lack

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<sup>32</sup>Note that household age and race/ethnicity are imputed by Infogroup and therefore entail measurement error. Appendix D.3 validates these measures using a subsample where self-reported race/ethnicity and age are observed in administrative data, and confirms that the imputed values are highly correlated with the more accurate measures.

of demographic change is somewhat surprising given that about half of marginal in-migrants move from outside of the commuting zone, compared to only about one-fifth of average in-migrants (Table 2, Column 4). Coupled with the disproportionate migration impacts in minority neighborhoods (Figure 7), these results suggest that although property tax increases disproportionately displace minority homeowners, they do not greatly alter neighborhood ethnic composition on average.

I also find limited evidence that the observed changes in neighborhood quality have negative impacts on children through neighborhood effects, a common concern in the literature on gentrification (Dragan et al. 2020, Brummet and Reed 2019; Baum-Snow et al. 2019). I analyze three neighborhood characteristics that are particularly relevant for child outcomes using tract-level data from Chetty et al. (2018): school test scores, male incarceration rates, and intergenerational mobility.<sup>33</sup> The estimates presented in Table 2 (Columns 5 through 7) indicate that all migrants experience small to moderate improvements in these neighborhood characteristics; however, it is worth noting that the confidence intervals encompass a relatively wide range of effect sizes. While this analysis does not capture other channels through which moves may harm children (e.g., through disruption effects), the confidence intervals do suggest that negative impacts that operate through neighborhood environment are modest at most.

## 8.2 Investment and Consumption Externalities

In addition to the previously mentioned negative externalities from distressed sales and positive externalities from new vacancies, tax-induced migration may yield positive externalities from home investments and moving expenditures that occur when a household moves. This possibility is consistent with the large spike in home improvement permits filed around a property sale depicted in Appendix Figure A3, Panel B.

However, I find that property tax increases lead to net reductions in home investment, which weighs against the presence of positive externalities. Figure 6, Panel C, shows that after 18 months, a \$100 predicted increase in property taxes reduces the annual share of properties filing a permit by about 0.1 percentage points (a 3% reduction). To gauge the value of these permits, I estimate the impact of permits on subsequent sales prices in the repeat sales sample. Appendix Table A9 reports that one additional permit is associated with a \$19,077 increase in the capital gain associated with an ownership spell (i.e., difference between purchase and sales price). Although this estimate must be interpreted with caution given the possibility of unobserved factors correlated with permitting, it nevertheless suggests that foregone improvements would have increased home values substantially.

In principle, it is possible that increases in other moving expenditures outweigh the reduction in home improvements. For example, Best and Kleven (2018) estimate that a property sale triggers additional spending of about 5% of the house price, implying that encouraging home sales stimulates aggregate economic activity. However, a simple back-of-the-envelope calculation suggests that

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<sup>33</sup>Test scores are defined as school district standardized 3rd grade math scores in 2013. Male incarceration rates are the fraction of children born in 1978-1983 birth cohorts who were incarcerated on April 1st, 2010. Intergenerational mobility is the mean rank in the national distribution of children born to parents at the 75th percentile of income.

moving expenditures among migrating homeowners are unlikely to outweigh tax-induced reductions among non-migrating homeowners.<sup>34</sup>

The reductions in home improvement imply three channels that exacerbate the economic costs of property taxes. First, home improvement represents increased housing consumption, and consequently can be interpreted as corroborating evidence that property taxes exacerbate consumption uncertainty. Second, since improvements are associated with substantial increases in home value, reductions in improvements also reduce the tax base. Third, to the extent that home improvements raise the value of nearby properties, reductions in improvements forgo positive housing externalities (Rossi-Hansberg et al., 2010).

## 9 Welfare Costs of Tax Increases

The previous analysis documents the impacts of property taxes on consumption, distress, migration, and investment. In order to assess the relative importance of each of these impacts in terms of their welfare costs, I embed the estimated impacts into the welfare framework presented in Section 2. In doing so, I use the estimated impacts as sufficient statistics for welfare to avoid making assumptions about both the functional form of borrowing frictions, and about the extent of wealth effects from house price increases. Below, I briefly outline the simplifying assumptions involved in calculating each of these three components. To avoid extrapolating my point estimates to longer time horizons, my calculations pertain to a one-year marginal increase in property tax rates. Appendix C discusses these assumptions and provides detailed calculations.

First, to calculate the welfare costs of consumption uncertainty, I apply a first-order approximation of marginal utility and assume that property taxes are approximately linear in home value (i.e.,  $T = \tau p_1 h$ ). Under these assumptions, consumption uncertainty can be calculated as:

$$1 + cov\left(\frac{p_1 h}{E[p_1 h]}, \frac{u'_1(c_1)}{E[u'_1(c_1)]}\right) \approx \frac{E\left[\frac{T}{E[T]}(1 - \gamma \Delta c)\right]}{E[1 - \gamma \Delta c]}$$

In the above,  $\gamma$  denotes the coefficient of relative risk aversion and  $\Delta c$  denotes the percentage change in consumption. I assume that the effects of property taxes on consumption are linear and extrapolate the effects on auto consumption to total consumption using the approach in (Di Maggio et al., 2017), which results in an MPC of 0.93 (i.e., nearly full pass-through).

Second, I calibrate welfare costs of financial distress and forced moves based on Ganong and Noel (2023), who estimate that mortgage default entails a \$100,000 consumption-equivalent utility cost. This utility cost embeds the costs of forced displacement (i.e.,  $M$ ) as well as the psychological costs of financial distress. Interpreting the consumption-equivalent utility cost as a willingness-to-pay and multiplying by the estimated impacts on distressed sales yields a component that can be added to the MVPF numerator. In my setting, a finding that supports this high willingness-to-pay is that

<sup>34</sup>A \$100 increase in property taxes increases the likelihood of a home sale by 0.071 percentage points. If a property sale triggers spending of 5% of the average home value of \$253 thousand (Best and Kleven, 2018), the sales impact generates additional spending of about \$9, which is less than my estimated reduction in auto consumption alone.

average prices of tax-induced property sales are substantially lower than their imputed value. Table 3, Column 4, estimates sale discounts (the percentage difference between the realized sale price and the home value estimated by Infogroup) between marginal and average sales. The OLS coefficient indicates that for the average move, this value is close to 0, indicating that the estimated home value is accurate on average. In contrast, the estimated discount for marginal moves is -0.18, indicating that these homes were sold for 18% less than their estimated value and suggesting a substantial amount of lost housing wealth from tax-induced moves.<sup>35</sup>

Third, I calculate the externality costs of distressed sales. Specifically, I calculate the spatial density of housing units from the 2010 Census and apply estimates of distressed sale externalities from Gerardi et al. (2015). I assume that distressed sale externalities only impact the 4.2% of properties that are sold in a given year, and conservatively exclude depreciation-related externalities that may occur prior to sale.

Fourth, I calculate the net fiscal costs of foregone home investment. To do so, I compute the elasticity of housing to property taxes as if property taxes were to only affect the housing stock through home improvement permits and apply the correlation between home improvement permits and increases in sale prices estimated in Section 8.2. To convert the impact on home permits into an elasticity, I multiply by the average effective tax rate in the repeat sales sample (1.4%) and divide by the average purchase price (\$248,083). Note that this approach to computing net fiscal costs abstracts from other impacts of property taxes on the aggregate capital stock, studied in prior work documenting impacts on new construction (Lutz, 2015) and capitalization into asset values (Yinger et al. 1988; Dray et al. 2023).

Table 4 lists the externally calibrated parameters (Panel A) and presents the computed values from each of the components (Panel B). These calculations indicate that the welfare costs of financial distress are orders of magnitude larger than costs arising from foregone investment and consumption uncertainty. The dominance of the financial distress costs is particularly stark given that consumption uncertainty is computed assuming near-full pass-through of property taxes into consumption. In part, this reflects the fact that for a homeowner at the average level of consumption, usual tax uncertainty over a one-year horizon induces only a modest amount of consumption-utility uncertainty. Indeed, the welfare costs of consumption uncertainty may be much higher for illiquid homeowners who have a particularly high marginal utility of consumption, or over longer periods.

Two additional points of interpretation are worth noting. First, the welfare costs of financial distress are calculated relatively conservatively. The baseline calculation assumes that only distressed sales are precipitated by liquidity constraints, and it ignores both psychological and pecuniary costs of financial distress among those who do not move. A less conservative approach is to scale by the increase in 60-day delinquency (Appendix Figure A5), the measure of default used in Ganong and Noel (2023). With this calculation, financial distress increases the numerator by 0.66, a quantitatively large increase in welfare costs.

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<sup>35</sup>These discounts occur partly because many of the tax-induced sales are distressed sales, which have been estimated to erase about 30% of home value (Kermani and Wong, 2021). At the same time, these discounts should be interpreted with caution given that the bias in Infogroup’s home value estimates may differ between marginal and average sales.

Second, these calculations do not incorporate the willingness-to-pay of in-migrating households who replace tax-induced out-migrants. Estimating willingness to pay for this particular subpopulation is challenging, particularly given that a single migration can generate a chain of property vacancies as each successive household moves. A household’s willingness to pay also depends on its outside option. For example, in a market with many vacancies, the willingness to pay of a counterfactual in-migrant may be close to 0. Adding in a vacancy externality term to the numerator and scaling by the estimated effect on all sales implies that if the total willingness to pay of other households for a new vacancy exceeds \$20 thousand, then a marginal property tax increase has an MVPF of below 1 (\$95 thousand when using the less-conservative calibration of distress costs), indicating that the benefits to in-migrants must be substantial in order to fully offset the welfare costs of forced moves. See Appendix C for detailed calculations.

## 10 Conclusion

This study demonstrates that homeowners do not internalize or draw on their housing wealth when facing property tax increases created by rising home values. Consumption responses are consistent with the presence of savings targeting, and survey responses indicate that preference-based debt aversion creates illiquidity and enables later financial distress. Because homeowners essentially ignore increases in their home values, subsequent tax hikes lead to reductions in consumption and increases in financial distress and displacement. These findings validate a popular narrative that property tax hikes created by rising home values impose hardship on homeowners, a narrative that has historically conflicted with standard economic reasoning.

These results have important implications for the optimal design of property taxes. Debt aversion coupled with uncertain house prices increases the welfare costs of property taxes, which implies lower optimal rates relative to a frictionless benchmark. These findings highlight the value of theoretical approaches that consider whether taxes mitigate or exacerbate uncertainty (as in [Varian 1980](#) for income taxes). This is particularly relevant for theoretical work on property taxes, which has until recently focused largely on redistribution and distortions to the tax base. More generally, to the extent that many households manage their finances under a savings target, taxes on cash inflows (e.g., income taxes) will tend to mitigate consumption uncertainty, whereas taxing illiquid assets has the opposite effect and also risks creating distress among illiquid households.

My findings suggest that policies that can mitigate financial distress among illiquid homeowners may meaningfully reduce welfare costs. Two such policies have already been enacted by dozens of states: assessment limits that prevent increases in home values from raising property taxes, and so-called circuit breakers that reduce property taxes for low-income homeowners. Circuit breakers may be particularly well-suited to mitigating the impacts of financial distress because they specifically target homeowners that are most likely to be illiquid. These policies are seemingly popular among voters: randomized information treatments in [Wong \(2023\)](#) indicate that circuit breakers improve taxpayer attitudes towards property taxes. Ultimately, these policies must be assessed

in light of the trade-off between mitigating financial distress and incurring additional inefficiencies (i.e., labor supply distortions for circuit breakers, lock-in effects for assessment limits). Nonetheless, the substantial welfare costs arising from financial distress suggest that, rather than approximating lump-sum taxation as prescribed by canonical theories, optimal property taxes may entail distortionary modifications.

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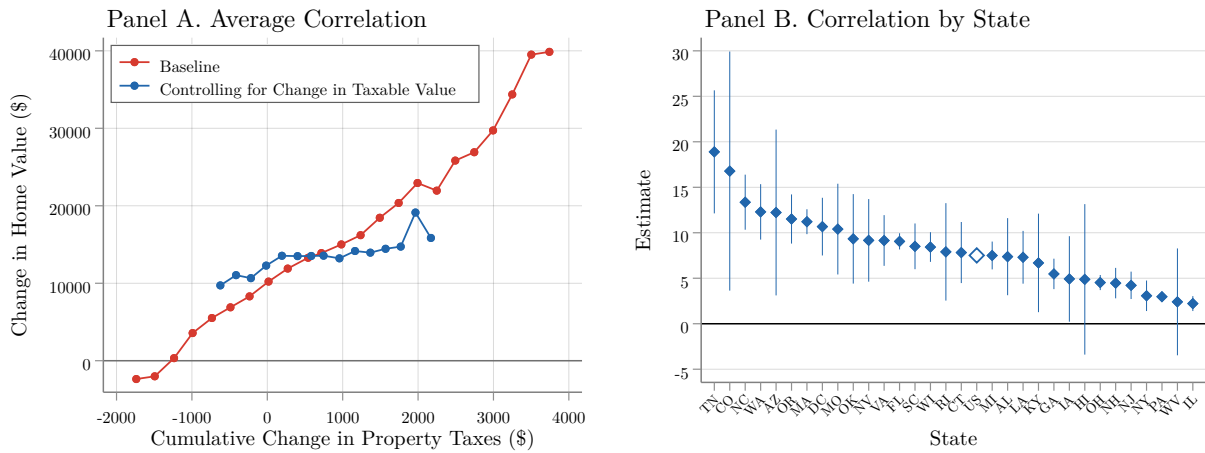


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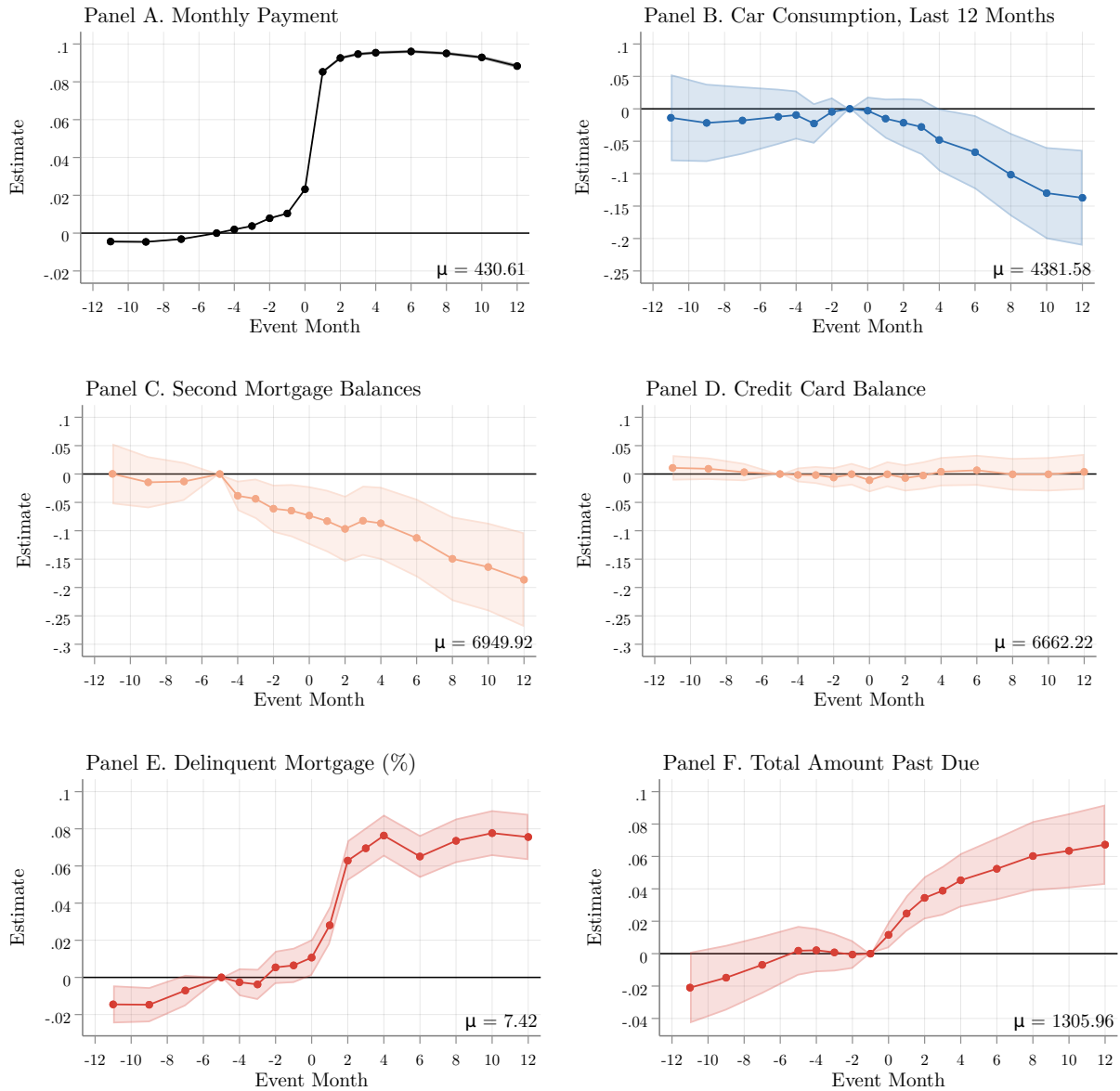
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Figure 1: Correlation Between Property Tax and Home Value Increases



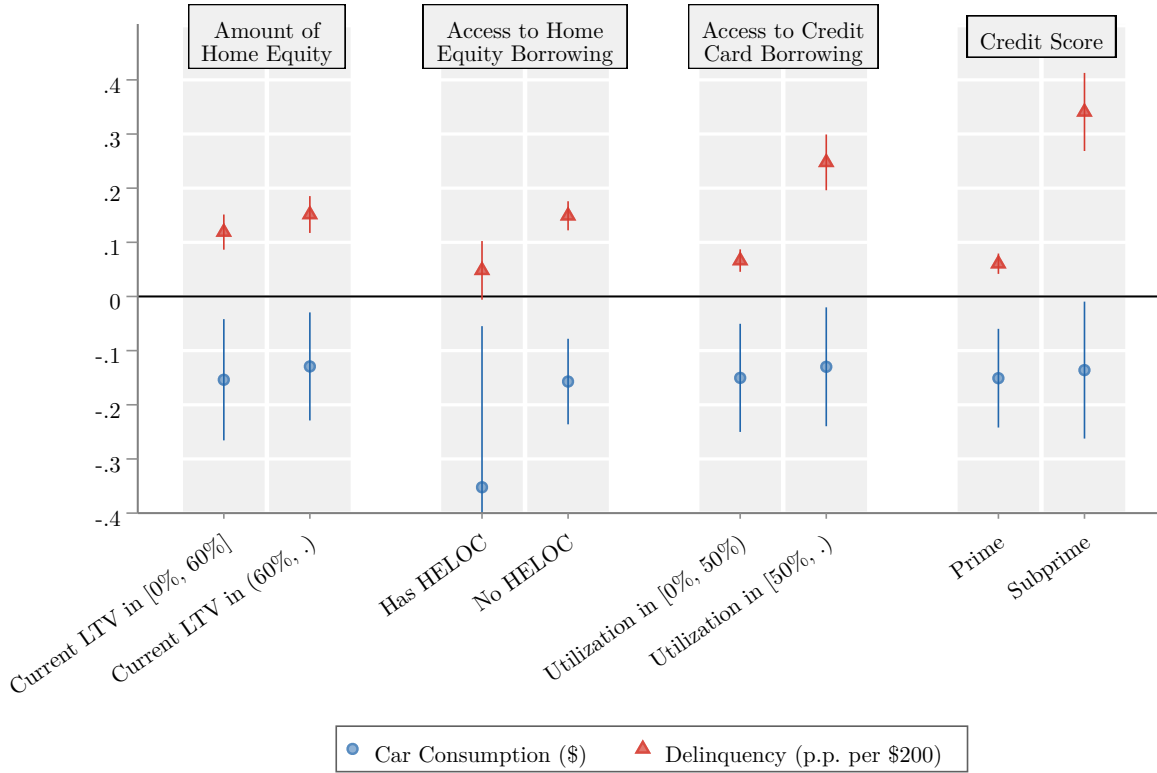
*Notes:* This figure illustrates the relationship between changes in property taxes and changes in actual home values. Panel A presents a binned scatterplot of annual changes in home values and annual changes in property taxes. The baseline specification residualizes by purchase year, sale year, county, and initial assessed property value. The line controlling for changes in taxable value further residualizes by changes in assessed property value. Panel B presents coefficients of a regression of annual changes in home values on annual changes in property taxes, controlling for purchase year, sale year, county, and ventiles of initial assessed value. Vertical lines depict 95% confidence intervals. Standard errors are clustered at property level. Data from repeat sales sample described in Section 3. Table 1 of the [Online Appendix](#) presents numerical values and additional statistics.

Figure 2: Impact of Tax Increase on Payments, Consumption, Borrowing, and Distress



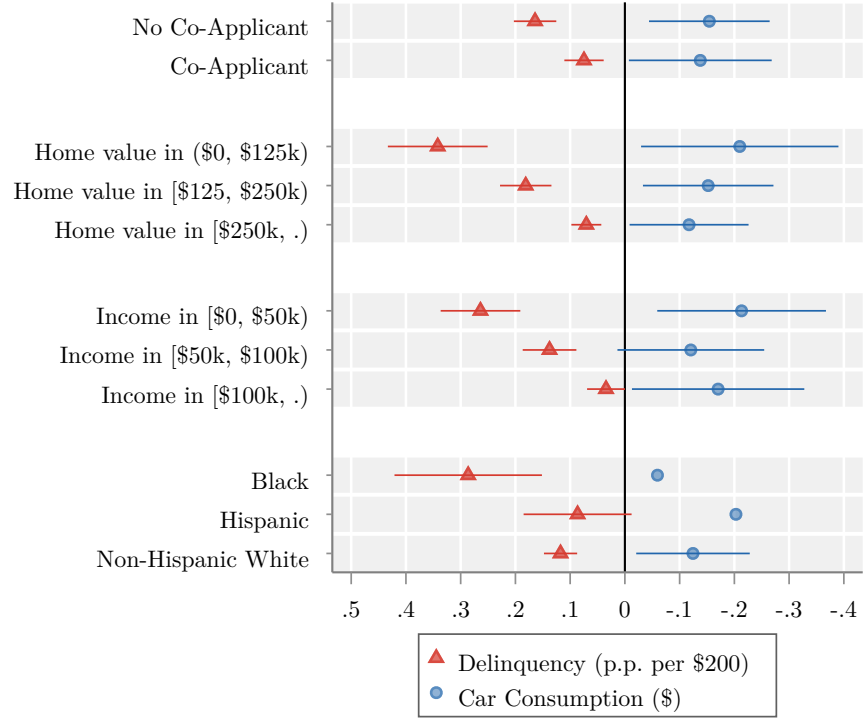
*Notes:* This figure depicts the time path of outcomes around a property tax increase that occurs at event time  $t = 1$ . The outcomes are the monthly tax and insurance payments (Panel A), the 12-month cumulative sum of auto consumption (Panel B), second mortgage balances (Panel C), credit card balances (Panel D), an indicator that a homeowner is 30 or more days past due on their mortgage (Panel E), and the total amount past due listed on their credit report (Panel F). The units of outcomes in Panels A, B, C, D, and F are dollar amounts. In Panel E, coefficients have been scaled to denote percentage point changes relative to a \$100 tax increase. The coefficients correspond to estimates of Equation 4. The coefficients indicate that a \$1 increase in property taxes lead to a reduction in auto consumption of about 14 cents, a reduction in mortgage borrowing of about 19 cents, no change in credit card borrowing; and that a \$100 increase in property taxes lead to a 0.08% increase in mortgage delinquency and a \$6.6 increase in amounts past due. Shaded regions depict 95% confidence intervals. Standard errors are clustered at loan level. Data from financial behaviors sample described in Section 3. Table 2 of the [Online Appendix](#) presents numerical values and additional statistics.

