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

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Abstract

This paper presents a dynamic heterogeneous-agent life-cycle model with housing demand to evaluate the economic implications of reforming U.S. state and local personal tax structures. Because of the extensive reliance of state and local governments on income, sales, and property tax revenue, those three taxes are explicitly modeled to generate a baseline and varied to evaluate alternative policy proposals. The results of the model show that the sales tax burden falls evenly across the distribution of income earners, while the property tax burden falls more heavily on the highest income earners. By design, the model's income tax is progressive, so the tax burden shares rise with income. Results also show that the property tax generally improves utilitarian social welfare relative to income and sales taxation, but these welfare gains depend on the availability of a state and local tax deduction on federal income taxes.

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

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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 local fiscal 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 that void 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] Another interesting feature of the Louisiana tax system is the statewide homestead exemption of $75,000 on the municipal property tax bill. This exemption creates progressivity in the property tax and

[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

causes interesting interactions following tax changes that affect the intensive and extensive margins 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 generated from the model and compared to the corresponding estimates from survey data. Results show that many of the model-generated moments provide a realistic match of the survey data moments of the Louisiana economy.

To begin analyzing the state and local tax structure, each individual tax category is measured in terms of the share of the total tax burden borne by each income quintile. This analysis provides insight into the distributional impact of the state and local tax system. The results show that the sales tax burden falls more evenly across all income quintiles, and the income and property tax burdens fall more heavily on the highest income earners. While the property tax share falls more evenly on the bottom 80% of income earners, the income tax remains progressive throughout all quintiles of income.

After evaluating the tax system on the basis of progressivity, the focus turns to understanding the implications of state and local tax policy through counterfactual experiments. In particular, each of the three non-federal taxes is eliminated, and one other tax is expanded to maintain revenue neutrality. This exercise highlights the relative value of eliminating individual tax categories and provides a sense of tax category rank. The utilitarian social welfare function favors property taxes over sales and income taxes. Sales-for-income and income-for-sales tax swaps are both favored over the baseline. This result only holds when the state and local tax (SALT) deduction from federal taxable income is allowed. In particular, the counterfactual experiments are solved again with that deduction fully eliminated, and the welfare benefits of an income-for-sales tax swap disappear. Although the 2017 U.S. federal tax reform only caps the SALT deduction, the two cases studied in this paper provide boundaries on the effects of the deduction. To that extent, the paper offers some implications for federal income tax policy.

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, in a steady-state, 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 the appendix.

2.1 Households

2.1.1 Demographics and Preferences

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}. 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. Spouses in the model share age and survival outcome and operate as an individual household. Marital status affects labor productivity and tax treatment. Agents retire exogenously at age T_r and live for a maximum of T years.

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. The composite good is comprised of service flows s_h from a housing good and a non-housing consumption good c by the constant elasticity of substitution (CES) function:

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

as in Ogaki and Reinhart (1998) and Yang (2009). Agents discount future utility at rate β and receive utility $V(b)$ from leaving a bequest b in the event of non-survival. Following Di Nardi (2004), the bequest value is specified as:

$$V(b) = \alpha_1 \left(1 + \frac{b}{\alpha_2}\right)^{\chi(1-\sigma)}, \tag{3}$$

[5]The term *regional* is used to describe a combination of state and local governments.

where b is the agent's net worth at the end of life. Net worth is characterized below by Equation (16) and Equation (22).

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 $\epsilon(j, m, z)$ depends on age j, marital status m, and a persistent idiosyncratic shock z. The shock z is assumed to follow a first-order autoregressive process:

$$z_{j+1} = \rho z_j + \varepsilon_{j+1}, \tag{4}$$

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 $\pi_z(z_{j+1}|z_j)$. By assumption, the model is a small open economy with constant prices, so wages are normalized to unity. Then, for a household who supplies n units of labor, total labor income is $\epsilon(j, m, z)n$. 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. Let h denote the stock of housing brought into the period, and let h' denote the housing stock chosen by the agent. Any housing stock chosen by the agent, h', is the agent's housing in the current period so that $s_h = h'$ in (2). 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 $\theta h'$ 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:

$$\Phi(h,h') = \begin{cases} 0 & \text{if} \quad \mid h - h' \mid \leq \phi h \\ \rho_s h + \rho_b h' & \text{if} \quad \mid h - h' \mid > \phi h \end{cases} \tag{5}$$

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.

The regional government taxes individuals' income, non-housing consumption, and stock of housing. The regional income tax levy is described below. Non-housing consumption is taxed at a proportional sales tax rate τ_c. Finally, the regional government levies a property tax on an individual's stock of housing: $\tau_p \max\left\{h' - h^E, 0\right\}$, where τ_p is the property tax rate, and h^E is a lump-sum homestead exemption.

Total household income in the model is defined as the sum of capital income and labor income or Social Security benefit: $ra + \epsilon(j,m,z)(1+g)^j n + \mathbf{1}_{\{j \geq T_r\}} ss$. 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 (6) below, whereas interest outlays are treated as mortgage interest and included as an excess itemized deduction, as in (8) below.

