Distributional Impacts of State and Local Tax Policy in a Heterogeneous-Agent Model *

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Abstract

This paper is a contribution to the structural modeling of state and local personal tax policy. The model is a standard heterogeneous-agent, small open economy with demand for housing, designed to evaluate the three main taxes levied by U.S. state and local governments: income, sales, and property taxes. Rather than modeling each state and corresponding municipal governments' tax systems, Louisiana, a state with all three taxes, is chosen for calibration. The quantitative model, which generates several realistic moments of the Louisiana economy, addresses structural tax reforms proposed by state-level policymakers. The results show that a shift towards sales taxation and away from income and property taxation improves social welfare.

Keywords: heterogeneous agents, regional tax policy, social welfare.

JEL Classification Numbers: E17, H2, H3, H7

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1 Introduction

This paper shows that a standard heterogeneous-agent macroeconomic model with housing can provide a robust tool for state and municipal policy analysis. Much of the macroeconomics literature studying the United States tax system focuses exclusively on policy at the federal level. Despite generating nearly as much tax revenue as the U.S. federal government, state and local fiscal policy is given little consideration. This paper fills the void in regional fiscal policy modeling by presenting a heterogeneous-agent model designed to measure the effects of broad changes in state and local tax structures.

According to the National Income and Product Accounts of the Bureau of Economic Analysis, the U.S. federal government collected $1.65 trillion in 2012, while total state and local tax revenue was $1.42 trillion in that same year. Further, almost 90% of all state and local tax revenue in 2012 came from income, sales, and property taxes. State and local government tax revenue estimates from the Bureau of Economic Analysis show that income taxes comprised 22.7% of total state and local tax revenue, while sales taxes generated 33.8%, and property taxes generated 31.1%. Accordingly, the model presented in this paper focuses on these three tax categories.

Most state and municipal governments rely on some combination of these three taxes to finance expenditures. Of the 50 U.S. states and the District of Columbia, 48 allow for taxation of sales[1], while 44 tax income[2], and all have property taxes[3]. Rather than modeling each state and municipal government tax system, Louisiana is chosen as a case study for two primary reasons. First, Louisiana state and municipal governments, combined, levy each of these three taxes. To that extent, Louisiana is a representative state that follows the majority of states in levying each of the three main taxes. Second, Louisiana's tax structure has several interesting features that allow for valuable counterfactual tax experiments. For example, Louisiana is one of only six states that allows for the deduction of federal income tax payments from state taxable income.[4] Eliminating this deduction shows how a federal tax deduction affects the progressivity of income taxes. Another

[1] https://files.taxfoundation.org/20170131121743/TaxFoundation-FF539.pdf
[2] https://taxfoundation.org/state-individual-income-tax-rates-brackets-2017/
[3] https://taxfoundation.org/how-high-are-property-taxes-your-state-2016/
[4] https://itep.org/wp-content/uploads/pb51fedinc.pdf

interesting feature of the Louisiana tax system is the statewide homestead exemption of $75,000 on the municipal property tax bill. This exemption causes interesting interactions following tax changes that affect the intensive and extensive margin of housing demand.

The first question addressed in this paper is a positive one: Can a standard heterogeneous-agent model generate realistic features of the U.S. state and local income, sales, and property tax systems estimated from the data? To address this question, the model was first calibrated to the Louisiana economy. Several moments were then estimated from the model's simulated data and compared to the corresponding estimates from survey data. Results show that the model-generated moments are remarkably close to the survey data moments.

After comparing the model to the data, the focus turns to understanding regional tax policy through important counterfactual experiments. The first counterfactual evaluates a specific tax proposal which involves eliminating the federal tax deduction and reducing income tax rates to offset the gain in income tax revenue. This experiment highlights the importance of determining the indirect effects of changes in the tax structure. Specifically, the model shows how the resulting increased progressivity would cause a decline in property tax revenue and a modest increase in the home ownership rate. Next, broad tax categories are eliminated to understand the behavioral responses and welfare implications. In separate experiments, income taxes and property taxes are eliminated and replaced with an increase in the sales tax. The results suggest that movement towards a sales tax base improves average welfare.

This paper follows several models in the incomplete-insurance market literature. The life-cycle productivity component of the model follows Huggett (1996), although prices and quantities in that paper are determined in a closed economy. Demand for housing follows Yang (2009), which extends Huggett (1996) to include housing demand over the life-cycle. I extend each of these papers by including elastic labor supply and focusing on the tax structure of the model economy. This paper also contributes to the quantitative public finance literature within the broader heterogeneous-agent, incomplete-insurance market literature, such as Conesa and Kreuger (2006) and Conesa, Kitao, and Krueger (2009). The latter models several features of the U.S. federal tax system that are included herein.

This paper contributes to a narrow literature regarding optimal state and local tax policy, including Arnott and Grieson (1981). While that paper studies a regional economy with residents and nonresidents involved in economic activity, this paper abstracts from such dichotomy by assuming that household mobility is restricted.

Several results in this paper are presented in the context of tax progressivity. Armenter and Ortega (2010) show how labor mobility generates convergence of optimal tax schedules across U.S. states, but offsetting tax base effects allow a progressive tax system to feasibly redistribute income in equilibrium. Therefore, tax competition and regional migration are not likely to undermine the local governments' ability to implement progressive tax schedules, as in Tiebout (1956), Oates (1972), Zodrow and Mieszkowski (1986), Feldstein and Wrobel (1998), and Braid (2013).

The rest of the paper is organized as follows: Section 2 of the paper presents the model, and Section 3 describes the calibration. Section 4 compares the model results to the data and measures progressivity of the tax system. Section 5 evaluates tax experiments, and Section 6 concludes.

2 Model

The model is a small open economy populated by overlapping generations of heterogeneous households that demand leisure, housing, and non-housing consumption. Agents face idiosyncratic shocks which they cannot fully insure. Non-housing goods are in infinite supply, and one unit of non-housing consumption can be converted into one unit of housing. Taxes are paid by households to both the federal government and a regional government.[5] A rigorous equilibrium definition is provided in Appendix 1.

2.1 Households

2.1.1 Preferences and Demographics

Population in the model economy is normalized to one and grows at rate ν. Each living agent of age j survives to age $j+1$ with probability s_{j+1}. Agents live for a maximum of T years and retire

[5]This can be thought of as a combination of state and municipal governments.

at exogenous age T_r. Households derive utility from leisure and a composite good $\tilde{c}$ according to the function:

$$u(\tilde{c}, 1-n) = \frac{\left(\tilde{c}^{\chi}(1-n)^{1-\chi}\right)^{1-\sigma}}{1-\sigma}, \tag{1}$$

where n is labor supply, and the composite good is comprised of a housing good h and a non-housing consumption good c by the constant elasticity of substitution function:

$$\tilde{c} = (\omega c^{\eta} + (1-\omega)h^{\eta})^{\frac{1}{\eta}}. \tag{2}$$

Agents discount future utility at rate β.

With probability p_m, the individual is born into the model married and remains married throughout the life-cycle. If the individual's marital status, $m \in \{0, 1\}$, is $m = 1$, then the individual is married. Otherwise, if $m = 0$ then the individual is not married. Marital status only affects tax treatment.

2.1.2 Labor Productivity

In each period before retirement, individuals are endowed with a unit measure of time which can be allocated to labor n or leisure l. Labor productivity $\epsilon(j, z)$ depends on age j and a persistent idiosyncratic shock z. The shock z is assumed to follow a first-order autoregressive shock:

$$z_{j+1} = \rho z_j + \varepsilon_{j+1}, \tag{3}$$

where ε_{j+1} has a mean of zero and variance σ_{ε}^2. Initial productivity draws are normally distributed with mean zero and variance σ_y^2. The persistent labor productivity shock has transition probability $\pi_z(z_{j+1}|z_j)$. Since the labor market is in partial equilibrium, wages are normalized to unity. Then, for a household who supplies n units of labor, total labor income is $\epsilon(j, z)n$. Aggregate labor productivity grows exogenously at rate g each period.

2.1.3 Housing

The housing good is both a stock of value and a physical good from which individuals derive utility. Because the non-housing good is in infinite supply and can be converted directly into housing, the supply of housing is perfectly elastic. Housing can either be rented or owned, and agents are born with a stock of zero. If the agent wishes to buy a house of value h, a down payment of θh must be paid in full at the time of purchase. The remainder of the house, $(1-\theta)h$ serves as collateral for any debt. Purchased homes have a minimum value of $\underline{h}$.

Buying a home causes the agent to incur transaction costs of ρ_b percent of the home's value, whereas selling a home incurs proportional cost ρ_s. Once owned, the agent can increase or decrease the value of the home by up to ϕh without incurring transaction costs, and the home naturally depreciates at rate δ_h. Transaction costs can then be summarized by the following equation:

$$\Phi(h,h') = \begin{cases} 0 & if \quad \mid h-h' \mid \leq \phi h \\ \rho_s h + \rho_b h' & if \quad \mid h-h' \mid > \phi h \end{cases} \tag{4}$$

Agents can also choose to rent housing at rate $q^R = r + \delta_h$, where r is the net interest rate. The model accounts for the possibility that a high-income household lives in a rental property by assuming that agents face the possibility of a rental shock, $R \in \{0,1\}$, in each period. With exogenous probability p_R, agents receive this rental shock ($R=1$), and rental is the only option.

2.1.4 Savings and Debt Constraints

Let a' denote savings, for which households receive (or pay if $a'<0$) $(1+r)a'$ in the following period. Household debt is constrained by home equity: $a' \geq -(1-\theta)h'$. Also, the net asset position of the household is constrained to be positive so that the net worth constraint $(1-\delta_h)h' + a' \geq 0$ is satisfied.

2.2 Tax Structure

Both the federal and regional governments levy taxes on households to finance their (exogenous) expenditures. The federal government levies an income tax, Social Security tax, and a Medicare tax, and the regional government levies an income tax, sales tax, and property tax.

Total household income in the model is defined as the sum of capital income and labor income or Social Security benefit: $ra+\epsilon(1+g)^j n+\mathbf{1}_{\{j\geq T_r\}}ss$. However, for the calculation of taxable income, special consideration must be given to capital returns ra. This term does not distinguish between financial capital used for savings and a collateralized debt instrument used to finance expenditures, i.e., a mortgage. Accordingly, capital returns influence the household's tax bill asymmetrically according to whether they are positive or negative. If the capital return is positive, then it is treated as ordinary income. However, because any debt must be collateralized by the home, the model assumes that all debt is mortgaged debt. For the purpose of taxation, mortgage interest is treated as an excess itemized deduction. To summarize, positive interest receipts are treated as ordinary income, as in (5) below, whereas interest outlays are treated as mortgage interest and included as an excess itemized deduction, as in (6) below.

Let y denote a household's total taxable income:

$$y = \max\{ra, 0\} + \epsilon(1+g)^j n + \mathbf{1}_{\{j\geq T_r\}} ss, \tag{5}$$

and let $y_m^f = \max\left\{y - D_m^f(a,h'), 0\right\}$ denote federal adjusted gross income, where $D_m^f(a,h')$ is the federal income tax deduction whose magnitude depends on marital status, mortgage interest payment, property taxes (described below), and the standard deduction, $\bar{D}_m^f$:

$$D_m^f(a,h') = \max\left\{|\min\{ra,0\}| + \tau_p max\left\{h' - h^E, 0\right\}, \bar{D}_m^f\right\}. \tag{6}$$

The deduction function (6) implies that the agent deducts the greater of excess itemized deductions and the standard deduction.[6]

[6] Another important itemized deduction is the greater of state and local sales or income taxes. This means that federal income tax calculation depends on consumption, and consumption depends on federal income taxes.

