Tax Reform, Homeownership Costs, and House Prices*

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Abstract

The effective cost of homeownership depends on the tax code. I derive a sufficient statistic formula for the effect of tax reform on house prices, and use it, together with nearly 4 million simulated tax returns, to measure the response of house prices to the Tax Cuts and Jobs Act of 2017. The measured price decline from the disincentives to itemize federal deductions is larger than the increase from higher disposable income. Measured house price declines in 269 metropolitan areas, are between 0 and 7 percent, 3 percent on average, and correlate with house price changes observed in 2018.

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1 Introduction

The Tax Cut and Jobs Act (TCJA) made important changes to individual tax provisions. On the one hand, it lowered marginal income tax rates and changed tax brackets, ceteris paribus, increasing individual after-tax income. On the other hand, it increased standard deductions and placed caps on state and local tax deductions, ceteris paribus, increasing the cost of homeownership. These changes affect housing demand, and prices, in opposite directions, so it is not clear in which direction these will respond. In this paper, I derive a sufficient statistics expression for the effect on regional house prices of the TCJA, and use this expression together with nearly 4 million simulated tax returns to simulate its effect on 269 different metropolitan areas.

The TCJA introduced several provisions that affect both the cost of homeownership and after-tax income for households. First, it reduced marginal income tax rates and adjusted the tax brackets. Second, it nearly doubled the standard deduction for all individual tax payers and eliminated personal exemptions. Third, it introduced a cap on the state and local tax (SALT) deduction. Finally, it lowered the cap on mortgage interests deductions and limited the deductibility of home equity line of credits (HELOCs).

Previous analyzes suggests that the negative effects on housing demand from the TCJA could be sizeable. The large increase in the value of the standard deduction is expected to make about 30 million households to stop itemizing their deductions (JCT 2018). The deductibility of mortgage interest and property taxes, allow homeowners to write down these costs at their income marginal tax rate (e.g., Poterba 1984, Poterba 1992, Himmelberg, Mayer, and Sinai 2005, Poterba and Sinai 2008). Thus, the TCJA is expected to increase the marginal cost of homeownership for millions of households. These tax-induced changes in the user cost of homeownership can have important capitalization effect into house prices, as emphasized by the literature that evaluate the effect of mortgage interest deductions on the demand for, and the price of, housing (e.g., Hilbert and Turner 2014, Rappoport 2016, Sommer and Sullivan 2018, Davis 2018). Therefore, we expect that the tax changes in the TCJA that limited the deductions for homeownership-related expenses will reduce the price of housing. By contrast, the reduction of income marginal tax rates is expected to increase disposable income, house demand, and house prices. What effect dominates when the TCJA is implemented is an empirical question.

On average, across the 269 regions in my simulated sample, house prices drop by about 3 percent. The simulated price changes exhibit great dispersion, with declines of 7 percent or more in Norfolk-Virginia Beach-Newport News, VA-NC; Chicago, IL; and Fort Lauderdale, FL, and a modest price increase of 8 basis points in St. Joseph, MO. These cross-sectional heterogeneity across metropolitan areas is correlated with the observed house price changes in 2018 for the largest metro areas.

I present a simple model to derive a sufficient statistics expression for the effect on regional house prices from the tax reform. To do so, I extend the framework presented in Rappoport (2016) to study the effect on homeownership costs of non-business tax changes introduced in the TCJA. I show how the increase in the standard deduction and the cap on state and local deductions increase the marginal cost of homeownership. Moreover, I derive a sufficient statistics formula for the change in regional house prices from the tax reform.

To measure the effect on house prices I apply my sufficient statistics formula to simulated data, generated using TAXSIM on nearly 4 million simulated tax returns considering the pre- and post-TCJA federal and state tax systems. Tax returns are simulated using individual mortgage borrower characteristics, supplemented with tax status information by ZIP Code and income groups. Simulated tax returns are used to determine the tax status of households, across the tax provisions that affect the marginal user cost of homeownership, and to determine the change in individual user cost and disposable income. These simulated data are then used to compute the effect on house prices for each of the 269 metropolitan areas in my sample.

The rest of the paper is organized as follows. Section 2 presents the simple model economy with a flexible characterization of the federal and local tax codes. Section 3 describes the data used in my simulation to quantify the effect of the TCJA. Section 4 details my simulation for the effect of the TCJA in the cost of homeownership and disposable income. Section 5 presents the measured response of house prices and compares these measures with the observed house price growth across metropolitan areas in 2018, the first year after the TCJA was enacted. Section 6 provides some concluding remarks. Additional material have been relegated to appendices.

2 Homeownership Costs, House Prices, and Tax Reform

In this section, I derive the sufficient statistic formula used to measure the effect of the TCJA on house prices. The exposition proceeds in two steps. First, I characterize how the TCJA changes the marginal user cost of homeownership and after-tax income brought about by the TCJA, for different borrowers, given their income, itemization status, and state of residence, and accounting for the caps on deductions on state and local taxes and mortgage interest. In section 2.1, I present a simple model economy with a parsimonious representation of the tax code, which is flexible enough to study the key individual tax provisions changed by the TCJA. Using this representation of the tax code, in section 2.2, I characterize the changes in the marginal user cost and after-tax income.

Second, in section 2.3, I derive sufficient statistics formulas to approximate the effect of the TCJA on house prices. This expression depends on the changes to the individual marginal user costs and to the individual after-tax income changes, previously derived.

2.1 An Economy with Federal and Local Taxes

To approximate the effects of the TCJA, I embed a parsimonious representation of the tax code in the framework for applied welfare analysis in Rappoport (2016). This section focusses on the description of the federal and local tax codes and briefly describes the other elements of the framework.

The economic environment considers two periods $t = 0, 1$, representing years. The economy is populated by households (homebuyers and homeowners), house producers, lenders, and the federal and local governments. There are two goods, durable housing and perishable consumption, which is the numeraire. In addition, households can borrow from lenders using mortgage debt.[1] The economic environment is kept deliberately simple, except for the characterization of taxes, in order to investigate the effect of tax reform on the cost of homeownership.

Homebuyers and Homeowners. There is a continuum of mass 1 of identical homebuyers and a continuum of mass 1 of identical homeowners, indexed by $\mathcal{H}_B$ and $\mathcal{H}_O$, respectively. Each agent $i \in \mathcal{H}_B \cup \mathcal{H}_O$, derives utility from consumption, $c_{i,t}$, in every period, and derives utility of housing services received between periods. Housing services are perceived from the ownership of housing, denoted by x_i, which is purchased in period 0 and sold in period 1. Households' preferences are represented by $u(x_i, c_{i,0}, c_{i,1})$, which is increasing and concave in each argument. This preference specification is very general as it does not impose separability between the utility derived from housing and consumption.

[1] The economic environment abstract away from saving instruments. As long as saving instruments yield a lower return than the cost of mortgage debt, the availability of these instruments does not change the optimality conditions for borrowers or the sufficient statistics expression for the effect on house prices (see Rappoport 2016).

Homebuyers receive income $y_{i,t}$ in year t in units of the numeraire. They have no initial housing units, but can purchase them in year 0 at price p. Homebuyers can finance their house purchases with their income or mortgage debt, denoted by $m_{i,0}$. Mortgages are assumed to be fixed rate, fixed payment, as in the data described in the next section. But to facilitate the derivation of analytical results I assume that mortgage payments are yearly in an amount equal to $i_i m_{i,0}$ and denote by $m_{i,1}$ the mortgage unpaid balance at the end of year $t = 1$. In year $t = 1$, the homebuyer pays federal and local income taxes, $\mathcal{T}_{F,i,0}$ and $\mathcal{T}_{L,i,0}$, respectively, for the income received in year $t = 0$. Similarly, in year $t = 1$, the homebuyer pays local property taxes, at a rate τ_p, on the value of the house px_i. The details of the tax code are described in more detail below.

In the model, for simplicity, house prices are endogenous only in year 0 with house prices in year 1 adjusting exogenously, as I abstract away from the equilibrium of the housing market in this period. However, in order to account for key determinants of the user cost of housing—expected capital gains and depreciation—I assume that the house price in year $t = 1$ is proportional to the endogenous house price in period 0. In particular, I assume that this price reflects (expected) house price appreciation $\tilde{\pi}_i$, the depreciation of the housing stock δ, and a risk premium ϕ, at annual rates. Thus, the house price in period t equals $(1 + \tilde{\pi}_i - \delta - \phi)p$. Under these assumptions the homebuyer problem can be written as

$$\max_{x_i,\, c_{i,0},\, c_{i,1},\, m_{i,0}} \quad u(x_i, c_{i,0}, c_{i,1}) \tag{1}$$

$$\text{s.t.} \qquad px_i + c_{i,0} + \leq y_{i,0} + m_{i,0}$$

$$c_{i,1} + i_i m_{i,0} + m_{i,1} + \mathcal{T}_{F,i} + \mathcal{T}_{L,i} + \tau_p px_i \leq y_{i,1} + (1 + \tilde{\pi}_i - \delta - \phi)px_i$$

Finally, I assume that both consumption and mortgages are non-negative.[2]

Homeowners face a similar problem as homebuyers but they already own a stock of housing h_i, which is assumed to equal to the demand for housing in period 0, x_i, as these households will be identified with homeowners that refinance their mortgages in the data. Thus, for homeowners the year 0 budget constraint is given by

$$px_i + c_{i,0} + \leq y_{i,0} + m_{i,0} + ph_i \qquad \Leftrightarrow \qquad c_{i,0} + \leq y_{i,0} + m_{i,0}\ ,$$

[2]Non-negative consumption imposes a natural borrowing limit, and the non-negativity of mortgages prevent buyers from saving at the mortgage rate, which is without loss of generality as I focus on unconstrained borrowers.

whereas the rest of the homeowners utility maximization problem is the same as for homebuyers, as given in equation (1).

