The Heterogeneous Impact of Redistributive Policies on Labor Supply *

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Abstract

In this paper, we provide new evidence on the inequalities arising from income taxation in the US, and their heterogeneous impact on labor supply. First, we develop a Real Business Cycle (RBC) model with two agents, which is solved using perturbation methods. Through impulse response functions, we show that an income tax shock affects differently the two agents, suggesting a heterogeneous response of labor supply. Furthermore, we observe a negative response of labor supply to an income tax shock. To validate these findings, we provide microeconomic evidence from the US Current Population Survey. Our analysis reveals that the bottom 10% of the income distribution pays a higher tax percentage relative to their earned income compared to the top 10%. Additionally, we find that the labor supply elasticity with respect to the income tax is positive. Subsequently, we extend our theoretical framework to include heterogeneous agents and present additional findings.

Keywords: Income tax, Labor supply, Labor supply elasticity

JEL Codes: E24, J20, H24, H31

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1 Introduction

The effect of income taxation on labor supply has been extensively investigated in literature. In broader terms, it shows how much more or less people are willing to work in response to increases in income taxes, which subsequently reduce disposable income. Income taxation in the US is set on a progressive basis. Although this taxing system been widely accepted, Piketty and Saez (2007) show that tax progressivity has declined over the recent decades. Notwithstanding, income taxation is one of the drivers of income inequality.

As a consequence of its impact on disposable income, income taxation has broad implications on macroeconomic dynamics. Following an increase in income taxes, workers may choose to (i) work or not work. The reason is that workers can be induced to work more in order to increase the after-tax income. Substitution effects may also occur. In the event of a higher tax burden on the workers, this may plausibly lead them to shift away towards less taxed economic activities. In additional to changes in the employment (extensive margin), individuals may (ii) work fewer or more hours (intensive margin); and (iii) be more or less productive. These changes affect aggregate labor supply, output, labor productivity and other economic aggregates. Hence, the trade-off between redistribution and economic efficiency of labor income taxes has become a key topic in public debate. The transmission mechanism of a tax shock is complex and yet the response of labor supply to changes in income taxation deserves in-depth studies. Therefore, in this paper, we focus on the impact of income taxation across different working groups, as well as the elasticity of labor supply measured by hours worked (intensive margin) in response to income taxes.

Firstly, we develop an RBC model with two agents. The model introduces heterogeneity in the flow budget constraint faced by households, introducing both wealthy and hand-to-mouth households. Through impulse response functions, we show that a shock to income taxes affects differently the two agents. We then provide micro evidence on the labor supply elasticity to income taxes based on the Current Population Survey (CPS) data spanning the period from 2009 to 2022. Our analysis reveals that low-income individuals bear a higher tax burden compared to their higher-income counterparts. Additionally, we find a positive labor supply elasticity in response to an income tax. Subsequently, we extend the theoretical model into a model with a continuum of households who have heterogeneous preferences, as in Kaplan et al. (2018). Our focus lies on examining the steady-state properties of the model, specifically the changes experienced by low-income and high-income households after an adverse tax shock. Finally, to validate the model predictions we examine the response of hours worked to changes in income taxes employing local projection.

Our paper contributes to the existing body of literature about the labor supply elasticity to changes in income taxes. Additionally, we address matters of income distribution inequalities. Impulse response analysis allow us to highlight several facts regarding income taxation and its implications on labor supply.

Our paper is related several strands of literature. Firstly, it is related to previous work about the implications of taxation on labor productivity and employment.

A seminal work by Mirrlees (1971) shows that taxing labor earnings causes a large decline in work effort and output. A different result is obtained by Summers (1981), who consider an overlapping generation framework and finds that the income tax has no effect on labor supply. In a related work, Gabrovski and Guo (2022) examine how progressive taxation under nominal wage rigidity causes the labor supply curve to shift. Golosov et al. (2013) assess the optimal policy mix that involves redistribution of labor income inequality using a labor earning tax and an unemployment benefit. Carbonell-Nicolau and Llavador (2021) characterize the optimal income taxation that reduces endogenous income inequality in two frameworks that assume constant elasticity of substitution (CES) and the quasi-linear preferences. Alpert and Powell (2020) find statistically significant and economically meaningful effects of taxes on labor force participation for older workers. Bick and Fuchs-Schündeln (2018) find very low cross country correlation between hours worked by married men and women. They investigate insofar taxes on consumption and on income contribute to the low correlation, and they find this result is driven by the different tax treatment (progressivity and joint taxation) of married couples and by different taxes on consumption across countries. Attinasi et al. (2016) examine the influence of labor income taxes on labor market performance in a sample of 30 OECD countries. They specifically focus on two performance indicators: the unemployment rate and employment levels. The findings of the study indicate that a more progressive tax system has a less distortionary impact on lower-income individuals compared to higher-income individuals.

Other studies focus on estimating the Frisch elasticity, that is the elasticity of labor supply to changes in wages, both along the extensive margin (employment) and along the intensive margin (hours worked).

Gottlieb et al. (2021) and Martinez et al. (2021) estimate Frisch elasticities across different groups using tax holiday data in Iceland and Switzerland. Martinez et al. (2021) use administrative social security earnings data matched with Census data to estimate the Frisch elasticity of labor supply during a unique period in Switzerland when income has not been subject to taxation. The authors observe a remarkably low Frisch elasticity parameter od 0.025 on an aggregate level. Furthermore, their analysis along the intensive margin reveals that men exhibit higher Frisch elasticities compared to women, self-employed individuals demonstrate higher elasticities than wage earners, and the highest earners exhibit the highest elasticities. Notably, the authors find no response along the extensive margin. Gottlieb et al. (2021) build a simple general equilibrium framework to investigate whether Frisch elasticities estimated with reduced-form evidence align with those estimated in models. The authors find that the range of values generally used in macro models to calibrate the Frisch elasticity parameter align with those from reduced-form estimates. Keane (2011) finds large Frisch elasticities for men. The author also uncovers substantial labor supply elasticities for women, especially in the long run, by considering the dynamic interplay of wages with factors like marriage, work experience, etc. Chetty et al. (2013) find Frisch elasticities estimations of 0.5 for aggregate hours worked.

Our paper is also related to the strand of literature on wage inequalities and the tax structure. Piketty and Saez (2003) present a new series on top share incomes and wages from 1913 until 1998. The authors show that top wage shares dropped during the WWII, and started recovering only since the 1970s. The authors suggest that steep progressive taxation have prevented the top incomes to fully recover from the war shock. Keane (2022) reviews frontier research in the field of optimal tax literature. His work underscores the significance of incorporating human capital investment and the participation margin in models accounting for labor supply. His findings suggest that the labor supply elasticity increases with age and is larger for married women. Diamond and Saez (2011) analyze optimal taxation from a policy perspective. Their findings suggest that high and rising marginal tax rates on earnings are more appropriate for individuals with very high incomes. Wu and Krueger (2021) analyze the impact of wage shocks and the optimal progressive taxation structure in a two-earner household. Gerber et al. (2018) find that a downward trend in corporate income taxes over the past years driven by international tax competition has contributed to reducing overall progressivity. This trend may in turn put downward pressure on personal income tax rates. According to Erosa et al. (2016) considering preference heterogeneity is crucial when assessing the impact of taxes on labor supply. The authors build a model and provide an aggregation theory using micro evidence to study implications of aggregate labor supply.

Additionally, our work is linked to literature about heterogeneity of agent behavior in macro models. Despite the seminal work of Krusell and Smith (1998), that demonstrated that business cycle features can be described through the mean of the wealth distribution, the literature on heterogeneous agents has focused on developing models that incorporate household-level risk factors. Since the work of Aiyagari (1994) on uninsured idiosyncratic risks, inequality of wealth and income distribution has gained increased attention in literature. Heathcote (2005) analyzed the impact of taxes on consumption within a model that considers households facing borrowing constraints. More recent literature, including extensive research conducted by Kaplan et al. (2018), Auclert et al. (2018), Patterson (2023) highlight an indirect channel of monetary policy transmission, that impacts heterogeneous households differently. We first use a simple RBC model with two agents to assess the heterogeneous effects of income taxation on labor supply. Then, we extend the model to include a continuum of households with heterogeneous preferences. The goal is to explain the consequences of re-distributive policies, namely the impact of the income tax on work effort and whether hours worked in the low-income households group are comparable to that in the high-income group.