The federal government taxes income according to the federal income tax function $\tau_m^f(y_m^f)$. In addition to the regular federal income tax liability, households also pay a proportional Social Security tax τ_{ss} on labor income up to a limit $\bar{y}^{ss}$. In retirement years, individuals receive lump-sum Social Security payments ss from the federal government. Finally, the federal government levies a proportional Medicare tax τ_m on all labor income.

The regional government taxes individuals' income, non-housing consumption, and stock of housing. Deductions at the regional level follow the federal government and also allow for the deduction of federal income taxes paid so that $D_m^s = D_m^f + \tau_m^f(y_m^f)$ and $y_m^s = \max\{y - D_m^s, 0\}$. Then income is taxed by the regional government at rate $\tau_m^s(y_m^s)$. Non-housing consumption is taxed at proportional sales tax rate τ_c. Finally, an individual's stock of housing is taxed at the property tax rate $\tau_p \max\left\{h - h^E, 0\right\}$, where h^E is a lump-sum homestead exemption.

2.3 Household Optimization

The value function of an individual for a given economic state is determined by solving the value of owning and the value of renting. At the beginning of the period, if the agent does not receive a rental shock ($R = 0$), then the maximum value of either owning or renting is chosen. Otherwise, if a rental shock is received ($R = 1$), then renting is the only option. Individuals take government policy and prices as given and optimize accordingly as follows.

2.3.1 Owner

A homeowner of marital status m, age j, assets a, housing stock h, and productivity ϵ solves the following optimization problem:

$$V_O^m(j,a,h,\epsilon) = \max_{a',h',n} u(\tilde{c}, 1-n) + s_{j+1}\beta E_{\{\epsilon'|\epsilon\}}\left[(1-p_R)V^m(j+1,a',h',\epsilon') + p_R V_R^m(j+1,a',h',\epsilon')\right] \tag{7}$$

$$\text{s.t. } c = (1+r)a - a' + (1-\delta_h)h - h' - \Phi(h,h') + \epsilon(1+g)^j n + \mathbf{1}_{\{j \geq T_r\}} ss - \tau \tag{8}$$

This would require solving a fixed point in each iteration of the optimization routine, which significantly reduces computational feasibility.

$$a' \geq -(1-\theta)h' \tag{9}$$

$$(1-\delta_h)h' + a' \geq 0 \tag{10}$$

$$h' \geq \underline{h} \tag{11}$$

$$n \in [0,1] \tag{12}$$

$$\tau = \tau_m^f(y_m^f) + \tau_{ss} min\left\{\epsilon(1+g)^j n, \bar{y}^{ss}\right\} + \tau_m \epsilon(1+g)^j n + \tau_m^s(y_m^s) + \tau_c c + \tau_p max\left\{h' - h^E, 0\right\} \tag{13}$$

where $\tilde{c}$ is determined according to (2), and current-period utility from housing is derived from h'. If $j \geq T_r$, the agent is retired, the indicator function $\mathbf{1}_{\{j \geq T_r\}}$ takes a value of 1, and the agent receives ss in Social Security payments in every remaining period of life. Also, if $j \geq T_r$, then the productivity shock is $\epsilon = 0$, and optimal labor supply is zero for the remainder of the life-cycle.

2.3.2 Renter

The problem of the renter is similar to the owner problem with three exceptions. First, the magnitude of housing purchased in the period is not kept as a stock at the end of the period. Second, the lack of housing stock nullifies collateral and implies that financial assets and net worth (which are equivalent in this case) can not fall below zero. Finally, while owned-home value has a positive lower bound, rental property value is only constrained to be positive. The problem of the renter can be stated as follows:

$$V_R^m(j,a,h,\epsilon) = \max_{a',e,n} u(\tilde{c}, 1-n) + s_{j+1}\beta E_{\{\epsilon'|\epsilon\}}\left[(1-p_R)V^m(j+1,a',0,\epsilon') + p_R V_R^m(j+1,a',0,\epsilon')\right] \tag{14}$$

$$\text{s.t. } c = (1+r)a - a' - q^R e - \Phi(h,0) + \epsilon(1+g)^j n + \mathbf{1}_{\{j \geq T_r\}} ss - \tau \tag{15}$$

$$a' \geq 0 \tag{16}$$

$$e \geq 0 \tag{17}$$

$$n \in [0,1] \tag{18}$$

$$\tau = \tau_m^f(y_m^f) + \tau_{ss} min \left\{ \epsilon(1+g)^j n, \bar{y}^{ss} \right\} + \tau_m \epsilon(1+g)^j n + \tau_m^s(y_m^s) + \tau_c c, \tag{19}$$

where e enters (2) in the place of h.

2.3.3 Housing Decision

The final step in determining the general value function V^m of an agent for a given economic state requires solving a discrete choice over home ownership. Let V_O^m denote the solution to the owner's optimization problem (7) - (13), and let V_R^m denote the solution to the renter's problem, (14) - (19). Then the discrete choice optimization problem is:

$$V^m(j, a, h, \epsilon) = max \left\{ V_O^m(j, a, h, \epsilon), V_R^m(j, a, h, \epsilon) \right\} \tag{20}$$

if the agent does not receive a rental shock ($R = 0$) and

$$V^m(j, a, h, \epsilon) = V_R^m(j, a, h, \epsilon) \tag{21}$$

if the agent does receive a rental shock ($R = 1$).

3 Calibration

The goal of the calibration exercise is to match the moments of the survey data as closely as possible while minimally varying the parameters from their documented origin. Model parameter values are summarized in Table 1. Preference and labor productivity parameters in the calibrated model follow common values used in the incomplete-markets literature, while the several values determining the market for housing follow Yang (2009). The remaining non-policy parameters are estimated directly from the data or calibrated to match a particular target. U.S. fiscal policy parameters correspond to their 2012 values, and sub-federal policy parameters correspond to the Louisiana state tax structure in the same year. A summary of the data is provided in Appendix 2, and details of the computation are provided in Appendix 3.

3.1 Demographics, Preferences, and Prices

Agents enter into the model at age 20 ($j = 1$), begin retirement at age 65 ($Tr = 46$), and live to a maximum of age 99 ($T = 80$). In each period, individuals survive to the next period according to the age-dependent probabilities reported in the 2008 Centers for Disease Control and Prevention Life Tables. Following Attanasio, et al. (2011), the population growth rate is set to 1.2% annually. According to data from the 2013 CPS, 52.4% of Louisiana adults were married, so $p_m = 0.524$.

The preference parameter σ is set to 3.0, and the consumption share of utility of 0.25 generates an average labor supply corresponding to 26% of the time endowment. Together, these parameters generate a coefficient of relative risk aversion of 1.5 and an elasticity of intertemporal substitution of 0.67. A high discount factor of $\beta = 1.05$ is needed to generate a realistic age-profile of home ownership. The Frisch labor supply elasticity is 1.4, which falls in the middle of microeconomic and macroeconomic estimates reported in Peterman (2016). The remaining preference parameters determine demand for housing. The elasticity of substitution between housing and non-housing is set to $\eta = 0.145$ according to Ogaki and Reinhart (1998), and the relative weight of non-housing consumption is set to $\omega = 0.825$ to help match the distribution of home values.

Because the region is assumed to be small relative to its influence on prices, the interest rate and wage are taken as exogenous. The annual interest rate is set to 4%, and the wages are normalized to unity. Model values are mapped to 2012 dollar amounts by setting average household income in the model to the mean value estimated from the 2012 ACS which was $77,536.

3.2 Labor Productivity

Productivity throughout the life-cycle is dependent on age and a persistent idiosyncratic shock. The deterministic age component of productivity is estimated from the CPS and displayed in Figure 1. This productivity-age profile is determined by estimating the parameters of a linear regression of log hourly wages of Louisiana men aged 20 to 65 on a fourth-order polynomial of age. The parameters of the idiosyncratic component follow Huggett (1996), where $\rho = 0.96$, $\sigma_\varepsilon^2 = 0.05$, and the variance of the initial distribution of productivity, $\sigma_y^2 = 0.38$. This AR1 process is approximated by a finite-state Markov transition matrix determined using the method in Adda and Cooper (2003). Finally, aggregate labor productivity is assumed to grow at an annual rate of 2%.

3.3 Housing

Individuals begin life with zero housing stock. Yang (2009) sets minimum owned-home value $\underline{h}$ to 140% of per-capita income to match moments that are not outputs of this model. Instead, the value is reduced to 100% of per-capita income, which provides a better match to the housing distribution in the data. The rental shock probability $p_R = 0.071$ is chosen to match the total home ownership rate. The remaining housing parameters follow Yang (2009).

3.4 Tax Rates and Exemptions

Consider first the federal income taxes, since this value is deductible at the state level. Following several papers in the incomplete-markets literature, the federal income tax bill is approximated by a Gouveia-Strauss tax function:

$$\tau_m^f(y) = \kappa_0^m(y - (y^{-\kappa_1^m} + \kappa_2^m)^{-\frac{1}{\kappa_1^m}}). \tag{22}$$

Nishiyama (2015) estimates the parameters of this function using ordinary least squares to match the marriage-weighted statutory effective tax rates applied to a linearly-spaced income grid. I modify this methodology by estimating separate functions for each marital status and applying the 2012 statutory tax rates to household income (net of the standard deduction) by marital status from the CPS. This modification delivers greater accuracy to portions of the tax function with higher densities of households. The tax rates, brackets, and standard deductions each correspond to the 2012 values. For that year, the standard deduction for single households with one exemption was \$9,750, and the married deduction with two exemptions was \$19,500. The estimated parameters of the Gouveia-Strauss tax function are provided in Table 2.

The U.S. federal government also levies Social Security and Medicare taxes evenly between employers and employees. However, the incidence of each tax is assumed to fall entirely on the employee. Therefore, the agent pays Social Security tax $\tau_{ss} = 0.124$ on income up to a maximum $\bar{y}^{ss} = \$110,000$, and the Medicare tax is $\tau_m = 0.029$.

The state tax system is modeled after the State of Louisiana and the municipal governments therein. Federal standard and excess itemized deductions, as well as the federal tax bill are deductible from state income taxes. In other words, Louisiana allows for the same standard deductions and excess itemized deductions as the federal government, and the federal income tax bill is deductible from state income taxes. State income tax rates applied to taxable income are 2% on the first $12,500 of income for singles ($25,000 if married), 4% on the next $12,500 of income ($25,000 if married), and 6% on any amount over $50,000 ($100,000 if married). The State of Louisiana levied a 4% sales tax in 2012, and Louisiana municipal governments, on average, have a 4.7% sales tax. According to (*author self-reference removed*), approximately 30% of non-housing personal expenditures are subjected to the sales tax, implying that the effective sales tax is $0.087 \times 0.3 = 0.0261$. Finally, according to (*author self-reference removed*), the average property tax rate is 1.12% of the property value after the deduction of a $75,000 homestead exemption.

