# Optimal Income Taxation of Singles and Couples

Egor Malkov*

This version: November 9, 2021
Most recent version: click here (regularly updating)

How should singles and married couples be taxed on their income? I answer this question using a general equilibrium overlapping generations model that features single and married households facing uninsurable idiosyncratic labor productivity risk, intensive and extensive margins of labor supply, and human capital accumulation. I analyze the optimal tax reform within a parametric class of tax and transfer functions that are allowed to depend on marital status. I estimate the model to match the U.S. economy and find that tax progressivity should be lower for couples than for singles. Next, the optimal tax schedule has a higher degree of progressivity for singles and lower progressivity for couples relative to the actual income tax policy. Replacing the U.S. tax and transfer system with the optimal schedule is associated with sizable welfare gains. I show that explicitly modeling couples and accounting for the extensive margin of labor supply combined with human capital accumulation is quantitatively important for the design of the optimal policy. Private within-household insurance through responses of spousal labor supply reduces the desired degree of tax progressivity for couples. Higher progressivity increases the employment of single women at the lower end of the income distribution. Under joint taxation of spouses, a decrease in progressivity leads to higher employment of married women.

**JEL:** C63, D15, D52, E21, E62, H21, J24.

**Keywords:** Optimal Taxation, Taxation of Couples, Labor Supply, Human Capital, Tax Progressivity.

* University of Minnesota. E-mail: malko017@umn.edu. I am indebted to Fatih Guvenen, Larry Jones, and Fabrizio Perri for their valuable advice and constant support. I thank Manuel Amador, Anmol Bhandari, V.V. Chari, Alex Frankel, Mariacristina De Nardi, Marek Kapička, Oksana Leukhina, Hannes Malmberg, Raoul Minetti, Nicolò Russo, Todd Schoellman, Kjetil Storesletten, and Hanzhe Zhang for their feedback and comments.

# 1 Introduction

How should singles and couples be taxed on their income? The answer to this question is of crucial importance for both academic economists and policymakers for several reasons. First, a notable feature of the U.S. income tax code is that it treats single and married individuals differently, and married couples pay taxes on their combined income.[1] Given the progressivity of the tax system, it is not neutral with respect to marriage. The tax and transfer system that features jointness creates substantial disincentive effects for the married women's labor supply relative to single women. Next, explicit accounting for couples allows studying the new angles of the redistributive role of progressive taxation. On the one hand, positive assortative mating, when similarly educated people are more likely to marry each other, is considered as one of the driving forces of between-household inequality (Fernandez et al., 2005). On the other hand, the presence of within-household insurance through responses of spousal labor supply allows smoothing the negative wage shocks. Should couples be taxed differently from singles? If so, how different from the current U.S. tax schedule?

In this paper, to address these questions, I develop a general equilibrium overlapping generations model that features single and married households facing uninsurable idiosyncratic labor productivity risk, intensive and extensive margins of labor supply, and human capital accumulation. I estimate the model using the Method of Simulated Moments (MSM) and data from the Current Population Survey (CPS) and the Panel Study of Income Dynamics (PSID). The model matches the patterns from the data remarkably well. In particular, it generates the compensated labor supply elasticities that are consistent with empirical studies. Having checked the validity of the model, I quantitatively characterize the optimal progressivity separately for single and married households. To find the optimal tax schedule, I maximize the welfare of the newborn household at the new steady state.

My first finding is that tax progressivity should be lower for married couples than for singles. One of the channels that explains this results is related to the private within-household insurance through responses of spousal labor supply in couples (Blundell et al., 2016b; Wu and Krueger, 2021). The presence of this private insurance device reduces the desired degree of public insurance

[1] Germany is another example of this policy.

in the form of tax progressivity. Second, I find that the optimal tax schedule has a higher degree of progressivity for singles and lower progressivity for couples relative to the actual income tax policy. The optimal tax reform increases the elasticity of post-government to pre-government income from 0.853 (under actual U.S. tax system) to 0.892 (under optimal tax system). This gives rise to an increase in married women participation by 2.6 p.p. (or 3.8%, from 69.2 percent to 71.8 percent). At the same time, it stimulates the employment of single women at the lower end of the income distribution. Furthermore, replacing the U.S. tax and transfer system with the optimal schedule is associated with sizable welfare gains of about 1.3 percent in terms of consumption equivalent variation. On top of that, I show that there exist welfare-improving reforms that replace the actual U.S. income tax code with a revenue-neutral income tax system so that the schedule for one group (e.g., singles) remains at the benchmark level while the schedule for the other group (e.g., couples) is changed. To the best of my knowledge, this paper is the first one that addresses the question of optimal taxation of singles *and* married couples in a unified general equilibrium framework with rich heterogeneity and human capital. I show that explicitly modeling couples and accounting for the extensive margin of labor supply combined with human capital accumulation is quantitatively important for the design of the optimal policy.

I consider several extensions of the baseline model and show that the main findings carry over into the other environments. First, I consider a version of the model where the government uses part of the revenue to service the outstanding government debt, hence abstracting from the assumption about the balanced government budget constraint. Second, I relax the assumption that individuals do not change their marital status over the life cycle. I model marriage and divorce as exogenous shocks in the spirit of Cubeddu and Ríos-Rull (2003) and Chakraborty et al. (2015). While accounting for the endogenous response of marriage and divorce rates to changes in tax policy is potentially important, the empirical literature finds that in the United States the magnitude of this impact is quite small. In other words, most individuals do not respond to tax incentives in their marriage and divorce decisions (Alm and Whittington, 1995; Whittington and Alm, 1997; Alm and Whittington, 1999).[2] Third, I relax the assumption that idiosyncratic

[2] Using the U.S. data, Fisher (2013) estimates that a $1000 change in the marriage bonus or penalty is associated with a 1.7 p.p. (or 1.9 %) change in the probability of marriage. This effect is substantially higher than in the other papers. For comparison, Persson (2020) find that elimination of survivors insurance in Sweden raised the divorce rate by 10%.

productivity shocks of spouses in couples are uncorrelated. Finally, I consider a version of the model where married couples can choose between joint and separate filing.