We consider first the federal income tax code, which depends on the regional tax, then consider the regional income tax, which depends on the federal income tax.[6] Let y denote a household's total taxable income:

$$y = \max\{ra, 0\} + \epsilon(j, m, z)(1+g)^j n + \mathbf{1}_{\{j \geq T_r\}} ss. \tag{6}$$

Federal adjusted gross income is determined by the following equations:

$$D_{SALT} = \tau_p max\left\{h' - h^E, 0\right\} + \max\left\{\tau^s_m(y^s_m), \tau_c c\right\} \tag{7}$$

$$D_{MI} = |\min\left\{ra, 0\right\}| \tag{8}$$

$$D^f_m = \max\left\{D_{MI} + D_{SALT} + D_{other}, \bar{D}^f_m\right\} \tag{9}$$

$$y^f_m = \max\{y - D^f_m, 0\}, \tag{10}$$

where $\tau^s_m(y^s_m)$ is the regional income tax described below, (7) is the SALT deduction, (8) is the mortgage interest deduction, D_{other} is a constant accounting for other excess itemized deductions, $\bar{D}^f_m$ is the standard deduction (which depends on marital status), (9) determines total federal income tax deductions, and (10) is federal adjusted gross income. The constant D_{other} is calibrated to match the share of households that itemize deductions. Federal tax liability is then a function

[6]Details of the solution method for this fixed-point problem are described in the appendix.

of federal adjusted gross income: $\tau_m^f(y_m^f)$.

As mentioned in the introduction, Louisiana and five other states allow federal income taxes to be deducted at the state level. Louisiana also allows for the deduction of all federal tax deductions, which includes the SALT deduction itself. Accordingly, regional income taxes are specified as follows:

$$D_m^s = D_m^f + \tau_m^f(y_m^f) \tag{11}$$

$$y_m^s = \max\{y - D_m^s, 0\}, \tag{12}$$

where (11) specifies the regional income tax deductions, (12) defines regional adjusted gross income, and regional income taxes are a function of state adjustable gross income: $\tau_m^s(y_m^s)$.

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 $\bar{y}^{ss}$ and a proportional Medicare tax τ_m on all labor income. In retirement years, individuals receive lump-sum Social Security payments ss from the federal government.

2.3 Household Optimization

The value function of a household 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 Owning

The value of choosing to own a home for an agent of marital status m, age j, assets a, housing stock h, and productivity shock z is represented by the following Bellman equation:

$$\begin{aligned} V_O^m(j,a,h,z) = \max_{a',h',n} u(\tilde{c}, 1-n) + s_{j+1}\beta E_{\{z'|z\}}[(1-p_R)V^m(j+1,a',h',z') \\ + p_R V_R^m(j+1,a',h',z')] + (1-s_{j+1})V((1-\delta_h)h'+a') \end{aligned} \tag{13}$$

$$\text{s.t. } c = (1+r)a - a' + (1-\delta_h)h - h' - \Phi(h,h') + \epsilon(j,m,z)(1+g)^j n + \mathbf{1}_{\{j\geq T_r\}} ss - \tau \tag{14}$$

$$a' \geq -(1-\theta)h' \tag{15}$$

$$(1-\delta_h)h' + a' \geq 0 \tag{16}$$

$$h' \geq \underline{h} \tag{17}$$

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

$$\begin{aligned} \tau = & \tau_m^f(y_m^f) + \tau_{ss} min\left\{\epsilon(j,m,z)(1+g)^j n, \bar{y}^{ss}\right\} + \tau_m \epsilon(j,m,z)(1+g)^j n \\ & + \tau_m^s(y_m^s) + \tau_c c + \tau_p max\left\{h' - h^E, 0\right\}, \end{aligned} \tag{19}$$

where $\tilde{c}$ is determined according to (2), and current-period utility from housing is derived from housing choice 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 $\epsilon(j,m,z) = 0$, and optimal labor supply is zero for the remainder of the life-cycle.

2.3.2 Renting

The renting problem is similar to the owning 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:

$$V_R^m(j,a,h,z) = \max_{a',e,n} u(\tilde{c}, 1-n) + s_{j+1}\beta E_{\{z'|z\}}[(1-p_R)V^m(j+1,a',0,z') + p_R V_R^m(j+1,a',0,z')] + (1-s_{j+1})V(a') \tag{20}$$

$$\text{s.t. } c = (1+r)a - a' + (1-\delta_h)h - q^R e - \Phi(h,0) + \epsilon(1+g)^j n + \mathbf{1}_{\{j \geq T_r\}} ss - \tau \tag{21}$$

$$a' \geq 0 \tag{22}$$

$$e \geq 0 \tag{23}$$

$$n \in [0,1] \tag{24}$$

$$\tau = \tau_m^f(y_m^f) + \tau_{ss} min\left\{\epsilon(j,m,z)(1+g)^j n, \bar{y}^{ss}\right\} + \tau_m \epsilon(j,m,z)(1+g)^j n + \tau_m^s(y_m^s) + \tau_c c, \tag{25}$$

where rental housing choice e enters (2) in the place of s_h.

2.3.3 Housing Decision and Welfare Function

The final step in determining the value function V^m involves a discrete choice between renting and owning when the agent does not receive a rental shock. Let V_O^m denote the value of choosing to own, characterized by (13) - (19), and let V_R^m denote the value of renting, characterized by (20) - (25). Then the discrete choice for a household that did not receive a rental shock is:

$$V^m(j,a,h,z) = max\left\{V_O^m(j,a,h,z), V_R^m(j,a,h,z)\right\}. \tag{26}$$

Let x denote an household's state vector over the state space, let $V(x)$ denote the value function over that state space, and let ψ denote the probability measure over that state, as described in the appendix. Then, the utilitarian social welfare function referenced throughout this paper is can be represented mathematically as:

$$W = \int_{\mathcal{X}} V(x) d\psi(x). \tag{27}$$

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. All data values are specific to residents of Louisiana. 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 and details of the computation are provided in the appendix.