4 Quantitative Results

4.1 Model vs. Data

The calibrated model provides a close match to income and housing moments of the Louisiana economy estimated from the 2012 ACS and the March 2013 release of the CPS. Figure 2 compares labor supply from the model and data by showing hours over the life-cycle relative to age 40. Hours in the model and data remain reasonably flat between ages 25 and 50. Model hours, however, increase sharply in the last 20 working years, while data hours steadily decline over that phase. This divergence is caused by the heightened discount factor, which drives up savings as the household approaches retirement.

While the model does not provide a close match of labor supply in the periods preceding retirement, the model parameters deliver a close match to nearly every other data moment. Most importantly, since tax policy is often evaluated on the basis of progressivity, matching the income distribution provides a common basis of comparison. The model delivers a remarkably close match to the income distribution, as shown in Figure 3, though some work remains to match the top decile.

The quantitative model generates several realistic moments of the housing data. Table 3 shows that the model provides a close approximation to the home ownership rate, mean and median home values, and the average property taxes paid by home owners. The model also generates a close match to the distribution of home values in Louisiana. Figure 4 compares the cumulative distribution of Louisiana home values in the ACS to the model's simulated distribution. Figure 5 shows that the model can also generate a reasonable match of the home ownership rate over the life-cycle. The transitory decline in the ownership rate near retirement reflects the model's sudden consumption shift at retirement, which smooths utility as full leisure commences. Finally, Figure 6 compares the predicted values from a logistic regression of home ownership on annual income in the data versus the model. This relationship is particularly important for understanding how changes in the progressivity of the tax structure influences home ownership at the extensive margin.

The model can also generate estimates of aggregate tax revenue from each tax category. According to the Census Bureau, Louisiana had 1.72 million households between 2011 and 2015.[7] Therefore, total tax revenue in each tax category is calculated by:

$$\text{Tax Revenue} = \text{Number of Households} \times \text{Average Taxes Paid}. \tag{23}$$

While personal tax revenue collected is only available for the Louisiana personal income tax, Table 4 provides the model estimates.[8]

4.2 Measuring Progressivity

Figure 7 presents the progressivity of each state and local tax instrument in the model, as well as the federal income tax, while Figure 8 stacks state and local effective tax rates by income. In this context, the federal income tax includes Social Security and Medicare taxes. Because the Social

[7] https://www.census.gov/quickfacts/LA
[8] Income tax revenue for Louisiana is the value reported in Richardson and Albrecht (2014).

Security tax reaches a maximum taxable amount, the maximum effective federal income tax rate tends towards the sum of the highest federal marginal income tax rate (35%) and the Medicare tax rate (2.9%). Then, because federal income taxes are deductible at the state level, the maximum effective state tax rate tends towards the highest state marginal tax rate (6%) times one minus the highest federal marginal tax rate, which yields approximately 3.7%.

Property tax progressivity measured by the model has clear non-monotonicity. The first spike in progressivity represents the measure of individuals receiving Social Security benefits. These are low-income, home-owning households. The subsequent rise can be explained by an increase in the home ownership rate and home value as income increases. The declining progressivity at very high incomes results from substitution away from housing (as a percentage of expenditures) as income rises.

The general shape of sales tax progressivity can be explained by raising savings rates as income increases. Since consumption as a share of income declines with income, sales tax outlays decline as well. A surprising result of the model is the asymptotic behavior of sales tax progressivity near the origin. In a model with no lump-sum transfers, it may seem as though consumption should roughly equal income near the origin. This would imply that the effective tax rate should approach the actual tax rate as income tends to zero. Instead, however, the average tax rate rises boundlessly near the origin. This happens because households can convert housing into non-housing consumption when income is low, allowing them to consume more than the sum of their labor income and financial capital income. This only happens for a small fraction of households, but a small fraction is enough to make average tax rates extremely high near the origin.

For both the total state and local, and the total federal, state, and local tax systems, progressivity is dominated by the sales tax near the origin. Total state and local tax progressivity is fairly flat at 4-5% for household with incomes above $50,000, suggesting that the income tax progressivity and sales tax progressivity roughly offset for these households. Total progressivity of the federal, state, and local tax systems, however, is dominated by the federal income tax at almost every income level.

5 Policy Evaluation

This section presents the results of structural tax reform proposals. The first experiment involves the elimination of the federal tax deduction (FTD) and uniform changes to income tax rates in a way that maintains income tax revenue neutrality. Because of interactions between tax bases, the results show that the policy reduces total tax revenue. A second policy experiment eliminates the personal income tax and replaces the decline in revenue by increasing the sales tax rates to preserve total revenue neutrality. The third counterfactual involves another shift towards sales tax by eliminating the property tax and increasing the sales tax to offset the decline in total government revenue. The latter two experiments require substantial increases in the sales tax rates because of the extensive exclusions in the tax base. Instead of raising the sales tax rate, the base could equivalently be expanded to increase revenues.

5.1 Elimination of Federal Tax Deduction

The first experiment evaluates the effects of the eliminating the FTD and reducing income tax rates by the same percentage points such that income tax revenue is held constant. Solving the model for this value finds that each tax rate could be reduced by nearly one percentage point, so the corresponding rates would decline from 2%, 4%, and 6% to 1.1%, 3.1%, and 5.1%, respectively.[9] Figure 9 shows how this policy change would modestly increase the progressivity of the income tax. Figure 10 shows the composition of state and local effective tax rates resulting from this policy.

Perhaps the more interesting results are the indirect effects of this change in policy, since ignoring the interaction between tax categories can lead to unintended consequences. By design, income tax revenue is held constant. Sales tax revenue is mostly unaffected, but property tax revenue declines by 2.5%, even though the home ownership rate increases by approximately one percentage point. The key here is the distributional impact of income tax progressivity on both the intensive and extensive margins of housing demand. As shown in Figure 6, the home ownership rate is

[9] An alternative specification of this counterfactual would have reduced rates by the same percentage, rather than the same percentage point. This reform was evaluated and found to have almost no effect on the income tax progressivity.

low for low-income households, but the marginal likelihood of home ownership is high for those households. Therefore, an increase in the progressivity of the income tax causes an increase in home ownership for low-income households. Since the new entrants into home ownership are low-income households, they are likely to purchase cheaper homes. Cheaper homes, in turn, are taxed at a lower effective rate because the homestead exemption shields the first $75,000 of a home's value from property taxation. At the opposite end of the distribution, higher-income individuals reduce their housing consumption, increasing the magnitude of the property tax base shielded by the homestead exemption. The decline in property tax revenue shows that the decline in housing demand by high-income households dominates the property tax revenue effect of increased home ownership by low-income households. Figure 11 illustrates this effect, as shown by the decline in the top 20% of home values.

5.2 Moving Towards a Consumption Tax Base

This section begins by showing the effects of eliminating the income tax and replacing the loss of revenue by increasing the sales tax. Then property taxes are eliminated and sales tax is increased to replace tax revenue. Because sales and property taxes are levied by different levels of government, the results implicitly assume that revenues are collected as if the region maintained a single government budget. Further, the model assumes that implementability of the sales tax remains constant as the rate increases. Realistically, any sales tax avoidance or consumption mobility would imply that the revenue-neutral sales tax rates reported in this section are underestimated. Another important consideration is that the sales tax is only levied on a small subset of all non-housing consumption. Each sales tax increase could also be achieved instead by expanding the sales tax base. The resulting progressivity of the tax structure and housing distributions following elimination of the income and property taxes are shown in Figures 12 - 14 and Figures 15 - 17, respectively. Table 5 summarizes the effects of the reforms on model moments, and Table 6 shows how tax collections respond to the reforms.

With only 30% of non-housing consumption available for sales taxation, the actual sales tax rate would have to rise by 16.1 percentage points to a total tax rate of 24.8% in order to offset the elimination of the income tax. Alternatively, the effective sales tax rate, i.e., the average sales tax paid per non-housing consumption, would rise from 2.6% to 7.5%. In the baseline economy, total income tax progressivity and sales tax progressivity roughly offset, so reform towards the sales tax and away from the income tax makes the overall tax structure regressive. Still, the reform shows an increase in average welfare of 0.7%. Following the reform, average hours worked increases 1.0 percent, the home ownership rate increases by 1.0 percentage point, and per-capita income declines by 4.4%.

In order to recover lost tax revenues from eliminating the property tax, the sales tax rate would have to rise by 6.4 percentage points, bringing the total sales tax rate to 15.1%. Alternatively, the effective sales tax rate in this case would only rise 1.9% percentage points from 2.6% to 4.5%. This reform results in very little change to the progressivity of the tax structure, although it increases average welfare by 0.2%. Average hours also increase by 1.0%, and ownership becomes more attractive as the rate goes up by 1.0 percentage point. While the reform has a modest impact on the extensive margin, the distribution of home values increases markedly, as shown in Figure 17.

6 Conclusion

This paper contributes to the macroeconomics and public finance literature by providing a structural model for state and local fiscal policy evaluation. Since 90% of all state and local tax revenues come from sales, income, and property taxes, the model focused exclusively on those three categories. Because state governments and corresponding municipalities vary in their combinations of these three tax categories, a representative state levying all three taxes was chosen for calibration. The model provides a general framework for evaluating personal-level fiscal policy of sub-federal levels of government.

The calibrated model generates several realistic features of the data. Specifically, the model closely matches the income distribution, several features of the housing market, and tax payments. The model provides progressivity measures of the three state and local taxes, as well as the total tax progressivity. The results showed that, relative to income, the sales tax is regressive, the income tax is progressive, and the property tax is non-monotone. The total tax structure showed that the sales tax progressivity and income tax progressivity roughly offset each other for most households.

The model measured the effects of changes in the tax structure. First, the model evaluated a revenue-neutral change in a single tax category to isolate the effect of income tax reform and show how ignoring interaction between tax categories can lead to unintended consequences. Then, the model evaluated the elimination of broad tax categories. Because of the varying progressivity of each tax, these alternative tax proposals shifted the tax burden across income levels. Welfare analysis showed that sales taxation is favored over both income and property taxation.

While the model provides a broad framework for analyzing state and local fiscal policy, several extensions could overcome some of its limitations. For example, more explicit characterization of household structure would delineate the mechanisms driving the impact of policy with respect to marital status. Also, the model focuses on the effects of taxation, but it could be extended to evaluate state-level social welfare programs, such as unemployment insurance and other needs-based transfer programs. Such extensions improve the model's ability to capture the role of risk mitigation in state and local fiscal policy. To that extent, the model provides a platform for the continued development of a framework to evaluate state and local fiscal policy.

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Appendix 1: Equilibrium Definition

The model regions are assumed to be sufficiently small such that wages and interest rates are determined exogenously. The partial equilibrium concept then only requires that individuals choose optimally and that the aggregate values are consistent with individual policy functions. To simplify notation, define an individual's state vector over marital status, rental shock, productivity, financial assets, housing stock, and age as $x = \{m, R, \epsilon, a, h, j\}$, where $m \in \mathcal{M} = \{0, 1\}$, $R \in \mathcal{R} = \{0, 1\}$, $\epsilon \in \mathcal{E} = \{\epsilon_1, \ldots, \epsilon_N\}$, $a \in \mathcal{A} = [\underline{a}, \infty)$, $h \in \mathcal{H} = [0, \infty)$, and $j \in \mathcal{J} = \{1, \ldots, T\}$. Define the state space to be $\mathcal{X} = \mathcal{M} \times \mathcal{R} \times \mathcal{E} \times \mathcal{A} \times \mathcal{H} \times \mathcal{J}$, and define $\Sigma_{\mathcal{X}}$ as the Borel σ-algebra on $\mathcal{X}$. Denote the probability measure over the measurable space $(\mathcal{X}, \Sigma_{\mathcal{X}})$ by $\psi(\mathcal{X})$. Then, for a given set of prices and government policy instruments, a recursive equilibrium is a set of value functions $V(x)$, decision rules $\{c(x), n(x), a'(x), h'(x), e(x)\}$, and distribution $\psi(x)$ such that:

1. Given prices and government policies, the value function and decision rules solve the individual optimization problem.