The rest of the paper is structured as follows. Section 2 describes the theoretical framework. Section 3 presents the quantitative analysis, including the model calibration, the model results. Section 4 present the micro-data evidence. Section 5 shows the steady-state properties of the heterogeneous-agent model and the results from the local projections. Finally, section 6 concludes.

2 Theoretical Framework

We develop a model that consists of two type of households: wealthy and hand-to-mouth households. The model framework includes a representative firm and a central government.

Government In this environment, we assume that the level of government spending g_t and the tax rate τ_t is determined exogenously. The tax rate shock is given by: $\tau_t = \kappa_\tau \tau_{t-1} + \epsilon_t^\tau$, and the government spending exogenous process is defined as $g_t = \kappa_g g_{t-1} + \epsilon_t^g$. We assume that the shock components of these AR(1) processes are all normally distributed. We further assume that the government debt dynamics is defined by:

$$d_{t+1} = s_t + (1 + r_t) d_t$$

where d_{t+1} is the newly issued government debt in terms of government bonds and $(1 + r_t) d_t$ is the servicing cost of public debt outstanding. We further assume government bonds are in net zero supply $d_t^S \equiv 0$, where d_t^S denotes the bond total supply in the economy. s_t denotes the government's fiscal deficit if $s > 0$, and fiscal surplus if $s < 0$. The government takes the interest rate on debt r_t as given and chooses the level of debt d_{t+1}. To capture the feedback effects of the debt burden, we assume that the government is **non-optimizing** and has a fiscal rule that captures the idea that government will raise taxes or decrease the level of government spending to reduce the debt burden.

$$s_t = g_t - \tau_t(\omega_t^w h_t^w + (1 + r_{t-1}) a_{t-1} + \Pi_t^w) - \tau_t(\omega_t^s h_t^s + \Pi_t^s)$$

If the government's financing needs s_t is positive, this will increase the government debt d_{t+1}. This definition of the fiscal rule is widely used in previous literature (e.g. Ghosh et al., 2013; Lorenzoni and Werning, 2019).

Wealthy household (saver) There is a continuum of households indexed by $j \in [0, 1]$ with utility function

$$\max_{c_{j,t}, h_{j,t}} \quad E_t \sum_{t=0}^{\infty} \beta^t \frac{(c_{j,t}^w)^{1-\sigma}}{1-\sigma} - \phi_{j,t}^w \frac{(h_{j,t}^w)^{1+\eta}}{1+\eta}$$

where $\beta \geq 0$ is the discount factor and σ is the coefficient of relative risk aversion. The household budget constraint is given by $c_{j,t}^w + a_{j,t} = (1 - \tau_{j,t}) e_{j,t}^w$, with total taxable income defined as $e_{j,t}^w = \omega_{j,t}^w h_{j,t}^w + (1 + r_{t-1}) a_{j,t-1} + \Pi_t^w$. The variable $c_{j,t}^w$ denotes consumption, $h_{j,t}^w$ represents labor and $\phi_{j,t}^w$ denotes a labor supply shock. Given our budget constraint specification, we refer to $\omega_{j,t}^w$ as the hourly wage rate, and r_t as the interest rate. The households are subject to an income tax shock $\tau_{j,t}$. Furthermore, we assume that the household type w accumulates assets $a_{j,t}$ over time and receives lump sum transfers Π_t^w. The household's optimality conditions with respect to consumption $c_{j,t}^w$, asset accumulation $a_{j,t}$, and hours worked $h_{j,t}^w$ are given by

$$\begin{aligned}\lambda_{j,t} &= (c_{j,t}^w)^{-\sigma},\\ \phi_{j,t}^w (h_{j,t}^w)^\eta &= \lambda_{j,t}(1-\tau_{j,t})\omega_{j,t}^w,\\ \lambda_{j,t} &= \beta E_t \lambda_{j,t+1}(1-\tau_{j,t})(1+r_t).\end{aligned}$$

Hand-to-mouth household (spender) Household s derives utility from consumption $c_{j,t}^s$ and disutility from hours worked $h_{j,t}^s$.

$$\max_{c_{j,t},h_{j,t}} \quad E_t \sum_{t=0}^{\infty} \beta^t \frac{(c_{j,t}^s)^{1-\sigma}}{1-\sigma} - \phi_{j,t}^s \frac{(h_{j,t}^s)^{1+\nu}}{1+\nu}$$

where $\phi_{j,t}^s$ represents a household preference shifter to labor. The budget constraint is given by $c_{j,t}^s = (1-\tau_{j,t})e_{j,t}^s$, and the taxable income of the hand-to-mouth households is defined as: $e_{j,t}^s = \omega_{j,t}^s h_{j,t}^s + \Pi_t^s$. The specification of the household budget constraint states that labor income $\omega_{j,t}^s h_{j,t}^s$ and dividends Π_t^s received are the only source of income. The household consumes $c_{j,t}^s$ and faces an income tax shock $\tau_{j,t}$, similarly to the saver. The household's optimality conditions with respect to consumption $c_{j,t}^s$ and hours worked $h_{j,t}^s$ are as follows.

$$\begin{aligned}\lambda_{j,t} &= (c_{j,t}^s)^{-\sigma},\\ \phi_{j,t}^s (h_{j,t}^s)^\eta &= \lambda_{j,t}(1-\tau_{j,t})\omega_{j,t}^s.\end{aligned}$$

Capital producers We follow Greenwood et al. (1997), and assume that capital k_t evolves according to $k_t = (1-\delta)k_{t-1} + i_t$, where δ is the capital depreciation rate, and i_t is the new investment. In each period, capital producers can make investment and sell capital to firms. Capital producers choose investment and capital with the flow of funds of capital producers constraint is given by $q_t i_t = r_t^k k_{t-1}$, where q_t is the price of installed capital (Tobin's marginal q) and r_t^k is the capital rental rate.

Final good firms The market is populated by final good firms, that combine capital k_t, and h_t^s and h_t^w, two types of labor provided by the saver households and the wealthy households respectively. The firms produce a final good y_t, subject to the following aggregation technology:

$$y_t = k_t^{\alpha} A_t \left((h_t^s)^{\frac{1}{\theta}} + (h_t^w)^{\frac{1}{\theta}} \right)^{(1-\alpha)\theta},$$

where $\alpha \in (0.1)$ is the Cobb Douglas parameter, indicating the share of capital in the production function and the exogenous variable A_t denotes the shock to total factor productivity. We assume that $\ln A_t$ follows an AR(1) such that $\ln A_t = \rho_a \ln A_{t-1} + \epsilon_t^a$.

Market equilibrium The market is in equilibrium if the output produced by the firms equals the demand of households for consumption, investment and government spending $y_t = c_t^w + c_t^s + i_t + g_t$.

Equilibrium definition We define an equilibrium as a collection of prices and quantities such that, (i) Government chooses $\{d_t^y\}$; (ii) Wealthy households choose $\{c_t^w,\ l_t^w,\ a_t,\ r_t\}$ in order to maximize their utility subject to the budget constraints; (ii) hand-to-mouth households choose $\{c_t^s,\ l_t^s\}$ in order to maximize their utility subject to the budget constraints; (ii) Producers choose how much labor and capital input to use for production $\{l_t^w,\ l_t^s,\ k_t\}$ to minimize their production cost. The first order conditions yields the market prices at the equilibrium $\{\omega_t^w,\ \omega_t^s,\ r_t^k\}$. (iii) Equilibrium requires that the market for assets clears $a_t = a_{t-1}(1 + r_{t-1})$. The model is driven by three exogenous shocks: a tax shock τ_t, a government spending shock, and a technology shock A_t.[1]

Solution method We use perturbation techniques as in (Schmitt-Grohé and Uribe, 2004) to solve our dynamic general equilibrium model, specifically a second-order approximation. This numerical approximation techniques of the policy function emerges as a convenient approach to compute the approximation in the neighborhood of particular non-stochastic steady state that can deliver a reasonably accurate solution. However, we also provide results for a first-order approximation solution and we show that the effects of the income tax on labor supply are qualitatively consistent when using one technique or another. The equilibrium conditions can be expressed by the equation:

$$E_t f(y_{t+1}, y_t, x_{t+1}, x_t) = 0$$

[1] Detailed model derivations are contained in the technical appendix.

where the E_t is the conditional expectation operator, y_t denotes the vector of non-predetermined variables, in our example variables l_t^s, l_t^w, k_t, r_t^k, and r_t belong to the vector y_t, and x_t denotes the vector of predetermined variables a_t, g_t, and τ_t. Note that all the predetermined variables are essentially exogenous states variables.