Figure 3: Heterogeneity by Housing Wealth and Access to Liquidity



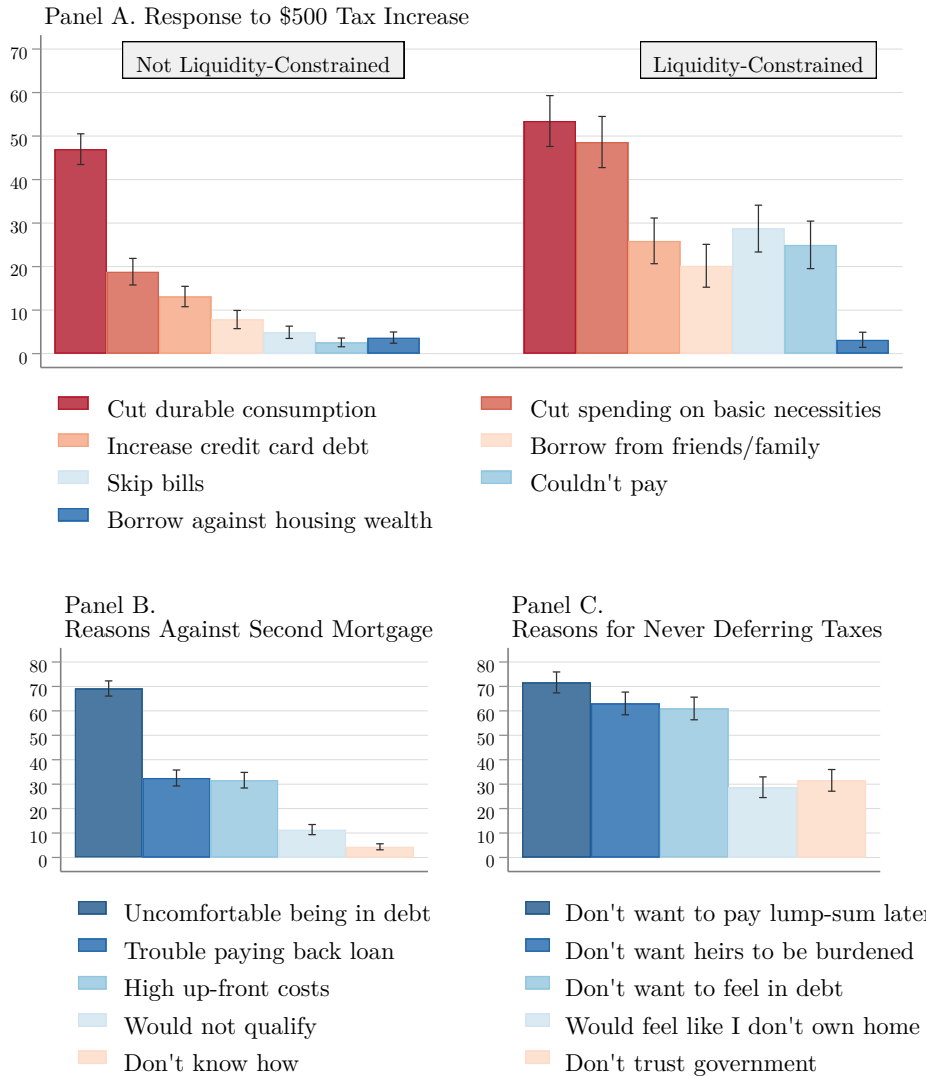
*Notes:* This figure documents heterogeneous impacts of property tax increases on auto consumption (12-month cumulative sum) and delinquency (an indicator that a homeowner is 30 or more days past due on their mortgage). Coefficients for delinquency are scaled to reflect percentage point impacts of a \$200 increase in property taxes. “Amount of Home Equity” compares homeowners by current combined loan-to-value prior to the tax increase. “Access to Home Equity Borrowing” compares homeowners who do not have a home equity line of credit (HELOC) to those with an open HELOC with less than or equal to 75% utilization prior to the tax increase. “Access to Credit Card Borrowing” compares homeowners by whether they have less than 50% utilization on open credit cards, or greater than or equal to 50% utilization or no open credit card. “Credit Score” compares homeowners by current credit score, with Prime being defined as a score of greater than 660. Coefficients correspond to estimates of Equation 4 for event time  $t=12$ , relative to event time  $t=-1$ . Vertical lines depict 95% confidence intervals. Standard errors are clustered at loan level. Data from financial behaviors sample described in Section 3. Tables 3 and 4 of the [Online Appendix](#) presents numerical values and additional statistics.

Figure 4: Heterogeneity by Demographic Characteristics



*Notes:* This figure documents heterogeneous impacts of property tax increases on auto consumption (12-month cumulative sum) and delinquency (an indicator that a homeowner is 30 or more days past due on their mortgage). Coefficients for delinquency are scaled to reflect percentage point impacts of a \$200 increase in property taxes. The first set of coefficients compares single borrowers (i.e., those with one applicant listed on the mortgage application) to couples (i.e., those with two applicants). The second set of coefficients compares homeowners by current home value. The third set of coefficients compares homeowners by income at mortgage origination. The fourth set of coefficients compares homeowners by self-reported race and ethnicity. Coefficients correspond to estimates of Equation 4 for event time  $t=12$ , relative to event time  $t=-1$ . Data from financial behaviors sample described in Section 3. Horizontal lines depict 95% confidence intervals. Standard errors are clustered at loan level. Confidence intervals for Black and Hispanic consumption impacts are suppressed for clarity, and reported in the [Online Appendix](#), which presents numerical values and additional statistics (Tables 5 and 6).

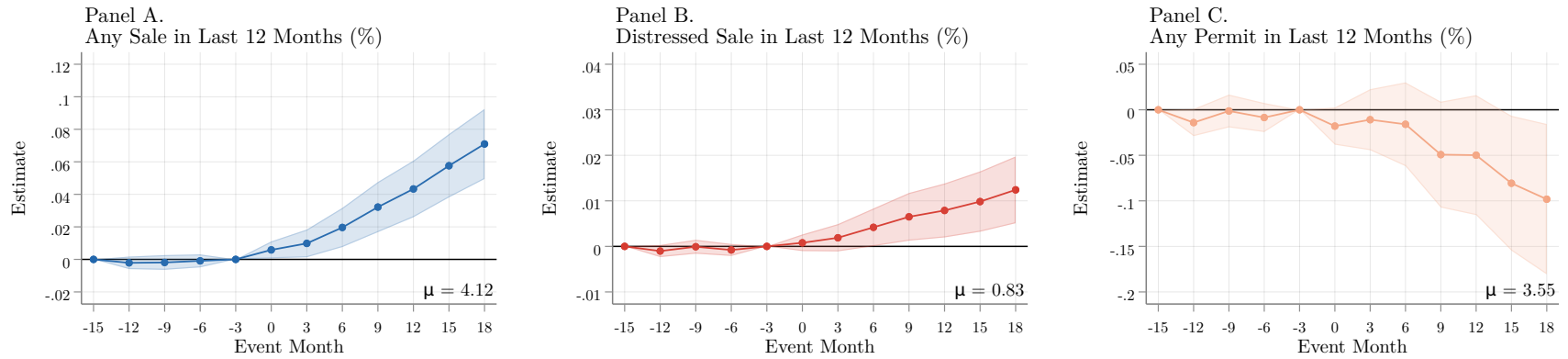
Figure 5: Survey Evidence on Financial Responses and Debt Aversion



*Notes:* This figure plots responses from an online survey of 2,000 homeowners across the US. Each bar and 95% confidence interval correspond to the share of respondents indicating each answer category. Panel A plots responses to the question, “Suppose that next year your yearly property tax bill increases by \$500. How would you pay for this?” The respondent sample is split by liquidity status. Liquidity-constrained homeowners are defined as those having fewer than \$100 left over at the end of a typical month. This panel indicates that very few homeowners would draw on their housing wealth to pay for a tax increase and that durable consumption reductions are very similar by liquidity. Panel B plots responses to the question, “You indicated that you would not consider taking out a second mortgage. What are your reasons for choosing this option?” Inclusion is conditional on respondent reporting that they would not consider taking out a second mortgage to pay property taxes (N=1,190). Responses indicate that debt aversion is the primary reason why homeowners do not draw on housing wealth in order to pay property taxes. Panel C plots responses to the question, “You indicated that you would never defer paying your property taxes. Which of the following are reasons you chose this option?” Inclusion is conditional on respondent reporting that they would never defer property taxes with zero interest if given the option (N=636). Responses indicate that debt aversion prevents homeowners from taking up a zero-interest loan in the form of an interest-free tax deferral. These questions asked of homeowners living in all US states except Michigan. One in five respondents were randomly presented with free response text box instead of multiple choice answers and are excluded. The [Online Appendix](#) presents numerical values and additional statistics in Table 7, as well as a version of the figure that does not reweight responses.

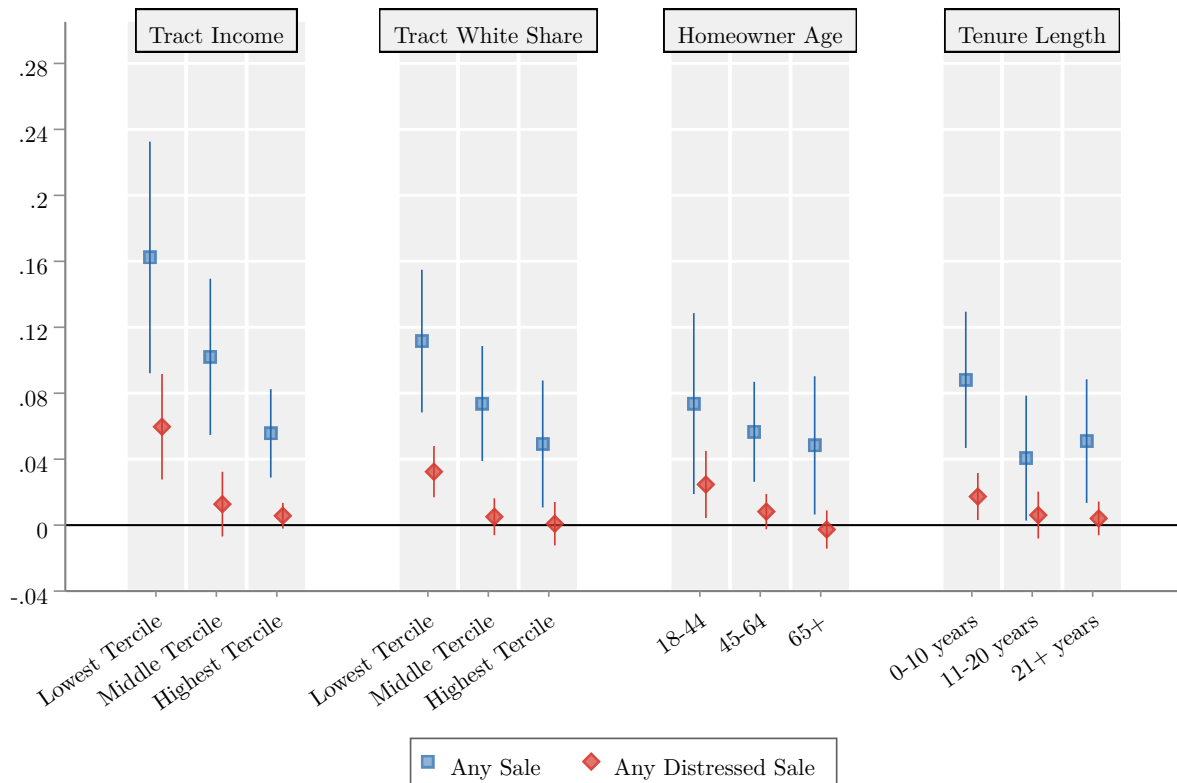


Figure 6: Impact of Tax Increases on Migration and Home Investment



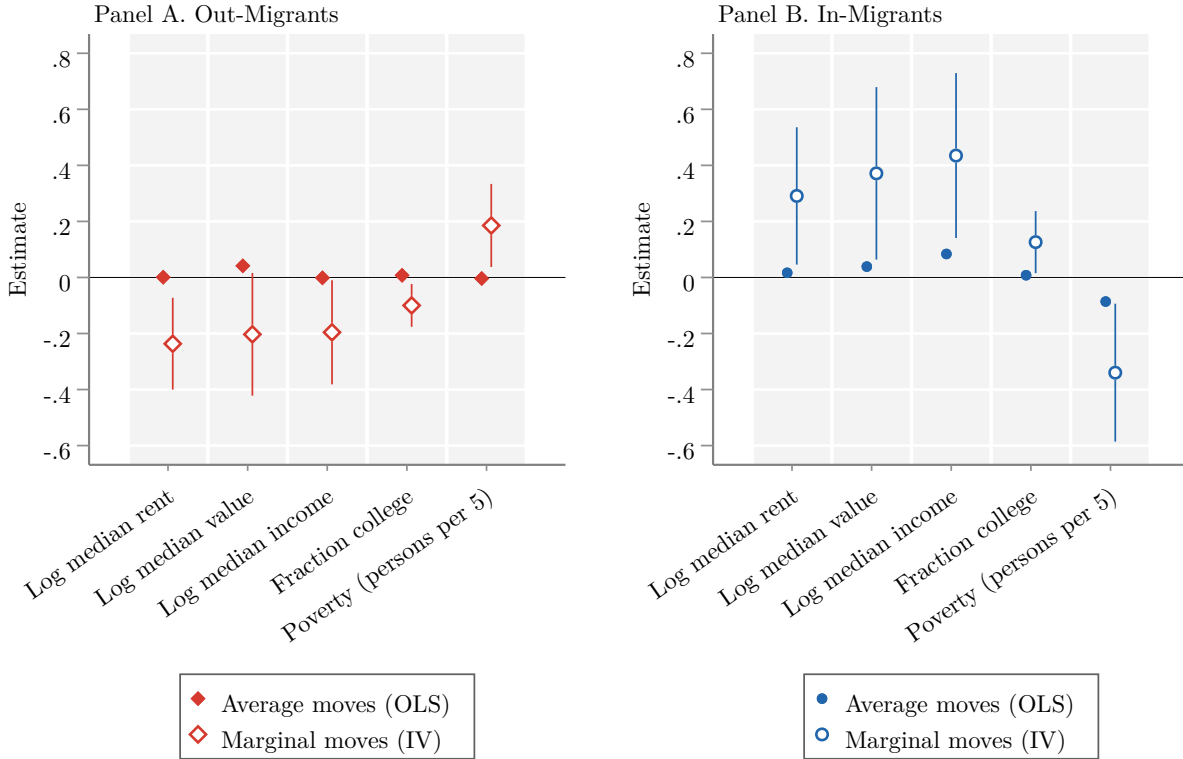
*Notes:* This figure depicts the time path of property sales and home investment around a property tax increase. In Panel A, the outcome is an indicator that a property has been sold in the last 12 months. In Panel B, the outcome is an indicator that a distressed sale (i.e., foreclosure or short sale) has occurred in the last 12 months. In Panel C, the outcome is an indicator that a homeowner has filed a permit for home improvement in the last 12 months. Coefficients are scaled to reflect percentage effects of a \$100 increase in property taxes, and indicate that a \$100 tax increase results in a 0.08 percentage point increase in annual property sales, a 0.016 percentage point increase in distressed sales, and a 0.1 percentage point reduction in annual permit filing. Estimates are derived from an event study specification that interacts event time indicators with the predicted property tax increase and includes a linear trend between event times -15 and -3. Shaded regions depict 95% confidence intervals. Standard errors are clustered at the property level. Data from migration sample described in Section 3. Table 8 of the [Online Appendix](#) presents numerical values and additional statistics.

Figure 7: Heterogeneity in Migration Impacts



*Notes:* This figure documents heterogeneous impacts of property tax increases on property sales (an indicator that a property has been sold in the last 12 months) and distressed sales (an indicator that a property has been sold in a foreclosure or short sale in the last 12 months). Coefficients correspond to effects after 18 months and are scaled to reflect percentage point impacts of a \$100 increase in property taxes. “Tract Income” splits the sample by terciles of median Census tract income among homeowners in 2010. “Tract White Share” splits the sample by terciles of the share of homeowners in a Census tract identifying as non-Hispanic White in 2010. “Homeowner Age” splits the sample by estimated homeowner age in the Infogroup data. “Tenure Length” splits the sample by estimated tenure length in the Infogroup data. Estimates are derived from an event study specification that interacts event time indicators with the predicted property tax increase and includes a linear trend between event times -15 and -3. Vertical lines depict 95% confidence intervals. Standard errors are clustered at the property level. Data from migration sample described in Section 3. Table 9 of the [Online Appendix](#) presents numerical values and additional statistics.

Figure 8: Characteristics of Moves Induced by Property Tax Increases



*Notes:* This figure plots characteristics of moves for out-migrating homeowners who sold their homes (Panel A) and for in-migrating households who succeed out-migrants (Panel B). Each marker corresponds to a separate regression. Hollow markers plot estimates of the impacts of moves from an ordinary least squares regression, while solid markers plot estimates from a 2SLS regression in which property tax changes are used as an instrument for migration. The 2SLS estimates can be interpreted as capturing the characteristics of moves associated with homeowners that were induced to move because of a property tax increase. Outcomes are calculated as the difference in the characteristics of the departure and arrival Census tracts associated with a move. “Log median rent” denotes the change in Census tract log median rents. “Log median value” denotes the change in tract log median home values. “Log median income” denotes the change in tract log median household income. “Fraction college” denotes the change in the fraction with at least a college degree. “Poverty (persons per 5)” denotes the tract poverty rate per 5 residents. Outcomes are measured in the 2019 American Community Survey. Vertical lines depict 95% confidence intervals. Standard errors are clustered at the property level. In Panel A (B), the F-statistic from the 2SLS first stage is 25.9 (12.7). Estimates indicate that out-migrants induced to move because of property taxes experience significant downgrades in neighborhood quality, and are replaced by households who experience upgrades in quality. Data from migration sample is described in Section 3. Table 10 of the [Online Appendix](#) presents numerical values and additional statistics.

Table 1: Summary Statistics

<i>Panel A. Financial Behaviors Sample</i>	Mean	SD	p10	Median	p90
Tax Amount (\$)	3358	2663	839	2631	6833
Tax Increase (\$)	171	259	4	88	409
Age (Years)	49.9	13.4	32.0	47.0	67.0
Tenure Length (Years)	13.4	8.6	5.0	11.0	25.0
Monthly Payment (\$)	1342	745	602	1159	2322
Current Property Value (\$)	253313	178997	94956	200288	474289
Estimated Home Equity (\$)	81354	100306	2944	52409	196462
Current Year	2017	2	2013	2017	2019
Any Second Mortgage	0.166				
N = 4,935,760 Loan-Years					
<i>Panel B. Migration Sample</i>					
Tax Amount (\$)	3567	3653	724	2666	7255
Tax Increase (\$)	193	483	1	89	442
Age (Years)	55	15	37	57	80
Tenure Length (Years)	18	11	6	16	34
Estimated Property Value (\$1k)	254	258	84	193	460
N = 38,578,498 Property-Years					
<i>Panel C. Repeat Sales Sample</i>					
Purchase Price (\$)	248083	276832	83500	194440	440000
Change in Home Value (\$)	60236	116545	2208	39661	129130
Tax Increase During Spell (\$)	949	1386	83	510	2205
Purchase Year	2012	2	2010	2012	2015
Ownership Spell Length (Years)	6.0	1.7	3.9	5.7	8.4
N = 372,213 Ownership Spells					

*Notes:* This table presents summary statistics for the financial behaviors sample (Panel A), the migration sample (Panel B), and the repeat sales sample (Panel C). The financial behaviors sample is derived from a merge between the property records and the Equifax credit bureau data, and McDash mortgage servicing data. The migration sample in Panel B does not use the merge with the Equifax and McDash data. Dollar values in Panels A and B have been adjusted to 2015 dollars. The repeat sales sample is derived from an algorithm that identifies repeat sales of properties, described in Section 3. Homeowner age, tenure length, and estimated property value are derived from Infogroup data. Monthly payment, current property value, any second mortgage, and estimated home equity derived from Equifax-McDash data. All other variables are measured in the ATTOM property records. Current property value is calculated by inflating appraised value at mortgage origination using county-level house price indices. Estimated home equity subtracts all observed mortgage balances from current property value.

Table 2: Characteristics of Moves Induced by Tax Increases

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	$\Delta$ Homeown. share	$\Delta$ Median Age	$\Delta$ SFR	Moved CZ	$\Delta$ Math scores	$\Delta$ Intergen. mobility	$\Delta$ Incarceration
<i>Panel A. Out-Migrants</i>							
Marginal moves (IV)	-3.125 (5.154)	-0.404 (1.837)	-17.002 (9.271)	20.198 (9.241)	0.352 (0.208)	0.564 (1.103)	-0.218 (0.461)
Average moves (OLS)	-1.005 (0.019)	0.693 (0.007)	-13.727 (0.039)	30.597 (0.038)	0.007 (0.001)	0.089 (0.004)	0.003 (0.002)
<i>Panel B. In-Migrants</i>							
Marginal moves (IV)	20.337 (8.004)	4.370 (2.294)	18.614 (12.153)	54.161 (14.652)	0.457 (0.283)	1.231 (1.470)	-0.679 (0.634)
Average moves (OLS)	7.971 (0.025)	1.637 (0.008)	16.181 (0.049)	21.180 (0.042)	0.109 (0.001)	0.600 (0.005)	-0.282 (0.002)
Mean	64.46	38.96	89.93	0	3.25	56.80	2.51
SD	22.33	7.43	30.09	0	0.89	6.28	2.81
N	35,174,277	35,174,277	35,174,277	35,174,277	35,174,277	35,174,277	35,174,277

*Notes:* This table presents characteristics of moves, and compares moves induced by property tax increases to average moves. Each estimate corresponds to a separate regression. OLS denotes estimated characteristics of (average) moves from an ordinary least squares regression, while 2SLS denotes estimates from a 2SLS regression in which property tax changes are used as an instrument for migration. The 2SLS estimates can be interpreted as reflecting the characteristics of moves that are induced because of property tax increases. Panel A presents estimates pertaining to out-migrants (i.e., the original residents of a property). Panel B presents estimates pertaining to in-migrants (i.e., the tenant who replaces the out-migrant). Outcomes in changes (labeled with  $\Delta$ ) are computed as the difference in the characteristics of the departure and arrival locations associated with a move. *Homeown. share* denotes the percent of owner-occupied households in a Census tract. *Median age* denotes the median age in a Census tract. *SFR* denotes an indicator that a property is a single-family residence (multiplied by 100). *Moved CZ* denotes an indicator that the household moved commuting zones (multiplied by 100). *Math scores* denotes school district 3rd grade math scores normalized to grade level. *Intergen. mobility* denotes the mean rank in the national income distribution of children born to parents at the 75th percentile of income in a given tract. *Incarceration* denotes male average incarceration rates in a given tract. Mean and standard deviation denote population-weighted statistics computed over national distribution. In Panel A (B), the F-Statistic of the 2SLS regressions is 25.9 (12.7). Standard errors are clustered at the property level. Data from migration sample described in Section 3.

Table 3: Changes in Resident Characteristics Induced by Tax Increases

	(1)	(2)	(3)	(4)
	$\Delta$ Household Age	$\Delta$ Household Size	$\Delta$ Non-Hisp. White	Sale Discount
Marginal moves (2SLS)	-13.229 (2.955)	-0.203 (0.240)	-0.066 (0.067)	-0.179 (0.070)
Average moves (OLS)	-12.298 (0.013)	-0.459 (0.001)	-0.059 (0.000)	0.008 (0.000)
Incumbent mean	54.01	1.95	0.93	
N	35,174,277	35,174,277	35,174,269	35,174,277

*Notes:* This table presents characteristics of moves, and compares moves induced by property tax increases to average moves. Each estimate corresponds to a separate regression. OLS denotes estimated characteristics of (average) moves from an ordinary least squares regression, while 2SLS denotes estimates from a 2SLS regression in which property tax changes are used as an instrument for migration. The 2SLS estimates can be interpreted as reflecting the characteristics of moves that are induced because of property tax increases.  $\Delta$  *Household Age* denotes the change in householder age, as inferred by Infogroup.  $\Delta$  *Household Size* denotes the change in the number of adults in the household recorded by Infogroup.  $\Delta$  *Non-Hisp. White* denotes the change in an indicator that the tenant is classified as non-Hispanic White, where race and ethnicity are inferred by Infogroup based on name and geographic location. *Sale Discount* denotes the ratio of the actual sale price recorded in property records to the home value estimated in address history data (minus one). *Incumbent mean* denotes average age, household size, and race/ethnicity for out-migrating homeowners. In Column 1 through 3 (Column 4), the F-Statistic of the 2SLS regressions is 36.8 (25.9). Standard errors are clustered at the property level. Data from migration sample described in Section 3.