My paper contributes to several strands of literature. Generally speaking, my paper contributes to the Ramsey-style literature that studies the optimal income taxation in heterogeneous-agent models with incomplete markets (Conesa and Krueger, 2006; Conesa et al., 2009). Keane (2011) emphasizes the importance of accounting for marital status in studying the relationship between tax and transfer policy and labor supply responses. In this vein, my paper is related to the papers that study income taxation of couples. Influential previous studies include Bar and Leukhina (2009), Kleven et al. (2009), Immervoll et al. (2011), Guner et al. (2012a), Frankel (2014), Gayle and Shephard (2019), and Bronson and Mazzocco (2021). Kleven et al. (2009) consider a static unitary model of the households where the primary earners make a labor supply decision at the intensive margin and the secondary earners choose whether to work or not. Gayle and Shephard (2019), using a static model, study the role of marriage market in shaping the optimal income tax schedule. These two papers suggest that the optimal tax schedule is characterized by negative jointness, i.e. marginal tax rate for individual should be lower the higher are his/her spousal earnings. In Bar and Leukhina (2009) and Immervoll et al. (2011), spouses choose labor supply at the extensive margin, but do not choose hours.

My paper also adds to the literature on tagging pioneered by Akerlof (1978) who showed that conditioning taxes on personal characteristics can improve redistributive taxation (Cremer et al., 2010). More recently, the idea of tagging was discussed in the context of age-dependent taxation (Weinzierl, 2011; Heathcote et al., 2020), gender-based taxation (Alesina et al., 2011; Guner et al., 2012b), and asset-based taxation (Karabarbounis, 2016).

Next, my paper is related to the literature that emphasizes the role of females and their labor supply in studying inequality and tax and transfer policy reforms. Eissa and Liebman (1996) and Eissa and Hoynes (2004) find that the Earned Income Tax Credit (EITC) expansions between 1984 and 1996, on the one hand, reduced the total family labor supply of couples mainly through lowering the labor force participation of married women, and, on the other hand, increased participation of single women with children relative to single women without children. Borella et al. (2021) show that eliminating marriage-related taxes and old age Social Security benefits in the United States would significantly enhance labor force participation of married women over their

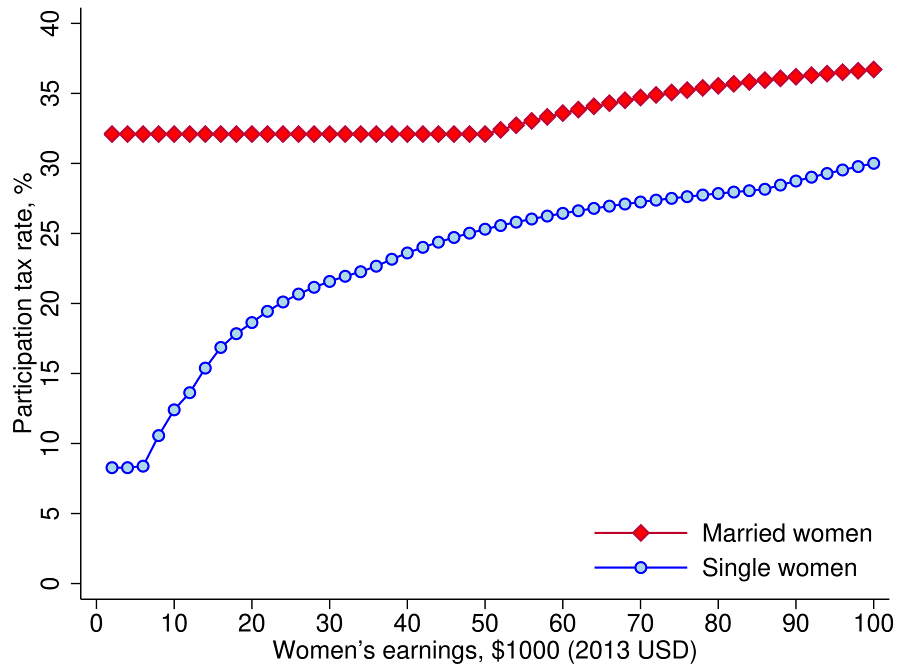



Figure 1: Participation tax rates of a married and a single woman in the United States

NOTES: Participation tax rate is defined as the change in household's tax liability divided by a women's earnings when she starts working. The tax rates are calculated using NBER TAXSIM and include federal, state, and FICA tax rates. Both women aged 40, live in Michigan, and have two children under age 17. A married woman husband's annual earnings are fixed at $35603 (2013 USD) which is the U.S. median level for 2013 (Song et al., 2019). Individuals do not have any non-labor income. Married couple is assumed to file jointly.

life cycle. Female labor supply is often considered in the context of the so-called "added worker effect," i.e. a temporary increase in the labor supply of married women whose husbands have become unemployed (Lundberg, 1985). The evidence on this effect is mixed. On the one hand, using the PSID data, Blundell et al. (2016b) find that a sizable share of smoothing of men's and women's permanent shocks to wages operates through changes in spousal labor supply. Furthermore, Park and Shin (2020) also find the empirical support of the added worker effect by showing that wives significantly increase their labor supply—mainly through adjustments along the extensive margin—in response to increases in the variance of permanent wage shocks of their husbands. On the other hand, Birinci (2019) and Busch et al. (2021) find that the magnitude of this effect is small.

The fact that joint taxation of couples creates substantial disincentive effects for the married women's employment (Bick and Fuchs-Schündeln, 2017) underscores the importance of accounting for extensive margin of labor supply in my analysis. Under this policy, the marginal tax rate on the first dollar earned by the secondary (lower income) earner is equal to the marginal tax rate on the last dollar earned by the primary (higher income) earner. As a result, married secondary earners typically face higher tax rates than otherwise identical single earners. Figure 1 illustrates the last point by showing the participation tax rates (change in household's tax liability divided by woman's earnings when she starts working) for married and single women in the United States. Except for the marital status, these two women are identical. Clearly, a married woman faces a significantly higher tax rate, when she starts working, than a single one.