3 Quantitative analysis

In this section, we first present the model parametrization details. Subsequently, we assess the effects of an unanticipated increase in income taxes on labor supply as implied by our model, and lastly we conduct a counterfactual exercise. To do so, we simulate the evolution of labor supply within a high and low income tax environment.

3.1 Calibration

The model is calibrated to the US data. Firstly, we set a target of debt-to-gross domestic product ratio of 90 percent, which is consistent with the observed US data[2]. This ratio varied between 80 and 120 percent during the period 2009 - 2022. We parametrize the government spending to be equal to 20 percent, and total investment to 10 percent of GDP, which are both in line with the US macro data in our sample. Additionally we set the persistence parameter of government spending shock to 0.9, in line with previous literature. Second, we set the values for the curvature on the disutility of labor supplied by wealthy households η^w at 1.05, and for the curvature on the disutility of labor supplied by hand-to-mouth households η^s at 1.20. The weight on the disutility of labor for the two types of households ϕ^w and ϕ^s are calibrated to 1. The discount factor is set at standard value 0.97 for the two agents, which can pin down the value of interest rate r in steady state ($1/\beta - 1 = r$). Additionally, the depreciation rate on capital equals 0.025. Given the depreciation rate we can calculate the stock of capital k in the economy, and we can compute the total level of consumption.

Third, the tax rate τ is set at 0.30, which is close to the top bracket of income tax rate, that ranges from 10 percent to 37 percent in the US. The share of wealthy household consumption to total consumption is assumed to be 60 percent of total consumption. This is consistent with Kaplan et al. (2018) and Bilbiie (2020). The risk aversion parameter for wealthy households

[2] Federal Reserve Bank of St. Louis (FRED) data available at: https://fred.stlouisfed.org/series/GFDEGDQ188S

and hand-to-mouth households equals 1, as in Kopiec (2022). Furthermore, we assume that the average hourly earnings for wealthy households is 22 dollars per hour (normalized to 22/100= 0.22), and that the average hourly earnings for hand-to-mouth households is 14 dollars per hour (normalized to 14/100= 0.14), which is close to value of average hourly wage rate in the US of 19 dollars. Finally, the Cobb Douglas parameter α is set a the value of 0.4. The coefficient on lagged productivity shock is equal to 0.95, and the standard deviation of the shock is equal to 0.52 in-line with the value reported in Christiano et al. (2014). We assume that the labor elasticity of substitution parameter between wealthy and hand-to-mouth households is 0.928.

Parameter	Description	Value	Source/Target
β	Discount rate	0.97	R
κ	Share of wealthy households consumption to total consumption	0.6	(Bilbiie, 2020)
η	Curvature on the disutility of labor supplied	1.05	Standard
ϕ	Weight on the disutility of labor	1	
τ	Income tax rate	0.30	CPS
σ^w	Risk aversion parameter for wealthy households	1	(Kopiec, 2022)
σ^s	Risk aversion parameter for hand-to-mouth households	1	(Kopiec, 2022)
ω_{ss}^w	Average hourly earnings for wealthy households	0.22	
ω_{ss}^s	Average hourly earnings for hand-to-mouth households	0.14	
δ	Depreciation rate on capital	0.025	Standard
α	Cobb Douglas parameter	0.4	Standard
θ	Labor elasticity of substitution between wealthy and hand-to-mouth households	0.928	
κ^g	The persistence parameter of government spending shock	0.9	
ρ_A	The coefficient on lagged productivity shock	0.95	(Christiano et al., 2014)
σ^A	Standard deviation of the shock	0.52	(Christiano et al., 2014)

Table 1: Calibrated Parameters

3.2 Effects of income tax changes: model

Responses of hours worked to the tax shock We investigate the impact of an increase in income tax on hours worked, as implied by our model, which is solved using a second-order approximation solution method. A second-order approximation method serves as a suitable approach when accounting for non-linearities that may arise in the model framework. Generally, the model solution obtained with a first-order approximation around the steady state should suffice for a small RBC model like ours. Therefore, we also solve the model with a first-order approximation and compare the IRFs. With both solution methods, we find that a positive one-standard deviation tax shock leads to a decrease in hours worked

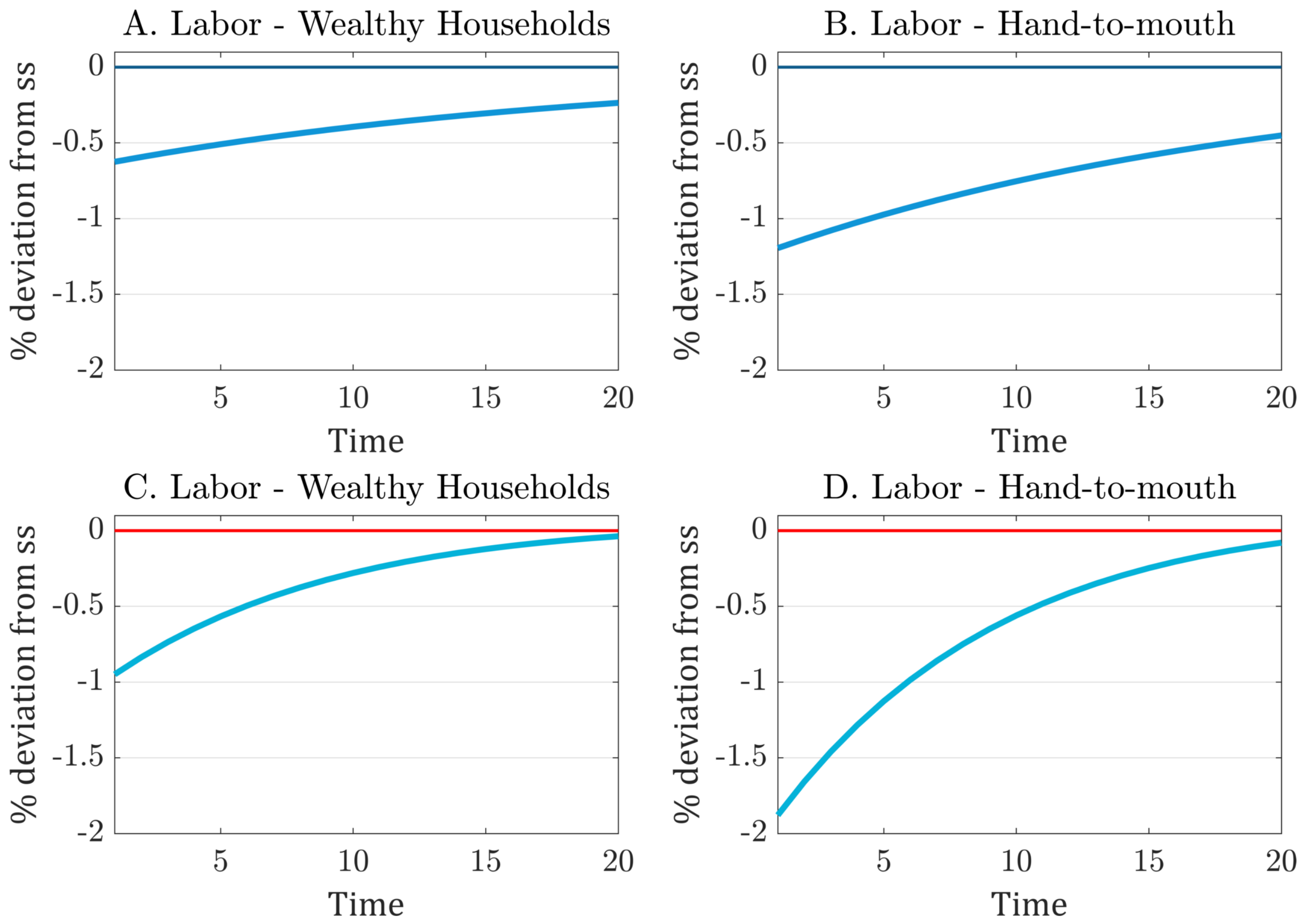


Figure 1: Tax Shock - labor response

Notes: The figure depicts the impulse responses to a positive tax shock. Panels A and B represent the response solving the model with the first order approximation technique and Panels C and D represent the response using the second order approximation.

by both wealthy households and hand-to-mouth households. This one-standard deviation negative tax shock experiment indicates that, conditional on household economic behavior, a tax rise can generate heterogeneity in the household's labor supply response. We find that the decrease in labor supply caused by an income tax shock is twice as much for wealthy households as for hand-to-mouth households.