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 Current Population Survey (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 0.5 generates an average labor supply corresponding to 31% of the time endowment. Together, these parameters generate a coefficient of relative risk aversion of 2 and an elasticity of intertemporal substitution of 0.5. The discount factor is set to $\beta = 0.99$, which, together with bequest value and rent shock probability, generates a realistic age-profile of home ownership. The Frisch labor supply elasticity is

1.5, 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 $\omega = 0.91$ to help match the distribution of home values. Without bequest value, an unreasonably high discount factor is needed to generate the home ownership rate, and the life-cycle match is poor. Adding bequest value allows for a reasonable discount factor and generates a realistic home ownership profile, especially late in life. The parameters of the bequest function are derived from De Nardi (2004).

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 3%, 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 American Community Survey (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 for single and married households is estimated from the CPS and displayed in Figure 1. These productivity-age profiles are 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 for each marital type. 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 Louisiana housing distribution in the data. The rental shock probability $p_R = 0.10$ 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. Following several papers in the incomplete-markets literature, the federal income tax bill is approximated by a Gouveia-Strauss tax function:

$$\tau_m^f(y) = \kappa_0^m (y - (y^{-\kappa_1^m} + \kappa_2^m)^{-\frac{1}{\kappa_1^m}}). \tag{28}$$

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 adjusted gross income 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. Finally, the additional excess itemized deductions parameter, D_{other}, is calibrated to match the share of Louisiana households that itemize, which is between 20-25%[7]. The parameter is set to \$6,200, which generates 20.6% of itemizing households in the baseline.

The U.S. federal government also levies Social Security and Medicare taxes evenly between employers and employees. The incidence of the tax is assumed to be proportional to its levy. Therefore, the agent pays only the employee portion of the Social Security tax, $\tau_{ss} = 0.062$, on income up to a maximum $\bar{y}^{ss} = \$110,000$ and the employee portion of the Medicare tax, $\tau_m = 0.0145$.

The state tax system is modeled after the State of Louisiana and the local governments therein.

[7] https://research.stlouisfed.org/publications/economic-synopses/2017/08/17/state-variation-of-tax-deductions/

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 also 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 Barro (2014), 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, the property tax rate is set to 1.5% of the property value after the deduction of a $75,000 homestead exemption, which provides a reasonable match of average property taxes as shown in Table 3.

4 Quantitative Results

4.1 Model vs. Data

Moments from the calibrated model are compared to income, housing, and other economic 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 40. Model hours, however, increase sharply in the remaining working years, while data hours steadily decline over that phase. This seems to be a feature of dynamic housing models with endogenous labor, as in Iacoviello and Pavan (2013). That paper displays a similar labor supply pattern over the life-cycle, which the authors argue finds support in the empirical literature.

The model parameters deliver a realistic match of the remaining data moments. 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 close match to the income distribution, as shown in Figure 3, though it understates 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-generated distribution. Figure 5 shows that the model can also generate a reasonable match of the home ownership rate over the life-cycle. Volatility in this series is the result of numerical error caused by the distribution solution method. 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.

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.[8] Therefore, total tax revenue in each tax category is calculated by:

$$\text{Total Tax Revenue} = \text{Number of Households} \times \text{Average Taxes Paid.} \tag{29}$$

While personal tax revenue collected is only available for the Louisiana personal income tax, Table 4 provides the model estimates.[9]

4.2 Tax Progressivity

In a simple static environment, the CES utility function over housing and non-housing consumption in (2) would result in constant shares of housing and non-housing demand as income changed. We can see traces of this mechanism by considering the housing share of total consumption over the life-cycle shown in Figure 6.[10] With the exception of periods near retirement, housing share of consumption remains reasonably stable. Although several additional factors interact in this model, the intuition suggests that income tax progressivity does not distort the ratio of housing to non-housing demand and that changes in this ratio are driven by the relative property and sales taxes.

Figure 7 shows how the burden of each tax falls across different quintiles of the income dis-

[8] https://www.census.gov/quickfacts/LA

[9] Income tax revenue for Louisiana is the value reported in Richardson and Albrecht (2014).

[10] Note that housing demand here does not distinguish between owned and rented housing.

tribution. Each bar in the graph represents the share of aggregate taxes paid by the respective income quintile. For the income tax, these shares steadily increase across income quintiles, making it the most progressive of the three taxes. The highest income quintile pays roughly 45% of property taxes, with the bottom four quintiles paying similar shares. Finally, the sales tax is the least progressive, with the top and bottom income quintiles differing by less than five percentage points.

Since the state levies a progressive income tax, the tax shares, by design, rise with income quintile. The highest income quintile pays more than half of all income taxes, and the top four quintiles pay roughly twice as much as the next lower quintile. By contrast, the sales tax burden falls much more evenly across income quintiles. This result might be expected in a model where agents are motivated to smooth consumption across time and across states of nature. The largest property tax burden clearly falls on the top income quintile, but shares are fairly even across all other quintiles. Retirees in the model continue owning homes even though their incomes decline, which reduces the progressivity of the property tax.

5 Policy Evaluation

This section presents the quantitative results from reforms to the state and local tax structure. Each reform involves the elimination of one tax category and expansion of one other tax category to maintain state and local government budget neutrality. Sales and property tax expansions are implemented by percentage point increases in the respective tax rates, while income tax expansions are implemented by proportional increases ε in the income tax function: $(1+\varepsilon)\tau_m^s(y_m^s)$. With three tax categories at the state and local level, this implies six possible combinations of tax reforms.