The rest of the paper is organized as follows. To build the intuition and discuss the main mechanisms, I provide a simple static model in Section 2. I present a full quantitative model in Section 3. In Section 4, I discuss the parameterization. Section 5 describes the optimal policy exercises and contains the main quantitative results. In Section 6, I discuss the extensions and future work. Section 7 concludes.

## 2 Simple Example

To provide the intuition for different channels through which tax progressivity interacts with the labor supply decisions of singles and couples, I consider a simple static analytically tractable household problem. I illustrate that the presence of intra-household insurance in couples through spousal labor supply limits the role of tax progressivity as a public insurance device. Furthermore, I show that an increase in tax progressivity can lead to the opposite outcomes for the labor force participation of single and married women. In the next section, I enrich this environment by extending it to a general equilibrium setting and adding empirically relevant features (such as human capital accumulation) that are necessary for a comprehensive quantitative analysis.

Consider two types of households, a single individual and a married couple. The households make consumption and labor supply decisions. In particular, each individual decides whether to work or not and if work, then how much. If an individual works, then there is additional fixed time cost of work. I interpret it as time spent on getting ready to work or the commuting costs. Modeling the participation margin with the fixed cost of work allows generating the distribution of hours that is consistent with the data (Cogan, 1981; French, 2005). In particular, as Figure

D.3 reports, the empirical distribution of annual working hours has a little mass at low positive number of hours. Instead, the weekly hours of work are clustered around 0 and 40 hours of work. This is true for both men and women irrespective of their marital status. Overall, each person is endowed with one unit of time which is allocated between work, leisure, and fixed cost of work $q$. Denote by $w_m$ and $w_f$ the labor market productivities (wage rates) of males and females, respectively. Households face tax and transfer function

$$T(y) = y - \lambda y^{1-\tau} \tag{1}$$

where parameters $\lambda$ and $\tau$ are allowed to vary by marital status. Parameter $\tau$ stands for the degree of progressivity of the tax system. Given $\tau$, parameter $\lambda$ determines the average level of taxes in the economy. Single households pay taxes based on their individual income, while married couples are taxed jointly, i.e. based on the total income of spouses.[3] I discuss the properties of this tax function in Appendix B.1.

First, consider the problem of a single individual with gender $i = m, f$:

$$\max_{c,n} \log(c) - \psi \frac{(n + q \cdot \mathbb{1}\{n > 0\})^{1+\eta}}{1+\eta} \tag{2}$$

$$\text{s.t.} \quad c = \lambda_s (w_i n)^{1-\tau_s} + \tilde{T}$$

where $c$ denotes consumption, $n$ denotes working hours, $\mathbb{1}\{n > 0\}$ is an indicator for working positive number of hours, $\tilde{T}$ is a lump-sum government transfer. Parameters $\lambda_s$ and $\tau_s$ characterize the tax schedule for single households.

Next, consider the problem of a married couple:

$$\max_{c,n_m,n_f} 2\log(c) - \psi \frac{(n_m + q \cdot \mathbb{1}\{n_m > 0\})^{1+\eta}}{1+\eta} - \psi \frac{(n_f + q \cdot \mathbb{1}\{n_f > 0\})^{1+\eta}}{1+\eta} \tag{3}$$

$$\text{s.t.} \quad c = \lambda_j (w_m n_m + w_f n_f)^{1-\tau_j} + 2\tilde{T}$$

[3] While couples in the United States can choose between separate and joint filing, most of them choose the latter option. For example, in tax year 2018, 94.3 percent of married couples filed joint tax returns. See Table 1.6 "All Returns: Number of Returns, by Age, Marital Status, and Size of Adjusted Gross Income" in the Statistics of Income (SOI) data. Hence both in a simple and a full-fledged quantitative model, I assume that couples are taxed on their joint spousal income. In Section 6.4, I relax this assumption and allow married couples to choose between separate and joint filing.

where parameters $\lambda_j$ and $\tau_j$ characterize the tax schedule for married couples. Note that the couples are taxed on their joint income.

Consider the following comparative static exercise. Suppose that an individual with gender $i$ is hit by a productivity (wage) shock. In the following proposition, I characterize the extent to which this shock translates into consumption movement.

**Proposition 1 (Passthrough of Wage Shocks to Consumption).** *Assume $q = 0$ and $\tilde{T} = 0$. For singles, the elasticity of consumption to wage shock is given by*

$$\frac{d\log(c)}{d\left(w_i\right)} = 1 - \tau_s \tag{4}$$

*For couples, the elasticity of consumption to wage shock is given by*

$$\frac{d\log(c)}{d\log\left(w_i\right)} = \frac{w_i^{\frac{1+\eta}{\eta}}}{w_i^{\frac{1+\eta}{\eta}} + w_{-i}^{\frac{1+\eta}{\eta}}}\left(1 - \tau_j\right) \tag{5}$$

**Proof.** *See Appendix A.1.*

Proposition 1 shows how consumption of single and married individuals respond to wage shocks, and how public insurance through the tax system affects these responses.[4] In particular, $(1-\tau_s)\%$ of the shock passes through to single household consumption. The degree of tax progressivity $\tau_s$ determines the extent of public insurance. For married individuals, the transmission coefficient is smaller than $(1-\tau_j)$. It is mitigated through the labor supply adjustment of spouses. Spousal labor supply serves as a private insurance against wage shocks, and therefore limits the role of tax progressivity as an insurance device. Summing up, Proposition 1 suggests that the availability of private within-household income insurance mechanism for couples serves as one of the arguments towards lower tax progressivity for couples than for singles. In Appendix A.1, I show that this result also holds in the environment when married couples are taxed separately rather than jointly.

Next, I discuss the effects of changes in tax progressivity on the labor force participation of

[4] Using the terminology from Blundell et al. (2008), I refer to the elasticities from Proposition 1 as transmission coefficients.

single individuals and secondary earners in the couples. The next two propositions show that an increase in tax progressivity leads to the opposite effects for these groups of people.