An increase in the income tax rate gives an incentive for households to reduce work efforts. This result appears to confirm the analysis done by Born et al. (2013). The authors analyze the impact of fiscal shocks on labor supply and other macroeconomic aggregates in a dynamic general equilibrium framework. In an estimated New Keynesian model, they find that labor supply responds negatively on impact to an income tax cut, but soon after labor supply increases. In an RBC framework, the impact on labor supply is positive on impact and remains positive for the entire adjustment period after the shock hits the economy. In our specification, an income tax increase translates in less disposable income for the household and this produces negative substitution effects, leading the households to cut labor efforts. This, in turn, induces firms to substitute labor for capital. Similarly, Zubairy (2014) found that in an estimated New Keynesian model, a labor tax cut can lead to a significant rise in labor supply, driven by intertemporal substitution effects.

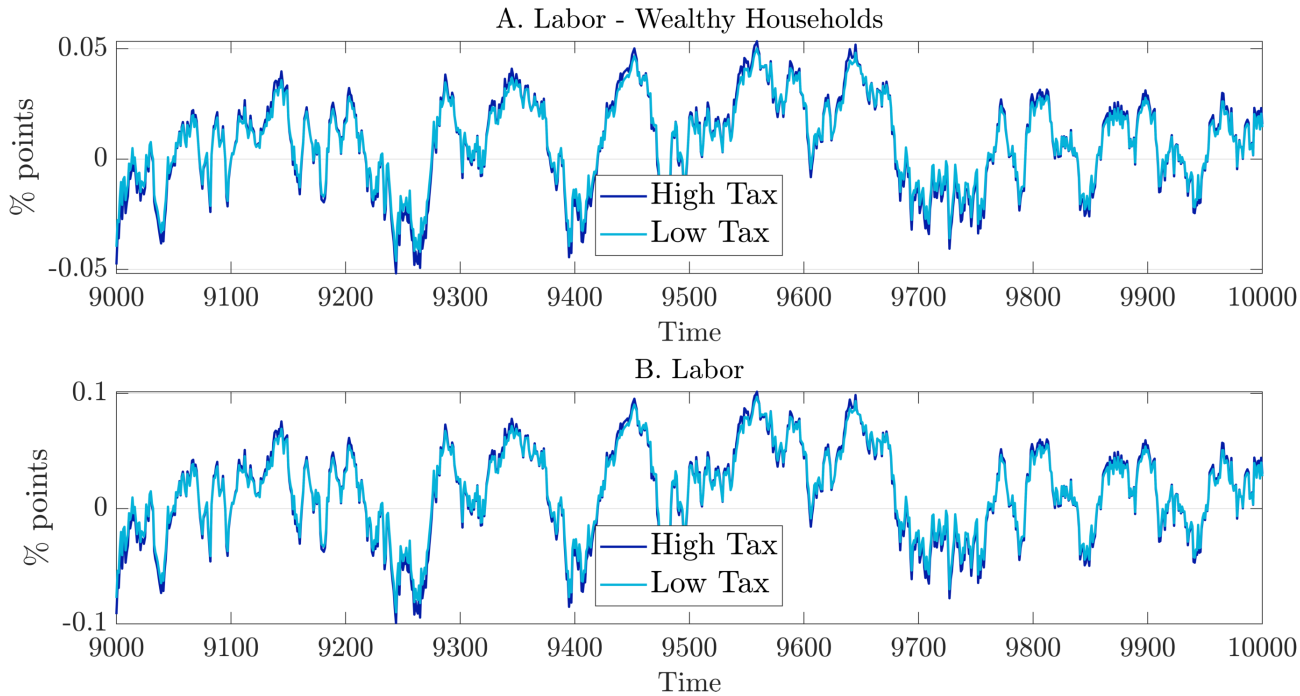


Figure 2: Counterfactuals

Notes: Model simulation under high and low taxation. Panel A represents the simulation for wealthy households. Panel B represents the simulation for the hand-to-mouth households.

Counterfactuals We now consider two experiments. In the first experiment the tax rate τ_t is significantly higher and equals 30 percent, while in the second experiment the tax rate is equal to 10 percent. We use our model to simulate and compare the time series of labor supply of the two agents under a high and a low tax environment, as depicted in figure 2. The effects of a low and a high tax environment show that hours worked fluctuations are either amplified or dampened. A low tax environment leads to an amplification of hours worked by both hand-to-mouth and wealthy households. The change in the tax rate does develop into an amplification of the labor supply, but does not exhibit a change in the pattern of labor supply fluctuations for the two households.

4 Income Tax and Hours Worked: Micro-Data Evidence

Data We use cross sectional data from the US Current Population Survey. This annual data allows us to observe the income tax after credit at the individual level and the level of taxable income. The sample period we use spans from 2009 to 2022. We first construct a measure of average tax rate as follows:

$$\textit{Average tax rate} = \frac{\textit{State income tax after credits}}{\textit{Taxable income}} \times 100$$

where taxable income, as defined in the Current Population Survey, is composed of the adjusted gross income with the allowable itemized deductions and exemptions subtracted. The State income tax after credit represents the total amount paid on taxes. Subsequently, we use these two observations to calculate the individual-specific average tax rate. Additionally, we construct a measure for hours worked:

$$\textit{Hours worked} = \textit{Hours worked per week} \times \textit{Number of weeks}$$

where we multiply the hours worked per week by 52, as our focus lies on the total annual hours worked.

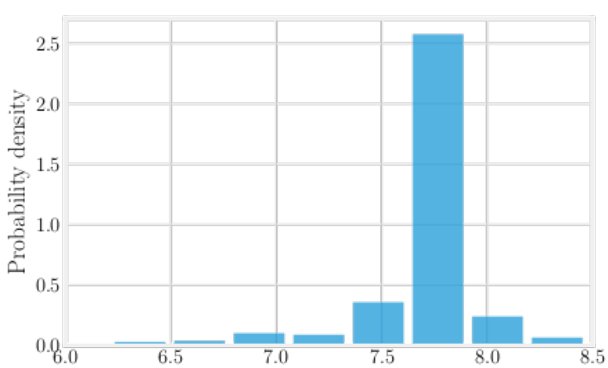


Figure 3: Log hours worked

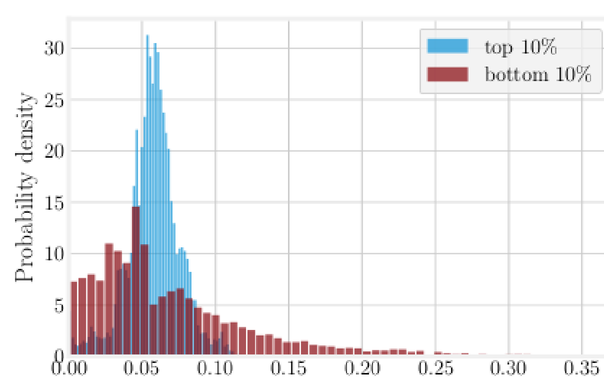


Figure 4: Tax rate top 10% vs bottom 10%

Notes: The two figures show data from the Current Population Survey between 2009 and 2022.

Figure 3 reports the distribution of weekly hours worked in the US between 2009 and

2022. Notably, there are few households that report lower hours worked in a week, with a log value that varies between 6 and 7, while the average of the log value of hours worked is between 7.5 and 8. It is also evident from the figure that there is an upper limit for log hours worked, that is 8.5.