The SALT deduction at the federal level distorts the behavioral and welfare implications of tax reform at the state and local level, so the set of counterfactuals is solved once with full SALT deductibility and once with the SALT deduction entirely eliminated. Although the 2017 tax reform capped the SALT deduction at $10,000, proposals to reform this deduction are ongoing, and the 2017 provision itself is set to expire. Accordingly, the set of reforms is instead evaluated at each extreme to provide a range of outcomes. All counterfactuals in the case of no SALT deduction are relative to an alternative benchmark where there is no SALT deduction.

The results of the counterfactual experiments in the case of full SALT deductibility are summarized in Table 5. To evaluate the effects of the tax reforms, changes to welfare and economic variables, such as hours worked, home ownership rate, income, and state and local tax burden by income quintile are included. Because of the influential role of the SALT deduction, the percentage point change in share of itemizers, as well as the percent change in total federal tax liabilities of households are also included.

Table 5 shows improvements to social welfare in cases where property taxes are expanded and cases where income taxes are eliminated. A shift towards sales taxes is only favorable when the income tax is being eliminated, but a shift away from sales taxes and towards income taxes is also favored over the benchmark. This latter result depends on the availability of the SALT deduction. Because the deduction is calculated by taking the greater of income or sales taxes paid, an income tax (and no sales tax) or a sales tax (and no income tax) reduces constituents' federal tax liabilities relative to a combination of income and sales taxes. Table 6 supports this claim, as the welfare improvement from a sales-for-income tax swap turns negative in the case of no SALT deduction.

The results also show how alternative tax structures affect several competing incentives, including how much to work and how much housing to own. Specifically, there is a close positive relationship between labor hours and home ownership, as they relate to policy changes. Dietz and Haurin (2003) review the empirical housing literature and corroborate this finding with cases relating home ownership to higher labor supply, especially for married women. Therefore, policies that discourage home ownership, such as a sales-for-property tax swap, also decrease labor hours and income.

The availability of a SALT deduction dampens the effects of shifts towards property taxation and amplifies the effects of shifts away from property taxation. This happens because the SALT deduction both reduces the effective property tax bill and makes the mortgage interest deduction more effective by increasing the share itemizers. Both effects combine to reduce the costs of home ownership for households that itemize deductions. This effect can be seen by comparing the changes in home ownership rate in Table 5 and Table 6. Additionally, because of the relationship between home ownership and labor hours, the SALT deduction indirectly affects households' average income.

Although the results of these experiments provide guidance to state and local policymakers, the results also have implications for federal tax policy. In particular, the SALT deduction was shown to mitigate the effects of property taxation. Property taxes are often used to finance public schools, which is a common defense in favor of maintaining the deduction. Federal policymakers, however, should be aware that the current design of the policy encourages the elimination of either the sales or income tax.

In both cases of SALT deduction availability, the property tax showed a persistent welfare improvement over alternative reforms. It is of interest, then to know whether a shift to a singular property tax with income taxes and sales taxes entirely eliminated might further improve welfare. Indeed, in both cases, the singular property tax yields an improvement over all other alternatives. However, while states often propose to eliminate one of three taxes or expand from two to three tax categories, serious attempts to impose a singular tax seem to be quite rare.

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 state and local fiscal policy.

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 also 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 the least progressive, while the income tax is the most progressive. Additionally, the total state and local tax burden falls more heavily on higher income quintiles.

The model evaluated elimination and expansion of broad tax categories. The results of these experiments included several behavioral effects of the reforms, as well as utilitarian social welfare gains or losses. Welfare measures favored property taxes over income and sales taxes and generally favored sales over income taxes. This result depended on the availability of the SALT deduction from federal taxable income, which broadened the scope of this model to implications of federal-level policy.

While the model provides a broad framework for analyzing state and local fiscal policy, several extensions could overcome some of its limitations. For example, the model focuses on the effects of personal taxation. In reality, state and local income, sales, and property taxes are often also levied onto businesses. A more complete economic model would include the effects of state and local taxes levied on businesses in addition to households. 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 risk-mitigating role of 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

A. Equilibrium Definition

The model regions are assumed to be sufficiently small such that wages and interest rates are determined exogenously. The small open economy 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 $x = \{m, R, z, a, h, j\}$, where $m \in \mathcal{M} = \{0, 1\}$, $R \in \mathcal{R} = \{0, 1\}$, $z \in \mathcal{Z} = \{z_1, \ldots, z_N\}$, $a \in \mathcal{A} = [\underline{a}, \infty)$, $h \in \mathcal{H} = [0, \infty)$, and $j \in \mathcal{J} = \{1, \ldots, T\}$. Define the state space to be $\mathcal{X} = \mathcal{M} \times \mathcal{R} \times \mathcal{Z} \times \mathcal{A} \times \mathcal{H} \times \mathcal{J}$, 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:

$$\psi'(\mathcal{X}) = \int_{\mathcal{X}} Q(x, \mathcal{X}) d\psi. \tag{30}$$

B. 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 weigh the estimates of the Gouveia-Strauss parameters and measure the profile of home ownership by age and weekly hours worked. To weigh the Gouveia-Strauss tax function for estimation, household adjusted gross income (ADJGINC) was used. Estimates of the age profiles 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.

C. Computation

The Bellman equation of the household is solved using backwards induction over the discretized state space. At each point in the discretized state space, the value function is solved using numerical optimization and interpolation over continuation values. Because of the non-convexity of the household adjustment cost function, the solution method involves partitioning housing choice (in the case of ownership) into three subsets: $h' < (1-\phi)h$, $h' > (1+\phi)h$, and $(1-\phi)h \leq h' \leq (1+\phi)h$. The optimization problem is solved once for each of these cases and once without partitioning the constraint set to maximize the likelihood of arriving at an optimal solution. Then, the maximum of the four optimization problems is accepted as the maximum to the problem.