Table 4: Estimated Costs of Marginal Increase in Property Tax Rate

$$MVPF = \frac{1}{1+\varepsilon_h} \left( 1 + cov\left(\frac{p_1 h}{E[p_1 h]}, \frac{u'_1(c_1)}{E[u'_1(c_1)]}\right) + \frac{\partial \phi}{\partial \tau} M + \frac{\partial \phi}{\partial \tau} E \right)$$

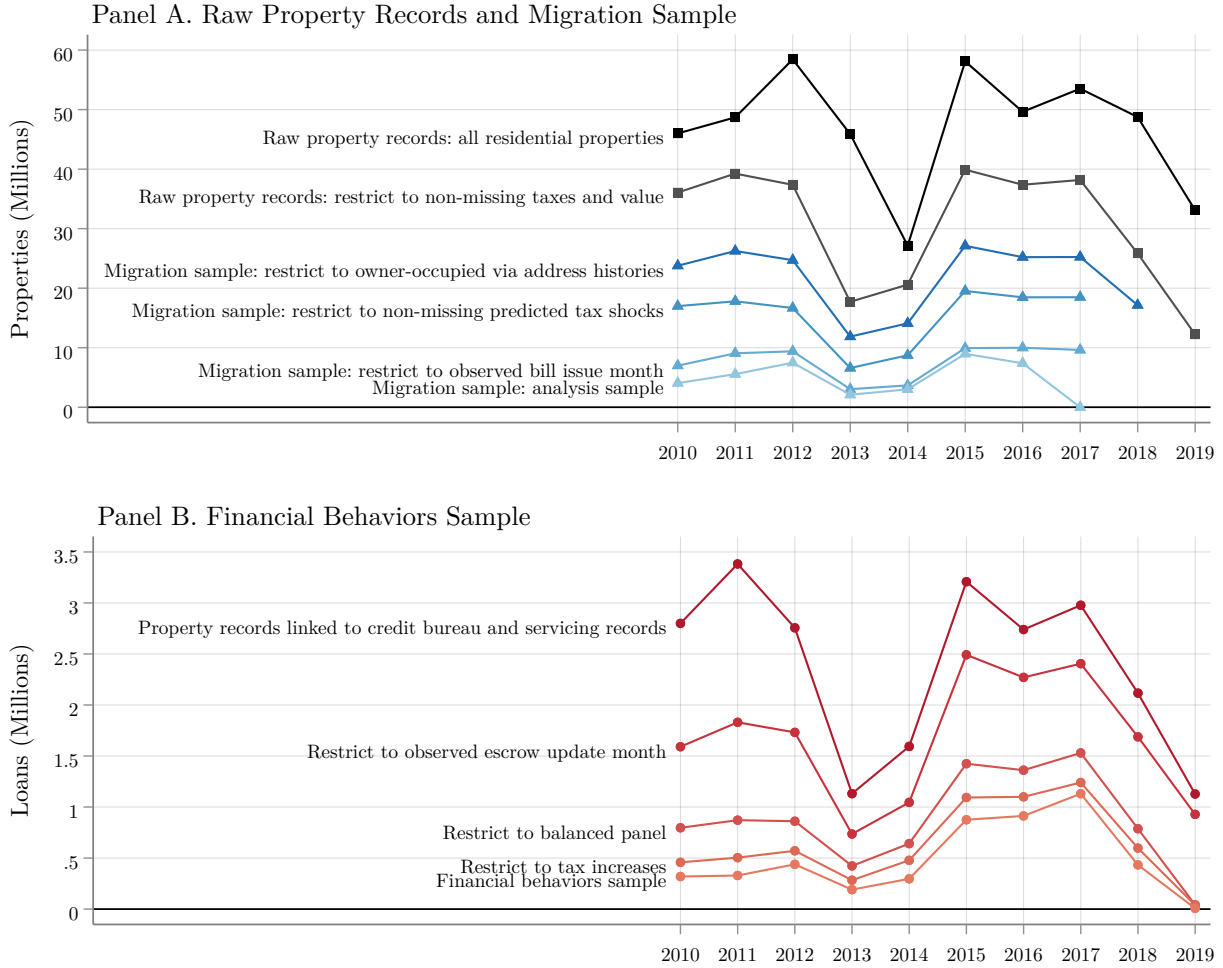
<i>Panel A. Calibrated Parameters</i>	Value	Source
Coefficient of relative risk aversion ( $\gamma$ )	2	-
Average annual consumption ( $\tilde{c}$ )	\$67,437	2010–2019 CEX
Housing units within 0–0.1mi (0.1-0.25mi)	75 (395)	2010 Census
Distress externality 0–0.1mi (0.1-0.25mi)	0.6% (0.2%)	<a href="#">Gerardi et al. (2015)</a>
Consumption-Equivalent Costs of Distress	\$100k	<a href="#">Ganong and Noel (2023)</a>
Value of Improvement Permit	\$19,077	Repeat sales sample
<i>Panel B. Estimated Values</i>	Estimate	Component
Financial distress and displacement	0.1241	$\frac{\partial \phi}{\partial \tau} M$
Distressed sale externalities	0.0158	$\frac{\partial \phi}{\partial \tau} E$
Consumption uncertainty	0.0014	$cov\left(\frac{p_1 h}{E[p_1 h]}, \frac{u'_1(c_1)}{E[u'_1(c_1)]}\right)$
Net fiscal cost of foregone investment	-0.0026	$\varepsilon_h$

*Notes:* This table presents calibrated parameters and estimates used for the welfare calculations discussed in Section 9. Panel A presents values and sources for selected calibrated parameters. Panel B presents estimated values of MVPF components along with the exact formulas for those components from Equation 3.

## A Appendix Figures

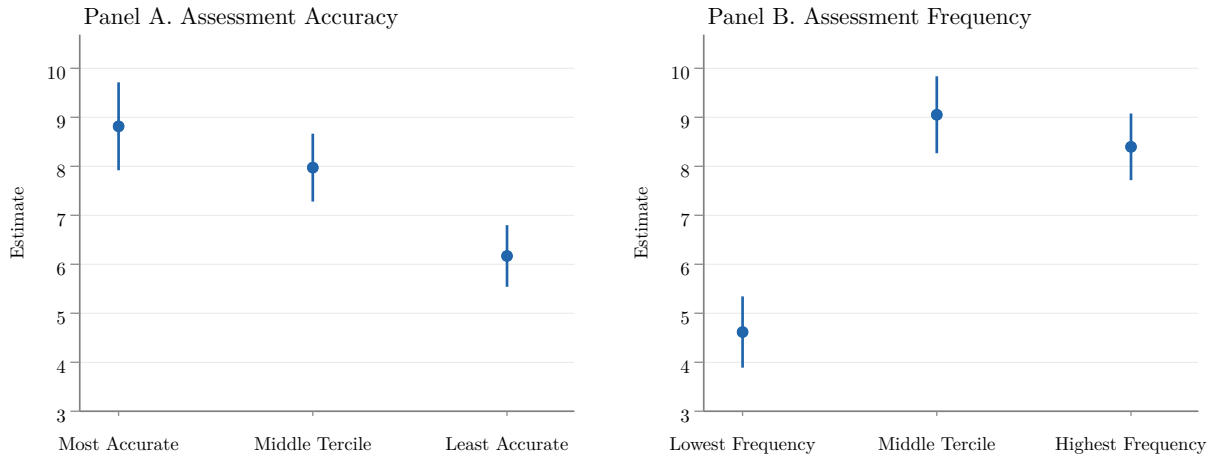


Figure A1: Changes in Sample Size Created by Sample Restrictions



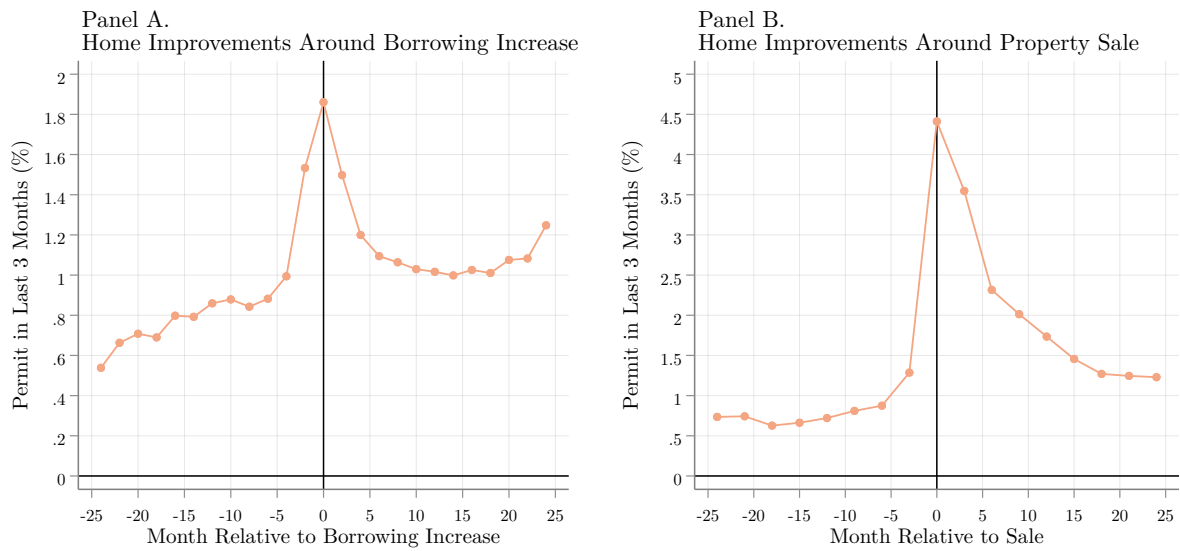
*Notes:* This figure illustrates the changes in sample sizes associated with the sample restrictions used to create the analysis samples. In Panel A, each point represents the number of properties in a given tax year. In Panel A, each point represents the number of mortgage loans in a given tax year. *Raw property records: all residential properties* denotes all residential properties in the ATTOM property records, excluding California. *Raw property records: restrict to non-missing taxes and value* denotes ATTOM sample restricted to properties where the property tax and assessed value are non-missing for the tax year as well as the next tax year, permitting measurement of changes in tax bills. *Migration sample: restrict to owner-occupied via address histories* denotes the set of properties where the name of the property owner matches the name of the resident listed in the Infogroup address histories, and represents the first step towards creating the sample used to analyze sales, migration, and investment responses (i.e., migration sample). *Migration sample: restrict to non-missing predicted tax shocks* drops properties where it is not possible to construct a predicted tax change using similar nearby properties. *Migration sample: restrict to observed bill issuance month* restricts to properties where event time can be constructed using the tax bill issuance month. *Migration sample: analysis sample* denotes the analysis sample used to analyze sales, migration, and investment responses, and restricts to properties with predicted tax increases where outcomes can be measured 24 months after the bill issue date. *Property records linked to credit bureau and servicing records* denotes the number of loans in a given year that are observed in the credit bureau and mortgage servicing records and linked to a tax change in the ATTOM property records. *Restrict to observed escrow update month* restricts to properties where the month of the tax change can be inferred from the pattern of monthly escrow payments. *Restrict to balanced panel* restricts to a panel that is balanced in event months  $t = -11$  to  $t = 12$  around a change in tax payments. *Financial behaviors sample* denotes the sample used for analysis of consumption, borrowing, and delinquency. See Appendix D.1 for more details.

Figure A2: Heterogeneity in Correlation of Tax Increase and Home Value Increases



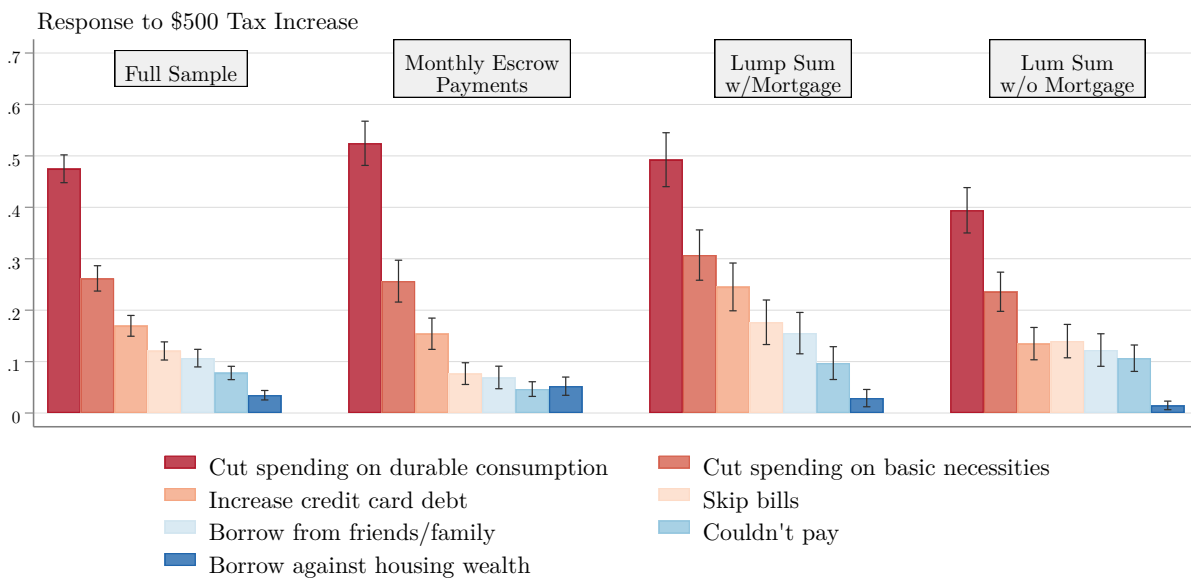
*Notes:* This figure illustrates heterogeneity in the relationship between changes in property taxes and changes in home values by location-specific characteristics. Each coefficient pertains to separate regression of changes in home value on cumulative increases in property taxes. Each regression includes fixed effects that interact property purchase year, sale year, county, and ventiles of initial assessed property value. Panel A splits the sample by terciles of assessment accuracy, measured by the county-level standard deviation of log assessment ratios (i.e., assessed value divided by realized sale price). Panel B splits the sample by terciles of assessment frequency, measured as the share of properties in a county whose assessed value is changed between years. Vertical lines depict 95% confidence intervals. Standard errors are clustered at the property level. Data from repeat sales sample described in Section 3.

Figure A3: Home Improvements Around Borrowing Increases and Sales



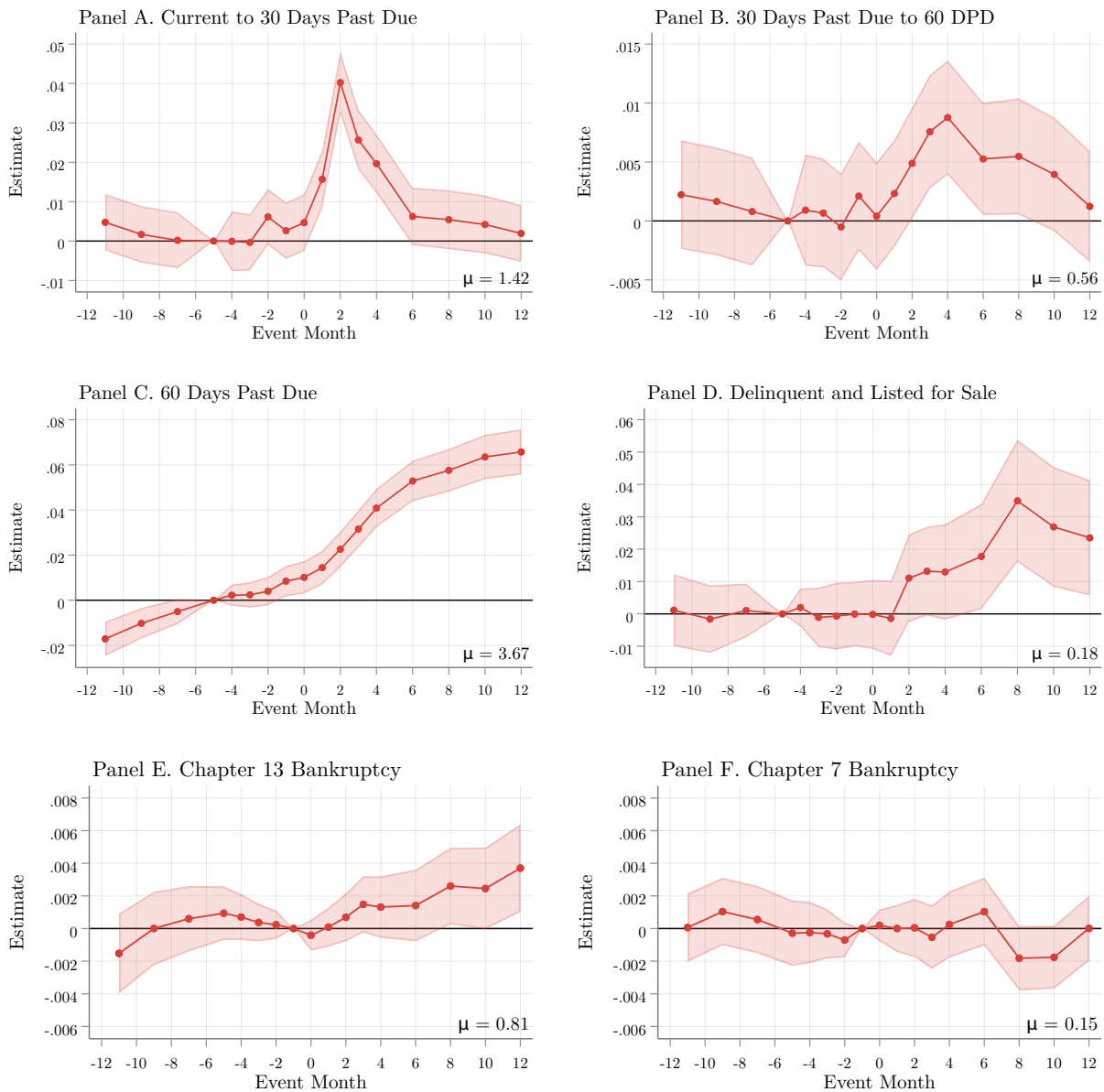
*Notes:* This figure illustrates the time path of home improvements around an increase in second mortgage borrowing (Panel A) and a property sale (Panel B). Home improvements are defined as an indicator that the homeowner has filed a home improvement permit for the property in the last three months. Borrowing increases are defined as an increase in second mortgage balances (both closed-end and HELOCs) of \$1,000 or more over two months. Data for Panel A comes from financial behaviors sample, not restricting to properties with escrow accounts. Data for Panel B comes from migration sample.

Figure A4: Survey Evidence on Responses to Tax Increase by Payment Type



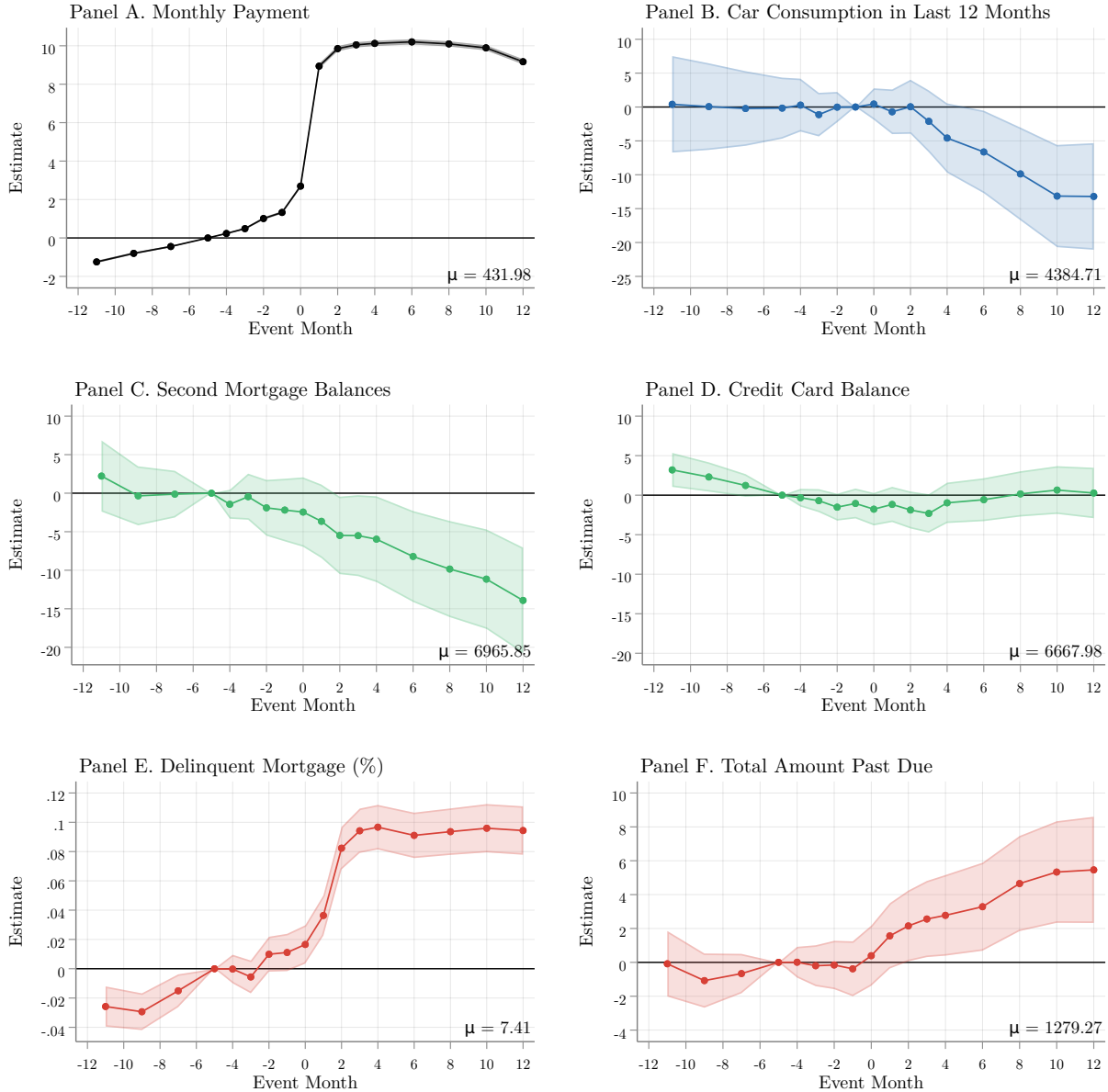
*Notes:* This figure plots responses from an online survey of 2,000 homeowners across the US. Each bar and 95% confidence interval correspond to the share of respondents indicating each answer category. The figure plots responses to the question, “Suppose that next year your yearly property tax bill increases by \$500. How would you pay for this?” The respondent sample is split into four categories: (i) the full sample of surveyed homeowners, (ii) homeowners who pay property taxes in monthly installments through their mortgage servicer (i.e., using an escrow account), (iii) homeowners who pay property taxes in lump sum directly to the government and who have a mortgage, and (iv) homeowners who pay property taxes in lump sum and who do not have a mortgage. The [Online Appendix](#) presents a version of the figure that does not reweight responses.