Salient observations from figure 4 point out to the differences in the way high and low-income individuals are taxed. On average, the tax rate for wealthy individuals is roughly 5%. On the other hand, the tax rate for the bottom 10% of the income distribution varies widely. Upon examination of the right side of the figure, it becomes clear that wealthy individuals are subject to a lower tax burden in relation to their income when compared to individuals with low incomes. This contradicts the idea that the tax schedule in the US exhibits equal sacrifice across the income distribution, as evidenced in (Young, 1990). Table 2 reports the

Table 2: Average tax rate and average annual hours worked, 2009 - 2022

Average tax rate	2009-2022	2009	2013	2017	2021	2022
Panel A: Average tax rate						
Bottom 10%	0.072	0.065	0.077	0.070	0.079	0.081
Bottom 50%	0.054	0.050	0.056	0.054	0.055	0.056
Top 50%	0.052	0.048	0.052	0.052	0.052	0.052
Top 10%	0.054	0.050	0.054	0.054	0.053	0.053
Panel B: Hours worked						
Bottom 10%	1847.880	1875.527	1846.871	1843.237	1852.900	1811.337
Bottom 50%	2044.741	2058.551	2058.948	2051.796	2041.024	2032.643
Top 50%	2150.402	2141.796	2175.178	2163.700	2144.775	2145.028
Top 10%	2195.593	2196.981	2233.946	2208.996	2184.967	2184.403

Notes: The table presents the effective average tax rate and annual hours worked across the income distribution between 2009 and 2022. Source: Current Population Survey.

average hourly earnings and the average annual hours worked during the reference period of 2009-2022. Panel A presents the tax rates for different income quantiles. It appears that tax rates slightly increased between 2009 and 2022, rising from 6.5 percent to 8.1 percent for bottom 10 % of income earners. On the other hand, top 10 % of the income distribution experienced a modest increase in tax rate, going from an average of 5 % in 2009 to 5.3 % in 2022. There has been a similar increase from 5 % to 5.6 % for the bottom 50 %, and from 4.8

% to 5.2 % for the top 50 %. The data show that income taxes imposed a greater burden on low-income households compared to high-income households during this period of time.

Panel B shows hours worked dynamics across income distribution between 2009 and 2022. The average annual hours worked by top 50 percent and top 10 percent of income distribution remain the largest with 2150 and 2195, respectively. Average total hours worked did not change much and show negligible fluctuations. Although not reported here, average total hours worked exhibit a large decline during the COVID-19 recession.

Estimation of the labor elasticity with respect to the income tax To get a better understanding of the influence of the income tax on hours worked, we consider a simple regression at the individual level by regressing log hours worked on the tax rate:

$$\ln h_{j,t} = \alpha + \alpha^{\tau} \ln \tau_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t},$$

where $\alpha^{\tau} = \frac{cov(\ln h_{j,t}, \ln \tau_{j,t})}{var(\ln \tau_{j,t})}$ is the labor supply elasticity with respect to tax rate, α_j and α_t denote the household and time fixed effects, respectively. $\epsilon_{j,t}$ is the error term, standard errors are two-way clustered at households and year level. We augment our model specification with time and household fixed effects to control for time trends and households specific factors that could affect our estimates. We use the Current Population Survey data to estimate this elasticity over the sample period 2009 to 2022. This data provides information on income, labor supply and income taxation which is useful for our research purpose.

Empirically, we find a positive elasticity of labor supply to the income tax. The results are shown in table 3. The point estimate is positive and statistically different from zero (the estimate of α^{τ} equals approximately 0.006) implying that households' work effort, interpreted here as hours worked, increases when the tax rate goes up. Our estimates are largely robust to a specification that controls for time and household fixed effects, and when we use a sample that exclude financial crisis and the COVID-19 recession. Additional results are reported in Appendix tables C.2 and C.3. It is worth mentioning that this empirical evidence is radically different from the model prediction that states that a positive tax shock leads to a decline in hours worked. Next, we quantitatively analyze the heterogeneous effects of tax shock across income distribution. Table 3 reveals that high income households are more responsive to tax shocks than low-income households. Column 1 records a positive

Table 3: Estimation of the relationship between the tax rate and hours worked

	Dependent Variable: Log Hours Worked			
	(1)	(2)	(3)	(4)
constant	7.63496***	7.63463***	7.64284***	7.64342***
	(0.00787)	(0.00811)	(0.00503)	(0.00488)
Log average tax rate	0.00642**	0.00631**	0.00898***	0.00917***
	(0.00264)	(0.00264)	(0.00170)	(0.00170)
Covariance Type:	Clustered	Clustered	Clustered	Clustered
Household Fixed Effects:	Yes	Yes	No	No
Year Fixed Effects:	No	Yes	Yes	No
F-statistic:	25.46	24.56	74.57	77.88
No. Observations:	214573	214573	214573	214573
	Dependent Variable: Log Hours Worked			
	Top 10 Income	Top 50	Bottom 10	Bottom 50
	(5)	(6)	(7)	(8)
Constant	7.7010***	7.7269***	7.4594***	7.5976***
	(0.0138)	(0.0073)	(0.0089)	(0.0063)
Log average tax rate	0.0120***	0.0248***	0.0015	0.0054***
	(0.0048)	(0.0025)	(0.0028)	(0.0020)
No. Observations:	21338	106688	21246	106688
R-squared:	0.002	0.002	0.000	0.000
Household Fixed Effects:	No	No	No	No
Year Fixed Effects:	No	No	No	No
F-statistic:	8.2264	175.5	0.2992	16.73
Covariance Type:	Clustered	Clustered	Clustered	Clustered

Notes: This table reports the ordinary least squares regression (1) with time and household fixed effects, (2) with time fixed effects, (3) with household fixed effects, (4) with no fixed effects, (5) top 10 % earners sample with no fixed effects, (6) top 50% earner sample with no fixed effects, (7) bottom 10% earners sample with no fixed effects, (8) bottom 50 % earners sample with no fixed effects. Statistical significance (Std. error in parentheses): 0.1*, 0.05**, 0.01***. Standard errors are clustered at household and year level. Data sources: Current Population Survey (2010-2019).

and statistically significant point estimate of roughly 0.02 for households at the top 10% of income distribution. In comparison, Column 4 reports a point estimate of 0.005 for low-income households. Our results are robust to controlling for time and household fixed effects. These results suggest that wealthy households are more tax sensitive than low-income households, which is broadly consistent with our model predictions. Indeed, our theoretical framework generates differential responses of hours worked to tax changes by agent type and predicts that hours worked by wealthy households are more responsive to tax changes. Overall, the idea that low-income households are slightly less responsive to tax shock is an interesting result. Although the effect seems quantitatively small, this indicates that accounting heterogeneity of household behavior is essential to provide an assessment of tax policy implications on labor supply.

This analysis presents two contrasting perspectives on how the tax wedge impacts labor supply. It is indeed perplexing that an increase in taxes can lead to an increase in hours worked, as observed in the CPS micro data. Households tend to compensate for the reduction in wages by increasing their work efforts and enhancing their labor productivity. In a related study, Kleven and Schultz (2014) estimates that the elasticity of labor income to tax reforms in Denmark is relatively modest, ranging between 0.05 and 0.10 for wage earners and self-employed individuals, respectively.

On the other hand, our theoretical model suggests that a tax increase could potentially result in a decrease in hours worked. This conclusion is supported by the cross-country analysis conducted by Prescott (2004), who examines the role of taxes and identifies several factors that could explain a decline in labor supply.