**Proposition 2 (Tax Progressivity and Extensive Margin of Singles).** *Define the threshold on fixed cost of work $\bar{q}_s$ through the following equation:*

$$\underbrace{V_1^s\left(c_1^*, n^*; \bar{q}_s\right)}_{\textit{work}} = \underbrace{V_0^s\left(c_0^*, 0\right)}_{\textit{does not work}}$$

*For singles whose income is below average, $w_i n_i < 1$, the fixed cost threshold is strictly increasing in progressivity, $\partial \bar{q}_s / \partial \tau_s > 0$, i.e. their labor force participation is increasing in progressivity.*

**Proof.** *See Appendix A.2.*

**Proposition 3 (Tax Progressivity and Extensive Margin of Secondary Earners).** *Assume that the primary earners (males) do not have fixed cost, so that they always choose to work. Assume $\tilde{T} = 0$. Define the threshold on fixed cost of work $\bar{q}_c$ through the following equation:*

$$\underbrace{V_2^c\left(c_2^*, n_{m,2}^*, n_f^*; \bar{q}_c\right)}_{\textit{dual-earner couple}} = \underbrace{V_1^c\left(c_1^*, n_{m,1}^*, 0\right)}_{\textit{single-earner couple}}$$

*Under joint taxation, if the primary earner's income is high enough, then the fixed cost threshold is strictly decreasing in progressivity, $\partial \bar{q}_c / \partial \tau_j < 0$, i.e. labor force participation of secondary earners is decreasing in progressivity.*

**Proof.** *See Appendix A.3.*

I define a threshold value $\bar{q}_s$ for singles ($\bar{q}_c$ for secondary earners in couples) such that for singles with $q < \bar{q}_s$ (secondary earners with $q < \bar{q}_c$) it is optimal to work. In turn, with high enough values of $q$, singles and secondary earners choose not to work. Propositions 2 and 3 characterize the way these thresholds change with the degree of tax progressivity. On the one hand, higher tax progressivity encourages labor force participation of single individuals at the low end of the income distribution. Hence, a more progressive tax system creates a negative income effect on the labor supply of individuals whose income is below average. On the other hand, an increase in tax progressivity under joint taxation of spousal income discourages the labor force participation of the secondary earners. Joint taxation is often considered as one of the main factors that

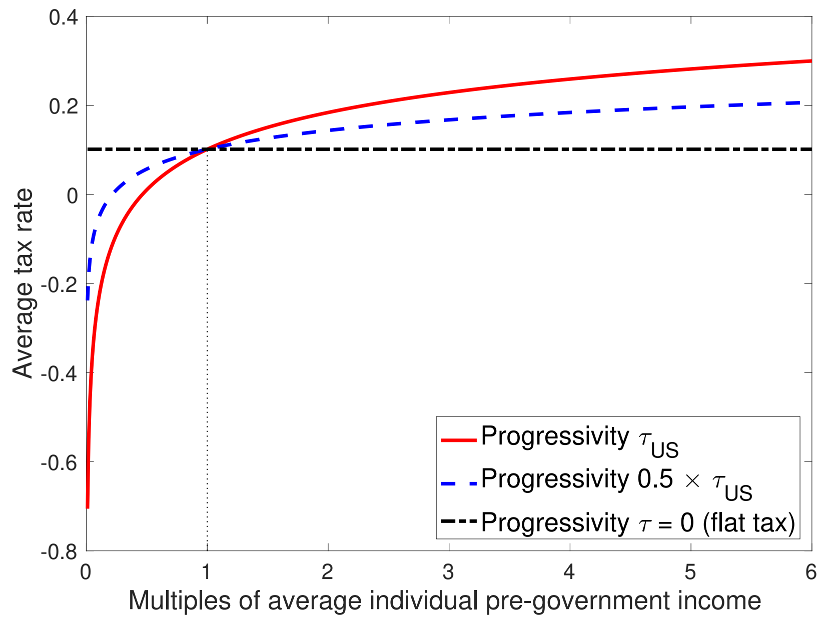



Figure 2: Average tax rate under different degrees of tax progressivity

NOTES: Parameters of the tax function for the United States are estimated using the data on single and married households from the Panel Study of Income Dynamics (PSID) for survey years 2013, 2015, and 2017, combined with the NBER TAXSIM (Feenberg and Coutts, 1993). See Appendix B.2 for the details.

limits female labor force participation in the United States and some European countries (Bick and Fuchs-Schündeln, 2017). These disincentive effects can have long-run consequences because of human capital depreciation, a feature that I account for in my quantitative model.

To provide more intuition, in Figure 2, I plot the average tax rates against income relative to average income for different degrees of tax progressivity $\tau$. The red solid line corresponds to the U.S. tax schedule.[5] Furthermore, the blue dashed line represents the less progressive tax schedule with the progressivity parameter that is equal to $0.5\tau_{US}$, and black dash-dotted line represents the flat tax system, i.e. $\tau = 0$. An increase in tax progressivity (e.g., moving from the blue dotted line to the red solid line) decreases the average tax rate for households whose income is below average and increases it for those whose income is above average.

[5] Note that I use Figure 2 for illustrative purposes only. In the quantitative part of this paper, I estimate the tax and transfer function separately for single and married households.

Taking stock, the simple model studied here highlights the different implications of tax progressivity for singles and couples. The presence of private within-household insurance through spousal labor supply for couples reduces the demand for public insurance in the form of tax progressivity. Next, higher tax progressivity may translate into opposite effects for the employment of single and married women.

# 3 Quantitative Model

In this section, I present an overlapping generations model that features single and married households, uninsurable idiosyncratic labor productivity shocks, intensive and participation margins of labor supply, and human capital accumulation. It provides a natural framework to analyze the reforms of a tax and transfer system. I focus on a balanced growth equilibrium where long-run growth is generated by exogenous technological progress and thus drop time subscripts.

**Economic Environment.** Consider a closed overlapping generations economy populated by a continuum of males ($m$) and a continuum of females ($f$). I index gender by $i$, so that $i \in \{m, f\}$. Time is discrete. There are no aggregate shocks. The production side is described by a constant returns to scale technology. The government levies taxes, spends money, and runs a balanced budget social security system.