Federal and Local Governments and Taxes. Both local and federal governments collect taxes in the year following when the household receives income or when she is in possession of housing. To illustrate the tax incentives from deducting mortgage interests and property taxes, I focuss on the taxation of adjusted gross income (AGI), which is identified with the household income endowment in the model, $y_{i,t}$. Federal income taxes can be calculated charging, up to federal taxable income, $y^{TI}_{F,i,t}$, marginal tax rates $\tau_{F,b,i,r}$ over income brackets, $[\theta_{F,b,i,r}, \theta_{F,b+1,i,r})$, where subindex F denotes federal income brackets, subindex i captures different filling status, subindex $b = 0, \ldots, B$ index tax brackets, with $\theta_{F,0,i,r} = 0$ and $\theta_{F,B+1,i,r} = \infty$, and $r = 1$ denotes the tax reform and $r = 0$ denotes no reform.

Taxable income, $y^{TI}_{F,i,t}$, corresponds to AGI minus deductions and exemptions. The federal tax code, for each individual i, specifies a standard deduction, $d^S_{F,i,r}$, the value of itemized deductions, $d^I_{F,i,r}$, and the value of personal exemptions $e_{F,i,r}$. Then, for a household that claims the largest between the standard and the itemized deduction, taxable income is given by

$$y^{TI}_{F,i,r} = y_{i,0} - \max\left\{d^I_{F,i,r}, d^S_{F,i,r}\right\} - e_{F,i,r} \ .$$

Using this notation, federal taxes can be calculated using

$$\mathcal{T}_{F,i,r} = \sum_{b=0}^{B} \tau_{F,b,i,r} \min\left\{\max\left\{y^{TI}_{F,i,0} - \theta_{F,b,i,r}, 0\right\}, \theta_{F,b+1,i,r} - \theta_{F,b,i,r}\right\} - c_{F,i,r} \ , \tag{2}$$

where $c_{F,i,r}$ denotes federal tax tax credits for household i under tax system $r = 0, 1$. In sum, a **federal tax system** describes for each individual i, marginal income tax rates, $\{\tau_{F,b,i,r}\}^B_{b=0}$, income tax brackets, $\{\theta_{F,b,i,r}\}^B_{b=0}$, a standard deduction, $d^S_{F,i,r}$, the value of itemized deductions, $d^I_{F,i,r}$, and the value personal exemptions $e_{F,i,r}$.[3]

My analysis considers the effect of four tax provisions of the TCJA that influence homeownership costs. First, I consider the changes to tax brackets, $\theta_{F,b,i,r}$, and marginal income tax rates, $\tau_{F,b,i,r}$. For example, Figure 1 shows how the TCJA lowered marginal tax rates. As shown in red in the figure, with the changes implemented by the TCJA married couples filling jointly will pay the following marginal income taxes: 10 percent on income below 19,050; 12 percent on additional income below 77,400; 22 percent on additional

[3]I abstract away from taxes on qualified dividends, interest, and capital gains that were largely unaffected by the TCJA. The interaction of the tax changes in TCJA with these other taxes is left for future research.

income below 165,000; 24 percent on income below 315,000; 32 percent on additional income below 400,000; 35 percent on additional income below 600,000; and 37 percent on any additional.

Second, the TCJA nearly doubled the standard deduction and eliminate personal exemptions. That is, for every household i, $d^S_{F,i,1} > d^S_{F,i,0}$. For example, the standard deduction for married couples filling jointly increased from 13,000 dollars to 24,000 dollars. The elimination of personal exemptions can be represented in the framework with $e_{F,i,1} = 0$.

Third, the TCJA introduced a cap on the SALT deductions, equal to 10,000 per year (5,000 for a married taxpayer filing a separate return). I denote with $\overline{SALT}_{F,i,r}$ the cap on SALT deductions, setting the cap pre-TCJA to infinity, $\overline{SALT}_{F,i,0} = \infty$, and post-TCJA to $\overline{SALT}_{F,i,1} = 10{,}000$. SALT deductions include state and local taxes on income or sales, and property taxes. Using the previously introduced notation, these deductions can be associated with state income taxes, $\mathcal{T}_{L,i,t}$, and property taxes, $\tau_p p x_i$, so we can write the effective SALT deductions as $\min\left\{\overline{SALT}_{F,i,r}, \mathcal{T}_{L,y,r} + \tau_p x_i p_0\right\}$.

Finally, the TCJA lowered the cap the mortgage interest deductions, denoted with $\overline{MID}_{F,i,r}$. Before the TCJA households could deduct interest paid on balances upto $\overline{MID}_{F,i,0} = 1{,}000{,}000$, while after the TCJA this deductions was lowered to $\overline{MID}_{F,i,1} = 750{,}000$. In my analysis I abstract from the changes to interest on HELOCs.

In sum, itemized deductions can be expressed as the sum of state and local taxes, mortgage interests, and other potential terms as follows

$$d^I_{F,i,r} = \min\left\{\overline{SALT}_{F,i,r}, \mathcal{T}_{L,y,r} + \tau_p p x_i\right\} + i_i \min\left\{\overline{MID}_{F,i,r}, m_{i,0}\right\} + \dots \ .$$

Since I am interested in simulating the effect of the TCJA, I allow the federal government government to run deficits or surpluses in the short-run and the model does not impose long-term debt sustainability or a balanced budget. In practice the TCJA reduced taxes and households can expect future tax increases to bring the federal budget back to a balanced path. Similarly, the TCJA altered the tax revenue of local governments and some local governments have instituted local tax changes to partly offset these effects. In my derivations, I abstract from these considerations, which are left for future research. These simplifications make the analysis more transparent and are likely to provide an upper bound for the effect of the TCJA, as potential offsetting effects are not accounted for.

The **local tax code** is modeled similarly as the federal tax code. Let $L \in \mathcal{L}$ index the local jurisdiction. Using the same notation as for the federal tax system, each local tax system is described by marginal income tax rates, $\{\tau_{L,b,i,r}\}_{b=0}^{B}$, income tax brackets, $\{\theta_{L,b,i,r}\}_{b=0}^{B}$, a standard deduction, $d_{L,i,r}^{S}$, the value of itemized deductions, $d_{L,i,r}^{I}$, and the value personal exemptions $e_{L,i,r}$, for each individual i. Finally, the local tax calculation follows the same calculations as for the federal income tax, and so an equation analogous to (2) can be used to compute the local income tax liability, $\mathcal{T}_{L,i,r}$.

It follows that the after-tax household income is given by

$$y_{i,t} - \mathcal{T}_{F,i,r} - \mathcal{T}_{L,i,r}$$

This representation of the tax code, allows me to analytically describe two effects of the TCJA that are important for housing demand. First, I describe the change in the after-tax household income, $\Delta\mathcal{T}_{F,i,t} + \Delta\mathcal{T}_{L,i,t}$. Second, in section 2.2, I characterize the changes in the marginal user cost of homeownership.

House producers. There is a continuum of mass 1 of identical house producers. They have a technology to produce z housing units at a cost $\kappa(z)$, which is increasing and quasi-convex. House producers' optimal behavior imply $p = \kappa'(z)$, which implicitly define producers' house supply, $S(p)$.

Lenders. There is a continuum of mass 1 of identical lenders, who maximize profits. Lenders have deep pockets and an opportunity cost of funds given by r_f. For each loan, lenders give borrowers 1 units of consumption in period 0 and are promised a fix stream of future payments in units of future consumption. Lenders operate a constant return to scale technology, which reflects origination and servicing costs ρ per loan. Thus, lenders maximization problem corresponds to $\max_l (i - r_f - \rho)l$. Lenders optimal behavior will pin down the lending mortgage rate $i = r_f + \rho$. That is, mortgage supply is effectively totally elastic at $r_f + \rho$. This is a consequence of the simplifying assumptions on this part of the model: constant funding cost and constant return to scale technology.

Equilibrium Definition. A competitive equilibrium consists of a house price, p, a mortgage rate, i, allocations for households, $\left\{x_i,\ c_{i,0},\ c_{i,1},\ m_{i,0}\right\}$, loan supply, l, housing production, z, homeowners' sales, h_i, such that: homebuyers, homeowners, house producers, and lenders behave optimally taking prices as given, and the housing and mortgage markets clear.

The simple economy described in this section abstracts from the extensive margin for housing demand. Incorporating a rental market in the analysis will provide additional channels for the tax reform to affect housing markets. But previous research suggests that these additional channels are relatively weak. Tax changes that reduce homeownership incentives are expected to reduce homeownership rates and increase the demand for and the price of rentals. But, as my analysis and related literature emphasize, the capitalization into house prices of mortgage subsidies increases the rental rate of homeownership, which the subsidy aimed to decrease. The overall effect of housing subsidies on the incentive to own versus to rent is thus ambiguous. The available research on the effect of MID on homeownership rates suggests that the overall effect of these subsidies on homeownership rates is small (Glaeser and Shapiro 2003, Bourassa and Yin 2008, Hilber and Turner 2014, Sommer and Sullivan 2018). The conclusion of these studies suggests that most of the response to changes in the user cost is expected to occur along the intensive margin of house demand, which I consider in my framework.

2.2 Homeownership Costs and Federal and Local Taxes

In general, homebuyers will choose different combinations of housing, consumption, and mortgage debt depending on the price of housing and mortgages, and households' preferences and income. To illustrate the effect of the TCJA, I derive the cost of homeownership focussing on buyers at an interior solution of problem (1). In this case, optimality imply that

$$\frac{u_x}{u_c} = \left[i_i + \delta - \tilde{\pi}_i + \phi + \tau_{p,i} + \frac{1}{p}\frac{\partial \mathcal{T}_{F,i,r}}{\partial x_i} + \frac{1}{p}\frac{\partial \mathcal{T}_{L,i,r}}{\partial x_i} + \frac{\partial \mathcal{T}_{F,i,r}}{\partial m_{i,0}} + \frac{\partial \mathcal{T}_{L,i,r}}{\partial m_{i,0}} \right] p = v_i \, p \;, \tag{3}$$

where u_x and u_c correspond, respectively, to the marginal utility of housing and consumption (in period 1). The term in square brackets corresponds to the marginal user cost of homeownership for household i, denoted by v_i. The user cost is increasing in the mortgage rate and depreciation, and decreasing in expected capital gains, as in Poterba (1984) or Himmelberg, Mayer, and Sinai (2005). But the flexible representation of the federal and local tax systems yields the partial derivatives of federal and local taxes with respect to housing demand, x_i, and mortgage debt, $m_{i,0}$, which will shape the effect of the tax code on housing and mortgage demand.