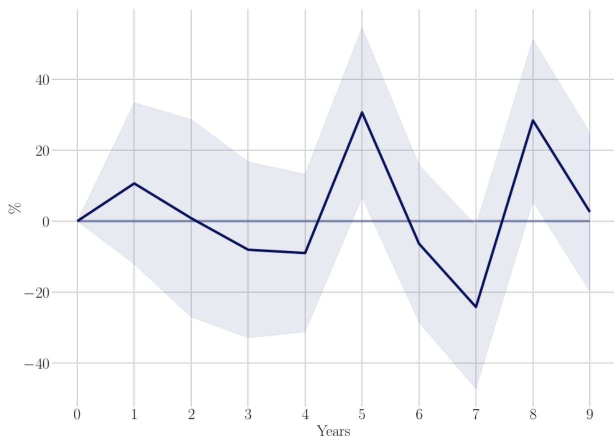
5 Heterogeneous Response of Labor to an Unanticipated Tax Shock

Local projections To empirically analyze the response of the hours worked to changes in average tax rate, we use local projection techniques as in (Jordà, 2005). We obtain the average impulse response function for both high and low income individuals at horizon h. This is specified for both high income and low income individuals:

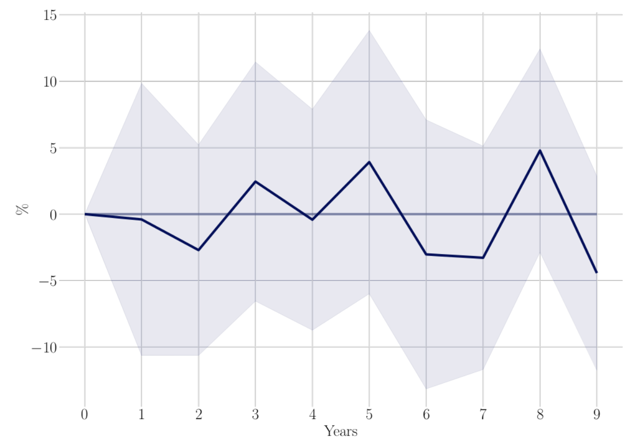
$$h_{j,t+h} = \alpha_{j,h} + \beta_{j,h}\tau_{j,t} + \gamma_j + \gamma_t + \epsilon_{j,t}$$

In this specification we control for individual fixed effects γ_j and time fixed effects γ_t. In our sample the number of entities is fairly large as it represents the household record, whereas the value of years that our sample covers is between 2009-2022. When we include additional controls to the specification, the estimated effects remain insignificant even at large values of h.

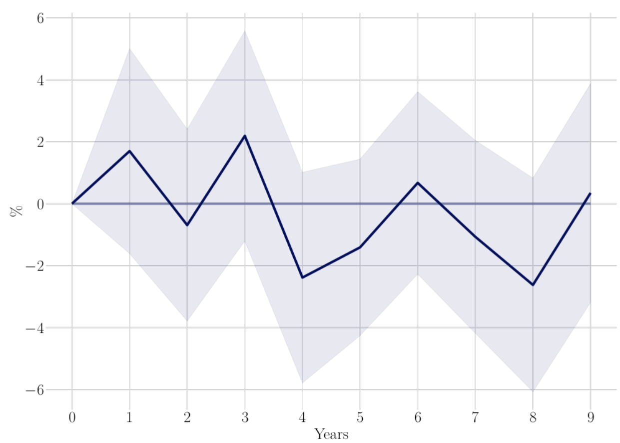
Figure 6 suggests that the response of ours worked after a positive income tax rate shock is mostly insignificant for both wealthy and low-income households. Within the wealthiest population, we observe an increase in hours worked by 2 percent, but the effect is rapidly subdued, see panel A. On the other hand, the response of hours worked for low-income households is quite different from that of wealthy households. An increase in the tax rate is merely near zero and only 6 years after the impact the response turns positive and significant. Despite adding more lags to the exogenous variables, this has not induced a better approximation or a significant estimates. Moreover, controlling for individual characteristics such age, nationality, occupation, gender, age, employment status, and marital status delivers insignificant estimates even at large values of h. That said, small changes in income tax rate could not lead to substantial changes in work efforts at both extremes of the income distribution.



Top 10%



Bottom 10%



Full Sample

Figure 5: Labor response to tax shocks

Notes: Local projection results for the top 10% and bottom 10% shares of the income distribution, and the full sample.

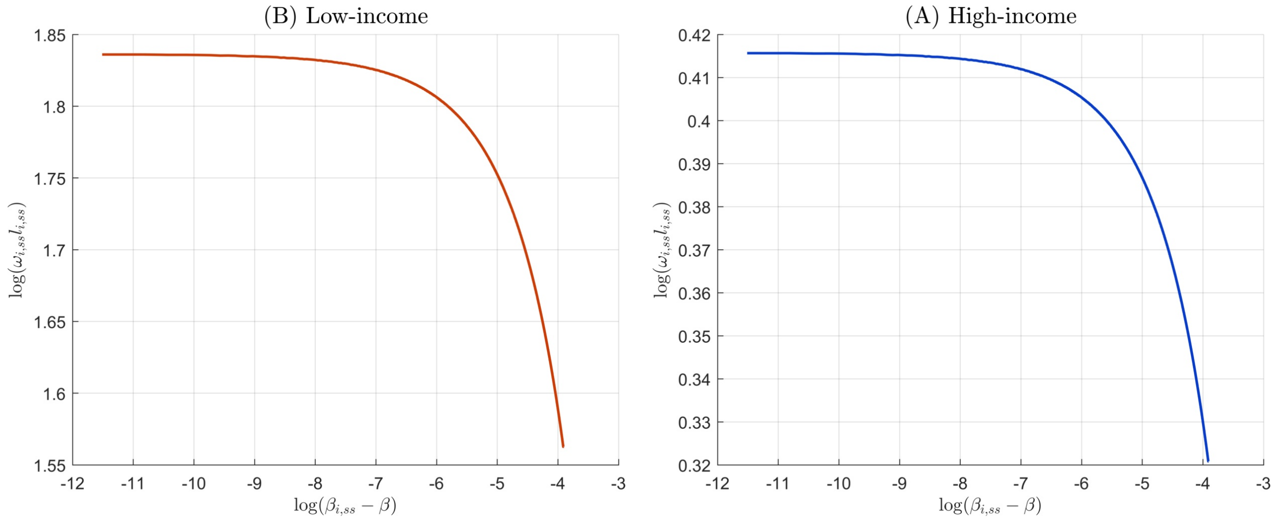


Figure 6: Discount factor and labor income

Notes: Steady states properties.

Heterogeneous agents

6 Conclusions

This paper examines the effects of income taxation on the labor market and its role in explaining hours worked dynamics. We consider a framework with two heterogeneous agents and demonstrate that an increase in income taxes leads to a decline in hours worked, although the magnitude of the shock varies between wealthy and hand-to-mouth households. The model clarifies that accounting for heterogeneity in household's economic behavior can generate differential impacts on labor supply. To test our general equilibrium model's results, we provide microeconomic evidence on the relationship between hours worked and effective tax rate using Current Population Survey data. We document that high-income individuals are taxed proportionally less than low-income individuals. Additionally, we find that the labor elasticity with respect to income tax is positive. The elasticities at the top and bottom of the income distribution are also positive, although we observe a much weaker elasticity for low-income households.

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Appendix

Appendix A Model Derivation

Household optimality conditions We solve the household maximization problem by the Lagrange's method

$$\mathcal{L}^w_{j,t} = E_0 \sum_{t=0}^{T} \left[\beta \left\{ \frac{(c^w_{j,t})^{1-\sigma}}{1-\sigma} - \phi^w_{j,t} \frac{(h^w_{j,t})^{1+\eta}}{1+\eta} + \lambda_{j,t} \Big((1-\tau_{j,t})(\omega^w_{j,t} h^w_{j,t} + (1+r_{t-1})\, a_{j,t-1} + \Pi^w_t) - c^w_{j,t} - a_{j,t} \Big) \right\} \right]$$

$$\mathcal{L}^s_{j,t} = E_0 \sum_{t=0}^{T} \left[\beta \left\{ \frac{(c^s_{j,t})^{1-\sigma}}{1-\sigma} - \phi^s_{j,t} \frac{(h^s_{j,t})^{1+\nu}}{1+\nu} + \lambda_{j,t} \Big((1-\tau_{j,t})(\omega^s_{j,1} h^s_{j,t} + \Pi^s_t) - c^s_{j,t} \Big) \right\} \right]$$