2. The distribution of agents is consistent with individual behavior:

$$\psi'(\mathcal{X}) = \int_{\mathcal{X}} Q(x, \mathcal{X}) d\psi. \tag{24}$$

Appendix 2: Data

In order to generate the complete set of salient moments, estimates were obtained from both the March 2013 release of the CPS and the 2012 ACS. Each data set was restricted to Louisiana data (STATEFIP = 22), and all individuals below the lowest model age, 20 years old, were dropped. After these restrictions, the CPS contained 1,419 observations, while the ACS contained 33,676 observations. Both samples were weighted to control for sample selection bias.

The CPS was used to measure the profile of home ownership by age and weekly hours worked. Estimates reflect the percentage of home owners (using OWNERSHP) for each age (using AGE). The CPS was also used to estimate the deterministic component of the age-productivity profile. This component was estimated using the INCWAGE variable (annual wage), then dividing it by 2,080 to get an hourly rate, and finally taking the natural log. This variable was regressed on a fourth-order polynomial of age, and the estimated relationship is plotted in Figure 1. The remaining variables from the CPS were weekly hours worked, which was measured by age using the variable UHRSWORK, and annual property taxes of home owners, which was calculated by taking the average over annual property taxes (PROPTAX), conditional on ownership.

The remaining variables were estimated using the ACS. These variables included housing value (VALUEH), home ownership (OWNERSHP), and marital status (MARST). Finally, in order to estimate the logistic regression of ownership on income, annual income was measured using the variable HHINCOME.

Appendix 3: Computation

Because of the non-convexities in the household's constraint set, calculation of the household's problem requires special consideration. The problem was solved using value function iteration, where an optimization routine solved the Bellman equation at every discretized point in the state space. To circumvent the possibility of a non-global maximum, the decision of a home owner is partitioned into separate optimization problems corresponding to each of the convex subsets of the constraint set. Each of these convex subsets is created by the discontinuous points in the domain corresponding to the housing adjustment cost function.

The distribution was approximated by generating 100,000 simulated lifetimes and appropriately sampling (according to age measures) to estimate moments. Because of the non-convexities, other approaches, including an application of the law of large numbers to produce corresponding probability measures, did not accurately approximate the distribution. For a similar reason, simulating a distribution by simply interpolating over the decision rule after solving the household optimization problem did not accurately generate the distribution. In each of these cases, interpolation generated actions outside of the feasible action set. Instead, the continuation values were taken from the household optimization problem and a new optimization problem corresponding to the history-dependent point in the state space was embedded into each iteration of the simulation. This method ensured that the simulated actions were consistent with the constraints on individual optimization.