**Demographics.** The economy is populated by $A$ overlapping generations. Households are finitely lived, and their age is indexed by $a \in \{1, ..., A\}$. I assume that the population is constant. In each period, a unit measure of new agents is born. Each household is either a single ($s$) or a married couple ($c$). I index marital status by $\iota$, so that $\iota \in \{s, c\}$. There are three types of households: single men, single women, and married couples. In the baseline model, I assume that agents are born as either single or married, and do not change the marital status over time. The life cycle of each individual consists of two stages, working stage and retirement. During the working stage that runs from $a = 1$ to exogenous retirement age $a_R$, the agents have zero probability of dying. They choose how much to consume, work, and save. During the retirement stage, the agents do not work and face age-dependent survival probability $\zeta_a$, and certainly die at age $A$, i.e. $\zeta_A = 0$. For tractability, I assume that spouses within each married couple have the same age and die at the same age.

**Households.** Household have preferences over consumption ($c$) and leisure ($l$). They discount the future at rate $\beta$. The momentary utility function for single household is given by

$$U^s(c,l) = \log(c) + \psi \frac{l^{1-\eta}}{1-\eta} \tag{6}$$

Married couples have joint utility function over (public) consumption and spousal leisure:

$$U^c\left(c, l^m, l^f\right) = \log\left(\frac{c}{\xi}\right) + \psi \frac{\left(l^m\right)^{1-\eta}}{1-\eta} + \psi \frac{\left(l^f\right)^{1-\eta}}{1-\eta} \tag{7}$$

where $\xi$ denotes the consumption equivalence scale. Parameter $\psi$ defines the utility weight attached to leisure and parameter $\eta$ is the curvature of leisure that affects the Frisch elasticity of labor supply.

Each individual with gender $i$ and marital status $\iota$ is endowed with $\bar{L}_\iota^i$ units of time that he/she splits between leisure and work. I interpret this time endowment to be net of home production, child care, and elderly care. Despite I do not explicitly model children, one can interpret lower $\bar{L}_\iota^i$ (and, therefore, less available time for leisure and work) as time costs associated with children. Furthermore, if an individual works, then he/she has to pay the fixed time cost of work. Therefore,

$$l_\iota^i = \bar{L}_\iota^i - n^i - q_\iota^i(a) \cdot \mathbb{1}\{n^i > 0\} \tag{8}$$

where $n^i$ denotes hours of work, $\mathbb{1}\{n > 0\}$ is an indicator for working positive number of hours. The net time endowment is given by

$$\bar{L}_\iota^i = \frac{112}{1 + \exp\left(\varphi_\iota^i\right)} \tag{9}$$

where the gross time endowment is calculated as 168 hours ($24 \times 7$ hours) minus 56 hours ($8 \times 7$ hours) for sleep. I estimate $\varphi_\iota^i$ using the model.

I allow the fixed cost of work $q^i_\iota(a)$ to depend on gender, marital status, and age. Following Borella et al. (2021), I assume that it is described by a quadratic function of age[6]

$$q^i_\iota(a) = \frac{\exp\left(\alpha^{i,\iota}_0 + \alpha^{i,\iota}_1 a + \alpha^{i,\iota}_2 a^2\right)}{1 + \exp\left(\alpha^{i,\iota}_0 + \alpha^{i,\iota}_1 a + \alpha^{i,\iota}_2 a^2\right)} \tag{10}$$

and estimate parameters $\left(\alpha^{i,\iota}_0, \alpha^{i,\iota}_1, \alpha^{i,\iota}_2\right)$ using the model.

Note that both men and women choose labor supply at intensive and extensive margin. Looking at the data on hours of work over the last six decades, as reported in Figure **??**, we can make several observations. First, the average hours for married men declined from about 39 hours in the early 1960s to 35 hours in the end of the 2010s. Second, the average hours for single men and women have not significantly changed over time, but the gap between them narrowed down. Finally, the labor supply of married women significantly increased (Jones et al., 2015), and today their average hours are very close to the hours for single men and single women.

**Human Capital.** Women endogenously accumulate human capital through the labor market experience. In particular, following Blundell et al. (2016a), I assume that women's human capital evolves according to

$$h_{a+1} = h_a + \mathbb{1}\{n^f_a > 0\} - \delta_h \cdot \mathbb{1}\{n^f_a = 0\} \tag{11}$$

where $\delta_h$ denotes human capital depreciation. Each period, if a women works, her human capital increases by one unit. In turn, if she does not work, it depreciates by $\delta_h$ units.[7]

**Labor Productivity and Wages.** During the working period, labor productivity of individuals depends on their human capital $h$ (for women) or age $a$ (for men), permanent ability $\upsilon$, and persistent idiosyncratic shock $u$. I assume that retired individuals aged $a \geq a_R$ have zero labor productivity. Denote the experience efficiency profile for women by $g^f(h)$ and the age-efficiency profile for men by $g^m(a)$. Permanent ability $\upsilon^i \sim \mathcal{N}\left(0, \sigma^2_{\upsilon^i}\right)$ is drawn once at birth and accounts for differences in education and innate abilities. I allow the draws for spouses to be correlated ($\rho_\upsilon$). This correlation measures the degree of assortative mating in the economy. Rich existing

[6] For example, this functional form allows to capture the role of child rearing for married women's labor force participation in a simple way.

[7] This formulation of human capital accumulation process is also close to the one described in Attanasio et al. (2008). They also assume that the returns to human capital diminish with age.

literature documents positive assortative mating by education in many countries, i.e. people with similar levels of education are more likely to marry each other (Pencavel, 1998; Greenwood et al., 2014; Eika et al., 2019). The idiosyncratic productivity shock $u$ follows an AR(1) process:

$$u_a^i = \rho^i u_{a-1}^i + \varepsilon_a^i, \qquad \varepsilon \sim \mathcal{N}\left(0, \sigma_{\varepsilon^i}^2\right) \tag{12}$$

In each period, the log wage of a female characterized by age $a$, human capital $h$, permanent ability $\upsilon$, and stochastic labor productivity $u$ is given by

$$\log\left(\tilde{\omega}^f\left(a,h,\upsilon,u\right)\right) = \log\left(\tilde{w}\right) + \underbrace{\gamma_0^f + \gamma_1^f h + \gamma_2^f h^2 + \gamma_3^f h^3}_{\text{experience-efficiency profile, } g^f(h)} + \upsilon^f + u^f \tag{13}$$

where $\tilde{w}$ is the aggregate wage per efficiency unit of labor.[8] Thus, a female with $\left(a,h,\upsilon^f,u^f\right)$ has $\exp\left(g^f(h)\upsilon^f u^f\right)$ efficiency units of labor.