The household optimality conditions with respect to consumption: $c^w_{j,t}$, $c^s_{j,t}$, asset accumulation $a_{j,t}$, hours worked: $h^w_{j,t}$, $h^s_{j,t}$ are derived as follow

$$\frac{\partial \mathcal{L}^w_{j,t}}{\partial c^w_{j,t}} : \qquad \lambda_{j,t} = (c^w_{j,t})^{-\sigma} \tag{A.1}$$

$$\frac{\partial \mathcal{L}^w_{j,t}}{\partial h^w_{t}} : \qquad \phi^w_{j,t} (h^w_{j,t})^{\eta} = \lambda_{j,t}(1-\tau_{j,t})\omega^w_{j,t} \tag{A.2}$$

$$\frac{\partial \mathcal{L}^w_{j,t}}{\partial a_{j,t}} : \qquad \lambda_{j,t} = \beta E_t \lambda_{j,t+1}(1-\tau_{j,t+1})(1+r_t) \tag{A.3}$$

$$\frac{\partial \mathcal{L}^s_{j,t}}{\partial c^s_{j,t}} : \qquad \lambda_{j,t} = (c^s_{j,t})^{-\sigma} \tag{A.4}$$

$$\frac{\partial \mathcal{L}^s_{j,t}}{\partial h^s_{j,t}} : \qquad \phi^s_{j,t} (h^s_{j,t})^{\nu} = \lambda_{j,t}(1-\tau_{j,t})\omega^s_{j,t} \tag{A.5}$$

Firms optimality conditions: Optimal capital and labor demand from the producer's optimization problem is

$$\omega^s_{j,t} = (1-\alpha)\, k^\alpha_t A_t (h^s_{j,t})^{\frac{1}{\theta}-1} \left((h^w_{j,t})^{\frac{1}{\theta}} + (h^s_{j,t})^{\frac{1}{\theta}} \right)^{(1-\alpha)\theta-1} \tag{A.6}$$

$$\omega^w_{j,t} = (1-\alpha)\, k^\alpha_t A_t (h^w_{j,t})^{\frac{1}{\theta}-1} \left((h^w_{j,t})^{\frac{1}{\theta}} + (h^s_{j,t})^{\frac{1}{\theta}} \right)^{(1-\alpha)\theta-1} \tag{A.7}$$

$$r^k_t = \alpha \left((h^s_{j,t})^{\frac{1}{\theta}} + (h^w_{j,t})^{\frac{1}{\theta}} \right)^{(1-\alpha)\theta} A_t k^{\alpha-1}_t \tag{A.8}$$

From equations (A.6) and (A.7) we can derive:

$$\frac{\omega^s_{j,t}}{\omega^w_{j,t}} = \frac{(h^s_{j,t})^{\frac{1}{\theta}-1}}{(h^w_{j,t})^{\frac{1}{\theta}-1}} \tag{A.9}$$

Equation (A.9) represents the marginal cost of labor supplied by the saver and the wealthy household.

Forwarding one period ahead (A.1), we obtain:

$$\frac{\lambda_{j,t}}{\beta E_t[\lambda_{j,t+1}]} = \frac{(c^s_{j,t})^{-\sigma}}{E_t[(c^s_{j,t+1})^{-\sigma}]}$$

and rearranging (A.3)

$$\frac{\lambda_{j,t}}{\beta E_t[\lambda_{j,t+1}]} = (1-\tau_{j,t+1})(1+r_t)$$

Finally, combining the two above-equation:

$$\frac{(c^s_{j,t})^{-\sigma}}{\beta E_t[(c^s_{j,t+1})^{-\sigma}]} = (1-\tau_{j,t+1})(1+r_t)$$

and rewriting:

$$\left(\frac{\beta E_t[c^s_{j,t+1}]}{c^s_{j,t}}\right)^{\sigma} = (1-\tau_{j,t+1})(1+r_t) \tag{A.10}$$

Equation (A.10) is the Euler equation, which describes how consumers trade-off between consumption today and consumption in the next period.

Capital producers optimality conditions We assume that capital producers provide capital to firms that evolves according to

$$k_t = (1-\delta)k_{t-1} + i_t$$

The objective of the capital producer is to choose k_t and i_t that maximizes the expected profits

$$\text{maximize} \quad E_t[r^k_t k_t - i_t]$$

The first order conditions with respect to capital and investment are

$$\frac{\partial \mathcal{L}_{j,t}}{\partial k_t}: \qquad \lambda_t - E_t \beta \lambda_{t+1}(1-\delta) = r_t^k$$
$$\frac{\partial \mathcal{L}_{j,t}}{\partial i_t}: \qquad q_t = \lambda_t$$

Using (A.3), that is the asset optimal choice, and the first order condition with respect to capital, we obtain:

$$\beta E_t \lambda_{j,t+1}(1-\tau_{j,t+1})(1+r_t) = r_t^k + E_t \beta \lambda_{t+1}(1-\delta)$$
$$r_t^k = \beta E_t \lambda_{j,t+1}(1-\tau_{j,t+1})(1+r_t) - E_t \beta \lambda_{t+1}(1-\delta)$$
$$r_t^k = \beta E_t \lambda_{j,t+1}((1-\tau_{j,t+1})(1+r_t) - (1-\delta))$$

Government debt:

$$d_{t+1} = s_t + (1+r_t)d_t$$

Government fiscal rule

$$s_t = g_t - \tau_t(\omega_t^w h_t^w + (1+r_{t-1})a_{t-1} + \Pi_t^w) - \tau_t(\omega_t^s h_t^s + \Pi_t^s)$$

Market clearing condition

$$y_t = c_t^w + c_t^s + i_t + g_t.$$

Model reduction Using the first order conditions wrt to labor (A.2) and (A.5) and the first order conditions wrt to consumption, (A.1) and (A.4), we write the equations as follows:

$$\frac{\phi_{j,t}^w (h_{j,t}^w)^\eta}{(1-\tau_{j,t})\omega_{j,t}^w} = (c_{j,t}^w)^{-\sigma}$$
$$\frac{\phi_{j,t}^s (h_{j,t}^s)^\eta}{(1-\tau_{j,t})\omega_{j,t}^s} = (c_{j,t}^s)^{-\sigma}$$

rearranging:

$$\left(\frac{\phi^w_{j,t}(h^w_{j,t})^\eta}{(1-\tau_{j,t})\omega^w_{j,t}}\right)^{-\frac{1}{\sigma}} = c^w_{j,t}$$
$$\left(\frac{\phi^s_{j,t}(h^s_{j,t})^\nu}{(1-\tau_{j,t})\omega^s_{j,t}}\right)^{-\frac{1}{\sigma}} = c^s_{j,t}$$

Then, we substitute $c^\omega_{j,t}$ and $c^s_{j,t}$ in the market clearing equation:

$$y_t = \left(\frac{\phi^w_{j,t}(h^w_{j,t})^\eta}{(1-\tau_{j,t})\omega^w_{j,t}}\right)^{-\frac{1}{\sigma}} + \left(\frac{\phi^s_{j,t}(h^s_{j,t})^\nu}{(1-\tau_{j,t})\omega^s_{j,t}}\right)^{-\frac{1}{\sigma}} + i_t + g_t$$

2) we use the optimality condition (A.3):

$$\lambda_{j,t} = \beta E_t \lambda_{j,t+1}(1-\tau_{j,t+1})(1+r_t)$$

and the first order conditions wrt labor (A.2) and (A.5):

$$\phi^w_{j,t}(h^w_{j,t})^\eta = \lambda_{j,t}(1-\tau_{j,t})\omega^w_{j,t}$$
$$\phi^s_{j,t}(h^s_{j,t})^\nu = \lambda_{j,t}(1-\tau_{j,t})\omega^s_{j,t}$$

We rewrite these two conditions as follows:

$$\frac{\phi^w_{j,t}(h^w_{j,t})^\eta}{(1-\tau_{j,t})\omega^w_{j,t}} = \beta \frac{\phi^w_{j,t+1}(h^w_{j,t+1})^\eta}{(1-\tau_{j,t+1})\omega^w_{j,t+1}}(1-\tau_{j,t+1})(1+r_t)$$
$$\frac{\phi^s_{j,t}(h^s_{j,t})^\nu}{(1-\tau_{j,t})\omega^s_{j,t}} = \beta \frac{\phi^s_{j,t+1}(h^s_{j,t+1})^\nu}{(1-\tau_{j,t+1})\omega^s_{j,t+1}}(1-\tau_{j,t+1})(1+r_t)$$