Another complication is the interdependence of regional taxes, federal taxes, and consumption. The set of equations characterizing each of these must hold simultaneously, which requires a nested fixed-point problem in each iteration of the optimization routine. The algorithm requires initial guesses of sales taxes and the regional income tax deduction. Then, regional income taxes are computed, which allows the SALT deduction and federal taxes to be computed. Finally, consumption is calculated, all values are updated, and this process iterates until regional taxes, federal taxes, and consumption each converge.

The distribution is solved using discrete measures over the state space. Transition rules are determined by decision rules and probability transitions over the state space. Probability masses are split into bounding nodes of the discretized state space in magnitude of the proximity of the decision rule to the respective nodes. Then, the discrete housing choice corresponds to the optimal decision at that node. As shown in Figure 5, this procedure results in some numerical error.

Figure 1: Labor Productivity Profiles

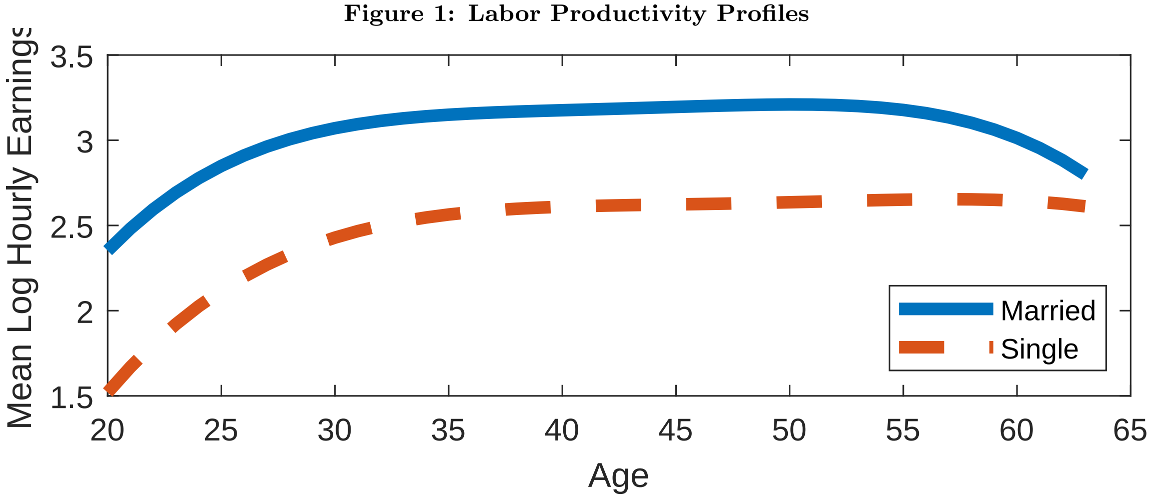

Figure 2: Labor Supply Profile

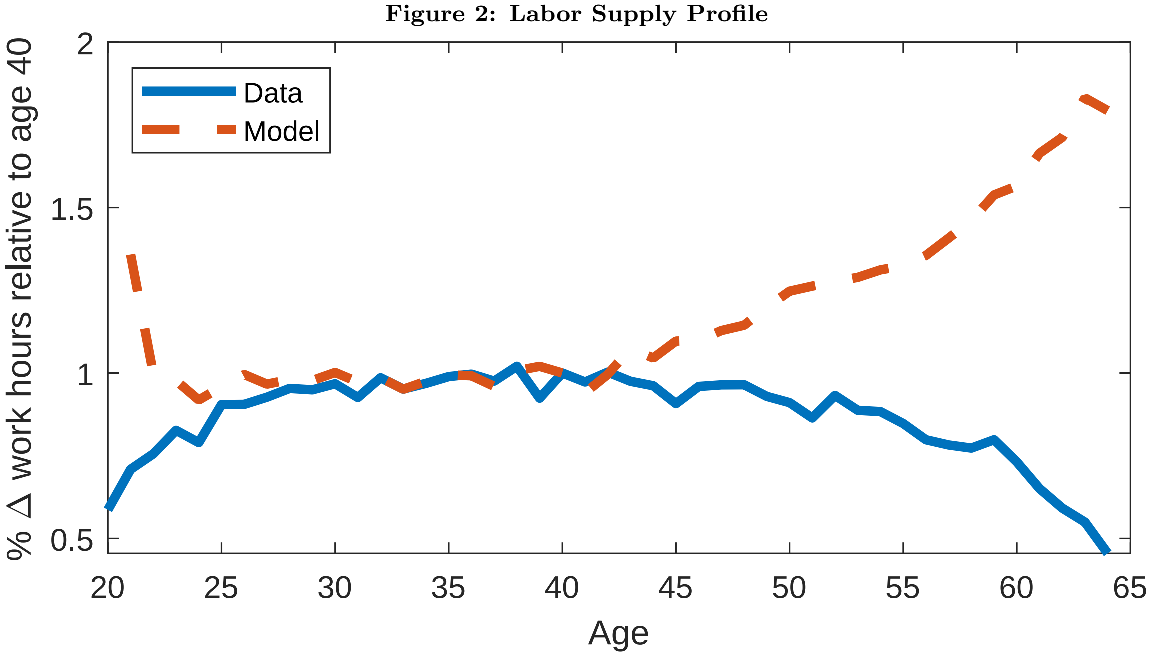

Figure 3: CDF of Household Income

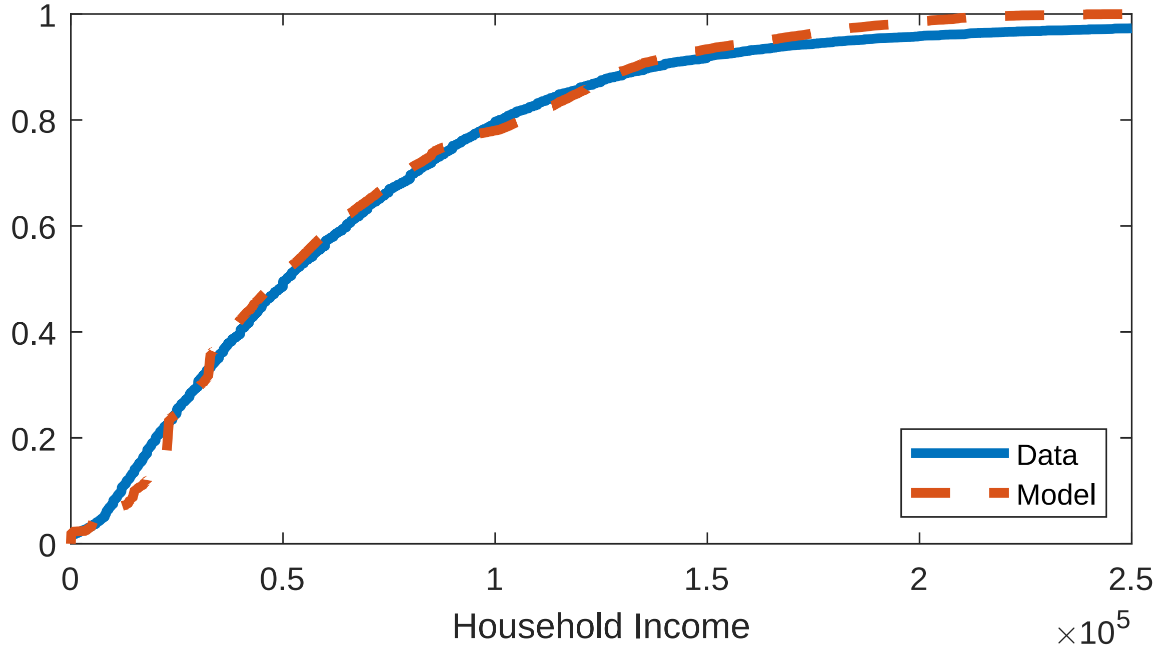

Figure 4: CDF of Owned-home Values

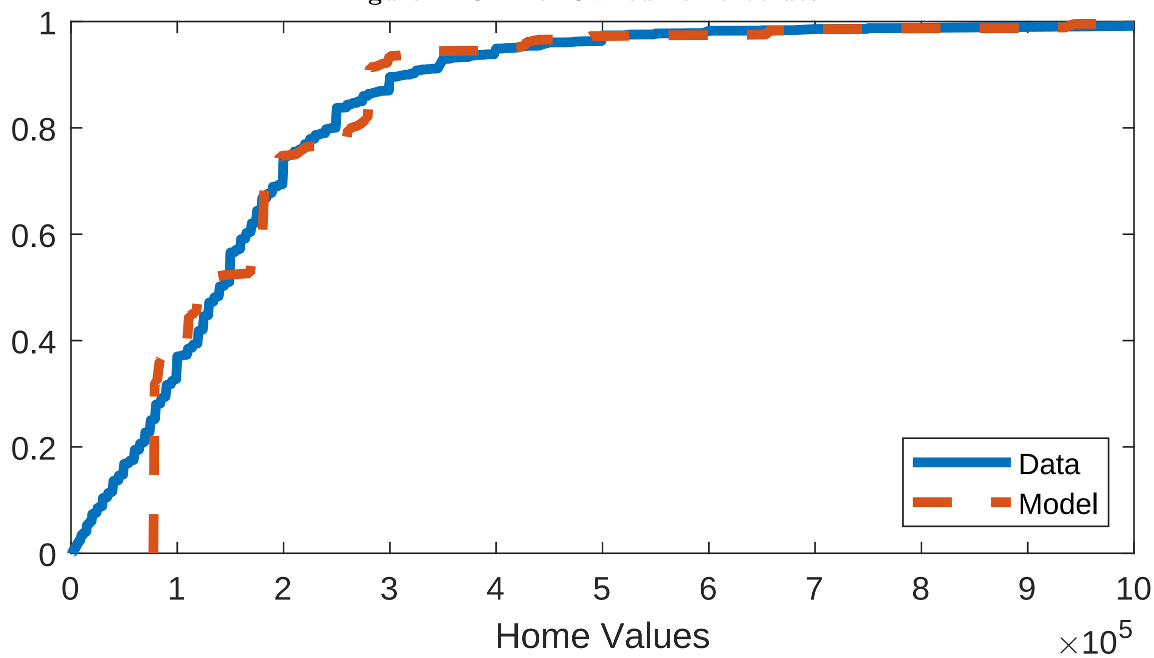

Figure 5: Home Ownership over the Life-cycle

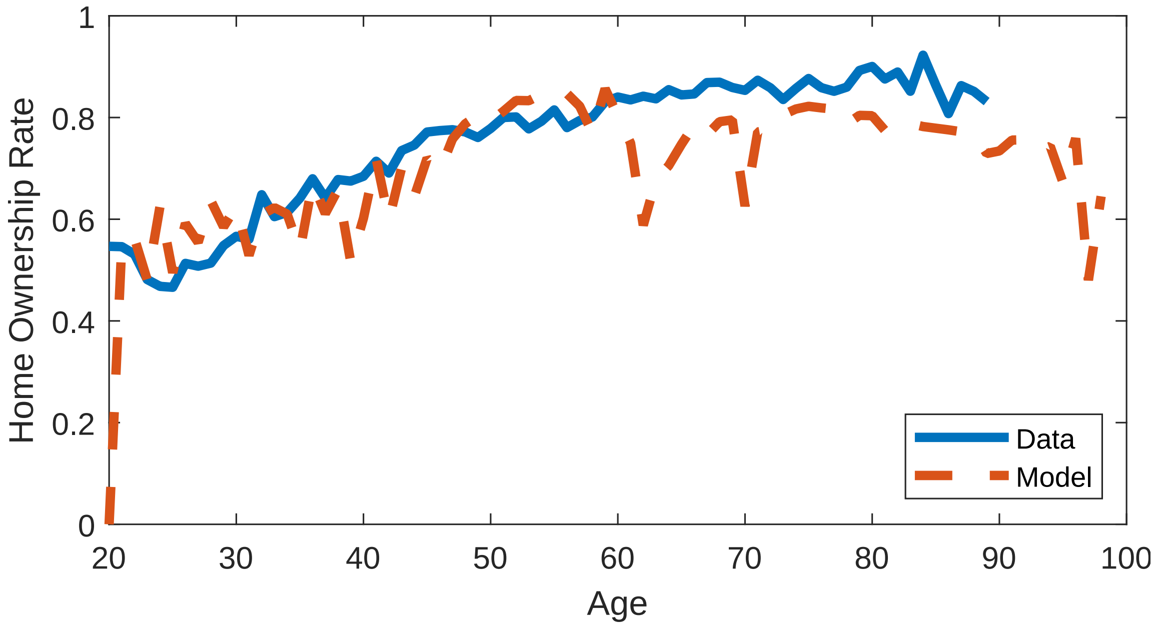

Figure 6: Housing Share of Consumption over the Life-cycle

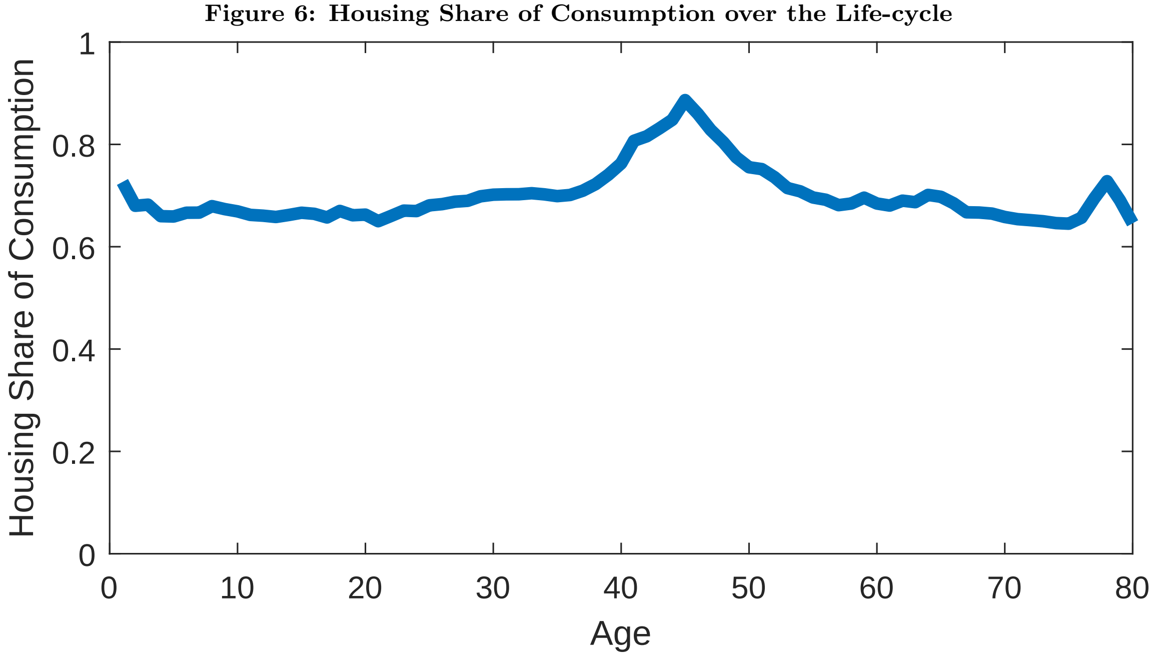

Figure 7: Measuring Progressivity of the Tax Structure

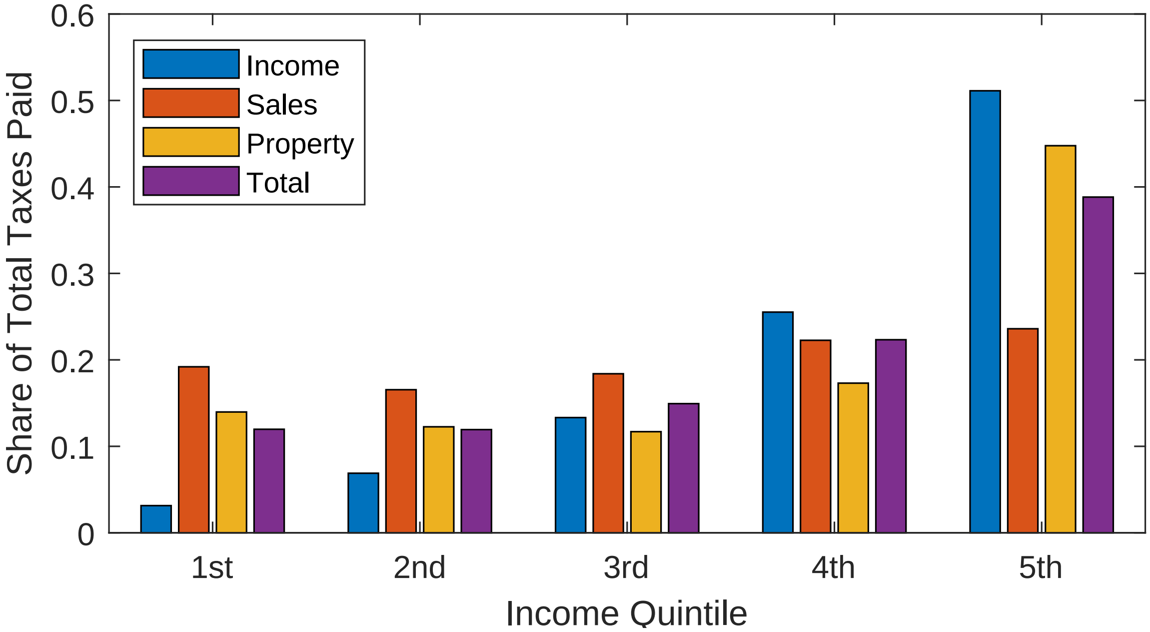

Table 1: Model Parameters

Parameter	Value	Target/Source
Preferences		
Consumption share (χ)	0.50	Average hours
Risk aversion (σ)	3.0	Elas. of Intertemporal Sub.
Discount factor (β)	0.99	Life-cycle ownership rate
Elasticity of substitution (η)	0.145	Ogaki and Reinhart (1998)
Non-housing consumption weight (ω)	0.91	Housing distribution
Bequest value (1) (α_1)	-9.5	De Nardi (2004)
Bequest value (2) (α_2)	11.6	De Nardi (2004)
Demographics		