Figure 1: Labor Productivity Profile

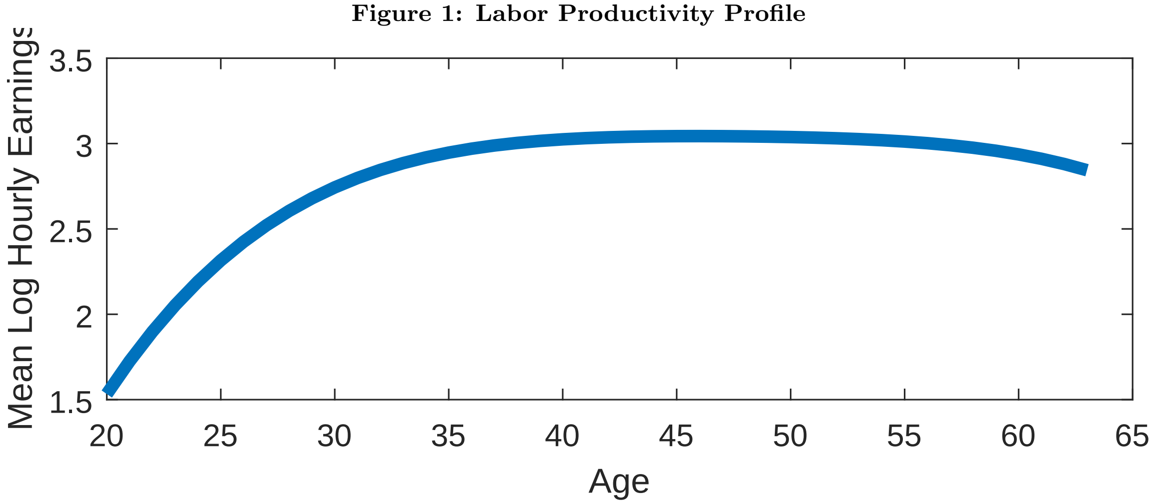

Figure 2: Labor Supply Profile

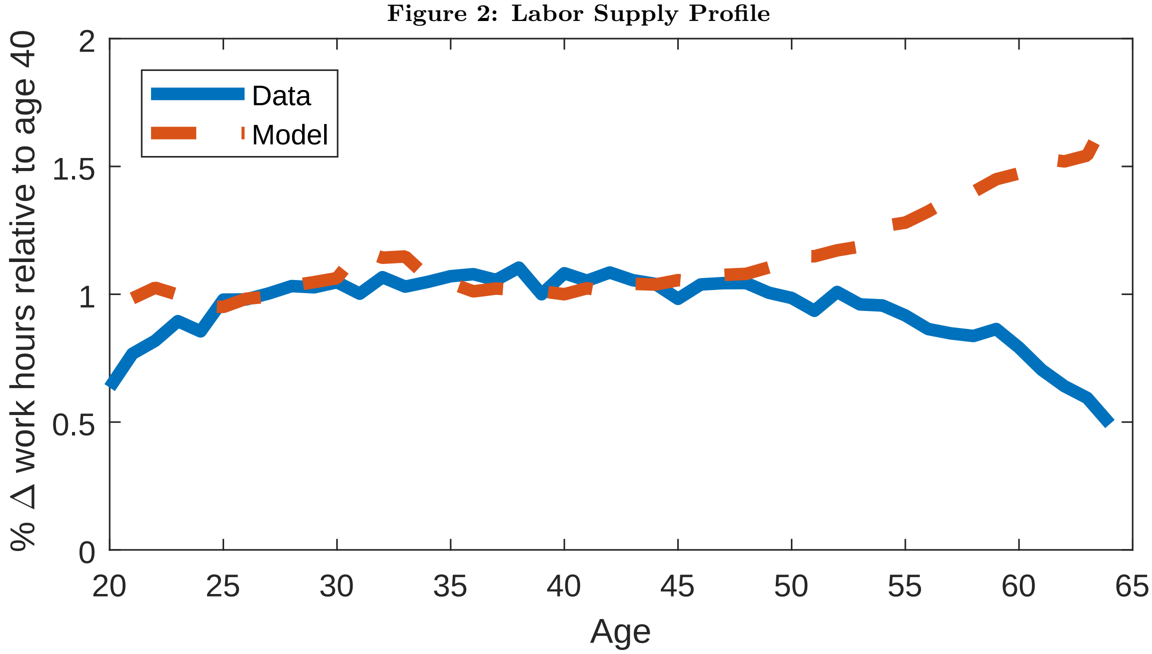

Figure 3: CDF of Household Income

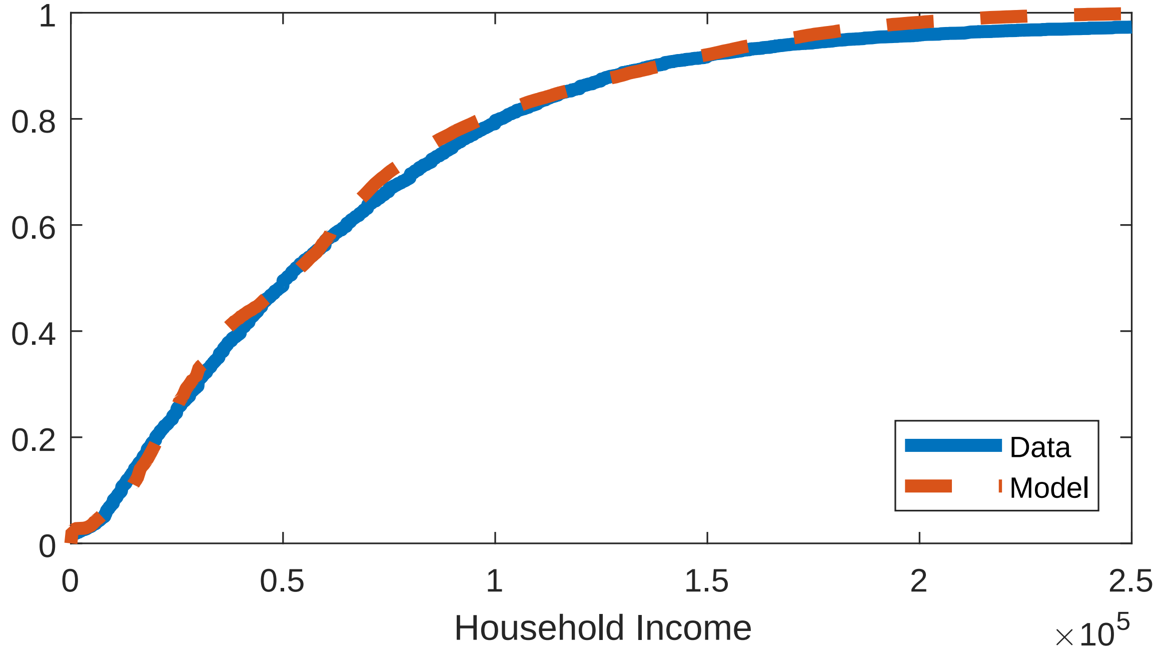

Figure 4: CDF of Owned-home Values

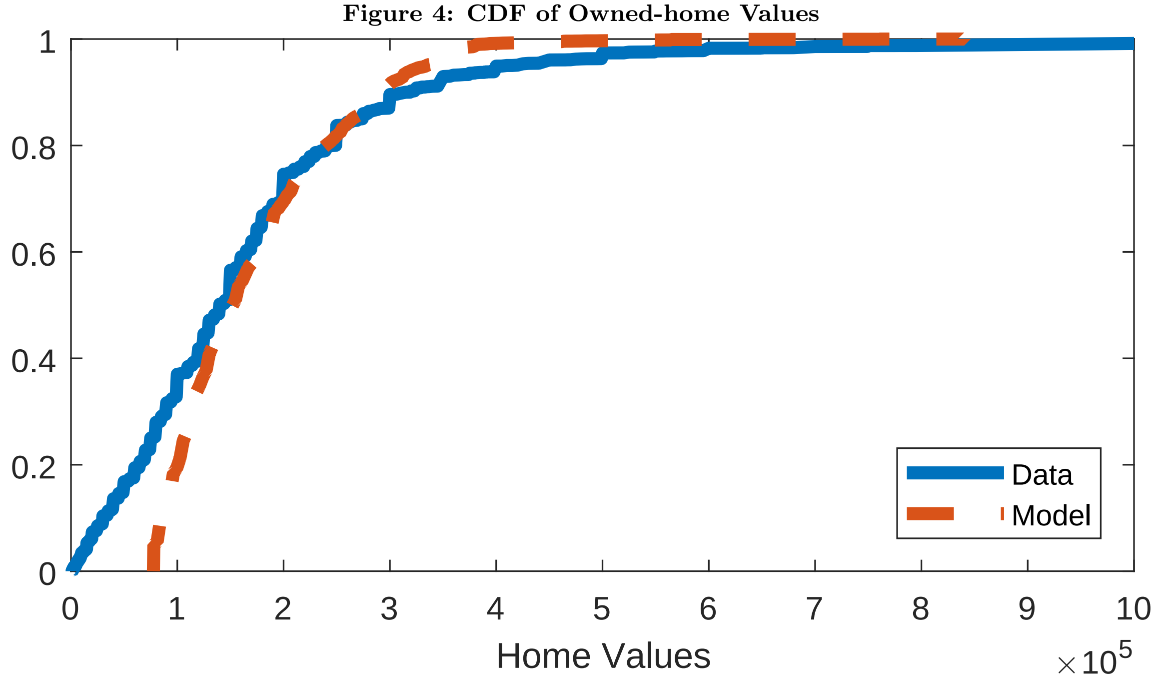

Figure 5: Home Ownership over the Life-cycle

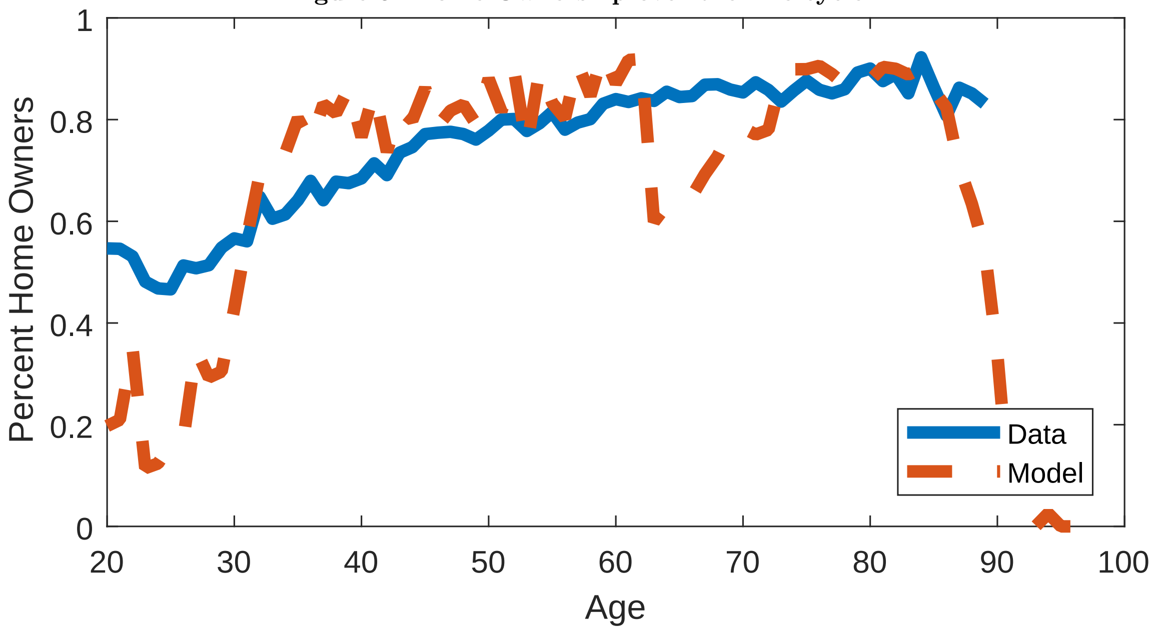

Figure 6: Home Ownership by Income

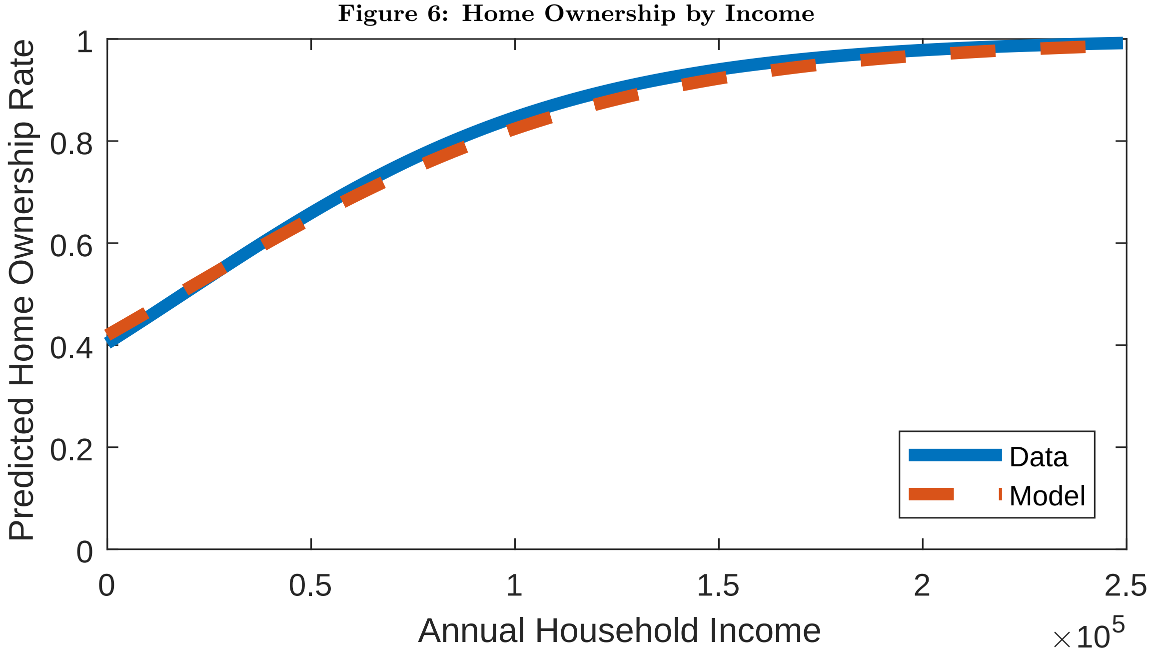