Given the nonlinearities introduced by the itemization decision, and the caps on SALT and mortgage deductions, the value of these partial derivatives will depend on the household tax status: itemization decision and whether the caps on deductions are binding. Next, I derive expressions for the user cost in each of these cases.

Since the federal and local taxes are affected by housing and mortgage demand through the deductions to income, their partial derivatives will equal the product of the partial derivative of taxable income and the marginal income tax ($\tau_{F,b^*,i,r}$ or $\tau_{L,b^*,i,r}$), where b^* denotes the final income tax bracket. The TCJA changed the federal tax brackets, which also adds to the increase in the user cost of homeownership, as it lowers the tax marginal benefit of the homeownership deductions.

In the case of a household that claims the federal and local standard deductions the demand of housing and mortgage debt does not affect taxable income, and therefore does not affect federal and local taxes, so the user cost of homeownership is simply

$$v_{i,r} = i_i + \delta - \tilde{\pi}_i + \phi + \tau_{p,i} \ . \tag{4}$$

In the case of a household that claims itemized federal deductions and is not subject to either the SALT or MID caps, and takes the standard local deduction, homeownership deductions at the margin will reduce only federal taxes, and we recover the familiar expression

$$v_{i,r} = i_i(1 - \tau_{F,i,b^*,r}) + \delta - \tilde{\pi}_i + \phi + \tau_{p,i}(1 - \tau_{F,i,b^*,r}) \ . \tag{5}$$

Note that the mortgage interest deduction fully distort the cost of funds in the user cost expression, i.e., the effective marginal user cost is the same regardless of what fraction of the house is financed with mortgage debt—the LTV ratio—and what fraction is financed with a downpayment. This result follows from the pecking order generated by financial market imperfections. Households finance their house expenditure using first internal funds, i.e., their income, and only then using mortgage debt. Then, at the margin borrowers trade-off present and future consumption at the mortgage interest rate. This result holds as long as borrowers cannot invest at interest rates higher than the mortgage rate.

In the case that caps are not binding and the household claims itemized deductions both at the federal and local levels, then federal and local taxable income will be sensitive to housing and mortgage choices. Thus, the marginal user cost can be expressed as

$$v_{i,r} = i_i(1 - \tau_{F,b^*,i,r} - \tau_{L,b^*,i,r}) + \delta - \tilde{\pi}_i + \phi + \tau_{p,i}(1 - \tau_{F,b^*,i,r} - \tau_{L,b^*,i,r}) \ . \tag{6}$$

It is interesting to note that in this case the federal and local tax provisions lowers both the effective cost of mortgage debt and property taxes. In the subsequent analysis, I will use TAXSIM to recover both the federal and state marginal tax rates to account for the additive effect of federal and local deductions in the cost of homeownership.

Finally, note that the effect of the caps is to remove the dependence of itemized deductions on the intensive margin of housing and mortgage demand. For example, in the case of a household that claim federal itemized deductions but is constrained by the cap on SALT, then the marginal user cost of homeownership will be given by

$$v_{i,r} = i_i(1 - \tau_{F,b^*,i,r} - \tau_{L,b^*,i,r}) + \delta - \tilde{\pi}_i + \phi + \tau_{p,i}(1 - \tau_{L,b^*,i,r}) \ . \tag{7}$$

That is, the SALT cap removes the tax incentives that lowered the effective property taxes.

Similarly, a binding cap on mortgage interest deductions will remove the tax incentive of financing the marginal house purchase with mortgage debt, therefore increasing the marginal cost of mortgage debt. In the interest of space, I do not consider all the possible cases of itemized federal or local deductions and all the potential binding caps on deductions. But the previous exposition illustrates the effect of the tax code on the user cost of homeownership, $v_{i,r}$, and will allow me to compute the change in the user cost of homeownership, $\Delta v_i = v_{i,1} - v_{i,0}$, brought about by the TCJA.

2.3 Tax Reform and House Prices

To account for the regional heterogeneity in the expected effects of tax reform, I assume that each metropolitan area corresponds to a segmented housing market with no household mobility in response to the TCJA, so each metropolitan region can be considered separately. In order to analytically describe the house price change that the model suggests from the introduction of the TCJA, I need to introduce some notation. Let $\mathcal{H}_{B,j}$ be the set of homebuyers in region $j \in \mathcal{J}$, where $\mathcal{J}$ is the set of regions, and let ω_i be household's i share of housing consumption in the region. Then, the equilibrium between aggregate demand and supply in the housing market requires that

$$\sum_{i \in \mathcal{H}_{B,j}} x_i(p_j, v_i, y_i) = S_j(p_j) \ . \tag{8}$$

I denote the households' user cost housing demand semielasticity with $\zeta_{D,v,i}$, the price housing demand elasticity with $\varepsilon_{D,p,i}$, and the income housing demand elasticity with $\varepsilon_{D,y,i}$. Given that the model calibration considers an homogenous price demand elasticity I simplify the exposition assuming that $\varepsilon_{D,p,i} = \varepsilon_{D,p}$. Similarly, I denote the price housing supply elasticity in region j with $\varepsilon_{S,p,j}$.

Then, fully differentiating the house market clearing condition for region j, I obtain the following expression for the local change in house prices from perturbations to the tax code that affect the the after-tax income of the household or her user cost of homeownership

$$\frac{dp_j}{p_j} = \frac{\sum_{i \in \mathcal{H}_{B,j}} \omega_i \left[\zeta_{D,v,i} dv_i + \varepsilon_{D,y,i} d \log(y_i) \right]}{\varepsilon_{S,p,j} - \varepsilon_{D,p}} \,. \tag{9}$$

Equation (9) suggests the following approximation to the effect of the TCJA on house prices in region j

$$\frac{\Delta p_j}{p_j} = \frac{\sum_{i \in \mathcal{H}_{B,j}} \omega_i \left[\zeta_{D,v,i} \Delta v_i + \varepsilon_{D,y,i} \Delta y_i / y_i \right]}{\varepsilon_{S,p,j} - \varepsilon_{D,p}} \,, \tag{10}$$

It should be noted that equation (10) nests the case of a totally inelastic house supply, taking $\varepsilon_{S,p,j} \equiv 0$. This case, is of interest for my analysis, as it has been argued that the supply of housing is totally inelastic to price declines in the short run, as housing units would not be disposed off. As shown below, the totally inelastic case does not fit the pattern of house price changes observed in 2018, suggesting that the supply elasticity is relevant in the short run to understand the effect of the TCJA. This could be the case because the negative effect of the TCJA on house prices does not seem large enough to offset the natural upward trend in house prices, or because owner-occupied units may be turned into rental units, allowing the owner-occupied housing stock to decline in response to declines in house prices.

It also worth noting that equation (10) was derived assuming that households respond to the effect of tax changes upon the implementation of the reform. By contrast, in practice, households might adjust their demand for housing considering the effect of the tax reform over their full expected housing tenure. The net present value of tax incentives over the full housing tenure is expected to be smaller than immediate effect of the reform, as households might not expect to itemize housing expenditures towards the end of their housing tenures. In fact, as mortgage balances and mortgage interest deductions decline, itemized deductions may become smaller than the standard deduction.

In Section 5, I calculate the price changes implied by equation (10) for 772 counties and 269 metropolitan areas.

3 Data

To gauge the effect of the TCJA on house prices, I combine information from several sources. First, I use individual-level mortgage origination records from McDash Analytics, supplemented with income information from the Federal Financial Institutions Examination Council (U.S.), Home Mortgage Disclosure Act (Public Data), henceforth HMDA Public Data. Second, I supplement individual-level information with tax return statistics by income group from the ZIP Code Data from the IRS, Statistics of Income Division. Third, I calibrate key house supply and demand elasticities from previous studies in the literature. Finally, I use data on house price indices (HPIs) from S&P Dow Jones Indices LLC.

Individual-level information. I source use mortgage origination records from McDash Analytics and HMDA Public DAata. The McDash data include information on the origination date, loan amount, contract rate, loan term, lien type, purpose type, and for the securing property the data include appraisal value, ZIP Code, and occupancy status.

I consider mortgages originated between 2013 and 2015, restricting attention to fixed mortgages—i.e., fixed monthly payment and fixed term—which have a first-lien on the property and with the most common mortgage terms (10, 15, 20, 25, and 30 years). My final sample comprise more than 2 million purchase mortgages (Table 1).

To obtain a measure of individual income this data is merged with the HMDA Public Data. I use the McDash/HMDA merged data available within the Federal Reserve System, which is merged based on origination/action date, origination amount, address, and other mortgage characteristics. The McDash/HMDA merged data corresponds to about 75 percent of loans in the original McDash data and is available until 2015, which determines the final year included in my sample.

Table 2 provides descriptive statistics of all mortgages in my sample. On average, interest rates are 3.94 percent at an annual rate, origination amounts are 230,000 dollars, and house prices are around 320,000 dollars. A fraction of 48 percent are purchase mortgages. Purchase mortgages have relatively larger interest rates and terms, higher leverage and lower house prices, consistent with borrowers who are purchasing taking relatively larger mortgages than borrowers who refinance (Table 2).

Tax return statistics by ZIP Code and income groups. I use IRS, Statistics of Income Division (SOI), ZIP Code Data. The SOI data presents the total amounts and the number of returns with reported tax provisions for six different groups by their Adjusted Gross Income (AGI) and by ZIP Code. SOI reports information for 27,681 ZIP Codes, for the 50 states and the District of Columbia, and for the national level. I use SOI information to impute household features that are important to determine the value of tax provisions that affect homeownership costs (see Appendix A for details).

I use SOI to determine the most common filling status by income group and ZIP Code, from the number of returns that are filed by singles, married couples filling jointly, and head of households.

Since not all sources of income are taxed at the same marginal rate or can be used to deduct real estate taxes or mortgage interests, SOI information is used to distribute income between wages and salary income, dividends, interest, and capital gains. I assume that AGI is distributed between wages and salary income, dividends, interest, and capital gains in the same proportion of the total amounts reported for these income sources for a given income group and ZIP code. Figure 2 presents the distribution of these shares for the different income sources for all households in my sample.