Maximum lifetime (T)	80	Assumed
Retirement age (T_r)	46	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)	10%	Ownership rate
Minimum house value ($\underline{h}$)	1 $\times$ 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

Parameter	Single	Married
κ_0^m	0.35000	0.35000
κ_1^m	0.31400	0.40148
κ_2^m	0.00750	0.00305

Table 3: Comparing Housing Data to Model Values

Moment	Data (Source)	Model
Home Ownership Rate	66.7% (CPS)	66.9%
Mean Home Value	$172,430 (ACS)	$176,193
Median Home Value	$140,000 (ACS)	$123,521
Average Annual Property Tax	$1,349 (CPS)	$1,196

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

Tax Category	Data	Model
Personal Income	$2,754	$3,341
Personal Sales	N/A	$3,509
Residential Property	N/A	$2,080

Table 5: Tax Reform under Full SALT Deductibility

tax eliminated	Income	Property	Income	Sales	Sales	Property
tax expanded	Sales	Sales	Property	Property	Income	Income
%Δ welfare	2.43	-0.73	2.96	2.51	0.01	-1.16
ppt. Δ itemizers	6.09	-7.62	-0.58	4.81	0.04	-0.74
%Δ fed. taxes	2.91	5.87	-2.88	-5.02	0.09	4.71
ppt. Δ ownership	-0.06	5.49	-4.42	-5.00	0.15	5.90