Similarly, the log wage of a male characterized by age $a$, permanent ability $\upsilon$, and stochastic labor productivity $u$ is given by

$$\log\left(\tilde{\omega}^m\left(a,\upsilon,u\right)\right) = \log\left(\tilde{w}\right) + \underbrace{\gamma_0^m + \gamma_1^m a + \gamma_2^m a^2 + \gamma_3^m a^3}_{\text{age-efficiency profile, } g^m(a)} + \upsilon^m + u^m \tag{14}$$

Thus, a male with $(a,\upsilon^m,u^m)$ has $\exp\left(g^m(a)\upsilon^m u^m\right)$ efficiency units of labor. I estimate the returns to age and experience using the PSID data.

**Production.** The production side of the economy is given by a representative firm that operates a constant returns to scale technology described by a Cobb-Douglas production function:

$$F_t\left(K_t, N_t\right) = K_t^\alpha \left(Z_t N_t\right)^{1-\alpha} \tag{15}$$

where $K_t$ is capital input, $N_t$ is labor input measured in efficiency units, and $Z_t = (1+\mu)^t Z_0$ is labor-augmenting technological progress. I normalize $Z_0 = 1$. Capital accumulation is standard

[8] As I explain later, I transform the growing economy into a stationary one, and therefore the wage per efficiency unit of labor $\tilde{w}$ is equal to the wage per efficiency unit of labor in a growing economy $w_t$ divided by labor-augmenting technological progress $Z_t$.

and given by

$$K_{t+1} = (1-\delta) K_t + I_t \tag{16}$$

where $I_t$ is gross investment and $\delta$ is the capital depreciation rate.

The aggregate resource constraint is given by

$$C_t + K_{t+1} - (1-\delta)K_t + G_t \leq K_t^{\alpha} (Z_t N_t)^{1-\alpha} \tag{17}$$

In each period, the firm rents labor efficiency units at rate $w$ and capital at rate $r$, and maximizes its profit

$$\pi_t = Y_t - (r_t + \delta) K_t - w_t N_t \tag{18}$$

**Government.** The government levies consumption and income taxes, spends collected revenues, and runs a balanced budget pay-as-you-go Social Security system. Retired individuals receive Social Security benefits $ss$ that are independent of their earnings history. These benefits are financed by proportional payroll taxes at exogenous rate $\tau_{ss}$.[9] There are no annuity markets, and the assets of households that die are collected by the government and uniformly redistributed among households that are currently alive as accidental bequests ($\tilde{\Omega}$).

The government needs to finance an exogenously given level of government consumption $G$. It collects revenue from the following sources. First, there is a proportional consumption tax ($t_c$). Second, the government taxes household income of singles, $y^m = \tilde{\omega}^m (a, \upsilon, u) n^m$ and $y^f = \tilde{\omega}^f (h, \upsilon, u) n^f$, and couples $y^c = \tilde{\omega}^m (a, \upsilon, u) n^m + \tilde{\omega}^f (h, \upsilon, u) n^f$, where $\tilde{\omega}^f$ and $\tilde{\omega}^m$ are given in (13) and (14) correspondingly. As in Benabou (2002) and Heathcote et al. (2017), I use the tax and transfer function of the form (1) and allow it to differ by marital status of taxpayers. For singles, it is given by

$$T^s (y; \lambda_s, \tau_s) = y - \lambda_s y^{1-\tau_s} \tag{19}$$

Couples are taxed on the basis of joint spousal income,

$$T^j (y_m, y_f; \lambda_j, \tau_j) = y^m + y^f - \lambda_j \left(y^m + y^f\right)^{1-\tau_j} \tag{20}$$

[9] I assume that Social Security benefits do not depend on the earnings history to reduce the computational burden, so that I do not need to keep track of Social Security contributions.

**Market Structure.** I assume that the asset market is incomplete, so that individual cannot insure against idiosyncratic labor productivity risk by trading explicit insurance contracts. Furthermore, annuity markets are missing. Individuals can trade one-period risk-free bonds but cannot borrow.

## 3.1 Recursive Formulation

At any period of time, a single household is characterized by gender ($i$), asset holdings ($b$), human capital ($h$), permanent ability ($\upsilon^i$), and idiosyncratic labor productivity ($u^i$), and age ($a$).[10] Hence the individual state space for single males is $(m, b, \upsilon^m, u^m, a)$. The individual state space for single females is $\left(f, b, h, \upsilon^f, u^f, a\right)$. The individual state space for married couples is $(b, h, \boldsymbol{\upsilon}, \boldsymbol{u}, a)$, where $\boldsymbol{\upsilon} = \left(\upsilon^m, \upsilon^f\right)$ and $\boldsymbol{u} = \left(u^m, u^f\right)$. I transform the growing economy into a stationary one by deflating all appropriate variables by the growth factor $Z_t$.[11] I denote by $\tilde{x}$ the deflated variable $x_t$, i.e. $x_t/Z_t$. In what follows, I describe the problems of single and married households during working and retirement stages of life.