In addition, I use SOI information to impute real estate taxes. Assuming that the share of housing expenditure is constant, for each ZIP Code and AGI group, I can use the ratio of real estate taxes to AGI to impute real estate taxes as the product of the household AGI and this ratio at the household's ZIP Code for her AGI group. I discard the ratios when individual property taxes represent more than 5 percent of individual AGI. This calculation and the information of house appraisal value provides a measure of local property tax rates. In my final sample these measures of property tax rates range between 0 and 5 percent, with an average of 1.56 percent (Table 3).

Elasticities. I draw from available studies to calibrate the key housing demand and supply elasticities.

The empirical literature suggests that the price elasticity of housing demand is close to −1, e.g., Rosen (1985) or Davis and Ortalo-Magne (2011). So I set $\varepsilon_{D,p} = -1$. Let $\varepsilon_{D,y}$ denote the income elasticity of house demand, which following Poterba (1992) is set to $\varepsilon_{D,y} = 0.75$.

To calibrate the user cost semielasticity of demand, $\zeta_{D,v,i}$, I follow Rappoport (2016), using that in an interior solution to the household problem

$$\zeta_{D,v,i} = \frac{\varepsilon_{D,p}}{v_i} . \tag{11}$$

This result follows from two identities. First, the equality between the user cost and price house demand elasticities. These elasticities are equal since house demand depends on the house rental rate, which equals the household's user cost, v_i, times the regional house price, p_j (equation (3)). Second, the equality between the user cost house demand *elasticity* and the user cost times the house demand *semielasticity* with respect to the user cost, $v_i \zeta_{D,v,i}$. It follows that $v_i \zeta_{D,v,i} = \varepsilon_{D,p}$ from where (11) obtains.

Equation (11) establishes a relationship between the house price demand elasticity of housing and the user cost demand semielasticity of housing: housing is more sensitive to a one percentage point reduction of the user cost than a one percent reduction in house prices, as a one percentage point reduction in the user cost has a greater effect on the housing rental rate. Equation (11) can be used to compute the mortgage rate semielasticity of house demand at the individual level, using the price elasticity of demand tat was set to -1 and information on the user cost of homeownership. But as I argued in section 2.2 to compute the user cost one needs to determine the federal and state itemization status and the value of deductions that count towards SALT and mortgage interest caps. Thus, I will use simulated tax returns to compute individual user costs, which will pin down the individual user cost housing demand semielasticities.

The price elasticity of house supply in region j, denoted by $\varepsilon_{S,p,j}$, is calibrated following two approaches. First, I assume that, in every region, the price house supply is totally inelastic, i.e., $\varepsilon_{S,p,j} \equiv 0$ for all j. This assumption is motivated by the observation that the housing stock cannot adjust swiftly, so in the short-run it is totally inelastic. This seems especially relevant in the case of house price declines, as housing units are unlikely to be disposed of to reduce housing supply. Under the totally-inelastic assumption equation (10) can be evaluated at any regional level. In section 5, I evaluate equation (10) under the totally-inelastic assumption at the county and metropolitan levels.

Second, I source the values of price house supply elasticities, $\varepsilon_{S,p,j}$, from Saiz (2010), who estimates these elasticities for 269 metropolitan areas (MAs). Saiz (2010) parametrizes the inverse of the supply elasticities as a function of land availability and land use regulations, and estimates a supply equation for the changes between 1970 and 2000, instrumenting for house demand. Thus, these elasticities are expected to reflect supply elasticities at relatively long, 30-year intervals. The estimated elasticities have ample dispersion with the 10^{th} and 90^{th} percentiles at 1.1 and 4.4, respectively, and their mean equals 2.5 (Table 5).

The first approach has the advantage that can be evaluated at any regional level, nonetheless, the ability to turn homeowner housing units into rental units cast doubt on the perfectly inelastic house supply, suggesting supply will respond more and house prices less. The second approach has the advantage that is data driven and incorporates regional heterogeneity from the supply response, but the long-run nature of Saiz (2010) elasticities suggests that these estimates will be less suitable for my analysis that focusses on the medium-run impact of tax reform on house prices. In section 5, I contrast measured price responses following these two approaches against observed price responses in 2018, the first year with the tax code changes introduced with the TCJA.

House price indices. House price indices are sourced from S&P Dow Jones Indices LLC at the metropolitan area level from 1976.

House price changes caused by tax reform, using equation (10), can be computed at different regional levels, county, metropolitan area (MA), or national level. In the latter case, counties are weighted by total house values in my sample of homebuyers. Therefore, for consistency, I compute MA- and national-level HPIs aggregating county-level indices, weighting counties by total house values in my sample of homebuyers (see Appendix B). In addition, the set of counties that makes up a MA changes over time. In my analysis the only information at the MA-level is the price house supply elasticities from Saiz (2010), so I fix MA constituent counties as of 1999, as used in Saiz (2010), see Appendix B.

Additional parameters of the user cost. The additional parameters of the user cost of homeownership are set following Himmelberg, Mayer and Sinai (2005), setting $\delta = 2.5\%$, $\pi = 3.8\%$ and $\phi = 2\%$. These parameter values give an average nominal user cost of housing in the range of 5.5 to 6.1 percent, as described in section 4.

4 The TCJA, Homeownership Costs, and Disposable Income

This paper measures regional house price responses to the TCJA simulating the changes in user costs and disposable income caused by this tax reform. Equation (10), derived in section 2.3, relates changes in house prices, in a given region, to the changes in the user costs of homeownership and changes in disposable income, for homeowners in that region. This section, describes how the changes in user costs and disposable income are simulated.

I use TAXSIM to simulate the effect of the TCJA on my sample of homebuyers. I use my sample of 2 million mortgage records, supplemented with income information, to approximate the distribution of homebuyers in the first year after the TCJA was passed, i.e., year 2018. The effect of the TCJA is simulated using TAXSIM to prepare these 2 million tax returns, with tax years 2017 and 2018, for the pre- and post-TCJA years, respectively. That is, first, I run TAXSIM with year 2017 to simulate individual tax returns pre TCJA, for each homebuyer in my sample. Then, I run TAXSIM for year 2018 to simulate the same returns with the changes introduced in the TCJA. I use TAXSIM to simulate both federal and state tax returns.

TAXSIM has a robust implementation allowing researchers to run simulations using limited information about the features that affect individual taxes. For example, a researcher without information on property taxes can run TAXSIM setting these deductions to zero, but this biases the evaluation of the effect of the cap on local and state taxes.[4] Therefore, the aforementioned data sources are used as follows to impute the values of the variables that are relevant for homeownership costs and are required to run TAXSIM.

The state is derived from the ZIP code of the property, as reported in McDash Analytics. The marital status is imputed from the most common reporting status in SOI by ZIP code and income group.

The age of the primary tax payer and the age of the spouse are set to zero. The number of dependents equals the ratio of number of dependents and total returns. On average, the number of dependents is 0.87 on the sample (Table 3).

Income is allocated to different sources based on the observed shares of income in the IRS, Statistics of Income, by income group and ZIP Code. Income is allocated across wages and salary income, dividends, interest, and long-term capital gains. Further details are provided in Appendix C.

Simulated tax returns are used to determine the tax status of households, across the tax provisions that affect the marginal user cost, and to determine the change in households' disposable income. As described in section 2.2, the user cost of homeownership depends on the tax status of the household. In particular, the analysis of section 2.2 showed that it is necessary to determine if the household claims itemized deductions at the federal or state level, and whether the household is limited by the cap on SALT deductions or mortgage interest deductions.

I determine itemization status using the itemization status reported in the tax returns

[4] TAXSIM calculates state taxes, so it accounts for the state tax portion of state and local taxes.

simulated with TAXSIM. I compare the cap on state and local taxes to the sum of property taxes, used as input in the simulation, and state income taxes, obtained as output of the simulation. Whether the cap on mortgage interest binds or not, is determined comparing the cap on mortgage balances to the remaining balance at the end of the simulated tax year.[5]

The average nominal user cost of housing is 5.5 to 6.1 percent, depending on the simulated year. In 2018 user cost are on average higher as more households claim the standard deduction and caps on SALT and mortgage interest deductions are tightened (Table 4). These values for the individual user costs yield corresponding values for the user cost demand elasticity of housing, $\zeta_{D,v,i}$. Table 4 present descriptive statistics of these individual elasticities. Considering the user cost in 2017, these elasticities takes value from -25 to -14, with an average value of -19.

Using the simulated data I compute the change in the user cost of homeownership brought about by the TCJA. Table 4 presents descriptive statistics of the change in the user cost. For at least 90 percent of simulated households the user cost does not decrease, the average increase is 58 basis points, and for 10 percent of households the user cost increases by more than 150 basis points. The increase in the user cost can be decomposed into the contribution of the change in federal itemization status, the contribution of the SALT cap becoming binding, and the contribution of the mortgage interest deduction becoming binding. Table 4 shows that the change in federal itemization status explain most of the increase in user costs, with an contribution that average 49 basis points, followed by the SALT deduction with 4 basis points, and the mortgage interest deduction with 1 basis point.

The distributional impact of the TCJA on homeownership cost is concentrated on households with income over 75,000 dollars. Figure 3 depicts the distribution of changes in the user cost for different income groups in my sample. For groups with income below 75,000 dollars the median change is zero, whereas median changes are closer to 100 basis points for groups with income above 75,000 dollar. This likely reflects the lower fraction of federal itemizers in the lower income groups, as well as the lower marginal tax rates that affect the size of user cost changes. It is interesting to note that the effect seems highest for households with income in the range 100,000-200,000 dollars, suggesting that richer households will continue itemizing their federal deductions under the TCJA.

[5] Remaining balances for fixed rate mortgages are calculated from interest rates, terms, and origination amounts, as described in Appendix C.

Using the simulated data I compute the change in disposable income caused by the TCJA. Table 4 presents descriptive statistics of the change in disposable income and federal and state tax liabilities. The TCJA did lower federal income taxes for at least 90 percent of the households in mi sample, reducing federal tax liabilities by 1,600 dollars on average. By contrast, state taxes changes were smaller and both positive and negative. In sum, the TCJA increased disposable income by a little more than 2 percent in my simulated sample.