Model equilibrium

$$lnA_t = \rho_A lnA_{t-1}$$

$$lng_t = \rho_g lng_{t-1}$$

$$ln\tau_t = \rho_\tau ln\tau_{t-1}$$

$$\left(\frac{(1-\tau_{j,t})\omega^w_{j,t}}{\phi_{j,t}(h^w_{j,t})^\eta}\right)^{\frac{1}{\sigma}} + \left(\frac{(1-\tau_{j,t})\omega^s_{j,t}}{\phi_{j,t}(h^s_{j,t})^\nu}\right)^{\frac{1}{\sigma}} - (1-\delta)k_t + k_{t+1} + g_t = k_t^\alpha A_t \left((h^s_{j,t})^{\frac{1}{\theta}} + (h^w_{j,t})^{\frac{1}{\theta}}\right)^{(1-\alpha)\theta}$$

$$\frac{\phi^w_{j,t}(h^w_{j,t})^\eta}{(1-\tau_{j,t})\omega^w_{j,t}} = \beta\frac{\phi^w_{j,t+1}(h^w_{j,t+1})^\eta}{(1-\tau_{j,t+1})\omega^w_{j,t+1}}(1-\tau_{j,t+1})(1+r_t)$$

$$\frac{\phi^s_{j,t}(h^s_{j,t})^\nu}{(1-\tau_{j,t})\omega^s_{j,t}} = \beta\frac{\phi^s_{j,t+1}(h^s_{j,t+1})^\nu}{(1-\tau_{j,t+1})\omega^s_{j,t+1}}(1-\tau_{j,t+1})(1+r_t)$$

$$r^k_t = \alpha\left((h^s_t)^{\frac{1}{\theta}} + (h^w_t)^{\frac{1}{\theta}}\right)^{(1-\alpha)\theta} A_t k_t^{\alpha-1}$$

$$r^k_t = \frac{\phi^s_{j,t}(h^s_{j,t+1})^\nu}{((1-\tau_{j,t+1})((1-\alpha)(h^s_{j,t+1})^{(1/\theta-1)}A_t(k_{t+1})^{(\alpha)}((h^w_{j,t+1})^{(1/\theta)} + (h^s_{j,t+1})^{(1/\theta)})^{((1-\alpha)\theta-1)}))} (1+r_t)(1-\tau_{j,t}) - (1-\delta)$$

Appendix B Data Details

Table B.1: Current population survey - variables

Variable	Description
YEAR	Survey year
SERIAL	Household serial number
CPSID	CPSID, household record
ASECFLAG	Flag for ASEC
CPSIDP	CPSID, person record
UHRSWORKT	Hours usually worked per week at all jobs
STATAXAC	State income tax liability, after all credits
TAXINC	Taxable income amount

Notes: Data source: Current Population Survey (2009-2022).

Appendix C Additional Results

Table C.2: Results of ordinary least squares estimation of the relationship between tax rate and hours worked 2010-2019

	Dependent Variable: Log Hours Worked			
	(1)	(2)	(3)	(4)
constant	7.6625***	7.6627***	7.6661***	7.6660***
	(0.0092)	(0.0096)	(0.0051)	(0.0049)
Log average tax rate	0.0147***	0.0148***	0.0159***	0.0158***
	(0.0031)	(0.0031)	(0.0017)	(0.0017)
Covariance Type:	Clustered	Clustered	Clustered	Clustered
Household Fixed Effects:	Yes	Yes	No	No
Year Fixed Effects:	No	Yes	Yes	No
F-statistic:	129.7	130.6	236.9	236.4
No. Observations:	231994	231994	231994	231994

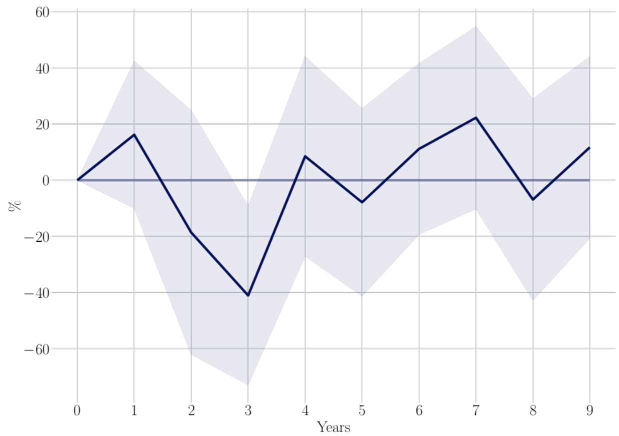
Notes: This table reports the ordinary least squares regression; (1) with time and household fixed effects, (2) with time fixed effects, (3) with household fixed effects, (4) with no fixed effects. Statistical significance (Std. error in parentheses): 0.1*, 0.05**, 0.01***. Standard errors are clustered at household and year level. Data sources: Current Population Survey (2010-2019).

Table C.3: Results of ordinary least squares estimation of the relationship between the tax rate and hours worked

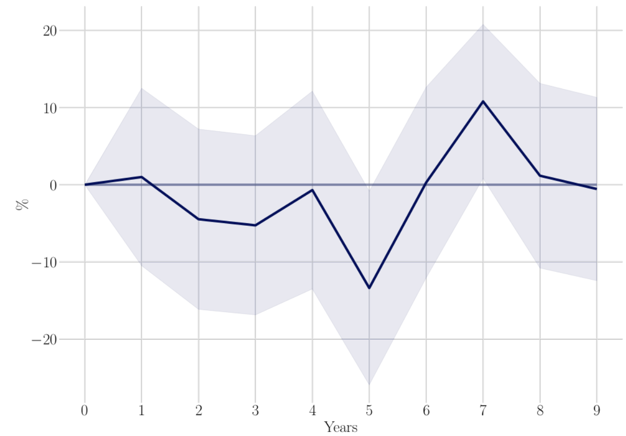
	Dependent Variable: Log Hours Worked											
	Top 10 Income			Top 50 Income			Bottom 10 Income			Bottom 50 Income		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
constant	7.7055***	7.7054***	7.7074***	7.7215***	7.7211***	7.7263***	7.4519***	7.4526***	7.4609***	7.5914***	7.5918***	7.5975***
	(0.0099)	(0.0098)	(0.0052)	(0.0139)	(0.0139)	(0.0072)	(0.0111)	(0.0109)	(0.0088)	(0.0101)	(0.0099)	(0.0062)
log average tax rate	0.0231***	0.0231***	0.0237***	0.0230***	0.0229***	0.0246***	-0.0010	-0.0008	0.0020	0.0034	0.0036	0.0054***
	(0.0032)	(0.0032)	(0.0018)	(0.0046)	(0.0046)	(0.0025)	(0.0035)	(0.0035)	(0.0027)	(0.0031)	(0.0031)	(0.0020)
No. Observations:	191996	191996	191996	106688	106688	106688	21246	21246	21246	106688	106688	106688
R-squared:	0.002	0.002	0.002	0.001	0.001	0.002	0.000	0.000	0.000	0.000	0.000	0.000
F-statistic:	241.3	240.0	397.2	87.37	86.11	172.1	0.08449	0.05051	0.5261	4.391	4.668	16.42
Eeffects:	Entity	Entity, Time	Time	Entity	Entity, Time	Time	Entity	Entity, Time	Time	Entity	Entity, Time	Time

Notes: This table reports the ordinary least squares regression. Statistical significance (Std. error in parentheses): 0.1*, 0.05**, 0.01***. Standard errors are clustered at household and year level. Data sources: Current Population Survey (2010-2019).

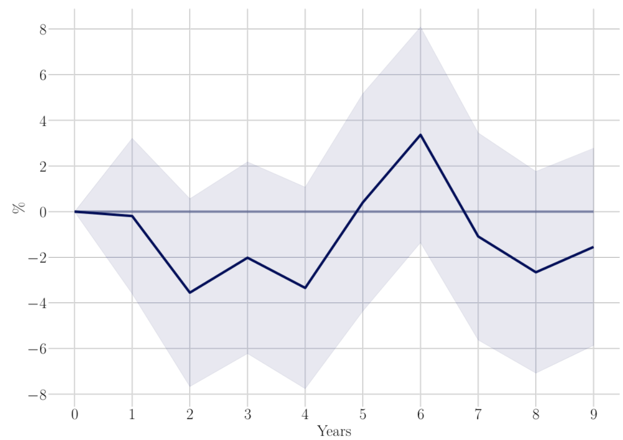
——————- updated results



Top 10%



Bottom 10%



Full Sample

Figure 7: Labor response to tax shocks

Notes: Local projection results for the top 10% and bottom 10% shares of the income distribution, and the full sample.