**Single Males (Working Stage).** The recursive problem for a single male during the working stage is given by

$$V^m\left(\tilde{b}, \upsilon, u, a\right) = \max_{\tilde{c}, \tilde{b}', n}\left[U^m\left(\tilde{c}, l\right) + \beta \mathbb{E} V^m\left(\tilde{b}', u', \upsilon, a+1\right)\right] \tag{21}$$

subject to

$$\begin{aligned}(1+t_c)\,\tilde{c} + (1+\mu)\tilde{b}' = (1-\tau_{ss})\underbrace{\tilde{\omega}^m\left(a, \upsilon, u\right) n^m}_{\text{labor income}} + \underbrace{(1+r)\left(\tilde{b} + \tilde{\Omega}\right)}_{\text{savings + accidental bequests}} + \underbrace{\tilde{T}}_{\text{lump-sum transfers}} - \\ T^s\underbrace{\left((1-0.5\tau_{ss})\,\tilde{\omega}^m\left(a, \upsilon, u\right) n^m + r\left(\tilde{b} + \tilde{\Omega}\right)\right)}_{\text{taxable income}}\end{aligned} \tag{22}$$

$$l^f = \bar{L}^f_s - n^f - q^f_s(a) \cdot \mathbb{1}\{n^f > 0\} \tag{23}$$

$$h' = h + \mathbb{1}\{n^f > 0\} - \delta_h \cdot \mathbb{1}\{n^f = 0\} \tag{24}$$

$$\tilde{b}' \geq 0, \quad \tilde{c} > 0, \quad n^f \geq 0, \quad a < a_R \tag{25}$$

[10] Recall that human capital is a relevant state variable only for females.
[11] See King et al. (2002) for the discussion.

The expectation in (21) is taken over the next period's labor productivity shock.

**Single Females (Working Stage).** The recursive problem for a single female during the working stage is given by

$$V^f\left(\tilde{b}, h, \upsilon, u, a\right) = \max_{\tilde{c}, \tilde{b}', n} \left[U^f\left(\tilde{c}, l\right) + \beta \mathbb{E} V^f\left(\tilde{b}', h', u', \upsilon, a+1\right)\right] \tag{26}$$

subject to

$$\begin{aligned}(1+t_c)\,\tilde{c} + (1+\mu)\tilde{b}' = (1-\tau_{ss})\,\tilde{\omega}^f\left(h, \upsilon, u\right) n^f + (1+r)\left(\tilde{b} + \tilde{\Omega}\right) + \tilde{T} - \\ T^s\left(\left(1-0.5\tau_{ss}\right)\tilde{\omega}^f\left(h, \upsilon, u\right) n^f + r\left(\tilde{b} + \tilde{\Omega}\right)\right)\end{aligned} \tag{27}$$

$$l^m = \bar{L}^m_s - n^m - q^m_s(a) \cdot \mathbb{1}\{n^m > 0\} \tag{28}$$

$$\tilde{b}' \geq 0, \quad \tilde{c} > 0, \quad n^m \geq 0, \quad a < a_R \tag{29}$$

The expectation in (26) is taken over the next period's labor productivity shock.

**Married Couples (Working Stage).** The recursive problem for a married couple during the working stage is given by

$$V^c\left(\tilde{b}, h, \boldsymbol{\upsilon}, \boldsymbol{u}, a\right) = \max_{\tilde{c}, \tilde{b}', n^m, n^f} \left[U^c\left(\tilde{c}, l^m, l^f\right) + \beta \mathbb{E} V^c\left(\tilde{b}', h', \boldsymbol{\upsilon}, \boldsymbol{u}', a+1\right)\right] \tag{30}$$

subject to

$$\begin{aligned}(1+t_c)\,\tilde{c} + (1+\mu)\tilde{b}' = (1-\tau_{ss})\left[\tilde{\omega}^m\left(a, \upsilon, u\right) n^m + \tilde{\omega}^f\left(h, \upsilon, u\right) n^f\right] + (1+r)\left(\tilde{b} + 2\tilde{\Omega}\right) + \\ 2\tilde{T} - T^c\left(\sum_{i=m,f}\left(1-0.5\tau_{ss}\right)\tilde{\omega}^i\left(h, a, \upsilon, u\right) n^i + r\left(\tilde{b} + 2\tilde{\Omega}\right)\right)\end{aligned} \tag{31}$$

$$l^m = \bar{L}^m_c - n^m - q^m_c(a) \cdot \mathbb{1}\{n^m > 0\} \tag{32}$$

$$l^f = \bar{L}^f_c - n^f - q^f_c(a) \cdot \mathbb{1}\{n^f > 0\} \tag{33}$$

$$h' = h + \mathbb{1}\{n^f > 0\} - \delta_h \cdot \mathbb{1}\{n^f = 0\} \tag{34}$$

$$\tilde{b}' \geq 0, \quad \tilde{c} > 0, \quad , n^m \geq 0, \quad n^f \geq 0, \quad a < a_R \tag{35}$$

The expectation in (30) is taken over the next period's labor productivity shocks for each of the spouses.[12]

**Single Households (Retirement Stage).** The recursive problem for a single individual with gender $i \in \{m, f\}$ during the retirement stage is given by

$$V^i\left(\tilde{b}, a, \upsilon\right) = \max_{\tilde{c}, \tilde{b}'} \left[U^i\left(\tilde{c}, \bar{L}_s^i\right) + \zeta_a \beta V^i\left(\tilde{b}', a+1, \upsilon\right)\right] \tag{36}$$

subject to

$$(1+t_c)\,\tilde{c} + (1+\mu)\tilde{b}' = \underbrace{ss}_{\text{retirement benefits}} + (1+r)\left(\tilde{b} + \tilde{\Omega}\right) - T^s\left(ss + r\left(\tilde{b} + \tilde{\Omega}\right)\right) \tag{37}$$

$$\tilde{b}' \geq 0, \quad \tilde{c} > 0, \quad a \geq a_R \tag{38}$$

**Married Couples (Retirement Stage).** Finally, the recursive problem for a married couple during the retirement stage is given by

$$V^c\left(\tilde{b}, a, \upsilon\right) = \max_{\tilde{c}, \tilde{b}'} \left[U^c\left(\tilde{c}, \bar{L}_c^m, \bar{L}_c^f\right) + \zeta_a \beta V^c\left(\tilde{b}', a+1, \upsilon\right)\right] \tag{39}$$

subject to

$$(1+t_c)\,\tilde{c} + (1+\mu)\tilde{b}' = 2ss + (1+r)\left(\tilde{b} + 2\tilde{\Omega}\right) - T^c\left(2ss + r\left(\tilde{b} + 2\tilde{\Omega}\right)\right) \tag{40}$$

$$\tilde{b}' \geq 0, \quad \tilde{c} > 0, \quad a \geq a_R \tag{41}$$

## 3.2 Recursive Competitive Equilibrium

Let $\Pi^m\left(\tilde{b}, \upsilon, u, a\right)$ be the measure of single males, $\Pi^f\left(\tilde{b}, h, \upsilon, u, a\right)$ be the measure of single females, and $\Pi^c\left(\tilde{b}, h, \boldsymbol{\upsilon}, \boldsymbol{u}, a\right)$ be the measure of married couples. A stationary recursive com-