5 The TCJA and Regional House Prices

The approach to measure house price effects from tax reform in this paper consist of computing equation (10) using the simulated data described in section 4.

5.1 Simulated Changes in Regional House Prices

Using expression (10) I can measure the effect of the TCJA on my simulated data. Table 5 present descriptive statistics of the simulated changes in house prices. On average across the 269 regions in my sample house prices drop by about 2 percent. The simulated price changes exhibit great dispersion, with declines of 7 percent of more in Norfolk-Virginia Beach-Newport News, VA-NC; Chicago, IL; and Fort Lauderdale, FL, and a modest price increase of 8 basis points in St. Joseph, MO.

Equation (10) shows that the effect on house prices differs across metropolitan areas given differences in the price elasticity of supply, $\zeta_{S,p,j}$, and the (house-value-weighted) average mortgage rate semielasticity of demand, $\zeta_{D,r,j} = \sum_{i \in I_j} \omega_i \zeta_{D,r,i}$. Figure 4 displays the simulated price changes against the price house supply elasticity. It is apparent that the severity of simulated price declines depends on the price elasticity of the supply of housing.

5.2 Simulated versus Observed Changes in Regional House Prices

To gauge the plausibility of the simulated responses of house prices I compare them against the house price changes observed recently. For this purpose, I consider the 12-month changes in house price indices at the metropolitan are level, using data from S&P Dow Jones Indices LLC. The last available month with information is November 2018, at the time of writing this paper. For each metropolitan area j, let $\Delta_{12} HPI_j^{2018m11} =$

$HPI_j^{2018m11} - HPI_j^{2017m11}$, denote the 12-month house price changes observed in the data, and let $\Delta HPI_j^{SIMULATION}$ denote my simulated house price changes. Using this notation, I specify the following regression equation:

$$\Delta_{12} HPI_j^{2018m11} = \alpha + \beta\, \Delta HPI_j^{SIMULATION} + \varepsilon_j \,, \tag{12}$$

where α and β are coefficients to be estimated and ε_j are zero mean residuals by metropolitan area. Note that the constant represents the rate of house price appreciation for a metropolitan area absent any tax changes or cyclical factors. In the simulation I set expected nominal house price appreciation, $\pi = 3.8\%$. But in 12-months of data we expect the constant term to deviate from this value as cyclical factors move house price appreciation around this level.

Table 6 reports the estimates for regression (12). Considering all metropolitan areas in my sample I estimate a constant equal to 3.9, which is statistically significant at 1%. The estimated slope on my simulated price changes is not statistically different than zero, with a negative point estimate (Figure 6a). Considering only the 84 metropolitan areas with a population of at leat 500,000 in the 2000 Census, I estimate the constant coefficient to be 6.0%. In this instance, the slope on my simulated changes is equal to 0.26 and is statistically significant al 10% (Figure 6b). This shows that the simulated price changes are correlated with the observed price changes in 2018 for the largest metropolitan areas.

6 Conclusion

This study presents simulated measures of the potential effect of the TCJA on house prices. Consistent with previous studies it finds that the increase in the standard deduction, and the tightening of caps on other real-estate-related deductions are expected to increase homeownership costs for several households. At the same time, the TCJA increases disposable income, with the effect on house prices of these two channels having opposite directions.

The effect on house prices through the user cost channel is seven times larger in my simulated data relative to the effect through disposable income. Therefore, simulated house prices decline an average of 3 percent across my sample of 269 metropolitan areas. House price effects display ample dispersion with declines ranging from as much as 7 percent to 0 percent. My simulations display some explanatory power on recent house price changes in larger metropolitan areas.

Future work should explore the welfare implication of the TCJA for households, accounting for the endogenous reaction of house prices. This paper provides a way to simulate these effects that are of interest for households, policy makers, and academics.

References

Bourassa, S. C. & Yin, M. (2008), 'Tax deductions, tax credits and the homeownership rate of young urban adults in the united states', *Urban Studies* **45**(5-6), 1141–1161.

Davis, M. (2018), The distributional impact of mortgage interest subsidies: Evidence from variation in state tax policies. mimeo.

Davis, M. A. & Ortalo-Magné, F. (2011), 'Household expenditures, wages, rents', *Review of Economic Dynamics* **14**(2), 248 – 261.

Glaeser, E. L. & Shapiro, J. M. (2003), The benefits of the home mortgage interest deduction, *in* J. Poterba, ed., 'Tax Policy and the Economy, Volume 17', MIT Press, pp. 37–82.

Hilber, C. A. L. & Turner, T. M. (2014), 'The Mortgage Interest Deduction and its Impact on Homeownership Decisions', *The Review of Economics and Statistics* **96**(3), 618–637.

Himmelberg, C., Mayer, C. & Sinai, T. (2005), 'Assessing High House Prices: Bubbles, Fundamentals and Misperceptions', *Journal of Economic Perspectives* **19**(4), 67–92.

Joint Committee on Taxation (2018), Tables related to the federal tax system as in effect 2017 through 2026, Technical Report JCX-32R-18.

Poterba, J. M. (1984), 'Tax subsidies to owner-occupied housing: An asset-market approach', *The Quarterly Journal of Economics* **99**(4), 729–52.

Poterba, J. M. (1992), 'Taxation and Housing: Old Questions, New Answers', *American Economic Review* **82**(2), 237–42.

Poterba, J. M. & Sinai, T. (2008), 'Tax Expenditures for Owner-Occupied Housing: Deductions for Property Taxes and Mortgage Interest and the Exclusion of Imputed Rental Income', *American Economic Review* **98**(2), pp. 84–89.

Rappoport, D. E. (2016), Do mortgage subsidies help or hurt borrowers? Finance and Economics Discussion Series 2016-081. Washington: Board of Governors of the Federal Reserve System.

Rosen, H. S. (1985), Housing Subsidies: Effects on Housing Decisions, Efficiency, and Equity, Vol. 1 of *Handbook of Public Economics*, Elsevier, pp. 375–420.

Saiz, A. (2010), 'The geographic determinants of housing supply', *The Quarterly Journal of Economics* **125**(3), 1253–1296.

Sommer, K. & Sullivan, P. (2018), 'Implications of us tax policy for house prices, rents, and homeownership', *American Economic Review* **108**(2), 241–74.

Appendix

A Variables from SOI Data

I use SOI data to determine the most common filling status by income group and ZIP code. I compare the number of joint returns (MARS2), the number of single returns (MARS1) and the number of head of household returns (MAR4). The category with the largest number of returns in a given income group and ZIP code determines the most common filling status.

I use SOI information to compute shares of sources of income. For households younger than 65 years of age, I assume that AGI is distributed between wages and salary income, dividends (A00600), interest (A00300), capital gains (A01000), and state and local income tax refunds (A00700). I calculate wages and salary income as the sum of salaries and wages (A00200), net income from partnership/S-corp (A26270), and business or profession net income (A00900). For each income group and ZIP code, the shares of each income source are computed as the ratio of its total amount to the sum of total amounts. Figure 2 presents the distribution of these shares for the different income sources for households younger than 65 years of age by income group.

For households 65 years of age or older, I assume that AGI is distributed between pensions (A01400), annuities (A01700) and social security benefits (A02500). Since TAXSIM considers pensions and annuities together I consolidate these categories into pensions and annuities. For each income group and ZIP code, first I compute the shares of pension and non-pension income, with the share of pension income equal to the ratio of total pension amount divided by the number of elderly returns (ELDERLY). The number of elderly returns started being reported in 2015, so I use the ratio of the number of elderly returns to total returns to impute the number of returns in 2013 and 2014. In the second step, the shares of each income source are computed as the ratio of its total amount to the sum of total amounts. Figure 2 presents the distribution of these shares for the different income sources for households 65 years of age or older, for each of the six income groups.

In addition, I use SOI information to calculate the ratio of real estate taxes to AGI, v_j, where j index the ZIP codes in my sample. Real estate taxes are computed as the ratio of the amount of real estate taxes (A18500) and the number of returns with real estate taxes (N18500). AGI corresponds to adjusted gross income (A00100) divided by the number of returns (N1). Table 3 report descriptive statistics of v_j across the ZIP Codes in my sample.

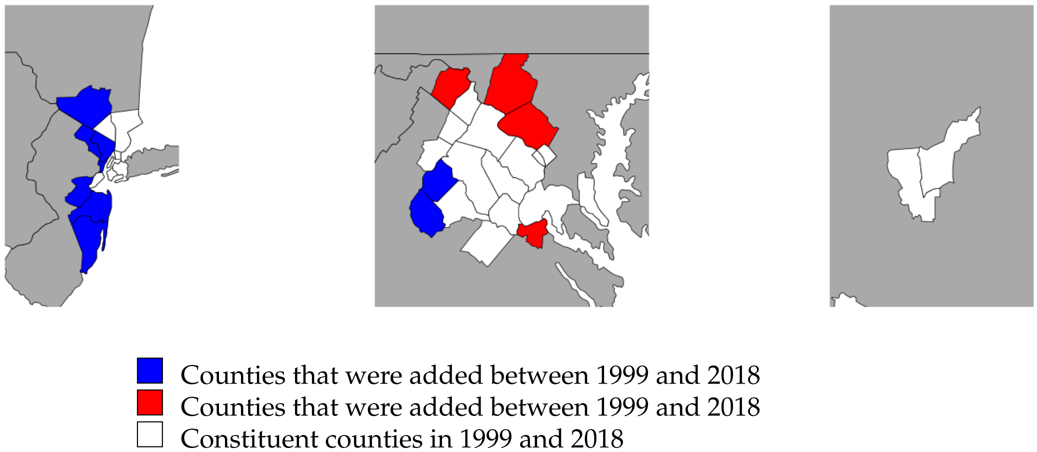
B Regional Aggregation of House Price Indices

My analysis uses house price indices (HPIs) for different levels of regional aggregation: county, metropolitan areas, and national. The house price changes prescribed by equation (10) naturally aggregate from county to metropolitan areas (MAs) and national level, using housing consumption shares. In equation (10), these shares are defined by the house values in my sample of home buyers. Moreover, counties comprising a MA change over time.[6] In fact, Figure B.1 shows three MAs from

[6]MAs are statistical areas containing a large population nucleus and adjacent communities that have a high degree of integration with that nucleus (75 Fed. Reg. 37245-37252, 2010). In practice, the Federal Office

Figure B.1: Changing Composition of Metropolitan Areas

(a) New York, NY (PMSA) (b) Washington, DC (PMSA) (c) Yuba City, CA (MSA)



Source: Census.

my sample between 1999 and 2018, with counties that were added in this period depicted in blue and counties that were removed in this period depicted in red.