Figure A5: Additional Measures of Financial Distress



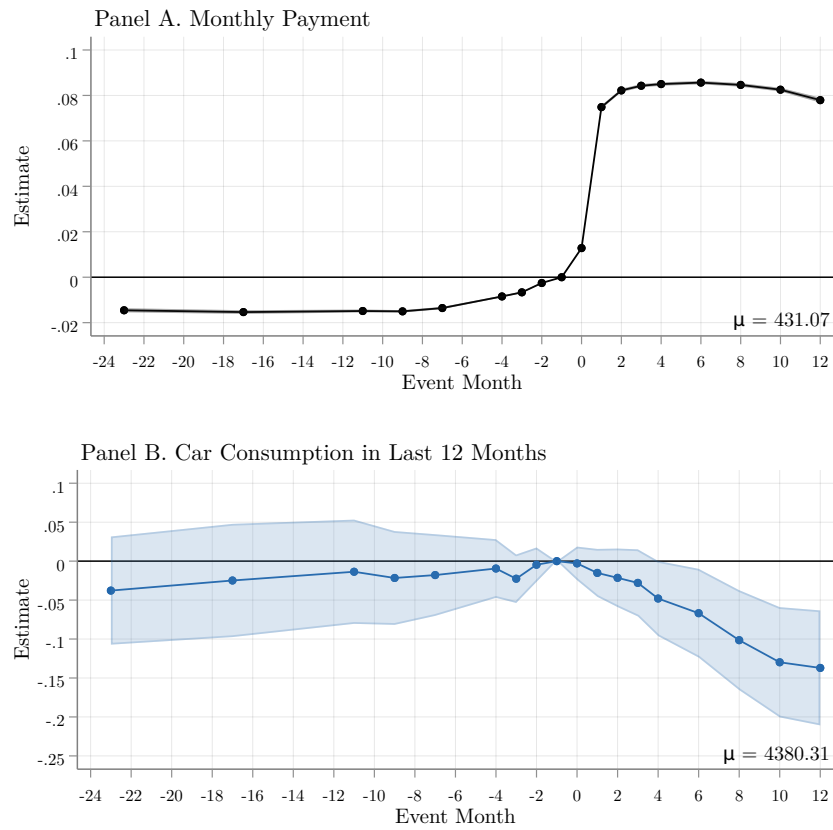
*Notes:* This figure depicts the time path of outcomes around a property tax increase that occurs at event time  $t = 1$ . The outcomes are an indicator that a homeowner’s mortgage has transitioned from current to 30 days delinquent (Panel A), an indicator that a homeowner’s mortgage has transitioned from 30 days delinquent to 60 days delinquent (Panel B), an indicator that a homeowner’s mortgage payment is currently 60 days past due (Panel C), an indicator that a homeowner’s property is both listed for sale and the mortgage is 30 or more days past due (Panel D), an indicator that a homeowner is currently in Chapter 13 bankruptcy (Panel E), and an indicator that a homeowner is currently in Chapter 7 bankruptcy (Panel F). The coefficients correspond to estimates of Equation 4 and have been scaled to denote percentage point changes relative to a \$100 tax increase. Shaded regions depict 95% confidence intervals. Standard errors are clustered at the loan level. Data from financial behaviors sample. Data used to measure property listings is described in Appendix D.

Figure A6: Robustness To Alternative Regressor



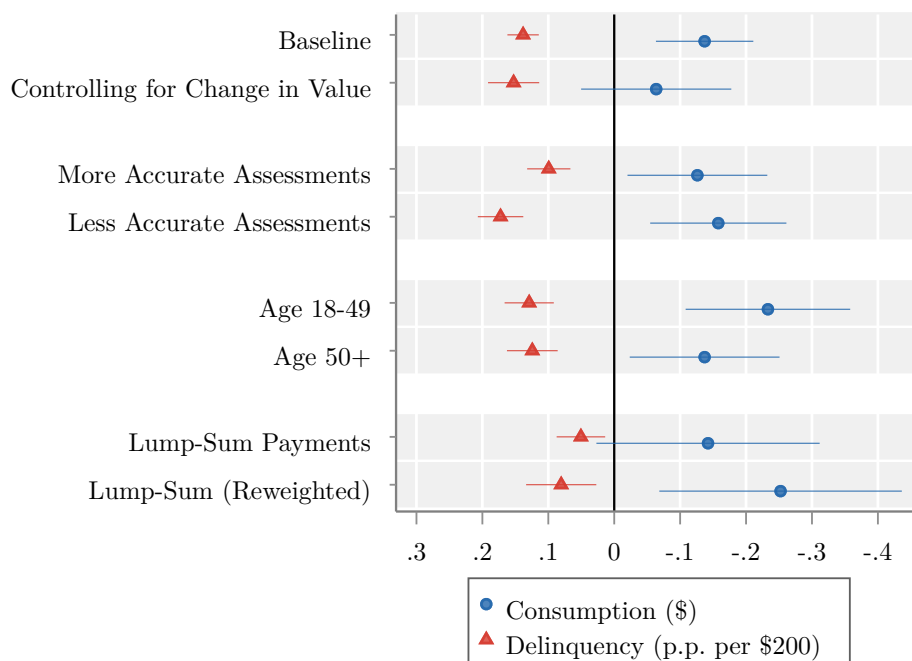
Notes: This figure depicts the time path of outcomes around a property tax increase that occurs at event time  $t = 1$ . In contrast to Equation 4, the main regressor is the annual property tax increase scaled as a percentage of annual housing payments (i.e., mortgage principal and interest plus taxes and insurance). The outcomes are the dollar amount of the tax and insurance payment (Panel A), the 12-month cumulative dollar sum of auto consumption (Panel B), the dollar amount of second mortgage balances (Panel C), the dollar amount of credit card balances (Panel D), an indicator that a homeowner's primary mortgage is 30 or more days past due (Panel E), and the total amount past due on all loans (Panel F). Shaded regions depict 95% confidence intervals. Standard errors are clustered at the loan level.

Figure A7: Robustness to Longer Pre-Period



*Notes:* This figure depicts the time path of outcomes around a property tax increase that occurs at event time  $t = 1$ . The outcomes are the monthly tax and insurance payments in dollars (Panel A) and the 12-month cumulative dollar sum of auto consumption (Panel B). Shaded regions depict 95% confidence intervals. Standard errors are clustered at the loan level. Data from financial behaviors sample described in Section 3, and restricted to loans balanced in event time  $[-23, 12]$ .

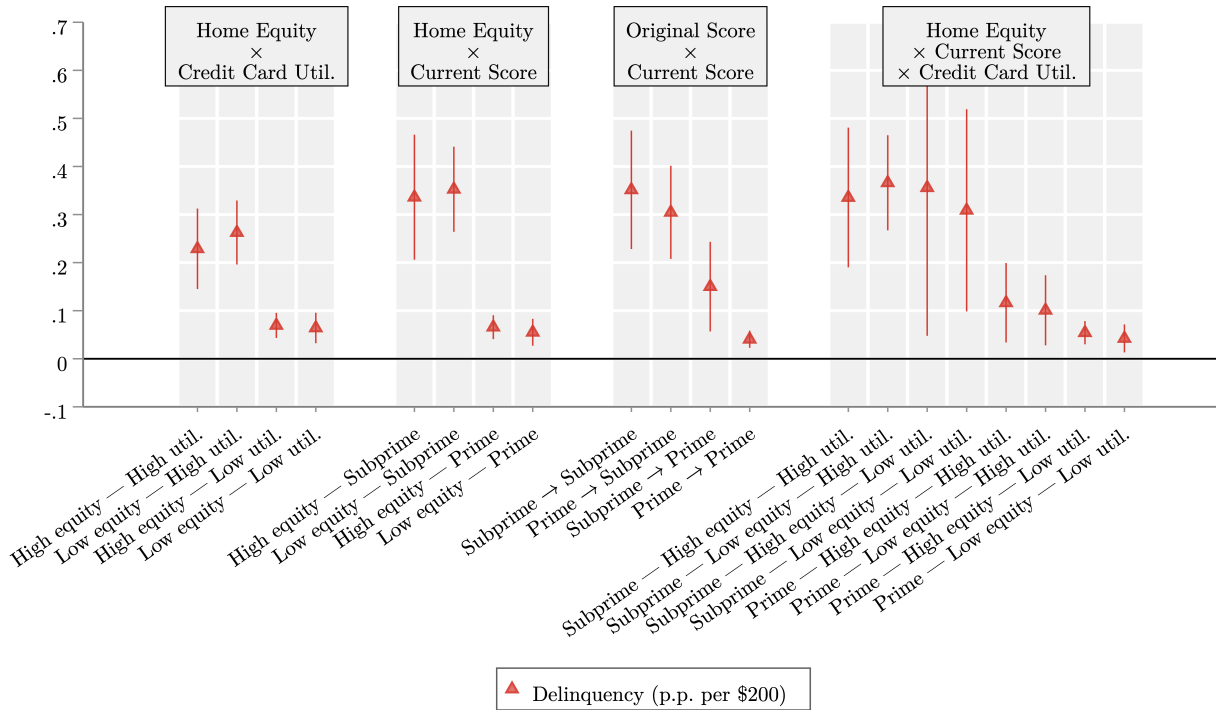
Figure A8: Additional Heterogeneous Responses



*Notes:* This figure documents heterogeneous impacts of property tax increases on auto consumption (12-month cumulative sum) and delinquency (an indicator that a homeowner is 30 or more days past due on their mortgage). Coefficients for delinquency are scaled to reflect percentage point impacts of a \$200 increase in property taxes. The first set of coefficients compares the baseline specification (i.e., controlling for fixed effects that interact county, year, and assessed value) with a specification that adds additional controls for percentiles of the percent change in assessed value. The second set of coefficients examines heterogeneity by above- and below-median assessment accuracy (measured as the county-level standard deviation of log assessment ratios). The third set of coefficient examines heterogeneity by homeowner age measured in the Infogroup address history data. The fourth set of coefficients estimates responses among homeowners who pay property taxes in lump-sum payments directly to the local taxing authority. The reweighted estimates match the distribution of credit scores at origination of homeowners paying property taxes using escrow accounts. Coefficients correspond to estimates of Equation 4 for event time  $t=12$  ( $t=18$  for homeowners paying in lump-sum), relative to event time  $t=-1$ . Horizontal lines depict 95% confidence intervals. Standard errors are clustered at the loan level. Data from financial behaviors sample is described in Section 3.

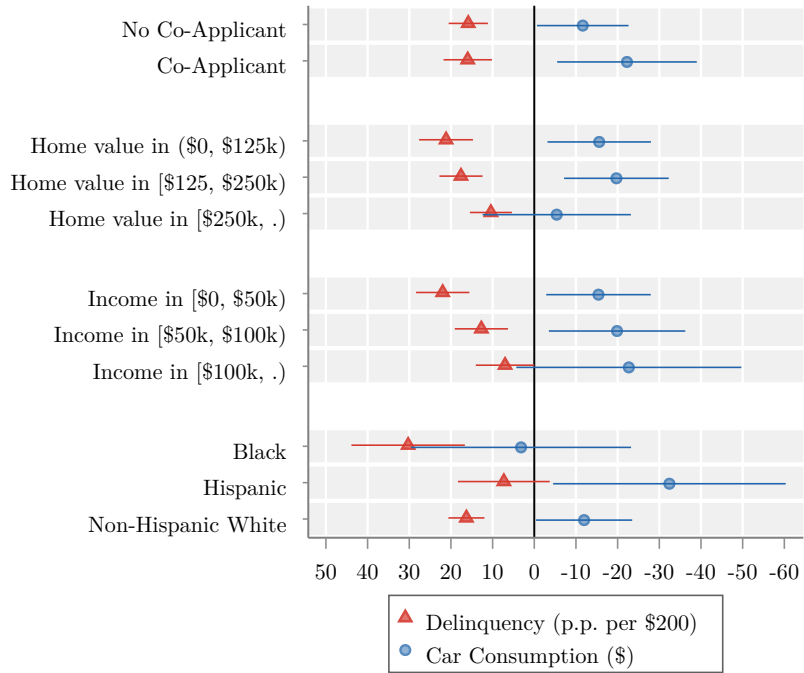


Figure A9: Additional Heterogeneity by Housing Wealth and Access to Liquidity



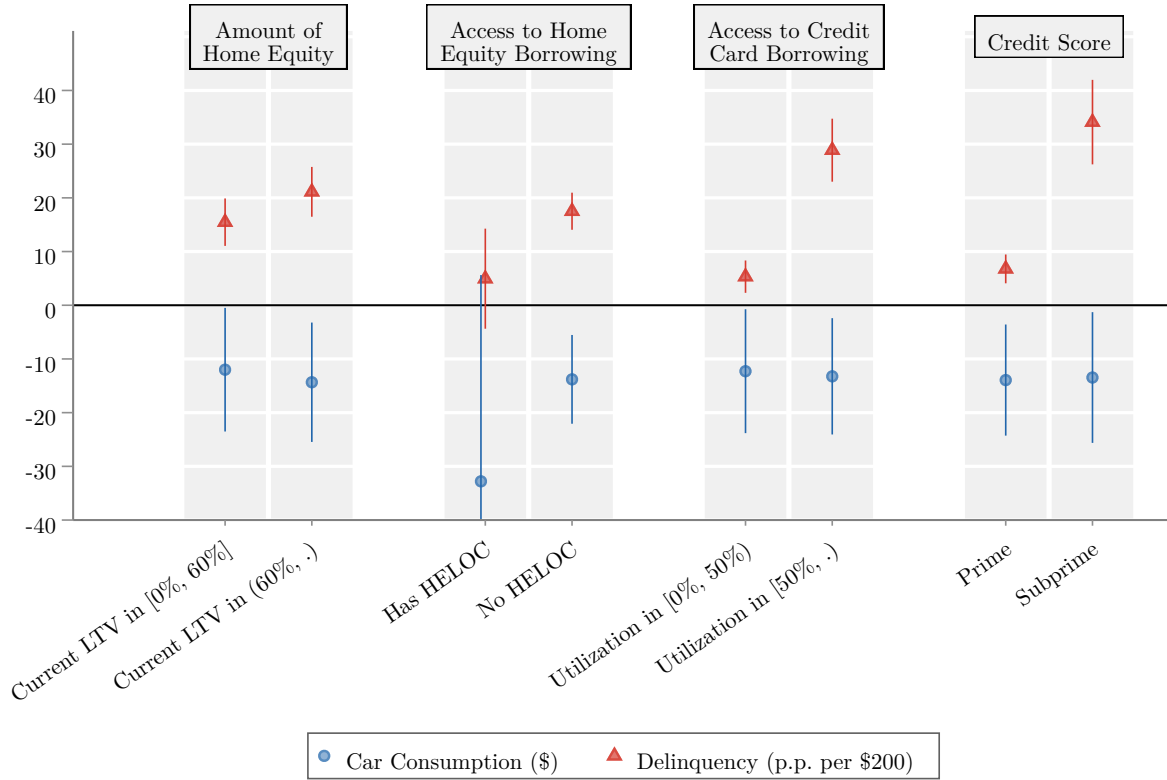
*Notes:* This figure documents heterogeneous impacts of property tax increases on delinquency, defined as an indicator that a homeowner is 30 or more days past due on their mortgage. Coefficients are scaled to reflect percentage point impacts of a \$200 increase in property taxes. “Home Equity” denotes heterogeneity by current combined loan-to-value (CLTV) prior to the tax increase. High-equity homeowners are defined as those with CLTV less than or equal to 60%. “Credit Card Util.” denotes heterogeneity by whether a homeowner has less than 50% utilization on open credit cards (“Low util.”), or greater than or equal to 50% utilization or no open credit card (“High util.”). “Credit Score” compares homeowners by current credit score, with Prime being defined as a score of greater than 660. Coefficients correspond to estimates of Equation 4 for event time  $t=12$ , relative to event time  $t=-1$ . Vertical lines depict 95% confidence intervals. Standard errors are clustered at the loan level. Data from financial behaviors sample described in Section 3.

Figure A10: Heterogeneity by Demographic Characteristics, Alternative Regressor



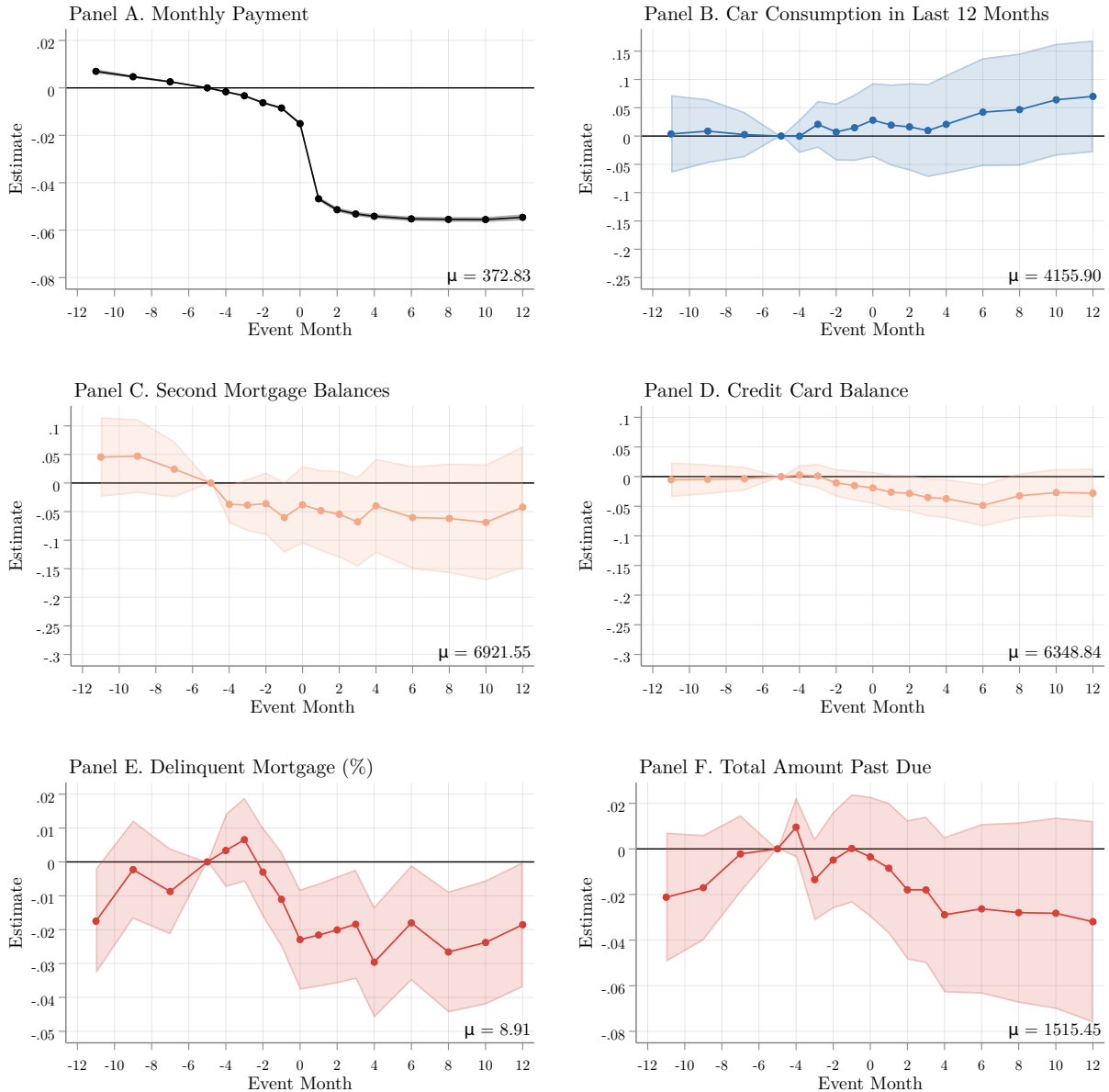
*Notes:* This figure documents heterogeneous impacts of property tax increases on auto consumption (12-month cumulative sum) and delinquency (an indicator that a homeowner is 30 or more days past due on their mortgage). Coefficients for delinquency are scaled to reflect percentage point impacts of a \$200 increase in property taxes. In contrast to Equation 4, the main regressor is the annual property tax increase scaled as a percentage of annual housing payments (i.e., mortgage principal and interest plus taxes and insurance). The first set of coefficients compares single borrowers (i.e., those with one applicant listed on the mortgage application) to couples (i.e., those with two applicants). The second set of coefficients compares homeowners by current home value. The third set of coefficients compares homeowners by income at mortgage origination. The fourth set of coefficients compares homeowners by self-reported race and ethnicity. Coefficients correspond to estimates of Equation 4 for event time  $t=12$ , relative to event time  $t=-1$ . Horizontal lines depict 95% confidence intervals. Standard errors are clustered at the loan level. Data from financial behaviors sample described in Section 3.

Figure A11: Heterogeneity by Housing Wealth and Access to Liquidity, Alternative Regressor



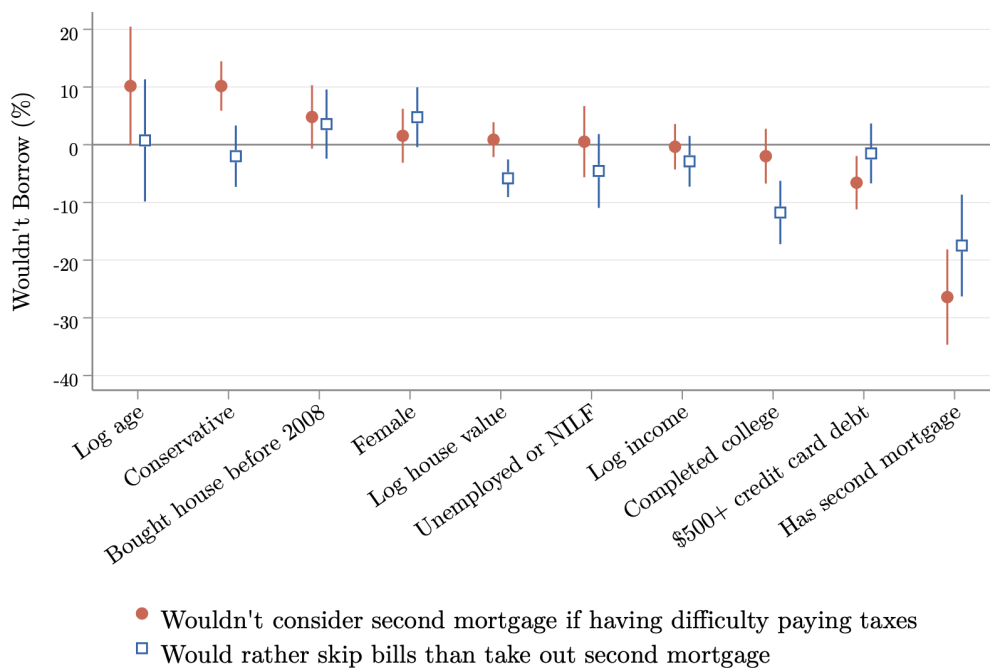
*Notes:* This figure documents heterogeneous impacts of property tax increases on auto consumption (12-month cumulative sum) and delinquency (an indicator that a homeowner is 30 or more days past due on their mortgage). Coefficients for delinquency are scaled to reflect percentage point impacts of a \$200 increase in property taxes. In contrast to Equation 4, the main regressor is the annual property tax increase scaled as a percentage of annual housing payments (i.e., mortgage principal and interest plus taxes and insurance). “Amount of Home Equity” compares homeowners by current combined loan-to-value prior to the tax increase. “Access to Home Equity Borrowing” compares homeowners who do or do not have a home equity line of credit (HELOC) open with less than or equal to 75% utilization prior to the tax increase. “Access to Credit Card Borrowing” compares homeowners by whether they have less than 50% utilization on open credit cards, or greater than or equal to 50% utilization or no open credit card. “Credit Score” compares homeowners by current credit score, with Prime being defined as a score of greater than 660. Coefficients correspond to estimates of Equation 4 for event time  $t=12$ , relative to event time  $t=-1$ . Vertical lines depict 95% confidence intervals. Standard errors are clustered at the loan level. Data from financial behaviors sample described in Section 3.