Figure 7: Measuring Progressivity of the Tax Structure

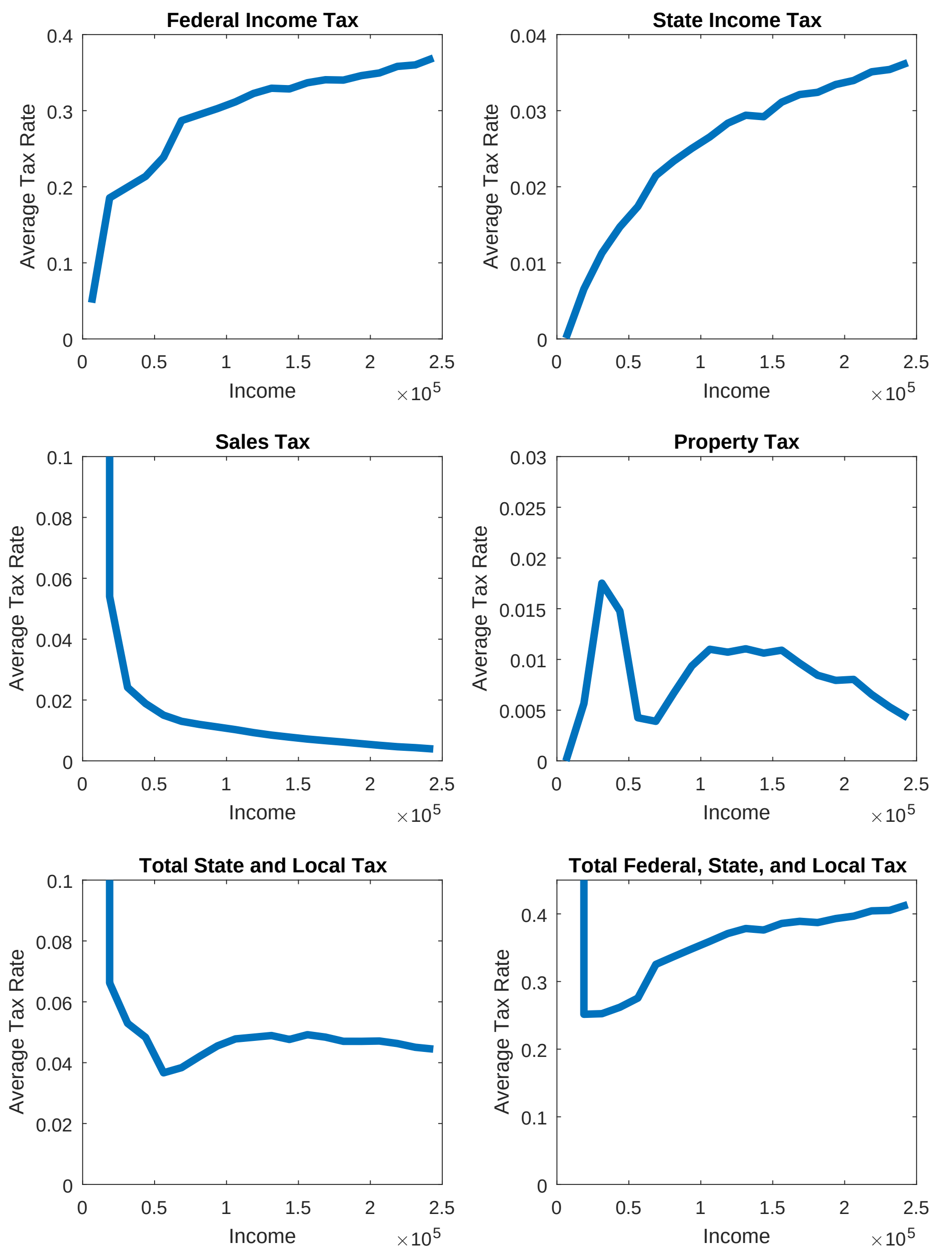

Figure 8: Average Tax Rate Composition: Benchmark

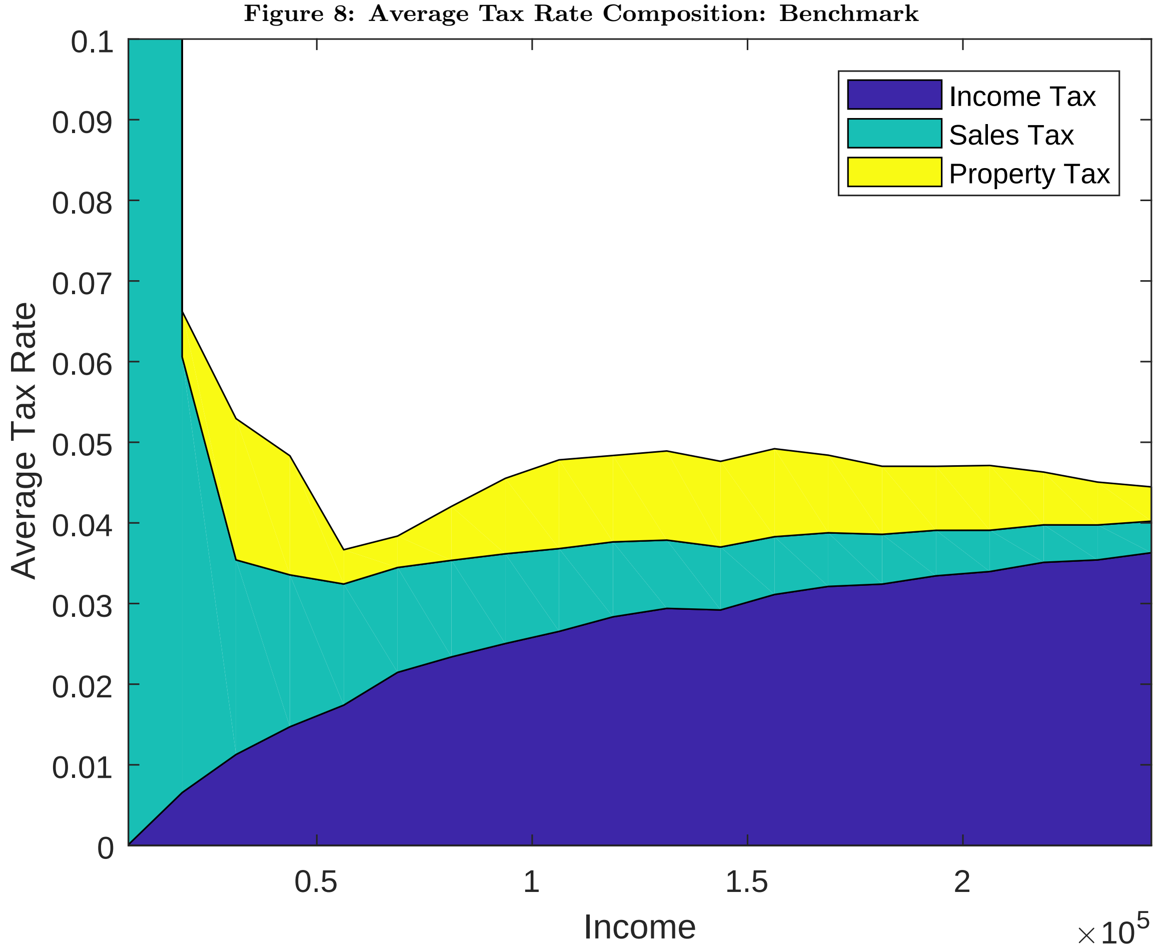

Figure 9: Effect of Eliminating the Federal Tax Deduction on Progressivity

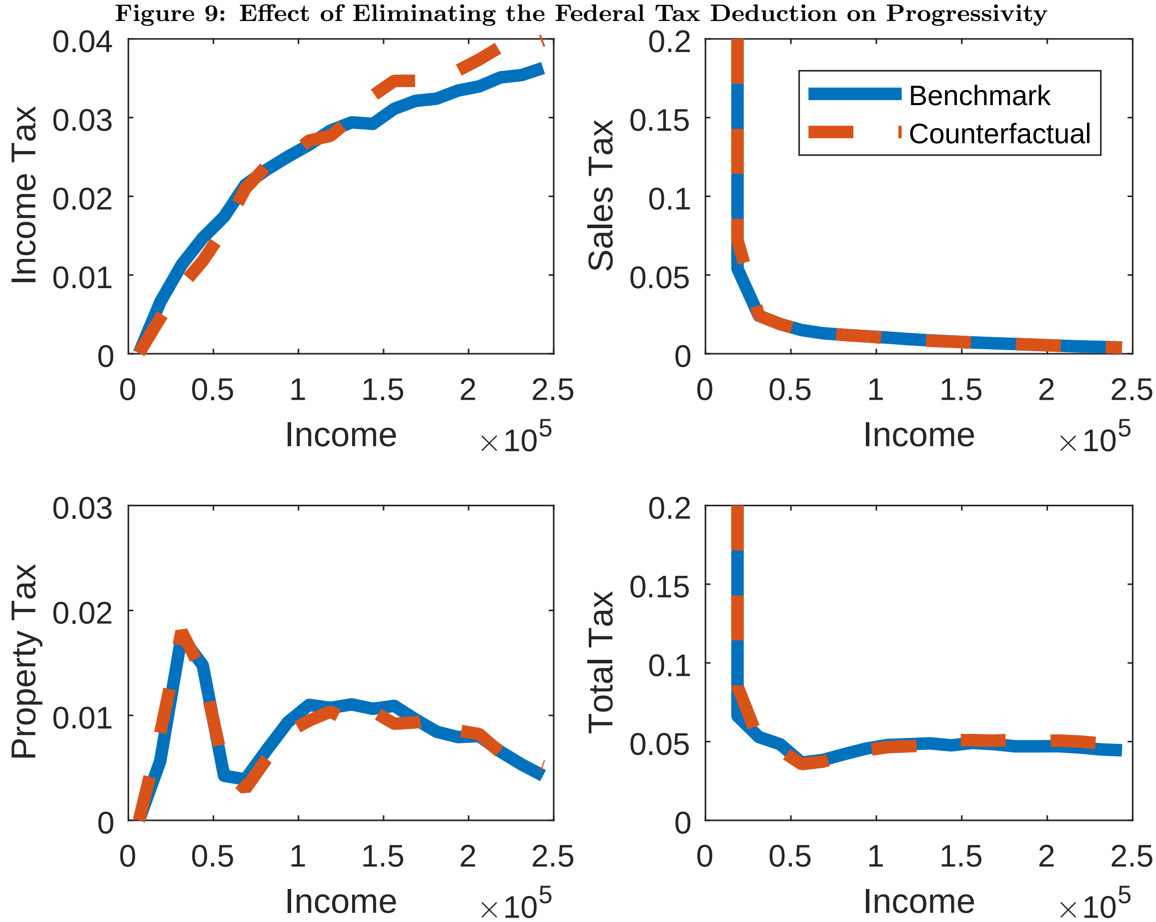

Figure 10: Average Tax Rate Composition: Eliminating Federal Tax Deduction

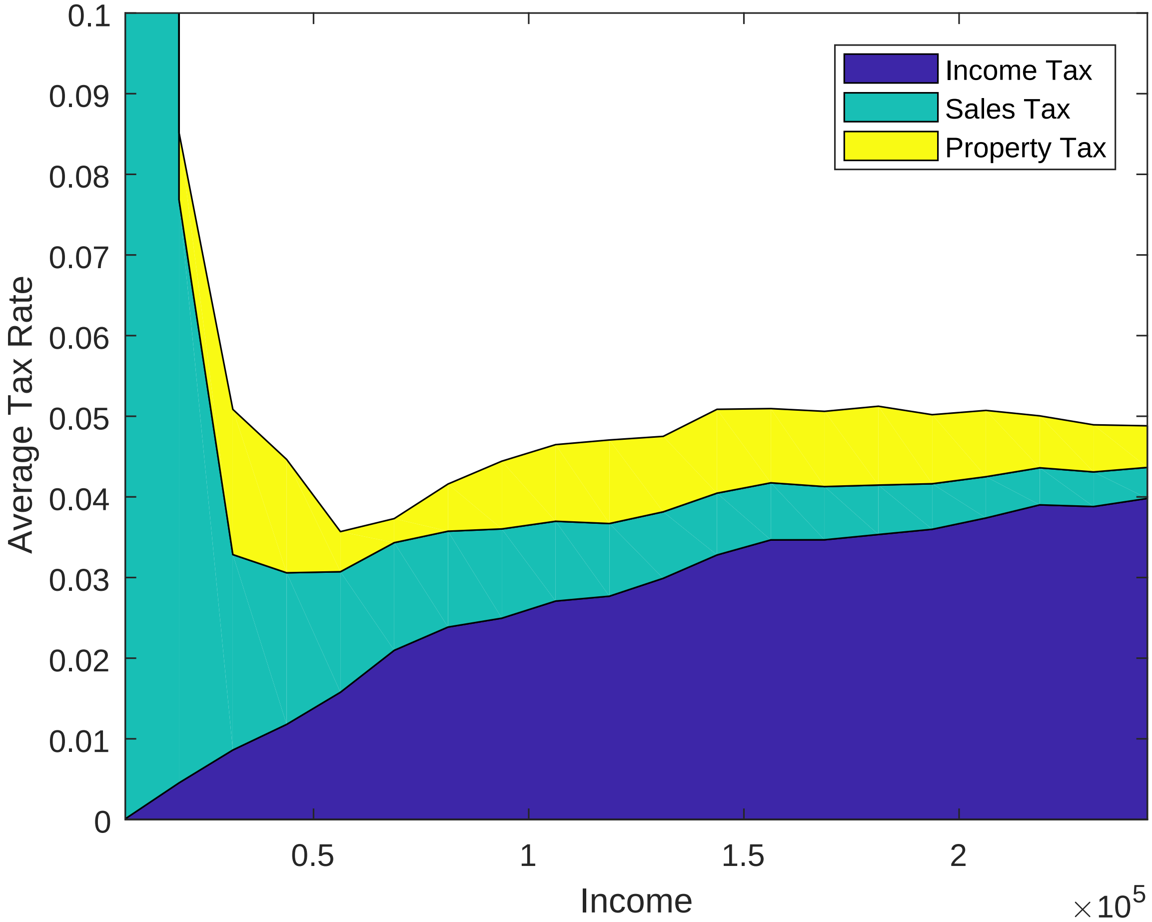

Figure 11: Effect of Eliminating the Federal Tax Deduction on Owned-Home Distribution