The time varying nature of MAs and the heterogeneity within MAs, calls for conducting the analysis at county-level when feasible. Under the assumption that the house supply is totally inelastic, I can compute house price effects of tax reform at the county-level (equation (10)). However, under the alternative assumption that the house supply is elastic, I use the price house supply elasticities computed by Saiz (2010) at the MA-level, using the 1999 county-based definitions of MAs. The price supply elasticity of housing is likely heterogeneous at the county-level, as land availability and zoning codes can vary across counties. Therefore, for consistency, I fix the county constituents of each MA to the ones included in the 1999 definitions; and I aggregate county-level HPIs to MA and national level, using the county housing consumption shares defined by my sample of mortgage buyers.

To aggregate house price indices from counties to MAs, I follow the methodology of the S&P CoreLogic Case-Shiller Home Price Indices.[7] According to this methodology, the regional aggregation of HPIs weights regions by their shares of the value of the housing stock at a reference date. To describe the aggregation of HPIs, let t_0 denote the reference month, which I set to January 2018, let $p_{c,t}$ denote the HPI in county c on month t, and let $v_{c,t}$ denote the value of the housing stock in county c on month t. The set of counties C corresponds to the constituent counties of the MAs in Saiz (2010), using the 1999 MA definitions. In addition, to describe how county-level information is aggregated to MA-level, let $p_{j,t}$ denote the HPI level in MA j on month t, and let C_j

of Management and Budget follows a set of official standards to update MA definitions, consisting of one or more counties that contain a city.

[7]The description of the methodology is available at https://us.spindices.com/documents/methodologies/methodology-sp-corelogic-cs-home-price-indices.pdf [accessed 12/25/2018].

denote the set of constituent counties of MA j.

Using this notation the weights to aggregate counties into MAs equal the shares of the value of the housing stock in MA j on month t, that is, $\omega_{c,t} = v_{c,t}/\sum_{j\in C_j} v_{j,t}$. Similarly, the weights to aggregate counties to national level equal the national shares of the value of the housing on month t, that is, $\omega_{c,t} = v_{c,t}/\sum_{j\in C} v_{j,t}$.

Following the S&P CoreLogic Case-Shiller methodology, I use the following expression to aggregate county-level HPIs to the MA-level (aggregation to the national level is performed in the same way)

$$\frac{p_{j,t}}{p_{j,t_0}} = \sum_{c\in C_j} \omega_{c,t_0} \frac{p_{c,t}}{p_{c,t_0}} \ . \tag{B.13}$$

It is worth noting that if the value of the housing stock grows at the rate of growth of HPI, i.e., $v_{c,t}/v_{c,t_0} = p_{c,t}/p_{c,t_0}$, then the previous expression implies two useful properties. First, gross growth rates aggregate using as weights the shares of values of the housing stock in the initial month. In fact, using that the value of the housing stock grows at the rate of growth of HPI and equation (B.13) I obtain

$$\frac{p_{j,t}}{p_{j,t-1}} = \frac{p_{j,t_0}}{p_{j,t-1}} \sum_{c\in C_j} \omega_{c,t_0} \frac{p_{c,t}}{p_{c,t-1}} \frac{p_{c,t-1}}{p_{c,t_0}} = \sum_{c\in C_j} \frac{p_{j,t_0}}{p_{j,t-1}} \frac{v_{c,t_0}}{\sum_{c\in C_j} v_{c,t_0}} \frac{p_{c,t-1}}{p_{c,t_0}} \frac{p_{c,t}}{p_{c,t-1}} =$$
$$\sum_{c\in C_j} \frac{v_{c,t-1}}{\sum_{c\in C_j} v_{c,t-1}} \frac{p_{c,t}}{p_{c,t-1}} = \sum_{c\in C_j} \omega_{c,t-1} \frac{p_{c,t}}{p_{c,t-1}} \ .$$

Second, the reference period can be changed and aggregation will obtain by updating the weights to be on the new reference period. This property is useful, as it allows me to aggregate HPIs taking January 2018 as the reference period.

C Filing TAXSIM Tax Returns

I "file" TAXSIM tax returns using data from McDash-HMDA-CRISM and SOI. TAXSIM input variables are calculated as follows.

The state (state) is derived from the ZIP code of the property, as reported in McDash Analytics.

The marital status (mstat) is imputed from the most common reporting status in SOI by ZIP code and income group. Mortgage records are supplemented with information from SOI given the households' income group and ZIP code. For each mortgage record I use the ZIP code of the property, as reported in McDash Analytics, and determine the income group using the income reported in HMDA.

The age of the primary tax payer (page) is set to zero, and the age of the spouse (sage) is set to zero, as well.

The number of dependents (depx) equals the the ratio of number of dependents (NUMDEP) and total returns (N1), rounded to the closest integer. I assume that all dependents are under 17, but over 13, so the number of dependents under 13 (dep13) is set to zero, whereas the number of dependents under 17 (dep17) and under 18 (dep18) is set equal to the number of dependents. The number of dependents is 0.87 on average (Table 3).

The value of the different income sources is derived from the income reported in HMDA and the shares of total income of each income source from SOI by income group and ZIP code. For all households, income is allocated across wages and salary income (pwages), dividends (dividends), interest (intrec), and long-term capital gains (ltcg). These income categories are associated with their respective income categories in SOI (see Appendix A).

In addition, it is assumed that the following sources are zero: income from pensions, taxable pensions and IRA contributions (pensions) and gross social security benefits (gssi); wages and salary of spouse (swages); short-term capital gains (stcg); other property income (otherprop); and other non-taxable transfer income (transfers).

Real Estate taxes paid (proptax) are imputed as the ratio of real estate taxes to AGI in the households' zip code, times households' income, as reported in HMDA.

Mortgage interest payments (mortgage) for deductions fiscal year, T_{FY}, are calculated as follows. I assume the mortgage was originated on year $T_{FY} - 1$ in the last month of the quarter of origination, denoted q_i. This assumption allows me to capture the full effect of mortgage interest payments on the decision to itemize, as mortgage payments occur throughout the fiscal year. From the McDash data, in addition, I obtain mortgage balances at origination, $m_{i,0}$, interest rate annualized, i_i, and term in years, T_i. Letting tilde variables represent the monthly counterparts of their annual analogues, it follows that $\tilde{i}_i = (1 + i_i)^{1/12} - 1$ and $\tilde{T}_i = 12\,T_i$. Let $m_{i,t}$ denote the path of unpaid principal balance, such that given the origination amount, $m_{i,0}$, the term, T_i, and annual interest rate, i_i, and making fixed payments the balance is zero at the end of the term, $m_{i,T_i} = 0$. Then, the mortgage balance $\tilde{t}$ months after origination is given by

$$m_{i,\tilde{t}} = m_{i,0}\left[1 - \frac{1}{(1+\tilde{i}_i)^{\tilde{T}_i - \tilde{t}}}\right]\left[1 - \frac{1}{(1+\tilde{i}_i)^{\tilde{T}_i}}\right]^{-1} .$$

Then, mortgage interest payments in fiscal year T_{FY} are given by $\tilde{i}_i \sum_{\tilde{t}} m_{i,\tilde{t}}$, where $\tilde{t} = (12 - q_i), \ldots, (12 - q_i) + 12$.

Finally, rent paid (rentpaid), child care expenses (childcare), other non-property income (nonprop), and other itemized deductions (otheritem) are set to zero. The last two assumption deserve some discussion. Other itemized deductions (otheritem) includes state taxes, which are calculated by TAXSIM when the state is provided, as done here. So even setting this item to zero, it will consider the simulated state tax liability. By contrast, in practice, the deduction for state tax on the federal return or federal tax on the state return is based on amount paid, or withholdings, not liability, and individuals need to report as income tax pervious tax refunds. So an alternative set of assumptions would be to use SOI information to impute state and local income tax refunds, and offset this additional income with additional deductions for state tax withheld. However, given that withholding information is not readily available I opt for the simpler alternative to set other non-property income and other itemized deductions to zero.

Tables and Figures

Table 1: Number of Mortgages for 2013-2015.

Description	Purchases	Total
Mortgages in McDash	2,504,241	5,409,053
Mortgages with income from HMDA	2,473,351	5,085,794
Mortgages matched to SOI	2,445,386	5,043,934

Source: McDash Analytics; Federal Financial Institutions Examination Council (U.S.), HMDA Public Data; and IRS, Statistics of Income Division, ZIP Code Data.

Table 2: Descriptive Statistics of Mortgages in Final Sample.

Description	Mean	Std. Dev.	P10	Median	P90
All Mortgages					
Mortgage rate (annual percent)	3.94	0.53	3.25	3.88	4.62
Mortgage term	26.42	6.40	15.00	30.00	30.00
Origination amount	231,449	175,255	87,370	187,200	411,350
House value	323,749	313,654	117,000	242,406	6e+05
Purchase mortgage dummy	0.48	0.50	0.00	0.00	1.00
Purchase Mortgages					
Mortgage rate (annual percent)	4.02	0.47	3.38	4.00	4.62
Mortgage term	29.09	3.57	30.00	30.00	30.00
Origination amount	240,516	178,370	96,662	195,000	417,000
House value	296,377	277,335	112,000	225,000	545,000

Notes: Author's calculations based on McDash Analytics; Federal Financial Institutions Examination Council (U.S.), HMDA Public Data; and IRS, Statistics of Income Division, ZIP Code Data.

Table 3: Descriptive Statistics of Simulation Inputs.