Figure A12: Responses to Property Tax Decreases



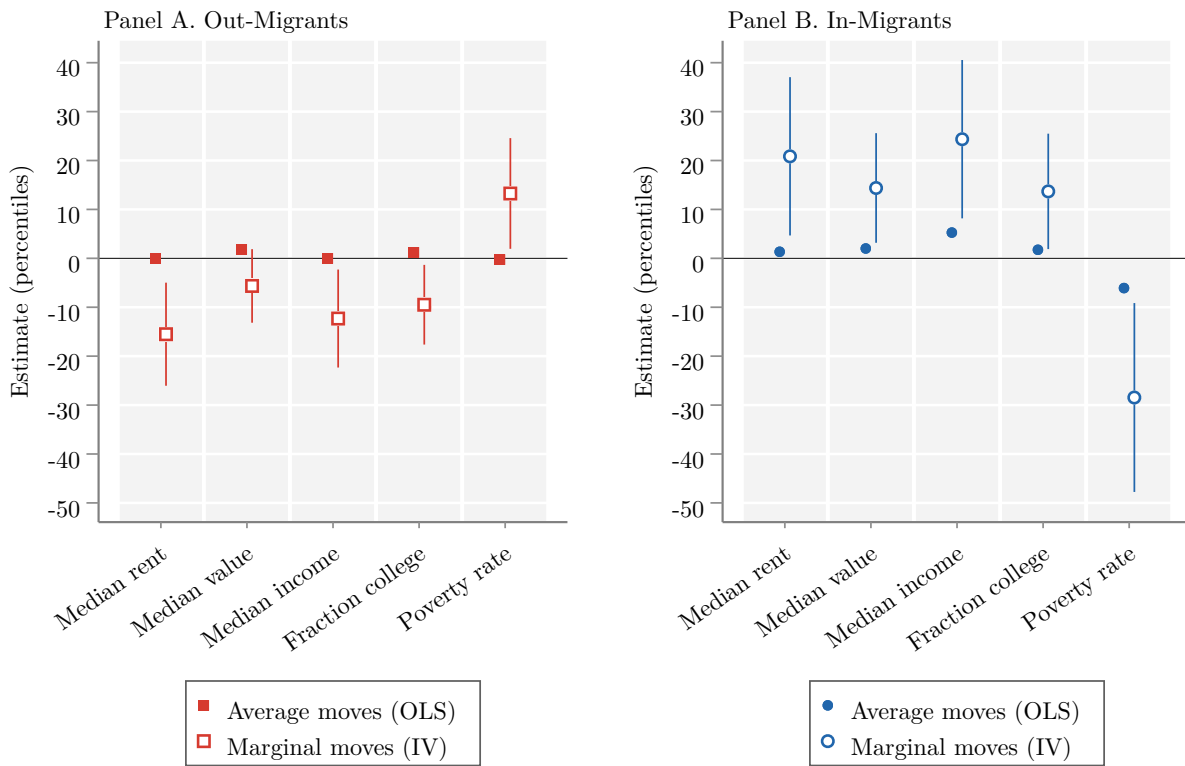
*Notes:* This figure depicts the time path of outcomes around a property tax decrease that occurs at event time  $t = 1$ . The outcomes are the dollar amount of the tax and insurance payment (Panel A), the 12-month cumulative dollar sum of auto consumption (Panel B), the dollar amount of second mortgage balances (Panel C), the dollar amount of credit card balances (Panel D), an indicator that a homeowner's primary mortgage is 30 or more days past due (Panel E), and the total amount past due on all loans (Panel F). The coefficients correspond to estimates of Equation 4. Shaded regions depict 95% confidence intervals. Standard errors are clustered at the loan level. Data come from sample of homeowners that experienced a tax decrease.

Figure A13: Correlates of Debt Aversion



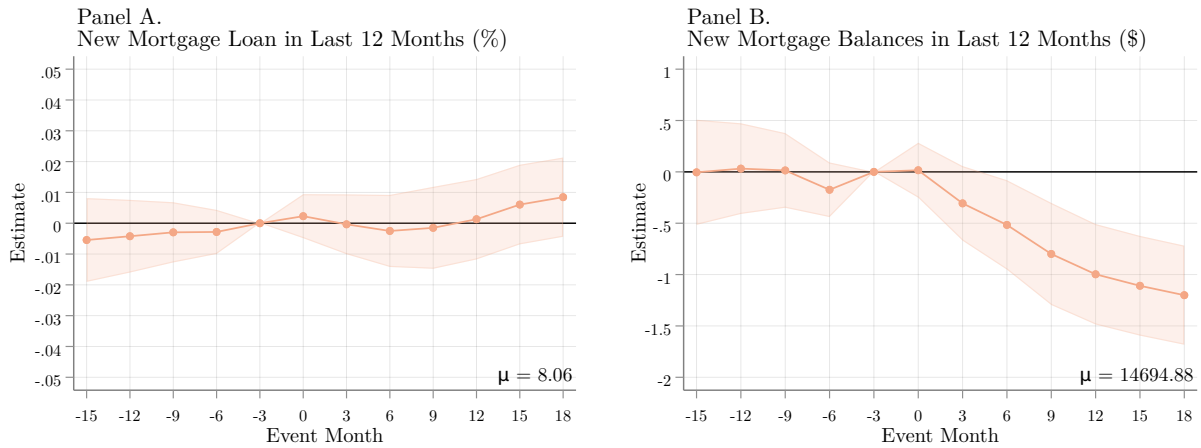
*Notes:* This figure plots coefficients from regressions that estimate the relationship between stated debt aversion and survey respondent characteristics. Debt aversion is measured using two variables: (i) an indicator that a homeowner reports not being willing to take out a second mortgage if the respondent were to have a hard time finding the money to pay property taxes, and (ii) an indicator that a homeowner would rather skip bills than take out a second mortgage. Responses come from the online survey consisting of 2,000 homeowners across the US, and weighted to match nationally representative demographics. Vertical lines depict 95% confidence intervals. The [Online Appendix](#) presents version of figure that does not reweight responses.

Figure A14: Characteristics of Moves, Normalized to Percentile Changes



*Notes:* This figure plots characteristics of moves for out-migrating homeowners who sold their homes (Panel A) and for in-migrating households who succeed out-migrants (Panel B). Each marker corresponds to a separate regression. Hollow markers plot estimates of the impacts of moves from an ordinary least squares regression, while solid markers plot estimates from a 2SLS regression in which property tax changes are used as an instrument for migration. The 2SLS estimates can be interpreted as capturing the characteristics of moves associated with homeowners that were induced to move because of a property tax increase. Outcomes are calculated as the difference in the characteristics of the departure and arrival Census tracts associated with a move and have been normalized to changes across the distribution of Census tracts in percentile terms. “Median rent” denotes the change in Census tract log median rents. “Median value” denotes the change in tract log median home values. “Median income” denotes the change in tract log median household income. “Fraction college” denotes the change in the fraction with at least a college degree. “Poverty rate” denotes the tract poverty rate per 5 residents. Outcomes are measured in the 2019 American Community Survey. In Panel A (B), the F-statistic from the 2SLS first stage is 25.9 (12.7). Data from migration sample is described in Section 3. Vertical lines depict 95% confidence intervals. Standard errors are clustered at the property level.

Figure A15: New Mortgage Originations



*Notes:* This figure depicts the time path of new non-purchase mortgage originations around a property tax increase. In Panel A, the outcome is an indicator that a new mortgage loan has been originated in the preceding 12 months. In Panel B, the outcome is the dollar balances of new mortgage loans originated in the prior 12 months. Coefficients in Panel A are scaled to reflect percentage effects of a \$100 increase in property taxes, and indicate that a property tax increase does not generate a statistically significant change in mortgage originations. Coefficients in Panel B indicate that a \$1 property tax increase results in a reduction in new mortgage balances of about \$1, implying intensive, but not extensive margin responses. Coefficients correspond to estimates of Equation 4. Shaded regions depict 95% confidence intervals. Standard errors are clustered at the property level. Data from migration sample described in Section E.3.

## B Appendix Tables

Table A1: Comparison with External Representative Sample

<i>Panel A. Financial Behaviors Sample</i>	Mean	SD	p10	Median	p90
Property Tax (\$)	3436	2380	1021	2893	6541
Monthly Payment (\$)	1433	754	644	1269	2428
Current Property Value (\$)	269248	189362	94105	215780	508372
Age	48.8	13.4	32.0	47.0	67.0
Tenure Length (Years)	12.9	8.4	4.0	11.0	24.0
Principal Balance 1st Mortgage (\$)	167319	101000	63000	144000	302000
N = 279,074 Loans					
<i>Panel B. American Housing Survey</i>					
Property Tax (\$)	3081	2615	612	2376	6312
Monthly Payment (\$)	1326	781	562	1151	2318
Current Property Value (\$)	256391	187450	85943	202293	490861
Age	49.0	12.9	32.0	49.0	66.0
Tenure Length (Years)	10.9	9.1	1.0	9.0	23.0
Principal Balance 1st Mortgage (\$)	154869	110672	40367	129815	301373
N = 11,915 Properties					

*Notes:* This table presents summary statistics for homeowners in the financial behaviors sample that are observed in 2015 and an external representative sample from the 2015 wave of the American Housing Survey (AHS). To maximize comparability, external sample restricts to mortgaged homeowners paying property taxes using mortgage escrow. Dollar values in Panel A have been adjusted to 2015 dollars. Due to data restrictions in the AHS Public Use File, first mortgage principal balances are computed among homeowners without second mortgages.



Table A2: Summary Statistics from Survey of Homeowners

	Survey (1)	ACS (2)
<i>Panel A. Variables used for weighting</i>		
Female share	0.60	0.51
Mean age	53.58	50.61
College educated share	0.42	0.32
Employed share	0.49	0.61
White only share	0.70	0.72
Black only share	0.13	0.08
Hispanic share	0.08	0.12
<i>Panel B. Other demographics</i>		
Share with children	0.30	0.34
Midwest share	0.23	0.23
Northeast share	0.17	0.18
South share	0.39	0.38
West share	0.20	0.22
Median household income	55000	87292
Median house value	187500	215465
N	2,000	8,551,469

*Note:* This table provides summary statistics for the online survey of homeowners alongside nationally representative statistics from the 2013-2017 American Community Survey (ACS). Column 1 contains statistics from the raw survey sample for Wave 1, which samples homeowners across all US states. Column 2 contains the corresponding statistics from the ACS, restricting to individuals aged 18+ living in owner-occupied housing. Panel A contains variables used to re-weight the raw survey sample to match population statistics. Panel B contains variables not used for weighting.

Table A3: Predictors of Variation in Property Tax Increases

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outcome	$\Delta Tax$	$\Delta Tax$	$\Delta Tax$	$\Delta Tax$	$\Delta Tax$	$\Delta Tax$	$\Delta \%AV$	$\Delta Tax$
Predicted Increase ( $\hat{\beta}$ )								0.810 (0.001)
Baseline Controls	X	X	X	X	X	X	X	X
Change in Tax Rate		X						
Change in Assessed Value			X	X	X	X		
Assessed Value-Block					X	X	X	
Property Characteristics							X	
Adjusted R <sup>2</sup>	0.439	0.538	0.685	0.839	0.863	0.973	0.894	0.531
Outcome Mean	172.85	210.05	170.42	264.96	149.76	262.84	3.79	169.84
Outcome Std. Dev.	268.55	293.07	262.57	301.15	239.10	296.21	5.96	260.02
N (Property-Years)	31,121,325	18,879,449	30,901,810	6,402,486	11,672,435	1,355,573	2,951,073	28,958,691
Sample	Baseline	Baseline	Baseline	Linear Tax	Baseline	Linear tax	Baseline	Baseline

*Notes:* This table presents statistics from regressions where the outcome is the dollar increase in property taxes ( $\Delta Tax$ ) or the percent change in assessed value ( $\Delta \%AV$ ). *Baseline Controls* denotes the inclusion of fixed effects that interact assessment year, county, and ventiles of assessed value (ventiles computed within state-year). *Change in Tax Rate* indicates the inclusion of a control for the predicted increase in property taxes holding the current assessed value fixed and applying the change in the property tax rate. *Change in Assessed Value* denotes the interaction of the baseline fixed effects with 0.1 percentage point bins of the year-to-year change in assessed value. *Assessed Value-Block* denotes fixed effects that interact assessment year, percentiles of assessed value, and Census block. *Property Characteristics* denotes fixed effects that interact assessment year, percentiles of assessed value, Census block, property type (e.g., single family, condo), number of bedrooms, number of bathrooms, and deciles of lot size and square footage. The *Baseline* sample contains all increases in property taxes, while the *Linear tax* sample restricts to a set of Census tracts where 80% of properties have the same tax rate (i.e., where property taxes are linear ad valorem taxes). Data are from migration sample described in Section 3, restricted to properties that did not transact within three years of tax increase.

Table A4: Robustness

	Baseline	ZIP FE	Tract FE	Property Type FE	18-Month Effect	Predicted Shock
	(1)	(2)	(3)	(4)	(5)	(6)
Car Consumption	-0.137 (0.038)	-0.163 (0.045)	-0.152 (0.054)	-0.227 (0.076)	-0.109 (0.041)	-0.087 (0.095)
2nd Mortgage Bal.	-0.186 (0.042)	-0.215 (0.049)	-0.263 (0.059)	-0.237 (0.080)	-0.204 (0.052)	-0.103 (0.122)
Delinquency	0.076 (0.006)	0.073 (0.008)	0.076 (0.009)	0.078 (0.012)	0.068 (0.007)	0.053 (0.013)
Credit Card Bal.	0.004 (0.016)	-0.007 (0.019)	-0.015 (0.022)	0.029 (0.031)	0.016 (0.019)	-0.002 (0.042)
Units	4,923,275	4,805,387	4,569,794	3,288,142	4,159,233	4,138,464

*Notes:* This table presents event study coefficients from 20 separate regressions estimated using alternative analysis specifications. Each row corresponds to a different outcome variable. Each column corresponds to a different specification or subsample. Delinquency is scaled such that estimates reflect impacts of a 100 dollar increase in property taxes on the percentage of homeowners that are delinquent. Column 1 reproduces the baseline specification (i.e., applying fixed effects that interact assessment year, county, and ventiles of assessed value). Column 2 substitutes ZIP code fixed effects for county fixed effects. Column 3 substitutes Census tract fixed effects for county fixed effects. Column 4 applies fixed effects that interact assessment year, Census tract, percentiles of assessed value, and property use code. In Columns 1, 2, 3, 4, and 6, coefficients correspond to effects after 12 months. Column 5 presents effects after 18 months. Column 6 interacts event time indicators with the predicted increase in property taxes instead of the actual increase. For comparability with figures, omitted period for car consumption is  $t=-1$ , and  $t=-5$  for all other outcomes. Standard errors are clustered at the loan level. Data from financial behaviors sample described in Section 3.

Table A5: Quadratic Specification

Outcome	(1) Car Consumption	(2) 2nd Mortgage Bal.	(3) Delinquency	(4) Credit Card Bal.
$\Delta T$	-0.0658203 (0.0726448)	-0.1551120 (0.0773884)	0.0893680 (0.0123876)	0.0343526 (0.0309846)
$\Delta T^2$	-0.0000467 (0.0000430)	-0.0000204 (0.0000505)	-0.0000090 (0.0000069)	-0.0000200 (0.0000186)
Marginal effect ( $\Delta T = \$0$ )	-.0658203	-.155112	.089368	.0343526
Marginal effect ( $\Delta T = \$500$ )	-.1124831	-.1755146	.08034903	.0143683
Outcome Mean	4381.583	6949.916	0.074	6662.221
Units	4,923,275	4,923,275	4,923,275	4,923,275

*Notes:* This table presents event study coefficients from 4 separate regressions. Regression specifications are a variation of Equation 4 that includes both linear and quadratic interactions of tax increases with event time dummies. Coefficients correspond to effects after 12 months. For comparability with figures, omitted period for car consumption is  $t=-1$ , and  $t=-5$  for all other outcomes. Delinquency is scaled such that estimates reflect impacts of a 100 dollar increase in property taxes on the percentage of homeowners that are delinquent. Marginal effects denote implied marginal effect at a given value of the property tax increase and capture curvature in the conditional expectation function. Standard errors are clustered at the loan level. Data from financial behaviors sample described in Section 3.

Table A6: Correlation Between Shock and Individual Characteristics

Controls	None (1)	Baseline (2)	Additional (3)
Income ( $\mu=83.77$ )	53.915 (0.398) [0.619]	13.139 (0.493) [0.151]	7.090 (0.621) [0.081]
Property Value ( $\mu=239.68$ )	186.493 (0.887) [0.632]	34.403 (0.850) [0.117]	15.904 (1.190) [0.054]
Housing Wealth ( $\mu=86.22$ )	96.286 (0.392) [0.811]	9.655 (0.293) [0.081]	1.585 (0.485) [0.013]
Credit Score ( $\mu=701.39$ )	14.715 (0.185) [0.160]	-1.589 (0.215) [-0.017]	-1.634 (0.413) [-0.018]
Debt-to-Income ( $\mu=36.16$ )	-0.742 (0.037) [-0.046]	-0.002 (0.046) [-0.000]	-0.060 (0.094) [-0.004]
Any Co-Applicant ( $\mu=0.43$ )	0.087 (0.001) [0.177]	-0.009 (0.001) [-0.018]	-0.006 (0.003) [-0.012]

*Notes:* This table presents regression coefficients from 18 separate regressions. Each cell presents a regression using a given outcome and set of controls. Each coefficient corresponds to the dollar increase in annual property taxes in thousands. *None* indicates that the specification includes no controls interacted with event time fixed effects; *Baseline* indicates that the specification includes the baseline set of controls that interact year, county, and ventiles of assessed value; *Additional* indicates that the specification includes fixed effects that interact year, Census tract, percentiles of assessed value, and use code. The outcomes are as follows: *Income* denotes household income in thousands at mortgage origination; *Property Value* denotes property value in thousands at mortgage origination; *Housing Wealth* denotes home equity in thousands at mortgage origination; *Credit Score* denotes credit score at mortgage origination; *Debt-to-Income* denotes back-end debt-to-income ration at mortgage origination; and *Any Co-Applicant* denotes an indicator for the presence of a co-applicant on the mortgage application. Standard errors clustered at the loan level are presented in parentheses, and point estimates normalized by the standard deviation of the outcome variable are presented in brackets. Data from financial behaviors sample described in Section 3.

Table A7: Responses from Nationwide Survey of US Homeowners

	Raw (1)	Weighted (2)
<i>Panel A. Credit access and debt aversion</i>		
Would easily qualify for second mortgage	0.628 (0.011)	0.620 (0.013)
Would consider taking out a second mortgage	0.225 (0.010)	0.225 (0.012)
Would rather skip bills than take out a second mortgage	0.647 (0.011)	0.667 (0.013)
<i>Panel B. Deferring property taxes</i>		
Would never defer property taxes	0.423 (0.011)	0.411 (0.014)
Would defer if having trouble paying	0.420 (0.011)	0.437 (0.014)
Would defer immediately	0.157 (0.008)	0.152 (0.010)

*Notes:* This table presents responses from Wave 1 of the online survey of US homeowners. Column 1 contains statistics from the raw survey sample. Column 2 contains the corresponding statistics with the sample re-weighted to match population statistics from the 2013-2017 American Community Survey. Each number corresponds to the share of respondents selecting the indicated answer. Standard errors in parentheses. Panel A presents answers to the following questions: (i) Which best describes how difficult it would be for you to qualify for a second mortgage? (ii) Suppose that one year you have a hard time finding the money to pay property taxes. In order to find the money to pay property taxes, would you consider taking out a second mortgage? (iii) Suppose again that one year you have a hard time finding the money to pay your property taxes. In order to find the money to pay property taxes, would you rather take out a second mortgage or would you rather skip paying one or more bills (e.g. credit card, mortgage, utilities)? Panel B presents answers to the question, Suppose you were given the option to defer your property taxes with zero interest. If you defer your property taxes, you only need to pay them when you sell or pass on your property. Which of the following best describes you? Wave 1 comprised of responses from 2,000 homeowners across US. Questions about second mortgage and tax deferrals asked only of homeowners not residing in Michigan (N=1,906). See Appendix F for more details.

Table A8: Robustness of Migration Impacts

	Baseline	Property Type FE	Coarse FE	ZIP FE	24-Month Effect
	(1)	(2)	(3)	(4)	(5)
Any Sale	0.071 (0.011)	0.070 (0.011)	0.068 (0.009)	0.115 (0.015)	0.090 (0.013)
Any Distressed Sale	0.012 (0.004)	0.011 (0.004)	0.007 (0.003)	0.013 (0.005)	0.016 (0.004)
Units	38,577,269	38,571,744	38,578,243	38,550,163	38,577,269

*Notes:* This table presents event study coefficients from 10 separate regressions estimated using alternative regression specifications. Each row corresponds to a different outcome variable. Each column corresponds to a different specification or subsample. Outcomes are scaled such that estimates reflect percentage point impacts of a 100 dollar increase in property taxes. Column 1 reproduces the baseline specification (i.e., applying fixed effects that interact assessment year, county, and ventiles of assessed value). Column 2 additionally interacts property use code with year, county and value fixed effects. Column 3 substitutes quintiles for ventiles of assessed value. Column 4 substitutes ZIP code fixed effects for county fixed effects. In Columns 1 through 4, coefficients correspond to effects after 18 months. Column 5 presents effects after 24 months. Standard errors are clustered at the property level. Data from migration sample described in Section 3.

Table A9: Estimated Value of Permit

	(1)	(2)	(3)	(4)	(5)
Number of Permits	22,650.32 (910.74)	20,344.84 (796.34)	19,935.90 (809.67)	21,014.03 (1,111.47)	19,076.78 (1,836.81)
Controls	None	County	Tract	Tract-Years	Tract-Yr-Val
Outcome Mean	42,199.60	42,212.02	43,068.38	45,532.99	52,382.80
Outcome SD	74,892.42	74,899.80	75,594.37	74,900.49	80,221.29
N	22,875	22,868	21,731	13,604	5,359

*Notes:* This table presents coefficients from regressions of the difference in purchase and sale prices of a property (in dollars) on the number of permits filed between purchase and sale. Each column corresponds to a different regression specification. *None* denotes a specification without a controls. *County* denotes a specification with county fixed effects. *Tract* applies Census tract fixed effects. *Tract-Years* applies fixed effects that interact tract, purchase year, and sale year. *Tract-Yr-Val* applies fixed effects that interact tract, purchase year, and deciles of purchase price. Data come from repeat sales sample described in Section 3.



Table A10: Second Mortgages Information Treatment

	Raw	Weighted
	(1)	(2)
<i>Panel A. Knowledge check</i>		
Identified second and reverse mortgages	0.295 (0.020) [0.572]	0.318 (0.025) [0.547]
Correct reverse mortgages	0.318 (0.019) [0.594]	0.340 (0.023) [0.582]
<i>Panel B: Attitudes towards borrowing</i>		
Would consider taking out second mortgage	0.047 (0.019) [0.201]	0.058 (0.024) [0.196]
Would take out second mortgage for \$500 increase	-0.005 (0.009) [0.041]	-0.001 (0.010) [0.036]
N	1907	1907

*Notes:* This table presents regression coefficients for 14 separate regressions. Each row corresponds to a different outcome variable, which is regressed on an indicator for the respondent being randomly assigned to receive information on second mortgages and reverse mortgages. The sample is comprised of respondents in Wave 1 of the survey who live in US states other than Michigan. Each row corresponds to a regression for a separate outcome. Panel A contains the following outcomes: an indicator for correctly identifying second mortgages and reverse mortgages as methods for borrowing against one's home and an indicator for correctly answering a question about the repayment structure of reverse mortgages. Panel B contains the following outcomes: an indicator for the respondent stating they would consider taking out a second mortgage if they had difficulty finding the money to pay property taxes and an indicator for the respondent identifying mortgage borrowing as a way to pay for a 500 dollar property tax increase. Column 1 contains unweighted regression coefficients and Column 2 contains regression coefficients re-weighted using the ACS. Standard errors are presented in parentheses and control means in brackets. See Appendix F for additional details of the experiment, including questionnaire and answer choices.