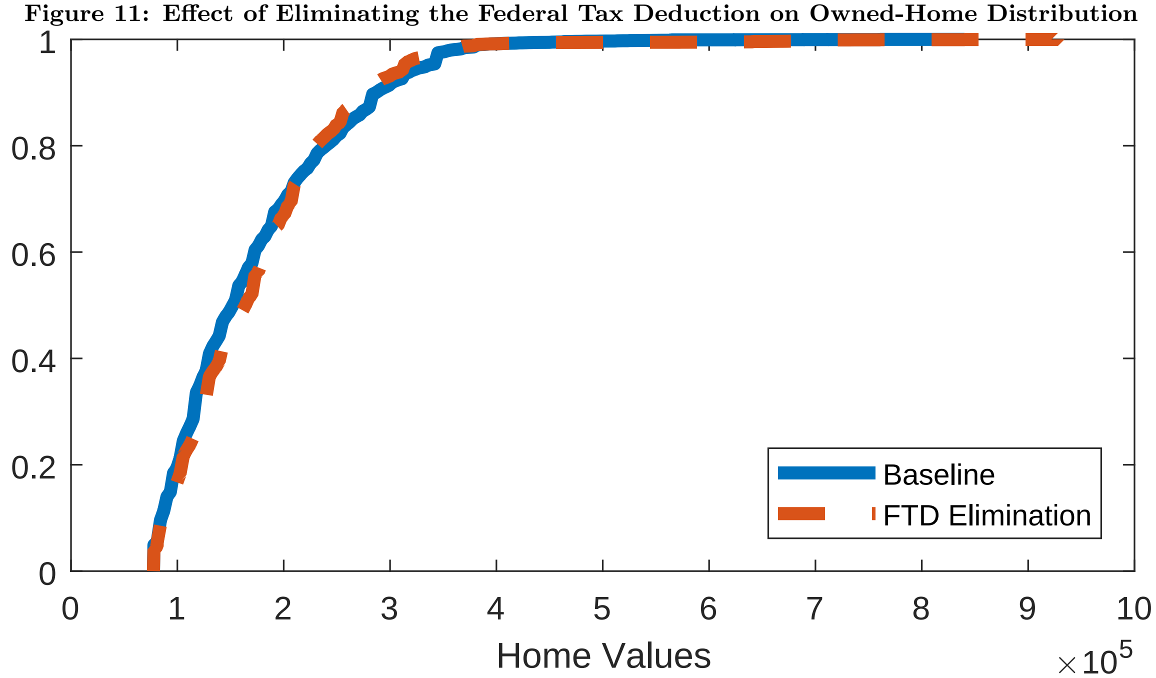

Figure 12: Change in Progressivity from Eliminating the Income Tax

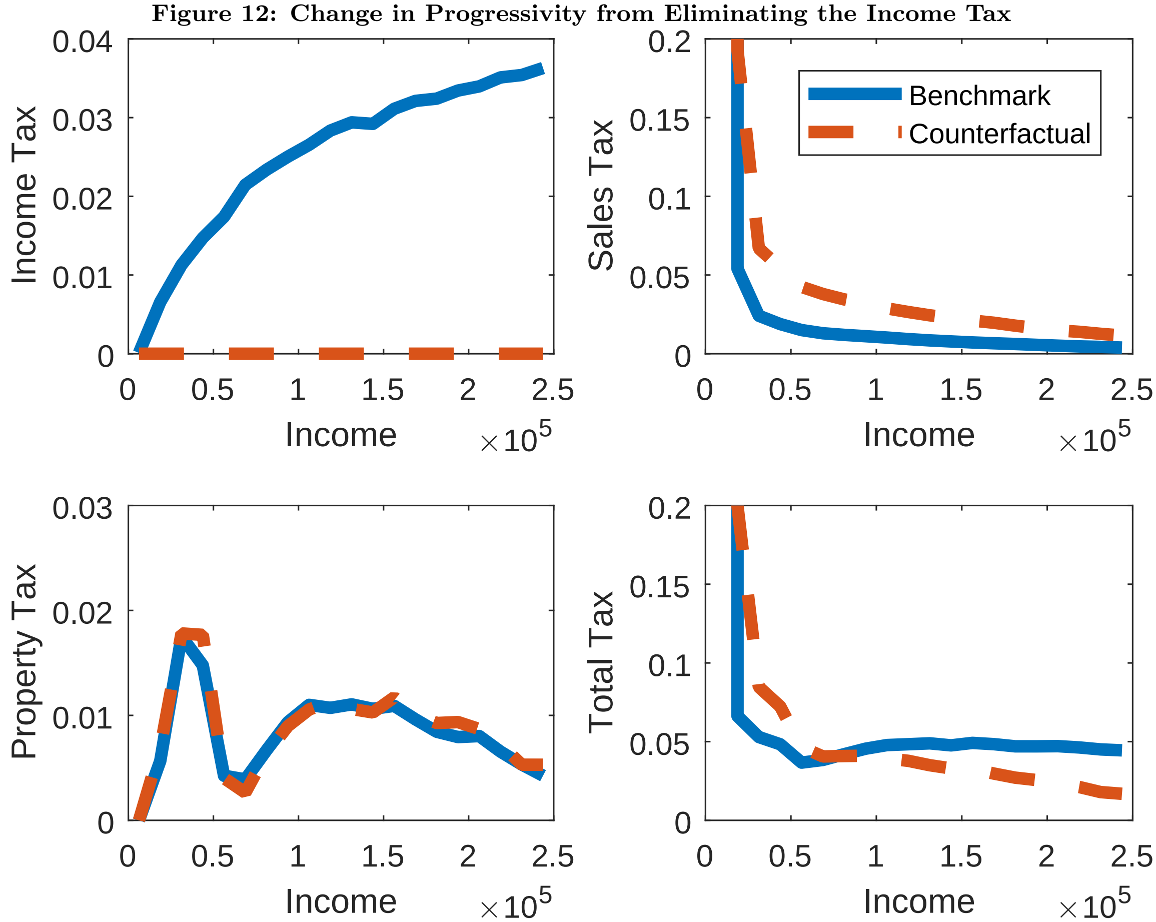

Figure 13: Average Tax Rate Composition: Eliminating Income Tax

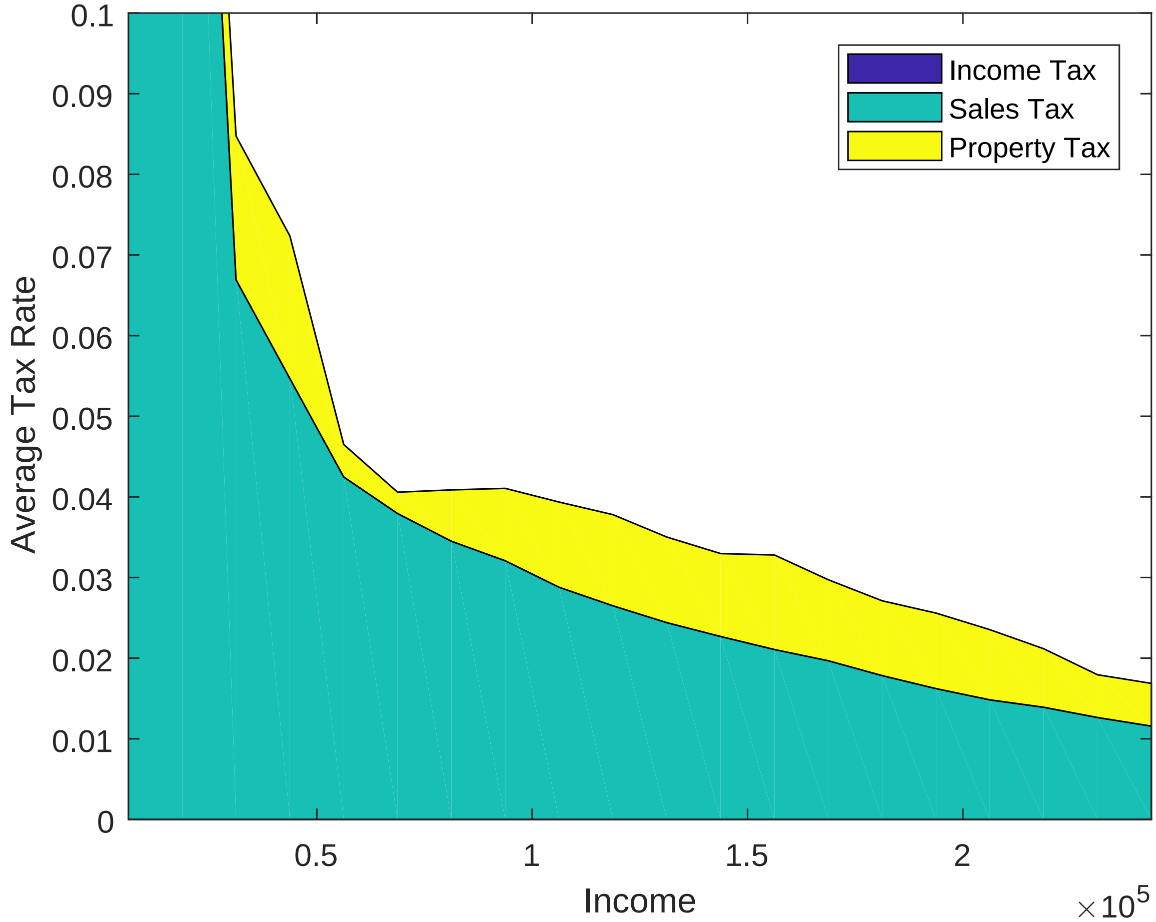

Figure 14: Effect of Eliminating the Income Tax on Owned-Home Distribution

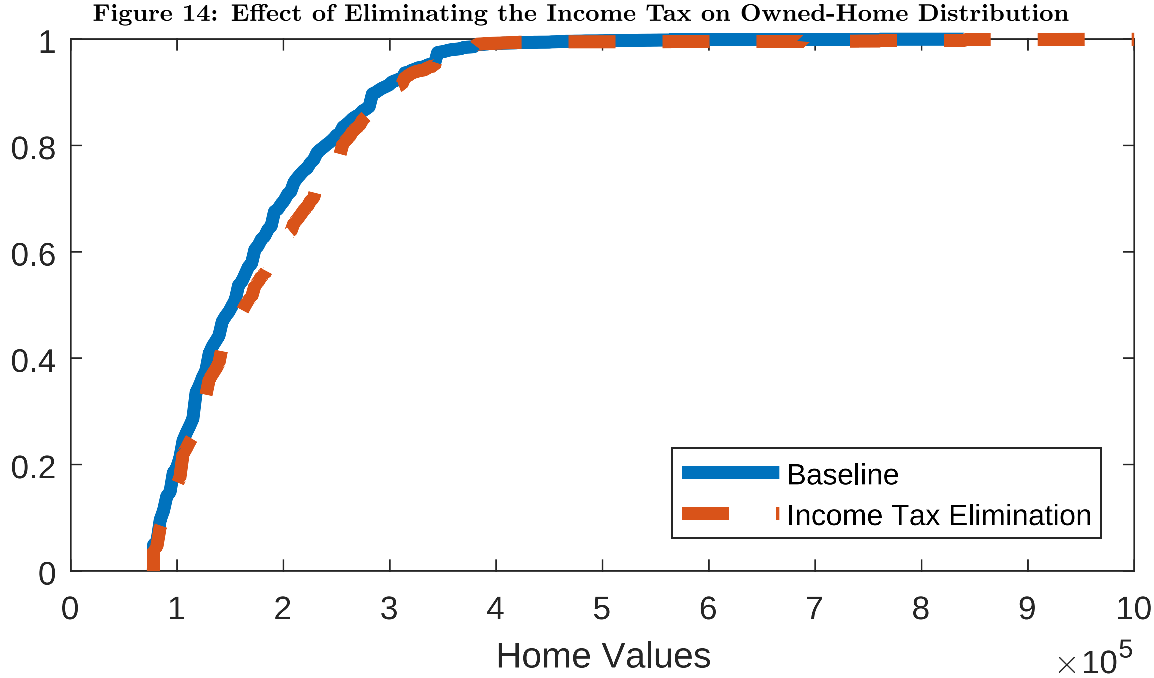

Figure 15: Change in Progressivity from Eliminating the Property Tax

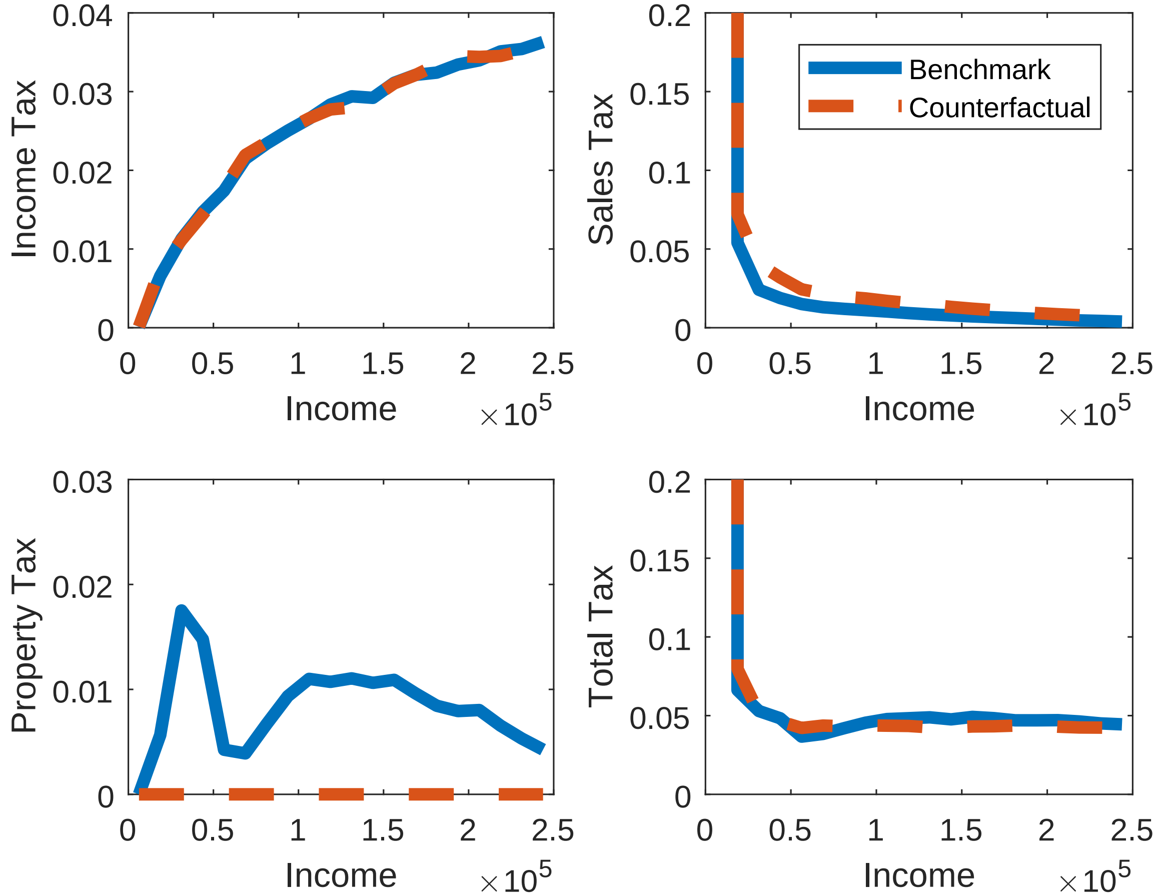

Figure 16: Average Tax Rate Composition: Eliminating Property Tax

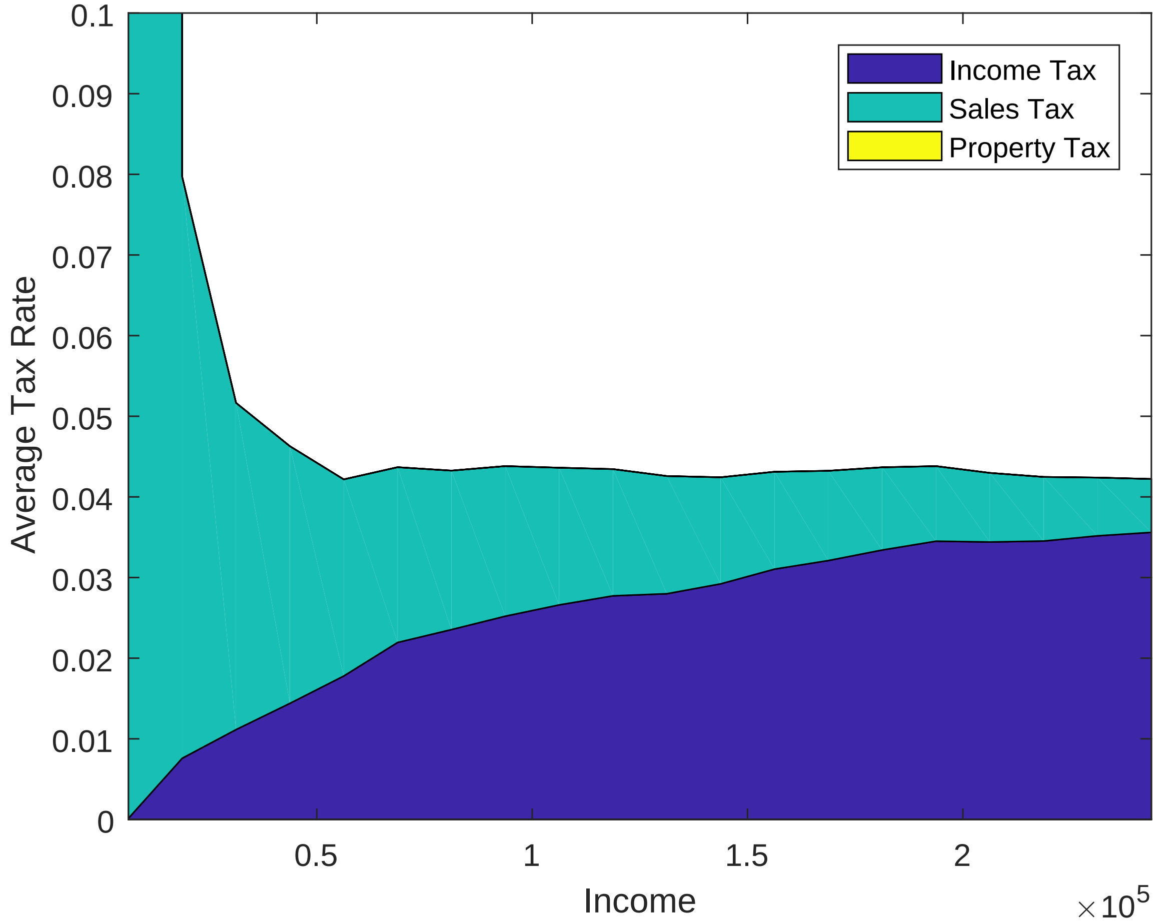

Figure 17: Effect of Eliminating the Property Tax on Owned-Home Distribution

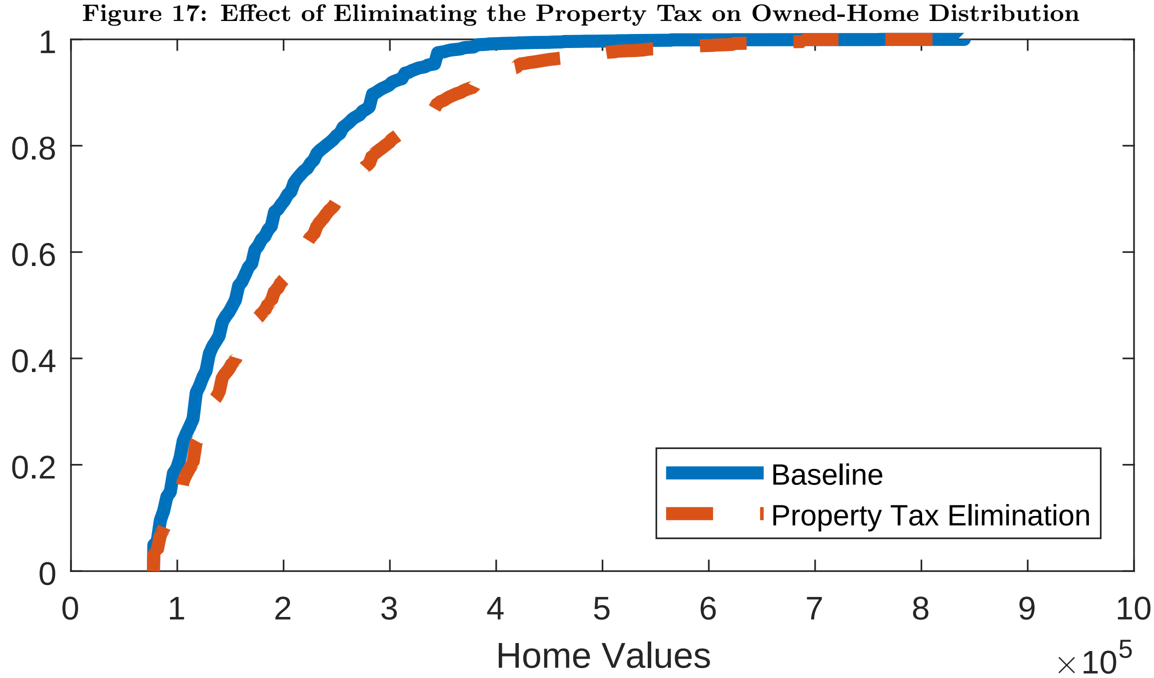

Table 1: Model Parameters

Parameter	Value	Target/Source
Preferences		
Consumption share (χ)	0.25	Average hours
Risk aversion (σ)	3.0	Elas. of Intertemporal Sub.
Discount factor (β)	1.05	Life-cycle ownership rate
Elasticity of substitution (η)	0.145	Ogaki and Reinhart (1998)
Non-housing consumption weight (ω)	0.825	Housing distribution
Demographics		
Maximum lifetime (T)	46	Assumed
Retirement age (T_r)	80	Assumed
Survival probability (s_{j+1})	(See source)	CDC Life Tables (2008)
Population growth (ν)	0.012	Attanasio, et al. (2010)
Marriage probability (p_m)	0.524	CPS data
Housing		
Down payment (θ)	10%	Yang (2009)
Rental shock probability (p_R)	7.1%	Ownership rate