%Δ hours	2.19	6.03	-3.26	-4.68	0.11	5.92
%Δ income	2.43	3.81	-1.13	-2.29	0.07	3.33
ppt. Δ quintile 1	5.37	-1.10	2.61	-3.79	0.06	-4.46
ppt. Δ quintile 2	4.12	0.99	1.19	-1.24	-0.02	-1.28
ppt. Δ quintile 3	1.80	2.36	1.41	-1.95	-0.00	1.49
ppt. Δ quintile 4	-1.41	2.07	-2.93	-2.56	-0.02	3.09
ppt. Δ quintile 5	-9.88	-4.33	-2.28	9.53	-0.02	1.16

Table 6: Tax Reform under No SALT Deductibility

Tax Eliminated	Income	Property	Income	Sales	Sales	Property
Tax Expanded	Sales	Sales	Property	Property	Income	Income
%Δ welfare	1.60	-1.30	2.97	1.52	-1.36	-2.33
ppt. Δ itemizers	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
%Δ fed. taxes	-0.13	3.34	-5.22	-6.49	-0.08	2.84
ppt. Δ ownership	-1.84	4.07	-6.98	-6.71	1.04	5.13
%Δ hours	-0.79	4.08	-6.59	-7.11	0.11	4.09
%Δ income	0.01	2.31	-3.35	-4.50	-0.08	1.78
ppt. Δ quintile 1	5.86	0.13	5.23	-2.35	-5.67	-3.75
ppt. Δ quintile 2	4.49	0.82	0.80	-1.86	-4.11	-1.59
ppt. Δ quintile 3	1.85	2.46	1.37	-0.96	-1.68	1.56
ppt. Δ quintile 4	-2.03	1.24	-4.61	-4.21	2.36	2.27
ppt. Δ quintile 5	-10.18	-4.64	-2.78	9.38	9.10	1.51