## C Model Appendix

In this section, I provide detailed derivations of the framework presented in Section 2 and the welfare calculations conducted in Section 9.

### C.1 WTP Without Migration

Consider an agent who lives for three periods. The agent derives utility from housing consumption  $h$  and non-housing consumption  $c$ . For simplicity, assume the interest rate is 0. Specifically, the agent's value function is given by:

$$V(A_0) = E[v(h) + u_1(c_1) + u_2(c_2)] \quad (5)$$

Expectations are taken over house prices that are uncertain in period 0, during which the agent commits to a certain level of housing consumption using initial endowment  $A_0$ . At the beginning of period 1, the stochastic house price  $p_1$  is realized, and the agent allocates consumption to periods 1 and 2. In addition, the agent must pay property taxes  $\tau$  in period 1. This environment yields the following per-period budget constraints:

$$\begin{aligned} A_0 &\geq p_0 h + A_1 \\ A_1 &\geq c_1 + A_2 + \tau p_1 h \\ A_2 + p_1 h &\geq c_2 \end{aligned}$$

Conceptually, period 1 models the period of time during after which a homeowner has chosen a certain level of housing consumption and faces uncertain changes in property tax payments due to house price fluctuations, while period 2 captures the period of time after which a homeowner has sold her home and has converted her housing wealth into liquid wealth.

In period 0, the agent chooses an amount of housing consumption according to the first order condition:

$$v'(h) + U_h(A_1, h) = U_{A_1}(A_1, h)p_0 \quad (6)$$

where  $U(A_1, h)$  denotes the value of entering period 1 with assets  $A_1$  and housing  $h$ . In choosing a value for  $h$ , the agent weighs the utility value of housing consumption against the lower levels of liquidity from entering period 1 with fewer assets. In period 1, the agent allocates intertemporal consumption according to a standard Euler equation,  $u'_1(c_1) = u'_2(c_2)$ .

Agent  $i$ 's willingness-to-pay for policy  $p$  can be calculated as  $WTP_i = \frac{dU_i}{dp} \frac{1}{\lambda_i}$ , where  $U$  denotes utility,  $p$  denotes the policy, and  $\lambda$  is the marginal utility of income. Differentiating the agent's optimized value function with respect to  $\tau$  yields:

$$\begin{aligned}
\frac{\partial V}{\partial \tau} &= v'(h) \frac{\partial h}{\partial \tau} + E \left[ u'_1(c_1) \left( \frac{\partial A_1}{\partial \tau} - \frac{\partial A_2}{\partial \tau} - p_1 h - \tau p_1 \frac{\partial h}{\partial \tau} \right) + u'_2(c_2) \left( \frac{\partial A_2}{\partial \tau} + p_1 \frac{\partial h}{\partial \tau} \right) \right] \\
&= E \left[ u'_1(c_1) \left( -\frac{\partial A_2}{\partial \tau} - p_1 h \right) + u'_2(c_2) \left( \frac{\partial A_2}{\partial \tau} \right) \right] \\
&= -E \left[ u'_1(c_1) (p_1 h) \right]
\end{aligned}$$

In the above, the second line follows from Equation 6, and the third line follows from the Euler Equation for  $A_2$  for an agent who borrows. For an agent who faces a binding borrowing constraint (e.g.,  $A_2 \geq \bar{A}$ ), the functional form of this equation remains unchanged because  $\frac{\partial A_2}{\partial \tau} = 0$ .

The marginal utility of income can be derived by differentiating Equation 5 with respect to income in period 1. This yields a WTP for agent  $i$  that is given by:

$$WTP_i = -\frac{E[p_1 h \cdot u'_1(c_1)]}{E[u'_1(c_1)]}$$

Note that the difference between the above expression and Equation 2 is that the above pertains to a marginal increase in  $\tau$ , whereas Equation 2 pertains to an increase in  $\tau$  of a size that results in a \$1 expected tax increase, resulting from the equation  $T = \tau E[p_1 h]$ .

## C.2 Disutility from Debt Aversion

In this subsection, I illustrate how a generic utility parameter that captures debt aversion can yield an increase in the MVPF of property taxes. Consider the following alternative to the objective function represented in Equation 5:

$$V(A_0) = v(h) + E[u_1(c_1) - \psi(A_1 - A_2) + u_2(c_2)] \quad (7)$$

In the above,  $\psi$  represents additional disutility from debt aversion, which is assumed to be differentiable with  $\psi' \geq 0$ . Following the derivations above, a standard envelope theorem derivation yields  $\frac{\partial V}{\partial \tau} = -E[u'(c_1)(p_1 h)]$  precisely as above. Therefore, the functional form of  $WTP_i$  does not change.

Debt aversion increases the magnitude of  $WTP_i$  by reducing the extent of consumption smoothing between periods 1 and 2. This is evident in the first order condition for the agent's period 1 problem:

$$u'_1(c_1) = \phi'(A_1 - A_2) + u'_2(c_2)$$

The case in which  $\phi' \approx 0$  corresponds to the frictionless benchmark in which the covariance of house prices and marginal utility is negative. An extreme case is if  $\phi'$  is very large, such that there is very little consumption smoothing between periods 1 and 2. In this case, the covariance of house prices and marginal utility is positive. Naturally, the precise effect of debt aversion on the MVPF depends

on the functional form of  $\phi'$ . Accordingly, this motivates the consumption approximation approach that I take when quantifying the MVPF, which avoids making assumptions about the functional form of  $\phi'$ .

### C.3 Adjustment Costs from Moving

In this subsection, I enrich the model to incorporate adjustment costs from moving. In this expanded environment, assume that the model proceeds in four steps. First, the agent begins with an initial endowment  $A_0$  and makes an initial housing choice  $h_0$ . Second, the stochastic house price  $p_1$  is revealed. Third, the agent has the choice to pay a fixed moving costs to re-optimize consumption by setting  $h_1 \neq h_0$ . Fourth, the agent allocates remaining resources to consumption in periods 1 and 2. In this environment, the agent's period 0 value function is as follows:

$$\begin{aligned} V(A_0) &= E \left[ v(h_1, p_1) + u_1(c_1) + u_2(c_2) \right] \\ \text{s.t. } A_0 &= p_0 h_0 + A_1 \\ A_1 + \mathbb{1}[h_1 \neq h_0]((h_0 - h_1)p_1 - \kappa h_0) &= c_1 + A_2 + \tau p_1 h_1 \\ A_2 + p_1 h_1 &= c_2 \end{aligned}$$

As in the baseline environment, the agent who has chosen a given level of  $h$  (unadjusted or not) chooses  $A_2$  to equate marginal consumption utility, such that  $u'_1(c_1) = u'_2(c_2)$ . Anticipating this, the agent chooses whether to move based on the following value function, conditional on  $p_1$ :

$$V(p_1, A_1, h_0) = \max(V^0(p_1, A_1, h_0), V^m(p_1, A_1, h_0))$$

Under certain regularity conditions, this environment results in a range of house prices such that  $\forall p_1 \in [s, S]$ , the agent does not move, and moves for all other values of  $p_1$ . The following derivations follow those in [Chetty and Szeidl \(2007\)](#). Assume that:

- A1.  $c_1$ ,  $c_2$ , and  $h$  are strictly increasing functions of  $p_1$ .

First, I establish a range of  $p_1$  for which it is optimal not to move. From A1, for any two levels of housing consumption  $h_l < h_h$ , there exist  $p_l < p_h$  that generate  $h_l$  and  $h_h$  as the optimal choices, conditional on moving. Therefore, there must exist  $p_l < p_h$  such that the optimal choice of  $h_1$  conditional on moving is  $h_0$  for  $p_h$ , and  $h_0(1 - \frac{\kappa}{\tau p_1})$  for  $p_l$ . Consider any  $h_1$  such that  $h_0(1 - \frac{\kappa}{\tau p_1}) \leq h_1 \leq h_0$ . Since the agent has chosen to move, total resources (in the absence of credit constraints) that can be devoted to  $c_1$  and  $c_2$  are given by

$$\begin{aligned}
A_1 - \kappa h_0 + p_1(h_0 - \tau h_1) &\leq A_1 - \kappa h_0 + p_1(h_0 - \tau h_0(1 - \frac{\kappa}{\tau p_1})) \\
&= A_1 + p_1 h_0(1 - \tau)
\end{aligned}$$

These inequalities follow from the assumptions about  $h_1$  in this range. These inequalities imply that  $c_1 + c_2 \leq A_1 + p_1 h_0(1 - \tau)$ , which are exactly the same resources that are available if the agent does not move. Therefore, in this range  $[p_l, p_h]$ , the agent can choose higher values of  $c_1$ ,  $c_2$ , and  $h_1$  if she does not move. Therefore, staying must be optimal for any  $p_1 \in [p_l, p_h]$ .

Second, I show that on each side of this range, the value functions cross each other exactly once given certain regularity conditions. Note that the optimal policy is to move iff  $V^m(p_1, A_1, h_0) > V^0(p_1, A_1, h_0)$ . Moreover, note that differentiating the value functions with respect to  $p_1$  yields:

$$\begin{aligned}
V_1^m(p_1, A_1, h_0) &= v_2(h_1, p_1) + u'_1(c_1)(h_0 - (1 + \tau)h_1) + u'_2(c_2)h_1 \\
&= v_2(h_1, p_1) + (h_0 - \tau h_1)u'_1(c_1) \\
V_1^0(p_1, A_1, h_0) &= v_2(h_0, p_1) + u'_1(c_1)(-\tau h_0) + u'_2(c_2)h_0 \\
&= v_2(h_0, p_1) + (1 - \tau)h_0 u'_1(c_1)
\end{aligned}$$

The equations above make use of the Envelope Theorem and the agent's first order condition in  $A_2$ . Assume further that:

A2. Marginal utility of housing is non-decreasing in house prices:  $v_{12}(h, p) \geq 0$

A3. Minimum curvature of consumption utility:

$$\begin{aligned}
h_1^m \leq h_0(1 - \frac{\kappa}{\tau p_1}) &\implies (h_0 - \tau h_1^m)u'(c_1^m) \leq (1 - \tau)h_0 u'(c_1^s) \\
h_1^m \geq h_0 &\implies (h_0 - \tau h_1^m)u'(c_1^m) \geq (1 - \tau)h_0 u'(c_1^s)
\end{aligned}$$

Where the superscripts  $m$  and  $s$  denote optimal choices conditional on moving and staying, respectively.

Since the marginal utility of consumption is lower (higher) when moving relative to staying for low (high) values of  $p_1$ , A2 essentially requires that consumption utility be sufficiently curved. Under these conditions, then  $V_1^m < V_1^0$  for  $p_1 < p_l$  and  $V_1^m > V_1^0$  for  $p_1 > p_h$ . Coupled with standard limit properties of utility, this implies that the value functions cross each other exactly once below  $p_l$  and one above  $p_h$ . Therefore, this environment admits a single range of house price realizations in which the agent stays, and outside of which the agent moves.

To derive an expression for the welfare costs of property taxes in this environment, let  $[p_L, p_H]$  denote the range of house price realizations over which the agent chooses to stay. The period-0 value function can be written as follows:

$$\begin{aligned}
V(A_0) &= \int_0^\infty V(p_1, A_1, h_0) f(p_1) dp_1 \\
&= \int_0^{p_L} V^m(p_1, A_1, h_0) f(p_1) dp_1 + \int_{p_L}^{p_H} V^0(p_1, A_1, h_0) f(p_1) dp_1 + \int_{p_H}^\infty V^m(p_1, A_1, h_0) f(p_1) dp_1
\end{aligned}$$

Note that in the above,  $A_1$  and  $h_0$  denote the optimized values chosen in Step 1. Differentiating with respect to  $\tau$  yields:

$$\begin{aligned}
\frac{dV(A_0)}{d\tau} &= V^m(p_L) f(p_L) \frac{dp_L}{d\tau} + \int_0^{p_L} \frac{\partial V^m(p_1)}{\partial \tau} f(p_1) dp_1 \\
&\quad + V^0(p_H) f(p_H) \frac{dp_H}{d\tau} - V^0(p_L) f(p_L) \frac{dp_L}{d\tau} + \int_{p_L}^{p_H} \frac{\partial V^0(p_1)}{\partial \tau} f(p_1) dp_1 \\
&\quad - V^m(p_H) f(p_H) \frac{dp_H}{d\tau} + \int_{p_H}^\infty \frac{\partial V^m(p_1)}{\partial \tau} f(p_1) dp_1 \\
&= \int_0^{p_L} \frac{\partial V^m(p_1)}{\partial \tau} f(p_1) dp_1 + \int_{p_L}^{p_H} \frac{\partial V^0(p_1)}{\partial \tau} f(p_1) dp_1 + \int_{p_H}^\infty \frac{\partial V^m(p_1)}{\partial \tau} f(p_1) dp_1 \\
&= \int_0^\infty \frac{\partial u_1(c_1^*)}{\partial \tau} f(p_1) dp_1 \\
&= -E[u'_1(c_1) p_1 h_1]
\end{aligned}$$

In the above notation, the dependence of  $V$  on the optimized values of  $A_1$  and  $h_0$  has been omitted for clarity. The second line follows from the fact that an agent who faces  $p_L$  or  $p_H$  is indifferent between moving and staying. As a result, the welfare effect of a marginal change in property taxes is therefore identical in form to the case where agents do not move because there are no welfare effects of tax-induced migration.

However, liquidity constraints can generate first-order welfare costs from moving. Consider a liquidity constraint by which the agent must meet a certain level of expenditure in period 1 (e.g., must make a mortgage payment), and must move if they are unable to meet this constraint. For an agent facing a binding borrowing constraint  $A_2 \geq \underline{A}$ , the expenditure constraint also becomes binding for sufficiently high realizations of  $p_1$  because the agent must pay property taxes in period 1. Unlike an unconstrained agent, a constrained agent whose moving decision is marginal to a tax increase is not indifferent between moving and staying. This lack of indifference generates additional welfare costs. Formally, let  $p_c \in [p_L, p_H]$  denote the value of  $p_1$  at which the liquidity constraint binds. Then,

$$\frac{dV(A_0)}{d\tau} = -E[u'_1(c_1) p_1 h_1] + \frac{dp_c}{d\tau} (V^0(p_c) - V^m(p_c)) f(p_c) \tag{8}$$

Since for a constrained agent who faces a house price realization of  $p_c$ , the value of staying is greater than the value of moving, tax-induced effects on migration entail welfare costs. Note that since  $f(p_c) = \frac{dF(p_c)}{dp_c}$ , the second term can be re-written as  $\frac{dF(p_c)}{d\tau}(V^0(p_c) - V^m(p_c))$ , which can be readily interpreted as the effect of a marginal tax increase on the share of tax-induced moves multiplied by average net moving costs. In Equation 3, the welfare costs of migration responses can be concisely expressed as  $\frac{\partial\phi}{\partial\tau} \times M$ , where  $\phi$  denotes the likelihood that the agent is induced to move, and  $M$  denotes average net moving costs among migrants (normalized by  $E[p_1h]$ ), which are zero for non-constrained agents.

#### C.4 Combined Expression for MVPF

This environment yields expressions for both the net fiscal cost and the agent's willingness to pay for a marginal increase in property taxes, both of which are necessary components for computing the the marginal value of public funds, defined as  $MVPF = \frac{\sum_i WTP_i}{\text{Net Cost}}$ .

To form an expression for the net fiscal cost to the government, I assume that revenues are given by  $R = \tau E[p_1h]$ . This formulation implies that the government balances its budget in expectation (or collects revenue across a large number of households). Because of this, the government is able to insure house price risk for a given agent using property taxes. Differentiating revenues with respect to  $\tau$  yields the following expression for the net fiscal cost:

$$\frac{dR}{d\tau} = E[p_1h](1 + \varepsilon_h)$$

Externalities from property sales can be incorporated into the MVPF through the WTP of other agents  $k \neq i$  to prevent a home sale. Note that this WTP can embed negative distressed sale externalities as well as positive externalities from additional vacancies. For convenience, define the externality component of the MVPF as

$$E \equiv \frac{\sum_{k \neq i} WTP_k}{E[p_1h]}$$

Combining the previous components, the MVPF of a marginal increase in the property tax rate can be written as:

$$MVPF = \frac{\sum_k WTP_k}{\text{Net Cost}} = \frac{1}{1 + \varepsilon_h} \left( \frac{E \left[ \frac{p_1h}{E[p_1h]} \cdot u'_1(c_1) \right]}{E[u'_1(c_1)]} + \frac{\partial\phi}{\partial\tau} M + \frac{\partial\phi}{\partial\tau} E \right) \quad (9)$$

In the above,  $\phi$  denotes the likelihood that the agent is induced to move, and  $M$  denotes average net moving costs among migrants. These costs are 0 if there are no liquidity-constrained households. Expressing agent  $i$ 's willingness to pay in terms of covariances yields an intuitive expression for the component of the MVPF that is due to house price uncertainty:

$$\frac{E\left[\frac{p_1 h}{E[p_1 h]} \cdot u'_1(c_1)\right]}{E[u'_1(c_1)]} = 1 + cov\left(\frac{p_1 h}{E[p_1 h]}, \frac{u'_1(c_1)}{E[u'_1(c_1)]}\right)$$

Note that if a homeowner does not borrow against housing wealth in response to changes in house prices, then the covariance term is positive, because marginal utility is higher when taxes are higher. But if the homeowner does borrow, then an increase in the price leads to a wealth gain, meaning that marginal utility is lower.

## C.5 Welfare Calculations

In this section, I use the formula represented in Equation 9 to quantify the welfare costs implied by each of the empirical responses I document.

**Consumption Uncertainty** To directly map my empirical estimates to the MVPF formula, I focus on uncertainty over property tax payments, rather than over house prices. Conceptually, this can be thought of as modeling uncertainty over an assessed value that is a noisy proxy for the true (unobserved) house price (e.g.,  $p_1 + \varepsilon$ ). I follow the approach to approximating consumption in Brockmeyer et al. (2022). Specifically, a first-order Taylor expansion of marginal utility yields the following approximation:

$$\begin{aligned} u'(c) &\approx u'(\bar{c}) + u''(\bar{c})(c - \bar{c}) \\ &= u'(\bar{c})(1 - \gamma \Delta c) \end{aligned}$$

To compute the distribution of  $p_1$ , I assume that the tax bill is a linear function of home value  $T = \tau p_1 h$ , which implies  $\frac{p_1}{E[p_1]} = \frac{T}{E[T]}$ .

To parameterize consumption, I assume that consumption is linear in  $T$ , consistent with the results of estimating a quadratic specification in Appendix Table A5. Under this assumption,  $c = \tilde{c} - \beta T$ , where  $\beta$  is the total MPC, and  $\tilde{c}$  is the amount of consumption in the absence of any property taxes. Therefore, consumption can be parameterized as  $\Delta c = \frac{-\beta T}{\tilde{c}}$ . Under these assumptions, the consumption uncertainty component can be approximated as follows:

$$\frac{E\left[\frac{p_1 h}{E[p_1 h]} \cdot u'_1(c_1)\right]}{E[u'_1(c_1)]} \approx \frac{E\left[\frac{T}{E[T]}(1 + \gamma \frac{\beta T}{\tilde{c}})\right]}{E\left[1 + \gamma \frac{\beta T}{\tilde{c}}\right]} \quad (10)$$

To calibrate this expression, I follow Di Maggio et al. (2017) who use state-level consumption data to estimate the response of auto sales growth and total consumption to Bartik shocks. They find that the ratio of responses to auto sales relative to total consumption is about 2.3 to 0.7. Accordingly, an increase of \$X in monthly car expenditure can be extrapolated to a consumption response of  $\Delta(c_t)$  using the formula  $\Delta(c_t) = \frac{1}{0.045} \times \frac{0.7}{2.3} \times \$X$ . This calculation implies that  $\beta = 0.93$ . To calculate  $\tilde{c}$ , I take average annual expenditures among homeowners between 2010 and 2019 from the Consumer



Expenditure Survey, and add  $0.93 \times \bar{T}$ , which yields  $\tilde{c} = \$67,437$ . Lastly, I assume  $\gamma = 2$ .

In order to compute expectations in Equation 10, it is important to isolate the uncertainty in yearly changes property taxes, as opposed to cross-sectional variation in tax amounts, which in large part arises from cross-sectional variation in property values. To do so, let  $T_{it}$  denote the tax bill for property  $i$  in tax year  $t$ ,  $\bar{T}$  denote the average tax bill, and  $\bar{\Delta}^p$  denote the average proportional yearly tax change (i.e., the average of  $\frac{T_{i,t+1}}{T_{i,t}}$ ). To construct the empirical counterpart of Equation 10, I define  $T = \bar{T} \times \frac{T_{i,t+1}}{T_{i,t}}$  and  $E[T] = \bar{T} \times \bar{\Delta}^p$ , thus isolating the distribution of uncertainty in taxes within properties. I calculate these objects using annual changes in tax bills within ownership spells in the repeat sales sample, and winsorize  $\bar{T}$  and  $\bar{\Delta}^p$  at the 1% level.

Following these calculations, Equation 10 evaluates to 1.00136, the contribution of consumption uncertainty to the MVPF of property taxes.

**Financial Distress** Suppose that households have a dollar-valued utility cost of becoming financially distressed. This can be entered into the numerator of Equation 9 via  $\frac{\partial \phi}{\partial \tau} M$ , where  $M \equiv \frac{\text{distress cost}}{E[p_1 h]}$  and  $\phi$  denotes an indicator that the household becomes financially distressed. Under this parameterization, I can apply the linearity assumption ( $T = \tau p_1 h$ ) to form an expression that allows me to simply multiply my empirical estimates of the impact of a \$1 tax increase by the distressed sale cost:  $\frac{\partial \phi}{\partial \tau} M = \frac{\partial \phi}{\partial T} \times \text{distress cost}$ .

In my baseline calculation, I focus on financial distress costs associated with distressed sales. I take the \$100,000 consumption-equivalent utility costs from Ganong and Noel (2023) and multiply by the 18-month distressed sale impacts from Figure 6. This yields a value of  $1.24126 \times 10^{-6} \times 100,000 = .124126$ . Note that I use 18-month impacts as opposed to 12-month impacts because for the analysis of distressed sales, the timing of the tax increase is not measured precisely and occurs in the months following event time 0.

The baseline calculation is conservative because it assumes that there are no costs of financial distress among homeowners who do not experience distressed sales. An alternative, less conservative approach is to scale by the increase in 60-day delinquency (Appendix Figure A5), the measure of default used in Ganong and Noel (2023). Applying the impact of a \$1 tax increase on 60-day delinquency yields the calculation  $6.57072 \times 10^{-6} \times 100,000 = .657072$ .

**Distressed Sale Externalities** I compute the externality component  $E$  as the extent of distressed sales spillovers, drawing on prior work that has measured their magnitude (Campbell et al. 2011; Gerardi et al. 2015). I assume that other homeowners' willingness to pay is equivalent to the amount of housing wealth lost due to distressed sale spillovers. Therefore, the externality component can be computed as the amount of lost wealth due to a marginal increase in property taxes divided by average home values.

The functional form assumption that the tax bill is linear in the assessed value,  $T = \tau p_1 h$ , implies that  $\frac{\partial T}{\partial \tau} = p_1 h$ . Let  $D$  denote an indicator that a homeowner realizes a distressed home sale. Applying this assumption,  $\frac{\partial D}{\partial \tau} = \frac{\partial D}{\partial T} p_1 h$ . I estimate that a \$1 increase in property taxes results in an increase of  $1.24 \times 10^{-6}$  distressed sales following a tax increase. Multiplying by the average

home value at purchase (\$248,083) implies that a marginal increase in the tax rate would result in an increase of 0.31 distressed sales.