Description	Mean	Std. Dev.	P10	Median	P90
Yearly gross income	93,693	60,083	37,000	77,000	172,000
Marital status (1 single, 2 married)	1.68	0.47	1.00	2.00	2.00
Number of dependents	0.87	0.37	0.00	1.00	1.00
Number of exemptions	2.37	0.54	2.00	2.00	3.00
Wages share of income	0.96	0.05	0.91	0.97	0.99
Dividends share of income	0.02	0.02	0.00	0.01	0.03
Interest share of income	0.01	0.01	0.00	0.00	0.01
Capital gains share of income	0.02	0.03	0.00	0.01	0.04
Mortgage interest deduction	9,084	5,787	3,762	7,586	16,112
Mortgage interest deduction to AGI	0.11	0.04	0.06	0.10	0.16
Property tax (%)	1.56	0.87	0.66	1.34	2.79

Notes: Author's calculations based on McDash Analytics; Federal Financial Institutions Examination Council (U.S.), HMDA Public Data; and IRS, Statistics of Income Division, ZIP Code Data.

Table 4: Descriptive Statistics of Simulated Returns.

Description	Mean	Std. Dev.	P10	Median	P90
Federal income tax liability 2017	9,647	11,607	1,188	5,745	23,996
Federal income tax liability 2018	8,031	10,584	268	4,380	21,768
Change in Federal income tax	-1,615	1,476	-2,935	-1,382	-168
State income tax liability 2017	2,674	3,325	0	1,717	6,738
State income tax liability 2018	2,689	3,407	0	1,704	6,791
Change in State income tax	15	217	-69	0	186
Change log disposable income (%)	2.05	1.17	0.24	2.26	3.62
Federal marginal tax 2017 (%)	20.09	6.60	14.10	15.00	29.99
Change Fed. marginal tax (%)	-2.52	3.41	-6.39	-2.86	0.00
State marginal tax 2017 (%)	3.85	2.79	0.00	4.35	7.05
Change State marginal tax (%)	0.02	0.33	0.00	0.00	0.01
Change in Fed. itemization status	0.44	0.50	0.00	0.00	1.00
SALT cap activated	0.13	0.34	0.00	0.00	1.00
MID cap activated	0.01	0.09	0.00	0.00	0.00
User cost 2017 (%)	5.49	1.21	4.04	5.36	7.12
User cost 2018 (%)	6.07	1.16	4.64	5.97	7.62
Change in user cost (basis points)	58.08	61.70	0.00	43.62	148.61
User cost 2017 demand elasticity	-19.09	4.16	-24.74	-18.66	-14.05
Change user cost: Fed. itemization	48.89	60.94	0.00	0.00	141.78
Change user cost: SALT cap	3.84	11.69	0.00	0.00	17.34
Change user cost: MID cap	0.88	10.09	0.00	0.00	0.00

Notes: Tax simulations use TAXSIM.
Source: Author's calculations based on McDash Analytics; Federal Financial Institutions Examination Council (U.S.), HMDA Public Data; and IRS, Statistics of Income Division, ZIP Code Data.

Table 5: Descriptive Statistics of House Price Effects and Other Regional Variables.

Description	Mean	Std. Dev.	P10	Median	P90
All Counties					
Home value (million 2015 dollars)	715.34	1,456.07	28.75	222.58	1,845.78
User cost semielasticity house demand	-19.73	2.25	-22.66	-19.63	-16.92
Change log house prices inelastic supply (%)	-8.86	4.24	-14.12	-9.36	-2.90
User cost term (%)	-10.47	4.00	-15.49	-10.85	-4.87
Disposable income term (%)	1.61	0.39	0.99	1.71	2.01
All Metropolitan Areas					
Price elasticity house supply	2.54	1.43	1.07	2.26	4.37
User cost semielasticity house demand	-18.82	2.01	-21.58	-18.71	-16.39
Change log house prices inelastic supply (%)	-8.56	3.26	-12.54	-8.75	-4.17
Change log house prices elastic supply (%)	-2.92	1.66	-5.26	-2.71	-0.90
User cost term (%)	-3.38	1.70	-5.70	-3.16	-1.29
Disposable income term (%)	0.46	0.14	0.30	0.45	0.65

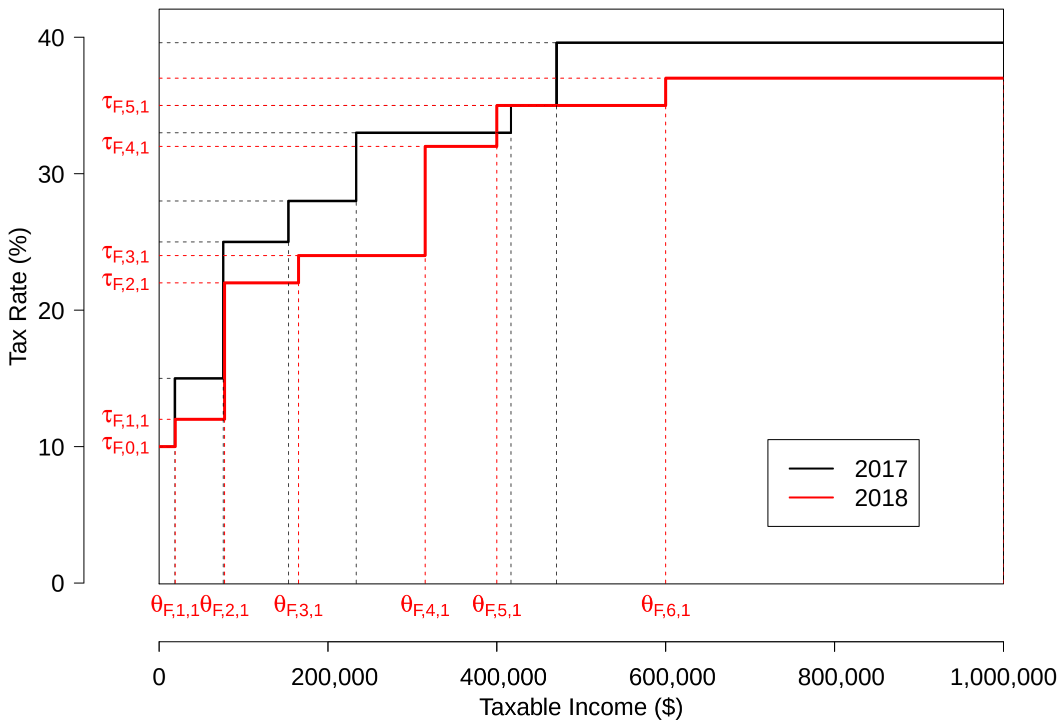
Notes: Tax simulations use TAXSIM.
Source: Author's calculations based on McDash Analytics; Federal Financial Institutions Examination Council (U.S.), HMDA Public Data; and IRS, Statistics of Income Division, ZIP Code Data.

Table 6: Regression of Recent House Price Changes on Simulated Changes.

	All metro areas		Metro areas ≥ 500,000	
Variable	Estimate	Std. Error	Estimate	Std. Error
constant	3.88**	0.398	5.95**	0.554
$\Delta HPI_j^{SIMULATION}$	-0.18	0.123	0.26*	0.137
Observations	252		84	
Adj. R Squared	0.005		0.03	

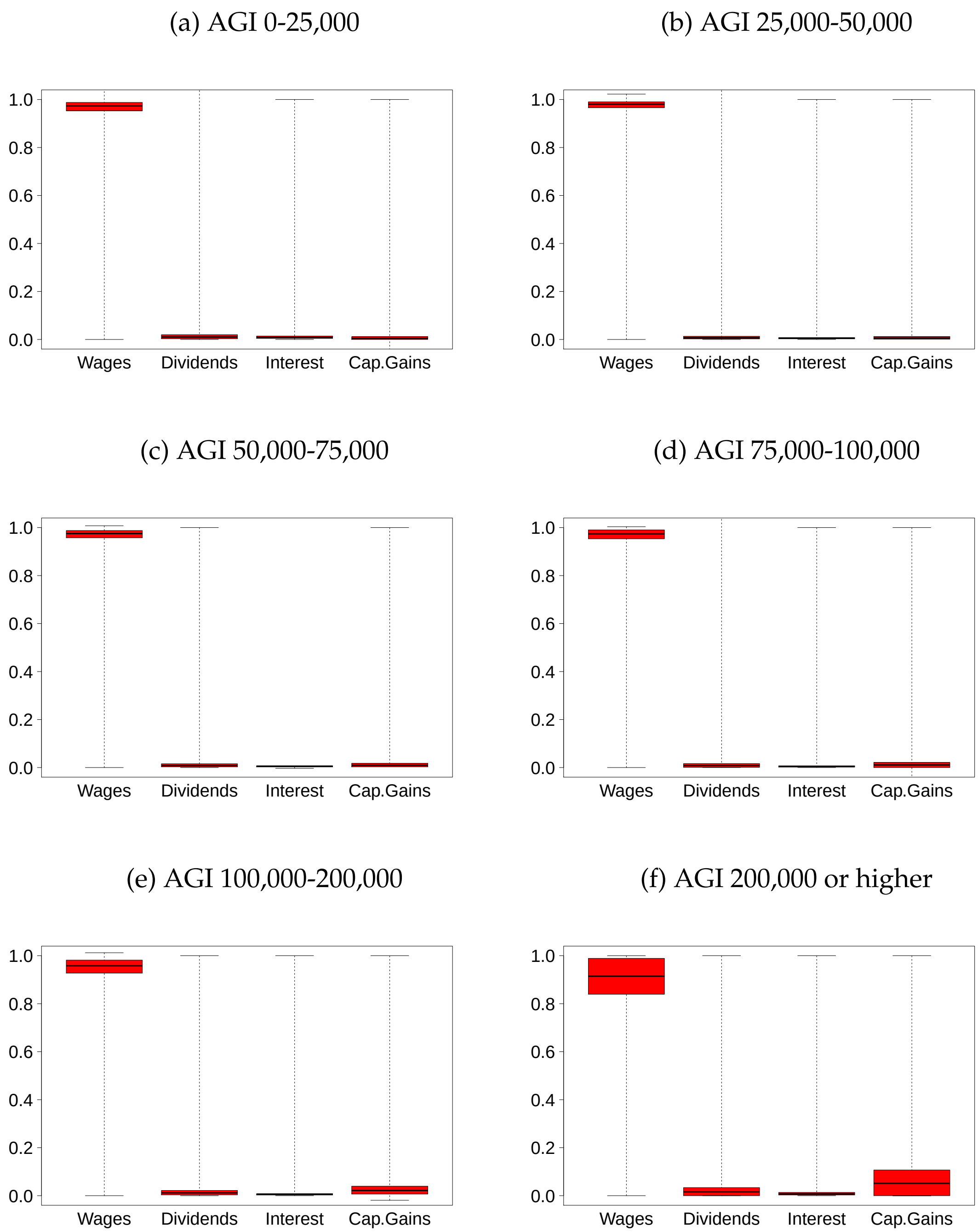
Notes: Tax simulations use TAXSIM. ** and * significant at 10% and 1%.
Source: Author's calculations based on McDash Analytics; Federal Financial Institutions Examination Council (U.S.), HMDA Public Data; and IRS, Statistics of Income Division, ZIP Code Data.