Minimum house value ($\underline{h}$)	1 × per capita income	Housing distribution
Housing depreciation (δ_h)	1.4%	Yang (2009)
Buying costs (ρ_b)	7.0%	Yang (2009)
Selling costs (ρ_s)	2.5%	Yang (2009)
Maximum cost-free value change (ϕ)	7.0%	Yang (2009)
Labor Productivity		
Variance of entering workers (σ_y^2)	0.38	Huggett (1996)
Persistence (ρ)	0.96	Huggett (1996)
Variance of innovation (σ_ε^2)	0.045	Huggett (1996)

Table 2: Gouveia-Strauss Tax Function Parameters

	Single	Married
κ_0^m	0.35000	0.35000
κ_1^m	0.45808	0.41964
κ_2^m	0.00264	0.00261

Table 3: Comparing Housing Data to Model Values

Moment	Data (Source)	Model
Home Ownership Rate	66.7% (CPS)	65.6%
Mean Home Value	$172,430 (ACS)	$171,681
Median Home Value	$140,000 (ACS)	$152,109
Average Annual Property Tax	$1,349 (CPS)	$1083

Table 4: Total Tax Revenue in 2012 by Source (in millions)

Tax Category	Data	Model
Personal Income	$2,754	$3,335
Personal Sales	N/A	$1,763
Residential Property	N/A	$1,237

Table 5: Effects of Eliminating Tax Categories Relative to Benchmark Economy

Moment	Income Tax Elimination	Property Tax Elimination
Average Hours Worked (%Δ)	1.0	1.0
Per-capita Income (%Δ)	-4.4	2.0
Ownership Rate (% points)	1.0	1.0
Average Welfare (%Δ)	0.7	0.2

Table 6: Changes in Tax Revenue by Tax Category (in Percentages)

Tax Category	Income Tax Elimination	Property Tax Elimination
Income	-100.0	0.1
Sales	187.6	71.4
Property	4.8	-100.0