To assess the magnitude of spillovers onto neighboring properties, I draw on estimates from [Gerardi et al. \(2015\)](#), who find that a foreclosure sale reduces sale prices by 0.6% in a 0.1 mile radius, and by 0.2% between 0.1 and 0.25 miles. I compute the average number of housing units within a given radius of a property by dividing the number of housing units in each Census tract by the area in square miles of each tract in the 2010 Census. This yields a housing-unit weighted average of 2,396 units per square mile, which implies about 75.3 units within a 0.1 mile radius and 395.1 units between 0.1 and 0.25 miles. The average annual property sale rate in the property data is 4.12%. Therefore, assuming that the distressed sale spillovers last for only one year (in line with the findings in [Gerardi et al. 2015](#)), the lost property wealth can be computed by multiplying the number of housing units affected by an estimate of the lost home value and by the increase in distressed sales:

$$\begin{aligned} & (75.3 \text{ housing units} \times 4.12\%) \times (\$248,083 \times 0.6\%) \times (0.31 \text{ distressed sales}) \\ & + (395.1 \text{ housing units} \times 4.12\%) \times (\$248,083 \times 0.2\%) \times (0.31 \text{ distressed sales}) \\ & = \$3,908.32 \end{aligned}$$

Lastly, dividing by the average home value in the repeat sales sample (\$248,083) yields  $\frac{\partial \phi}{\partial \tau} E = .01575$ .

**Net Fiscal Cost** I compute the net fiscal cost to the government as if property taxes were to only affect the housing stock through home improvement permits, and apply the correlation between home improvement permits and increases in sale prices in the data. The average effective tax rate in the repeat sales sample is 1.384% (derived by dividing the first tax bill by the purchase price in the sample described above). I find that a \$1 increase in property taxes results in a reduction in permitting of  $9.82 \times 10^{-6}$ , and each permit is correlated with an increase in property value of \$19,077. Let  $P$  be an indicator that a homeowner files a permit in a given year. The desired elasticity can be computed as follows:

$$\varepsilon_h = \frac{\tau}{h} \frac{dh}{d\tau} = \frac{\tau}{h} p_1 h \frac{dh}{dP} \frac{dP}{dT} \approx 1.384\% \times \$19,077 \times (-9.82002 \times 10^{-6}) = -.00259$$

**Valuation of In-Migrants** The baseline calculations omit the valuation of in-migrants of a new vacancy from homeowners who are induced to move due to a property tax increase. To calculate the average valuation of in-migrants that would reduce the MVPF to a value of 1, one can add a term to the numerator that captures positive WTP of other households:  $\frac{\partial \psi}{\partial T} \times \frac{\text{in-migrant WTP}}{E[p_1 h]} = \frac{\partial \psi}{\partial T} \times \text{in-migrant WTP}$ , where  $\psi$  is an indicator that the incumbent homeowner moves from their property. As with the previous calculations, I apply the 18-month impacts of any sale, which yields

the following calculation:

$$\begin{aligned} \text{in-migrant WTP} &= \frac{\varepsilon - \text{cov}\left(\frac{p_1 h}{E[p_1 h]}, \frac{u'_1(c_1)}{E[u'_1(c_1)]}\right) - \frac{\partial \phi}{\partial \tau} E - \frac{\partial \phi}{\partial T} \text{distress cost}}{\frac{\partial \psi}{\partial T}} \\ &\approx \frac{-0.00259 - 0.00136 - 0.01366 - \frac{\partial \phi}{\partial T} \times \$100k}{7.09694 \times 10^{-6}} \end{aligned}$$

When the distress sale component is calculated using the conservative baseline calculation (i.e.,  $\phi$  is defined as an indicator for a distressed sale), this expression evaluates to -\$20,267. When using the less conservative calculation (i.e.,  $\phi$  defined as an indicator for 60-day delinquency), this expression evaluates to -\$95,362.

## D Data Appendix

This section provides additional details on the various data sources used in this study. All administrative data linkages were conducted by the Fisher Center for Real Estate and Urban Economics at UC Berkeley. All analysis was conducted on a de-identified dataset. Many of these linkages are identical to those used in [Kermani and Wong \(2021\)](#); the following description parallels the corresponding description of the data presented in that paper.

I use a linkage of the property data to credit bureau and mortgage servicing data, which allow me to observe a wide range of financial outcomes and behaviors. These data are also known as the Equifax Credit Risk Insight Servicing McDash Database (CRISM). The CRISM data consist of two components: mortgage servicing records from McDash and credit bureau records from Equifax. The McDash data contain information on both mortgage characteristics measured at origination, as well as subsequent mortgage performance. The Equifax data are constructed using information from the Equifax credit bureau records associated with borrowers of mortgages captured in the McDash data. The Equifax data are at the monthly level and capture a broad range of financial outcomes and behaviors, including balances and delinquencies on credit cards, auto loans, and mortgages. Given a number of variables with mostly zero values (e.g., amounts past due, second mortgage balances), I topcode dollar-valued variables in the credit bureau data at the 97.5th percentile of positive values.

I rely on a k-nearest neighbors algorithm developed by the Fisher Center to link the ATTOM property records with the CRISM dataset. The algorithm proceeds as follows. Within each US county, the algorithm creates a stable linkage between transactions in ATTOM and loans in McDash, matching records along a vector of attributes. These attributes include the loan amount, the value of the property, the origination date, the purpose of the loan (e.g., purchase or refinance), whether the loan ended in distress (e.g., foreclosure), the loan lien type, the interest rate, and the date the loan was paid off.

A number of sample restrictions mitigate the potential impact of measurement error. First, I restrict to matches for which the algorithm chose the nearest neighbor (e.g., as opposed to the

second-nearest neighbor). Second, I restrict to matches for which there are no other close matches. The measure of match closeness comes from a score generated by the algorithm that denotes the closeness of the match along the vector of matched attributes. The 10th, 25th, 50th, and 75th percentiles of this score are 230, 510, 809, and 1,239, respectively (lower scores denote closer matches). I drop any match with a neighbor with a score within 200 of the score of the chosen match. Third, I restrict the sample to matches with scores at or below 2,000 (around the 85th percentile of the score).

Address histories from Infogroup enable an analysis that compares the neighborhoods from which homeowners depart when they purchase a home, to the neighborhood where their new home is located. The Infogroup data were originally collected for business marketing purposes and are comprised of a yearly panel of households from 2006 to 2019. Infogroup links households and individuals over time and space. Each record provides a household address and names of household members. These data are linked to the ATTOM transaction records using addresses and names reported in property transaction records.

The sample linking properties to income, race, and ethnicity is constructed from a linkage between the HMDA mortgage origination records and the ATTOM property transaction records. The ATTOM property data link mortgages to properties and are merged with the HMDA records by matching on transaction year, Census tract, dollar amount, and lender name. I restrict to merges that are unique along these characteristics, and I require an exact merge on year, tract, transaction amount, and a fuzzy string match on lender name.

While the ATTOM data cover purchases made through December 2020, the merge between ATTOM and HMDA only cover purchases starting in 2016 and earlier. Mapping ownership spells to yearly tax increases yields a measure of income and race/ethnicity for each tax increase measured in the data. This linkage is very similar to those used in previous research (e.g., [Bayer et al. 2017](#); [Avenancio-León and Howard 2022](#); [Kermani and Wong 2021](#)).

Appendix Figure A5, Panel C also makes use of an outcome that is defined as an indicator that a mortgage is 30 or more days past due, and the property is listed for sale. To construct this outcome, I make use of MLS listing data. These data cover property listings in a selected set of metropolitan areas and cover listings at the weekly level from 2007 through 2016. Listings in the MLS data were linked to property records using property address.

## D.1 Sample Restrictions

This section provides additional details on the sample restrictions that are used to construct the analysis samples. Appendix Figure A1 provides a visual illustration of these sample restrictions. Overall, there are 469.3 million residential property-years in the ATTOM data between 2010 and 2019. Restricting to property-years where the next year's tax bill is observed, and with nonzero assessed values and tax bills, and non-missing property use codes reduces the sample to 304.6 million property-years.

In constructing the financial behaviors sample, the linkage between the ATTOM property records

and the credit bureau and mortgage servicing records is the key factor that reduces the overall sample size. Panel B of Appendix Figure A1 shows that restricting to properties linked to the credit bureau and servicing records results in 23.8 million loan-years among owner-occupied properties.<sup>36</sup> Restricting to properties with an observed escrow update month that occurs at least 3 years after loan origination, which I use to define event time, results in 16.7 million loan-years. I restrict to a panel that is balanced between event times -11 and 12 (i.e., the mortgage is observed throughout this period), which yields 8.7 million loan-years, and tax increases, yielding 6.4 million loan-years.

To define the financial behaviors sample, I make two restrictions to mitigate the influence of measurement error in the property records. Even without linkages to other data sources, property data that is sourced from local tax assessors can entail measurement error (Nolte et al., 2021). I first drop any tax increases of more than \$3,000, which yields 6.3 million loan-years. Second, I compute correlations between tax increases in the property records and mortgage records within state-year cells. I drop cells where a \$1 tax increase in the property data corresponds to an increase in the servicing data of less than \$0.60. This results in an analysis sample of 4.9 million loan-years. Panel A of Table 1 provides summary statistics for this sample.

I conduct several empirical exercises to confirm that any remaining measurement error does not significantly affect the results, and that the aforementioned restrictions affect estimates by limiting attenuation due to measurement error rather than creating other sources of bias. First, Figure 2, Panel A reveals that a \$1 increase in annual property taxes results in an increase of monthly payments of about 9 cents, indicating that measurement error does not attenuate the first stage. Second, I estimate the baseline specification on two alternative samples in Appendix Table D1. Column 1 reproduces the analysis using the baseline data. Column 2 applies a stricter merge criterion using the closeness score generated by the k-nearest neighbors algorithm. I drop approximately half of the sample with the highest scores (i.e., largest distance between pairs). The estimated coefficients are both economically very similar and statistically indistinguishable. In Column 3, I include the state-years with low correlations between tax increases in the property records and servicing data. Unsurprisingly given the measurement error that their inclusion entails, the estimated effects are attenuated relative to the baseline specification, although the effects are economically and statistically similar. These findings illustrate that my results are not meaningfully affected by measurement error.

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<sup>36</sup>The credit bureau and servicing records are at the level of the mortgage loan, which in the linkage correspond to properties essentially one-to-one in a given year.

Table D1: Robustness to Alternative Sample Criteria

	Baseline (1)	More Strict Criterion (2)	Less Strict Criterion (3)
Car Consumption	-0.137 (0.038)	-0.153 (0.055)	-0.117 (0.032)
2nd Mortgage Bal.	-0.186 (0.042)	-0.218 (0.059)	-0.120 (0.035)
Delinquency	0.076 (0.006)	0.089 (0.009)	0.064 (0.005)
Credit Card Bal.	0.004 (0.016)	0.014 (0.023)	0.016 (0.014)
Units	4,923,275	2,619,820	6,325,471

*Notes:* This table presents event study coefficients from 12 separate regressions estimated using alternative samples. Each row corresponds to a different outcome variable measured at event time  $t=12$ . Each column corresponds to a different specification or subsample. Delinquency is scaled such that estimates reflect impacts of a 100 dollar increase in property taxes on the percentage of homeowners that are delinquent. Column 1 reproduces the baseline sample. Column 2 restricts to a sample that requires a higher-quality merge between the ATTOM and Equifax-McDash datasets, as measured by the merge score associated with the k-nearest neighbors algorithm. Column 3 expands the sample in Column 1 to include state-years with a lower quality merge. For comparability with figures, omitted period for car consumption is  $t=-1$ , and  $t=-5$  for all other outcomes. Standard errors are clustered at the loan level.

For the migration sample used to analyze investment, sales, and migration responses, I do not require the merge with the McDash data, which enables analysis of a substantially larger sample. Starting from the 304.6 million property-years in the raw ATTOM data, I then focus on owner-occupied properties by restricting to the 195.4 million property-years where the owner of the property is identified as the resident in the Infogroup address histories. Because my empirical strategy for analyzing these outcomes requires predicting tax increases using similar properties, I restrict to the 123.3 million property-years with a sufficient number of similar properties. I then restrict to 49.9 million property-years with coverage of primary outcomes in the event window around the bill issuance month, which I identify using empirically-observed increases in tax payments in the mortgage servicing data (see Appendix E.1 for more details). Finally, I restrict to property-years where the primary predicted property tax shock is non-negative, and drop properties where the predicted increase is more than \$3,000 (which is above the 99.9th percentile). Together, these restrictions yield a sample of 38.6 million property-years. Panel B of Table 1 provides summary statistics for this sample.

## D.2 Repeat Sales Sample

I apply the algorithm developed in [Kermani and Wong \(2021\)](#) for identifying repeat sales of properties. This allows me to compare observed purchase and sale prices of homes. This algorithm

Table D2: Comparison of Age in Voter Registration and Address History Data

	<i>Voter Registration Records</i>									
	18-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65+
<i>Address Histories</i>										
18-24	72	10	8	5	3	2	1	0	0	0
25-29	5	74	6	5	4	3	2	1	1	1
30-34	1	6	81	3	2	2	2	1	1	1
35-39	1	1	6	85	2	1	1	1	1	1
40-44	1	1	1	6	86	1	1	1	1	1
45-49	1	1	1	1	5	88	1	1	1	1
50-54	1	1	1	1	1	5	87	1	1	1
55-59	1	1	1	1	0	1	5	88	1	1
60-64	0	0	1	1	1	0	0	5	88	2
65+	0	0	1	1	1	1	1	1	2	91

*Notes:* This table compares the sample distribution by self-reported and imputed age. Each row pertains to the set of individuals assigned to a given age range in the address history data. Each number denotes the percent of individuals in a given age range in the voter registration records.

distinguishes transaction records that represent mortgages used to purchase a property, transfers of ownership, and mortgage refinances. The algorithm proceeds as follows. First, I identify property purchases by restricting to arm’s length, full-consideration transactions in the ATTOM data. To identify the future sale of a given purchased property among the set of all future transactions of that property, I drop transactions in which the new buyer’s name is similar to the original buyer name, and select the first subsequent arm’s length full-consideration transaction. A natural language processing algorithm classifies names as individuals, trusts, and non-trust institutions (e.g., banks, governments). I restrict to purchases in which the buyer is a person or trust, and to sales in which the seller in the second transaction is the same as the buyer in the first transaction, excluding distressed sales from the requirement because distressed sales are typically executed by institutions rather than individuals. Finally, I drop transactions with prices that are less than \$10,000. I win-sorize dollar-valued outcomes (e.g., changes in tax bills and home values between purchase and sale) at the 0.1% level. Panel C of Table 1 provides summary statistics for this sample.

### D.3 Validating Demographic Proxy Variables

Table D3: Comparison of Race/Ethnicity in HMDA and Address History Data

	<i>HMDA Mortgage Records</i>			
	Hispanic	Black	Non-Hispanic White	Asian
<i>Address Histories</i>				
Hispanic	66	2	29	3
Black	3	58	37	2
Non-Hispanic White	3	4	90	2
Asian	2	1	20	77

*Notes:* This table compares the sample distribution by self-reported and imputed age. Each row pertains to the set of individuals assigned to a given race/ethnicity in the address history data. Each number denotes the percent of individuals self-reporting a given race/ethnicity.

The Infogroup address histories contain imputed measures of homeowner age and race/ethnicity. I leverage linkages to two administrative datasets to validate these imputed measures.

To validate homeowner age, I make use of a linkage between the ATTOM property records and publicly-available voter registration databases provided by Aristotle, a private data provider. Voter registration records were linked to the property records using individual name and address. Appendix Table D2 presents a cross-tabulation of age categories provided by the Infogroup address histories and the voter registration records. Reassuringly, these two measures are highly correlated, which offers confidence that the heterogeneity analysis using imputed age from Infogroup is not greatly biased by measurement error.

To validate homeowner race/ethnicity, I leverage the linkage between the ATTOM property records and the HMDA mortgage origination records, described in Section 3. The HMDA records contain self-reported race/ethnicity of homeowners, but since these measures are only available for observations with a linked mortgage origination, I rely on the race/ethnicity measured by Infogroup for analysis using the migration sample. Infogroup imputes race/ethnicity using homeowner names and location. Appendix Table D3 presents a cross-tabulation of self-reported race/ethnicity in the HMDA records and imputed race/ethnicity in the Infogroup data. Imputed race/ethnicity is highly correlated with self-reported race/ethnicity; however, imputed race/ethnicity contains a non-negligible amount of measurement error. The amount of measurement error is comparable to that in existing approaches that impute race/ethnicity using homeowner name and location (Kermani and Wong, 2021).



## E Methodological Appendix

### E.1 Identifying Timing of Tax Increases Using Mortgage Escrow and Statutory Deadlines

Many empirical exercises in this study analyze outcomes around the month in which a homeowner faces newly increased property tax payments. This subsection describes the methods used to identify this month for each homeowner.

For the analysis of credit bureau and mortgage servicing outcomes, I analyze a sample of homeowners who pay property taxes through escrow accounts. Escrow accounts are typically maintained by mortgage servicers and allow homeowners to pay their property taxes, homeowner’s insurance, and mortgage insurance in monthly installments together with their monthly mortgage principal and interest payments. By law, mortgage servicers are required to conduct an escrow analysis at least once a year (CFPB, 2019). During an escrow analysis, servicers determine any account surplus or shortfall associated with changing tax or insurance amounts. Servicers then adjust the monthly escrow payment for the following twelve months accordingly. Because monthly escrow payments are constant in the twelve months between escrow updates, for most borrowers there exists a specific month in which the prior year’s property tax increase begins to be reflected in monthly property tax payments.

In the mortgage servicing data, I am able to observe the monthly escrow payment that is due. To identify the escrow update month for a given homeowner, I take the first change in the escrow payment amount that occurs in the 12 to 24 months prior to the first month in which servicers begin updating escrow accounts to incorporate updated property tax bills. Since mortgage servicers must wait for local taxing authorities to issue tax bills in order to update escrow payments, this first month varies by county and year. To identify this first month, I use the aggregate time series of property tax and escrow payments for each county. For each year and each county, the first month in which escrow payments reflect new property tax bills can be readily identified from the time series for that county by examining the relationship between monthly escrow payments and  $\Delta T_i$  in calendar time. In practice, this month is typically in the 0 to 4 months after the statutory deadline for the local taxing authority to issue updated property tax bills.

Whether an individual pays their property taxes through an escrow account depends on both lender-specific and borrower-specific factors. Homeowners without mortgages generally do not pay property taxes through escrow accounts. Lenders are required to maintain escrow accounts for certain loans with high loan-to-value ratios and interest rates (CFPB, 2019). In other cases, lenders may voluntarily choose to offer escrow accounts. As discussed in Cabral and Hoxby (2012), this decision is likely to depend on the profitability of offering borrowers access to escrow accounts, and by extension on the extent of the lender’s existing servicing operations. In general, the requirement to pay property taxes through an escrow account is a feature of mortgage contracts that is opaque to borrowers, and information about escrow accounts tends to be revealed late in the process of securing a mortgage (Cabral and Hoxby, 2012). Particularly given the well-established lack of shopping across

lenders on behalf of mortgage borrowers, there is likely little systematic self-selection of borrowers into mortgage contracts based on escrow requirements. This is consistent with the fact that almost half of borrowers only seriously consider one lender when applying for a mortgage (Alexandrov and Koulayev, 2018).

The analysis of property sales and investment outcomes do not make use of the merge with the mortgage servicing and credit bureau data, meaning that I need to define event time using an alternative method. Since in general, homeowners (including those who pay taxes through escrow) do not pay newly increased taxes before the bill issuance date, I define event time relative to the month of the bill issuance date. Most states have public deadlines for taxing authorities to issue tax bills (National Property Tax Group, 2023); however, taxing governments are sometimes delayed in issuing tax bills. In order to reduce noise, I define the tax issuance month using the empirically-observed month of first issuance described above, and drop counties where this month is not between 0 and 4 months after the state-imposed deadline.

## E.2 Constructing Predicted Property Tax Increases

To estimate effects of property tax increases on sales and investment outcomes, I require a measure of property tax changes that is not affected by these outcomes. For instance, local assessors may adjust the assessed value (and therefore tax bill) of a property in response to a recent sale. Therefore, I construct predicted property tax increases that use variation in taxes from nearby properties with similar characteristics. Specifically, for each property  $i$ , I compute:

$$\Delta\tilde{T}_i = \frac{Tax_1 - Tax_0}{AV_0}$$

That is, I construct a property-level tax shock that is the change in property taxes normalized by the property’s assessed value. I then compute the leave-out mean of  $\Delta\tilde{T}_i$  among groups of similar properties. Specifically, I group properties within cells of assessment year, property type (e.g., single-family, condominium), Census tract, deciles of square footage, number of bathrooms, number of bedrooms, and deciles of property lot size. I compute the leave-out mean within the 20th and 80th percentiles of the shocks, and drop groups where fewer than 3 observations are available to compute the leave-out mean. If it is not possible to compute a predicted tax change using this method, or if the predicted tax change is negative, I repeat the process but instead form groups within property type, Census block, quintiles of assessed value, and Infogroup occupancy status. To transform the leave-out measure to a dollar-valued shock for a given property, I multiply by that property’s baseline assessed value ( $AV_0$ ).

## E.3 Additional Results: Mortgage Originations Measured in Property Data

In addition to second mortgage borrowing, homeowners can also take out a cash-out refinance loan, which would also allow them to convert housing wealth into liquidity. To analyze refinances, I analyze the migration sample, which does not use the merge with the credit bureau data and therefore

does not require that a primary mortgage remain unpaid. This exercise follows the empirical strategy used in Section 8 used to analyze outcomes in the migration sample. I restrict to properties that were not sold, and measure new mortgage originations measured in the property data, which includes both refinances of first mortgages as well as new second mortgages. Appendix Figure A15 shows that a property tax increases entails a statistically and economically insignificant increase in new mortgage borrowing (a \$100 increase results in a 0.01% increase in new mortgages). At the same time, dollar balances of new mortgage loans fall about one-for-one with an increase in property taxes, implying reductions in borrowing on the intensive but not extensive margin.

#### E.4 Instrumenting for Migration

In Section 8, I use the predicted property tax shocks as an instrument for migration. I estimate a 2SLS specification that parallels the primary event study specification used for the property sales outcomes. The following 2SLS specification is estimated using a dataset that includes only event times -15, -3, and 24:

$$M_{it} = \beta_{24}\mathbb{1}\{s(t) = 24\}\Delta\hat{T}_i + \phi s(t)\Delta\hat{T}_i + \alpha_i + \gamma_{s(t),g(i)} + \varepsilon_{it} \quad (11)$$

$$y_{it} = \delta_{24}\mathbb{1}\{s(t) = 24\}M_{it} + \psi s(t)\Delta\hat{T}_i + \omega_i + \theta_{s(t),g(i)} + \nu_{it} \quad (12)$$

As before,  $i$  denotes a homeowner facing a tax increase in a given year,  $t$  denotes calendar month, and  $s(t)$  denotes event time relative to the month of the tax increase.  $\Delta\hat{T}_i$  denotes the (predicted) tax increase. Both specifications include homeowner fixed effects and event time fixed effects interacted with tax year, county, ventiles of assessed value.

The first stage regression represented in Equation 11 is analogous to the baseline event study specification (Equation 4), with the addition of a linear trend between event times -15 and -3 (represented by  $s(t)\Delta\hat{T}_i$ ).  $M_{it}$  is an indicator that a homeowner has sold their home in the last 24 months, and has been tracked in the address history data to their next home.

In the second stage regression (Equation 12),  $y_{it}$  denotes an outcome of interest for homeowner  $i$  in month  $t$ , such as the change in median neighborhood income from any move occurring in the last 24 months. When the outcome  $y_{it}$  pertains to a change in neighborhood characteristics, this outcome is computed as the difference in the characteristics of the Census tract from which a mover departs and the characteristics to which the mover arrives. For example, if the median income in the departing neighborhood is \$40k and in the arrival neighborhood is \$50k, the change in log median incomes would take the value of  $\log(50000) - \log(40000) = 0.22$ , reflecting an approximately 22% increase in neighborhood income. Note that the outcome is mechanically zero for homeowners who do not move. I winsorize  $y_{it}$  at the 1% level among homeowners who move.