Figure 1: Marginal Income Tax Rates in 2017 and 2018 for Married Couples Filling Jointly



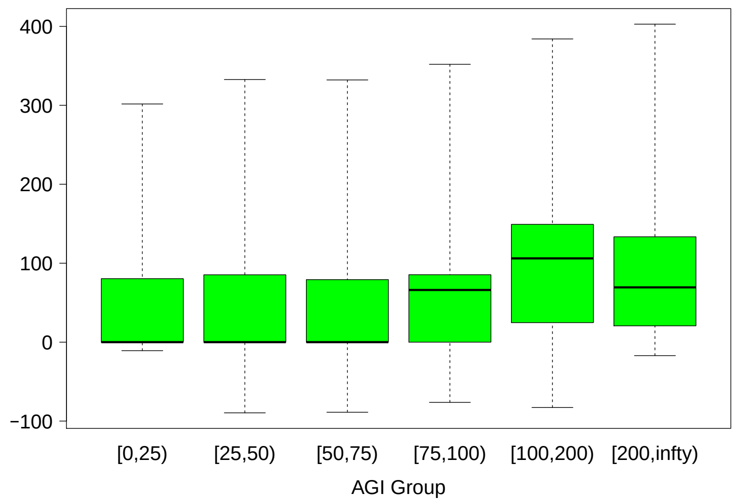
Notes: Marginal income tax rates $\tau_{F,b,r}$ over income brackets, $[\theta_{F,b,r}, \theta_{F,b+1,r})$, for married couples filling jointly, where subindex F denotes federal income brackets, subindex $b = 0, \dots, B$ index tax brackets, with $\theta_{F,0,r} = 0$ and $\theta_{F,B+1,r} = \infty$, and $r = 0, 1$ denotes pre- and post-TCJA tax systems.
Source: US Tax Center, www.irs.com.

Figure 2: Distribution of Income Shares Calculated from SOI.



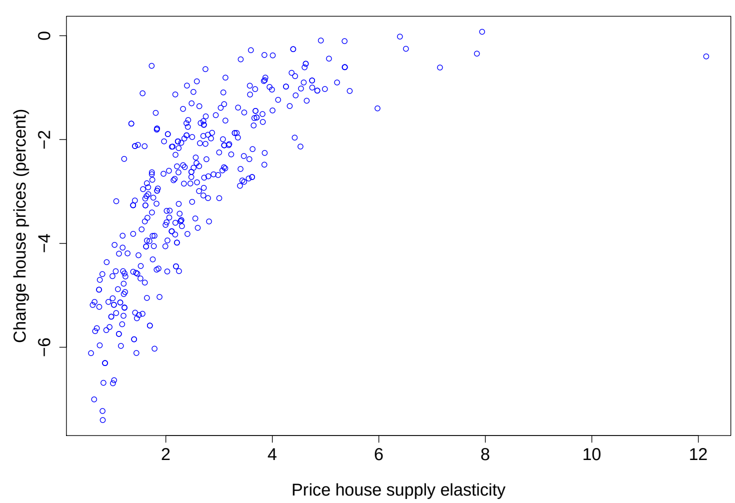
Notes: Wages corresponds to salary and wages, business or professional income, and income from partnership or S-corporation, Dividends corresponds to ordinary dividends, interest corresponds to taxable interest, Ca.Gains corresponds to net capital gains, Total Pen corresponds to the share of income from total pensions for elders, Pension corresponds to the share of pensions and annuities in total pension, and Soc.Sec. corresponds to the share of gross social security benefits in total pension.
Source: Author's calculations based on McDash Analytics; Federal Financial Institutions Examination Council (U.S.), HMDA Public Data; and IRS, Statistics of Income Division, ZIP Code Data.

Figure 3: Distribution of Changes in User Cost for Different Income Groups.



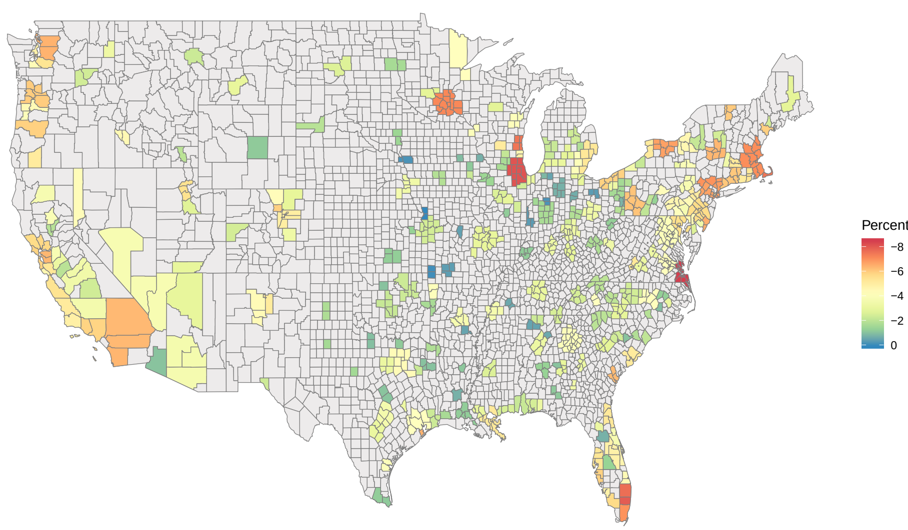
Notes: Changes in user cost in basis points.
Source: Author's calculations using TAXSIM and based on McDash Analytics; Federal Financial Institutions Examination Council (U.S.), HMDA Public Data; and IRS, Statistics of Income Division, ZIP Code Data.

Figure 4: Changes in House Prices versus the Price House Supply Elasticity.



Source: Author's calculations using TAXSIM and based on McDash Analytics; Federal Financial Institutions Examination Council (U.S.), HMDA Public Data; and IRS, Statistics of Income Division, ZIP Code Data; and Saiz (2010).

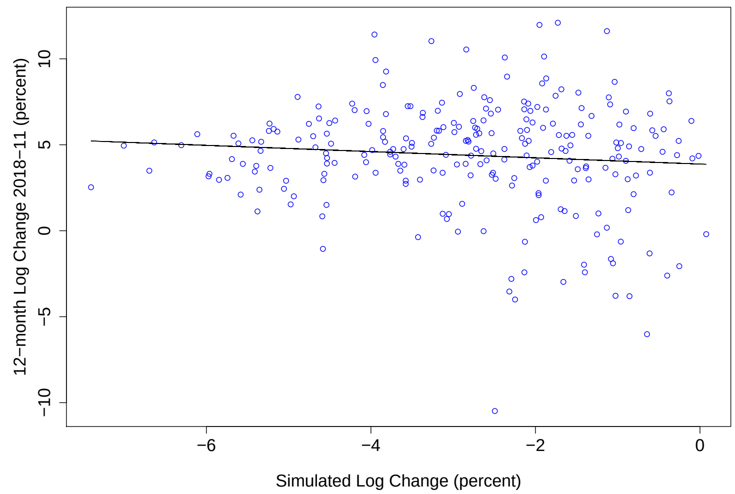
Figure 5: Simulated House Price Changes



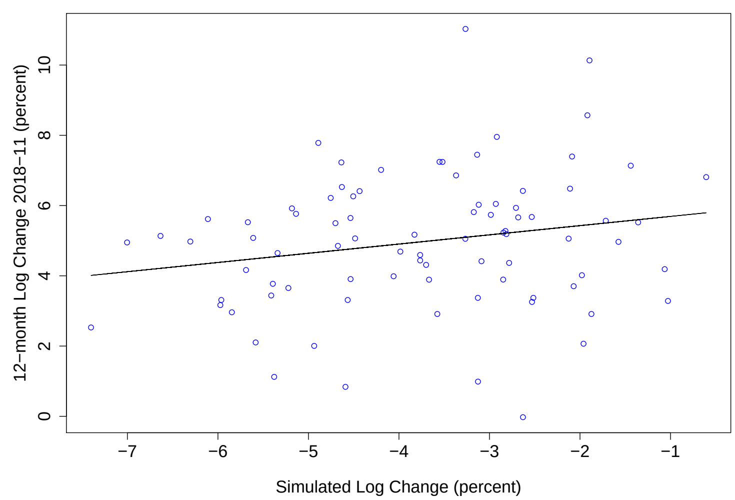
Source: Author's calculations using TAXSIM and based on Federal Financial Institutions Examination Council (U.S.), HMDA Public Data; IRS, Statistics of Income Division, ZIP Code Data; and Saiz (2010).

Figure 6: House Price Changes: Simulation versus Recent Data.

(a) All Metropolitan Areas.



(b) Large Metropolitan Areas.



Notes: Large metropolitan areas have population of at least 500,000 in 2000 Census.
Source: Author's calculations using TAXSIM and based on S&P Dow Jones Indices LLC, McDash Analytics; Federal Financial Institutions Examination Council (U.S.), HMDA Public Data; IRS, Statistics of Income Division, ZIP Code Data; and Saiz (2010).