Under standard IV assumptions, this recovers a LATE among complier homeowners, defined as those who would not have migrated if they had received a smaller property tax increase. The four assumptions that this analysis entails are independence, exclusion, relevance, and monotonicity.

Under the independence assumption, property tax increases are independent of potential outcomes. This can be viewed as an extension of the strong parallel trends assumption that is made in the baseline analysis.

In this context, the exclusion restriction requires that property tax shocks have no direct impact on the outcomes of interest, beyond those that operate through migration. Given that the outcomes of interest are outcomes that only occur conditional on migration (e.g., homeowners do not realize any change in neighborhood characteristics if they do not migrate), this assumption is relatively mild.

The relevance assumption can be tested empirically. Figure 6 indicates that property taxes have a strong impact on migration. The F-statistic from the 2SLS regressions for out-migrants is 25.9, and for in-migrants is 12.7. Note that these statistics differ because the address histories track a smaller share of in-migrants relative to out-migrants, and the endogenous variable has been defined as a property experiencing a move *and* the out- or in-migrant being tracked.

Finally, the monotonicity assumption requires that property tax increases monotonically raise the probability of migration. In this setting, the underlying channel through which property taxes affect behavior is almost certainly financial. To the extent that financial considerations are the primary channel, monotonicity is a natural assumption. That is, defiers who are less likely to move under a counterfactual of tax increase are unlikely to be a quantitatively meaningful share of the population.

One potential concern with this analysis is that homeowners who are tracked using the Infogroup address histories may differ from those who move but are not tracked to their new neighborhood, which could limit the external validity of this approach. To probe this possibility, Appendix Tables E1 and E2 present balance tables, where tracking status is determined by the out-migrating and in-migrating households, respectively. These tables present regressions of property/household characteristics on an indicator for being tracked, for the sample of homeowners who move. Note that these characteristics are observable regardless of whether the in-migrating or out-migrating household was tracked across locations. Reassuringly, tracked and non-tracked homeowners appear very similar along observable characteristics. Differences in tenure, annual tax amounts, estimated home value, and neighborhood income are very small when normalized by the standard deviation of the outcome. Tracked homeowners are slightly younger than non-tracked homeowners, consistent with selection patterns present in prior studies using similar data (Diamond et al., 2019).

Table E1: Covariate Balance by Out-Migrant Tracked Status

	(1)	(2)	(3)	(4)	(5)
Outcome	Tax Amount	Home Value	Tract Income	Tenure	Age
1[Tracked]	0.0080 (0.0019)	0.1104 (0.1656)	0.5892 (0.0206)	-0.3691 (0.0135)	-2.0647 (0.0196)
Outcome Mean	3.768	267.993	77.723	15.726	53.352
Outcome $\sigma$	3.770	260.663	28.434	10.989	16.649
$\hat{\beta}/\sigma$	0.002	0.000	0.021	-0.034	-0.124
Units	5,323,728	4,816,774	5,317,887	5,323,728	5,323,728

*Notes:* This table measures covariate balance between migrating homeowners who were and were not tracked to their next home using the Infogroup address histories. The sample is comprised of homeowners who moved within the window of a tax increase in a given year. Each column presents coefficients from a regression of a homeowner characteristic on an indicator that the homeowner was tracked to their next address, and includes fixed effects that interact county, year, and deciles of assessed value. Homeowner tenure and age are measured in years. Property tax amount, home value, and tract income are measured in thousand dollars. Standard errors are clustered at the level of the original property.

Table E2: Covariate Balance by In-Migrant Tracked Status

	(1)	(2)	(3)	(4)	(5)
Outcome	Tax Amount	Home Value	Tract Income	Tenure	Age
1[Tracked]	0.0089 (0.0020)	-0.6154 (0.1766)	0.4253 (0.0222)	-0.9162 (0.0136)	-1.2913 (0.0202)
Outcome Mean	3.768	267.993	77.723	15.726	53.352
Outcome $\sigma$	3.770	260.663	28.434	10.989	16.649
$\hat{\beta}/\sigma$	0.002	-0.002	0.015	-0.083	-0.078
Units	5,323,728	4,816,774	5,317,887	5,323,728	5,323,728

*Notes:* This table measures covariate balance between in-migrating households who were and were not tracked to their next home using the Infogroup address histories. The sample is comprised of properties where the original homeowner moved within the window of a tax increase in a given year. Each column presents coefficients from a regression of a characteristic of the property or original homeowner on an indicator that the in-migrating household was tracked to from their previous address, and includes fixed effects that interact county, year, and deciles of assessed value. Original homeowner tenure and age are measured in years. Property tax amount, home value, and tract income are measured in thousand dollars. Standard errors are clustered at the level of the property.

## F Survey Data Collection

This section describes the survey of homeowners. Responses were collected between September and November 2019 in two waves. This paper analyzes responses from the first wave, which consists of

responses from 2,000 homeowners over the age of 18 across the US. A second wave consistent of 1,040 homeowners living in Michigan is analyzed in [Wong \(2023\)](#).

The survey employs several measures to improve data quality. First, in contrast to samples drawn from Amazon mTurk, Qualtrics screens survey respondents to verify their characteristics, including US residency. Second, respondents failing a basic attention check are dropped from the analysis sample.<sup>37</sup> Third, halfway through the survey, respondents are asked whether they have devoted their full attention to the survey. This question has been shown to improve the quality of subsequent responses ([Alesina et al. 2018](#), [Meade and Craig 2012](#)). Fourth, respondents are dropped from the analysis sample if they complete the survey faster than 50% of the median completion time, as well as faster than 50% of the median time after dropping the 20% of pages on which respondents spent the most time. Lastly, the survey follows the approach used in [Alesina et al. \(2018\)](#) and includes a warning against responding without adequate effort, as well as an appeal to respondents' intrinsic motivation.

Table [A2](#) provides summary statistics from Wave 1 of the survey sample. Respondents in Wave 1 were sampled from across the US with quotas targeting respondents by age, gender, race, and location to ensure broad representation. Compared to demographic statistics from the 2013-2017 American Community Survey (ACS) 5-year estimates, respondents are somewhat more educated, more female, and less likely to be employed; however, these differences do not appear to meaningfully affect the results, which are generally unaffected by reweighting to match average homeowner characteristics from the ACS alongside unweighted results.

## F.1 Mortgage Information Treatment

Half of survey respondents not living in Michigan were randomly assigned to receive information on second mortgages and reverse mortgages. The treatment is comprised of a series of six slides, presented in Figure [F1](#). This treatment is designed to test whether information frictions deter homeowners from taking out second mortgages in response to property tax increases.

Table [A10](#) presents the results from regressions that estimate the treatment effect of receiving information treatment. Each outcome is regressed on an indicator for being assigned to the treatment group. The outcomes in Panel A represent first stage outcomes. Each outcome tests respondent knowledge of second mortgages. Results show that receiving information results in a 30 percentage point increase in the likelihood of correctly identifying second mortgages and reverse mortgages as ways of extracting home equity, and a 32 percentage point increase in the likelihood of correctly answering that reverse mortgages do not have to be repaid until a property is transacted. This indicates that the treatment successfully and substantially increases knowledge of second mortgages and reverse mortgages.

Table [A10](#), Panel B examines effects on attitudes towards borrowing. Results indicate that homeowners are 5 percentage points more likely to state that they would consider taking out a second mortgage if they had difficulty paying property taxes; however, homeowners are not more

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<sup>37</sup>The attention check is similar to that applied in [Berinsky et al. \(2014\)](#).

likely to take out a second mortgage if they face a \$500 property tax increase next year. This zero effect is estimated precisely. These results appear contradictory at first glance; however, it is important to note that the former question asked whether a respondent would specifically consider a second mortgage, while the latter asked about actual decisions and allowed homeowners to select from a variety of different options. Thus, it is likely that respondents exhibited survey demand effects when responding to the former question. In contrast, the question asking about a \$500 tax increase is likely to be more robust to survey demand effects and therefore more reflective of the impacts of information. Coupled with the fact that 63% of respondents report that it would be easy or very easy to take out a second mortgage, these results suggest that information frictions are not an important driver of housing wealth illiquidity or of aversion to property taxes.

Figure F1: Mortgage Information Treatment

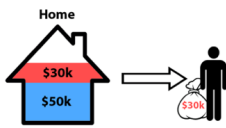
(a) Slide 1

A **second mortgage** is a loan you take on top of your existing mortgage. It lets you turn the equity in your home into cash that you can spend now.



(c) Slide 3

If you took out a \$30k **second mortgage**, you would have \$30k in cash and still have \$20k left in home equity.



(e) Slide 5

A **reverse mortgage** is another type of loan that lets homeowners 62 or older convert the equity in their home into cash.



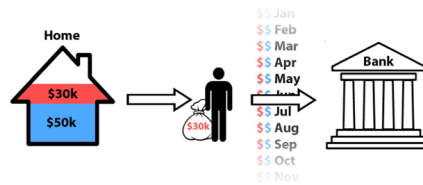
(b) Slide 2

Imagine your home is worth \$100k and you owe \$50k on your primary mortgage.



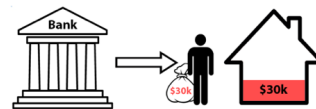
(d) Slide 4

Just like your primary mortgage, you would repay the second mortgage on a monthly basis until the loan is paid back in full.



(f) Slide 6

With a **reverse mortgage**, homeowners generally do not have to repay the loan until they move, sell the house, or pass on the house to heirs.



Notes: Figure depicts information treatment randomly presented to homeowners outside of Michigan.



## G Survey Questionnaire

This section presents the survey questionnaire used for the survey of homeowners. The following questionnaire is presented in a simplified format and omits the logic that decides which questions are presented to each respondent.

Hello, we are researchers at the University of California, Berkeley who are interested in people's experiences with homeownership. It is very important for the success of our research that you answer honestly and read the questions very carefully before answering. Some of the questions in this survey might be difficult to answer, or you might have a hard time coming up with an exact answer. Don't worry, that's just fine! Even if you're not sure of the exact right answer, we would like you to give us your best guess. To ensure the quality of survey data, your responses will be subject to sophisticated statistical control methods. Responding without adequate effort may result in your responses being flagged for low quality.

It is also very important for the success of our research project that you complete the entire survey once you have started. This survey should take about 10 minutes to complete. Before you proceed to the survey, please complete the captcha below. Your participation in this study is voluntary. Your name will never be recorded and you will never be identified in the study results. If you have any questions about this study, please contact us at [ucb.home.research@gmail.com](mailto:ucb.home.research@gmail.com).

1. In which state do you currently live?
2. What is your ZIP code?
3. In what year were you born?
4. Are you currently married or living as a partner with someone? {Yes, No}
5. How many children under age 18 live in your household? {0, 1, 2, 3, 4 or more}
6. Will the children in your household be attending kindergarten through grade 12 this year? {Yes, in public school, Yes, in private school, Yes, in both public and private schools, No, children not attending school this year }
7. Please describe the housing arrangement where you currently live. Do you: {Own your home with a mortgage or loan, Own your home without a mortgage or loan (i.e. free and clear), Rent your home, Neither rent nor own your home}
8. In what year did you move into your current home?
9. What is the value of your primary home? That is, how much do you think your primary home would sell for if it were for sale?
10. Which of the following are ways to borrow against your home? Check all that apply. {Second mortgage, Reverse mortgage, Upside-down mortgage, Credit card, Cash-out refinance}

11. Which of the following is true about reverse mortgages? {There is no such thing as a reverse mortgage, A homeowner doesn't have to repay a reverse mortgage before the property changes ownership, Reverse mortgages carry no interest, Reverse mortgages are primarily meant for working-age homeowners}
12. Which level of government would you least like to see expanded? {Federal, State, Local}
13. Which do you think is the worst tax—that is, the least fair? {Federal income tax, Federal Social Security tax, State income tax, State sales tax, Local property tax}
14. You indicated that the federal income tax is the worst/least fair tax. Which of the following are reasons that you feel this way? Please select all that apply. {I cannot control how high federal income taxes are, I do not benefit from the way federal income tax revenues are spent, I sometimes have trouble finding the money to pay federal income taxes, Other people have trouble finding the money to pay federal income taxes, High-income people pay too much/low-income people pay too little, High-income people pay too little/low-income people pay too much, Other:}
15. You indicated that the federal Social Security tax is the worst/least fair tax. Which of the following are reasons that you feel this way? Please select all that apply. {I cannot control how high Social Security taxes are, I do not think I will benefit from Social Security when I retire, I sometimes have trouble finding the money to pay Social Security taxes, Other people have trouble finding the money to pay Social Security taxes, High-income people pay too much/low-income people pay too little, High-income people pay too little/low-income people pay too much, Other:}
16. You indicated that the state income tax is the worst/least fair tax. Which of the following are reasons that you feel this way? Please select all that apply. {I cannot control how high state income taxes are, I do not benefit from the way state income tax revenues are spent, I sometimes have trouble finding the money to pay state income taxes, Other people have trouble finding the money to pay state income taxes, High-income people pay too much/low-income people pay too little, High-income people pay too little/low-income people pay too much, Other:}
17. You indicated that the state sales tax is the worst/least fair tax. Which of the following are reasons that you feel this way? Please select all that apply. {I cannot control how high sales taxes are, I do not benefit from the way sales tax revenues are spent, I sometimes have trouble finding the money to pay sales taxes, Other people have trouble finding the money to pay sales taxes, High-income people pay too much/low-income people pay too little, High-income people pay too little/low-income people pay too much, Other:}
18. You indicated that the local property tax is the worst/least fair tax. Which of the following are reasons that you feel this way? Please select all that apply. {I cannot control how high

property taxes are, I do not benefit from the way property tax revenues are spent, I sometimes have trouble finding the money to pay property taxes, Other people have trouble finding the money to pay property taxes, Property assessments are subjective and/or arbitrary, Property taxes make me feel that I do not own my house, Other:}

19. Does your regular monthly mortgage payment include payments for property taxes on your house? {Yes, taxes included in monthly mortgage payment, No, taxes paid separately, No, have no mortgage}
20. Approximately how much did you pay in property taxes for your house during the 2018 tax year? Simply give us your best estimate. You need not go to the trouble of consulting your records.
21. Before proceeding to the next set of questions, we want to ask for your feedback about the responses you provided so far. It is vital to our study that we only include responses from people who devoted their full attention to this study. Your answer to this question will not affect in any way the payment you will receive for completing this survey. In your honest opinion, should we use your responses, or should we discard your responses since you did not devote your full attention to the questions so far? {Yes, I have devoted full attention to the questions so far and I think you should use my responses for your study. No, I have not devoted full attention to the questions so far and I think you should not use my responses for your study.}
22. Imagine that in next year's election there were a ballot proposal that would increase property taxes to pay for local public school infrastructure improvements. Your taxes would increase by \$200. How would you vote on this proposal? {Vote yes, Vote no}
23. How do you feel about the following statement? {"My local government does a good job of accurately valuing my property for tax purposes."} {Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Strongly agree}
24. Since you first became a homeowner, how often have you had difficulty finding the money to pay property taxes on your primary residence? {Never, Once or twice, Occasionally, Very often, Every year}
25. Suppose we were to survey 100 homeowners {across the US, in your state, in your city/town, in your neighborhood}. Out of those 100 homeowners, how many do you think would report that at some point they have had difficulty paying property taxes on their primary residence? {Please enter your answer as a number between 0 and 100.}
26. Have you ever done any of the following in order to pay property taxes?  
Cut back on spending on basic necessities like food or heat  
Cut back on spending on big-ticket items like cars, home improvements, or appliances

Used money from your savings to pay your tax bill

Increased your credit card debt

Taken out a second mortgage or refinanced your existing mortgage

Borrowed from a friend or family member

Skipped paying bills (e.g. utility, mortgage, credit card)

27. Each state has its own way of collecting property taxes, and property taxes can be complicated and burdensome to think about. We want to understand how people manage their property tax obligations. We also want to make sure that respondents are paying close attention to the survey questions. It is crucial for the success of this research that we have your full attention for this survey. Instead of answering the following question accurately, please only select Other and enter your favorite number. This will help us to evaluate whether your response allows us to understand homeowners' experiences paying property taxes in the US. Which of the following sources do you use for information about property taxes? {Local TV news, National TV news, Local online news, National online news, Friends and/or family, Local government website, Online resources, Tax attorneys, Other:}
28. Thinking back to the years in which you had difficulty finding the money to pay your property tax bill, did any of the following happen to you? Please check all that apply. {I forgot that my tax bill was coming up, I had unexpectedly low income or high expenses in the months before my tax bill was due, I wasn't able to borrow the money to pay my tax bill, My tax bill was higher than I expected, I procrastinated coming up with the money to pay my tax bill, Other:}
29. Suppose that next year your yearly property tax bill increases by \$500. How would you pay for this? If you would use more than one method to cover these taxes, please select all that apply. {Increase my credit card debt, Pay out of pocket using the money currently in my checking/savings account or with cash, Borrow from a friend or family member, Cut back on spending on basic necessities like food or heat, Cut back on spending on big-ticket items like cars, home improvements, or appliances, Take out a second mortgage or refinance your existing mortgage, Skip paying some bills, I wouldn't be able to pay my property taxes, Other (please specify):}

The following questions were asked only of homeowners who reported residing outside of Michigan.

30. Suppose you were given the option to defer your property taxes with zero interest. If you defer your property taxes, you only need to pay them when you sell or pass on your property. Which of the following best describes you? {I would defer all of my property taxes immediately, I would defer my property taxes if I had trouble finding the money to pay them, I would never defer my property taxes}

31. You indicated that you would never defer paying your property taxes. Which of the following are reasons you chose this option? Please select all that apply. {I don't want to pay a large lump-sum tax bill when I sell my house, I don't want to feel like I'm in debt, I don't want my heirs to be burdened by the deferred taxes, Deferring my taxes would make me feel like I don't own my home, I wouldn't trust the government to correctly implement the deferral, Other:}
32. Imagine that in next year's election there were a ballot proposal that would do the following: {Reduce property taxes by \$500 for homeowners that are low-income, Reduce property taxes by \$500 for homeowners that are elderly, Reduce property taxes by \$500 for homeowners that are struggling to pay their property taxes} Increase property taxes by \$100 for all other homeowners. How would you vote on this proposal? {Vote yes, Vote no}
33. Suppose that one year you have a hard time finding the money to pay property taxes. In order to find the money to pay property taxes, would you consider taking out a second mortgage? {Yes, No}
34. You indicated that you would not consider taking out a second mortgage. What are your reasons for choosing this option? {The up-front costs would be too high, I would not qualify for a loan, I don't know how to take out a second mortgage, I am uncomfortable being in debt, I would have trouble paying back the loan, Other:}
35. Suppose again that one year you have a hard time finding the money to pay your property taxes. In order to find the money to pay property taxes, would you rather take out a second mortgage or would you rather skip paying one or more bills (e.g. credit card, mortgage, utilities)? {I would rather take out a second mortgage, I would rather skip paying one or more bills}
36. Many people report that at some point, they have had a hard time finding the money to pay property taxes. In general, which has more to do with why a person has difficulty finding the money to pay property taxes? {Lack of effort on his or her own part, Circumstances beyond his or her control}

The following questions were shown only to homeowners who reported residing in Michigan.

37. Which of the following programs reduce property taxes for homeowners in Michigan? Check all that apply. {Limits on the growth of assessed value of property (assessment limit), Property tax reductions based on household income, Property tax deferral programs, Maximum property tax rates}
38. The assessed value of property is the value used by local governments for tax purposes. The state of Michigan limits how quickly assessed value can increase from year to year. What is

the maximum percentage by which the assessed value of property can increase in one year?  
Please enter your answer as a percent.

39. Which of the following groups do you think currently benefits the most from this limit on assessed value? {Homeowners who bought their home recently benefit the most, Homeowners who bought their home a long time ago benefit the most, All homeowners benefit equally}
40. The state of Michigan offers income-based property tax reductions to homeowners through the Homestead Property Tax Credit. What do you think was the average reduction to property taxes for homeowners who received this credit? Please enter your answer in dollars.
41. Do you think that low-income or high-income homeowners benefit more from the Homestead Property Tax Credit? {Low-income homeowners benefit more, High-income homeowners benefit more, Low-income and high-income homeowners benefit equally}
42. As a result of Michigan's limit on the growth of assessed values, a homeowner who recently purchased a home will pay much higher property taxes than a homeowner who purchased a similar home several years ago in the same neighborhood. Do you approve or disapprove of this feature of Michigan's property tax system? {Approve, Disapprove}
43. Because of Michigan's income-based property tax relief, a low-income homeowner will pay lower property taxes than a higher-income homeowner who owns a similar home in the same neighborhood. Do you approve or disapprove of this feature of Michigan's property tax system? {Approve, Disapprove}

The following questions were asked of respondents regardless of reported location.

44. Now, we would like to ask you a few questions about your household finances.
45. Have you struggled to pay your bills at any point in the past 12 months? {Yes, No}
46. Which best describes how difficult it would be for you to qualify for a second mortgage? {Very difficult, Somewhat difficult, Somewhat easy, Very easy}
47. Do you currently have a second mortgage? {No, neither, Yes, home equity loan, Yes, home equity line of credit (HELOC), Yes, both a home equity loan and a home equity line of credit (HELOC)}
48. At the end of a typical month, approximately how much money do you have left over after paying for your regular expenses? Regular expenses can include food, clothing, mortgage payments, transportation, and utilities. {Less than \$100, Between \$100 and \$500, Between \$500 and \$1,000, Between \$1,000 and \$5,000, Between \$5,000 and \$10,000, More than \$10,000}

49. What is your best estimate of the total amount of money that you currently owe on credit cards? Please also include any cards you own jointly with other members of your household. {I don't own a credit card, Less than \$500, Between \$500 and \$1,000, Between \$1,000 and \$5,000, Between \$5,000 and \$10,000, More than \$10,000}
50. Including what you owe now, what is the maximum amount you could owe on your credit cards? That is, what is your total limit on your credit cards? Please also include any cards you own jointly with other members of your household. {Less than \$1,000, Between \$1,000 and \$5,000, Between \$5,000 and \$10,000, Between \$10,000 and \$20,000, More than \$20,000}
51. Are you male or female? {Male, Female, Other, Prefer not to answer}
52. How would you describe your political views? {Very liberal, Liberal, Moderate, Conservative, Very conservative}
53. Which category best describes your highest level of education? {Eighth grade or less, Some high school, High school degree / GED, Some College, 2-year college degree, 4-year college degree, Master's Degree, Doctoral Degree, Professional Degree (JD, MD, MBA)}
54. What is your current employment status? {Full-time employee, Part-time employee, Self-employed or small business owner, Unemployed and looking for work, Student, Not employed and not looking for work}
55. For statistical purposes only, we need to know your total household income for last year (2018). Which of the following categories best represents your total household income? {Less than \$10,000, \$10,000 to \$19,999, \$20,000 to \$29,999, \$30,000 to \$39,999, \$40,000 to \$49,999, \$50,000 to \$59,999, \$60,000 to \$74,999, \$75,000 to \$99,999, \$100,000 to \$149,999, \$150,000 to \$199,999, \$200,000 or more}
56. Would you describe yourself as Spanish, Hispanic, or Latino? {Yes, No}
57. How would you describe your race? Check all that apply. {White, Black or African-American, American Indian or Alaska Native, Asian, Native Hawaiian or Pacific Islander, Other, Prefer not to answer}
58. Were any of the questions we asked in this survey confusing? {Yes, No}
59. On a scale of 1 to 10 (with 1 being extremely easy and 10 being extremely difficult), how difficult was this survey to understand? {1 (extremely easy), 2, 3, 4, 5, 6, 7, 8, 9, 10 (extremely difficult)}
60. Please feel free to give us any other feedback regarding this survey. We are especially interested in knowing if you found any parts of the survey confusing or unclear.