[12] In the baseline version of the model, they are assumed to be independent. I relax this assumption in Section 6.3.

petitive equilibrium is defined by

1. Given initial conditions, prices, transfers, and social security benefits, the value functions $V^m(\Pi^m)$, $V^f(\Pi^f)$, and $V^c(\Pi^c)$, and associated policy functions for consumption, hours, and savings, $\tilde{c}(\Pi^m)$, $n^m(\Pi^m)$, $\tilde{b}(\Pi^m)$, $\tilde{c}(\Pi^f)$, $n^f(\Pi^f)$, $\tilde{b}(\Pi^f)$, $\tilde{c}(\Pi^c)$, $n^m(\Pi^c)$, $n^f(\Pi^c)$, and $\tilde{b}(\Pi^c)$ solve the households' optimization problems.

2. Markets for labor, capital, and final output are clear:

$$\tilde{N} = \int \exp\left(g^m(a)v^m u^m\right) n^m d\Pi^m + \int \exp\left(g^f(h)v^f u^f\right) n^f d\Pi^f + \int \left(\exp\left(g^m(a)v^m u^m\right) n^m + \exp\left(g^f(h)v^f u^f\right) n^f\right) d\Pi^c \quad (42)$$

$$\tilde{K} = \int \tilde{b} d\Pi^m + \int \tilde{b} d\Pi^f + \int \tilde{b} d\Pi^c \quad (43)$$

$$\int \tilde{c} d\Pi^m + \int \tilde{c} d\Pi^f + \int \tilde{c} d\Pi^c + (\mu + \delta)\tilde{K} + \tilde{G} = \tilde{K}^\alpha \tilde{N}^{1-\alpha} \quad (44)$$

3. The factor prices satisfy:

$$\tilde{w} = (1-\alpha)\left(\frac{\tilde{K}}{\tilde{N}}\right)^\alpha \quad (45)$$

$$r = \alpha\left(\frac{\tilde{K}}{\tilde{N}}\right)^{\alpha-1} - \delta \quad (46)$$

4. The assets of dead households are uniformly redistributed among households that are currently alive:

$$\tilde{\Omega}\left(\int \zeta_a d\Pi^m + \int \zeta_a d\Pi^f + \int \zeta_a d\Pi^c\right) = \int (1-\zeta_a)\tilde{b} d\Pi^m + \int (1-\zeta_a)\tilde{b} d\Pi^f + \int (1-\zeta_a)\tilde{b} d\Pi^c \quad (47)$$

5. The social security system is budget balanced:

$$\tau_{ss}\tilde{w}\tilde{N} = ss\left(\int_{a \geq a_R} d\Pi^m + \int_{a \geq a_R} d\Pi^f + \int_{a \geq a_R} d\Pi^c\right) \quad (48)$$

6. The government budget is balanced:

$$
\begin{aligned}
\tilde{G} = t_c \left( \int \tilde{c} d\Pi^m + \int \tilde{c} d\Pi^f + \int \tilde{c} d\Pi^c \right) + \\
\int T^s \left( (1 - 0.5\tau_{ss}) \, \tilde{w} \exp \left( g^m(a) v^m u^m \right) n^m + r \left( \tilde{b} + \tilde{\Omega} \right) \right) d\Pi^m + \\
\int T^s \left( (1 - 0.5\tau_{ss}) \, \tilde{w} \exp \left( g^f(h) v^f u^f \right) n^f + r \left( \tilde{b} + \tilde{\Omega} \right) \right) d\Pi^f + \\
T^c \left( (1 - 0.5\tau_{ss}) \left( \tilde{w} \exp \left( g^m(a) v^m u^m \right) n^m + \tilde{w} \exp \left( g^f(h) v^f u^f \right) n^f \right) + r \left( \tilde{b} + 2\tilde{\Omega} \right) \right)
\end{aligned} \tag{49}
$$

# 4 Parameterization

I now discuss the parameter choices for the model. I estimate the model using a two-stage procedure (Gourinchas and Parker, 2002). In the first stage, I calibrate the parameters that can be set directly to their empirical counterparts without using the model. I take some parameter values from the literature, and estimate the remaining parameters directly from the data. In the second stage, I use the Method of Simulated Moments (MSM) (Pakes and Pollard, 1989; Duffie and Singleton, 1993). In Appendix C.2, I described the estimation procedure in detail.

## 4.1 First-Stage Parameterization

**Demographics.** A model period is one year. The individuals enter the economy at age 25 (model age 1), retire at age 65 (model age 41) and live up to a maximum age of 100 (model age 76). I take the survival probabilities from "Life table for the total population: United States, 2014" provided by the National Center for Health Statistics. Table E.1 reports the survival probabilities for the ages 65-100. I take an adult equivalence scale from OECD, $\xi = 1.7$. Following Guner et al. (2012a), I set the share of married couples to be 77% of all households.

**Preferences.** Following Erosa et al. (2016), I set parameter $\eta$ that governs the Frisch elasticity of labor supply to 2. Discount factor $\beta$, the utility weight attached to leisure $\psi$, and parameters that govern net time endowment and fixed cost of work are estimated in the second stage.

**Human Capital.** Following Mincer and Ofek (1982), I set human capital depreciation rate to $\delta_h = 0.02$.

Table 1: Parameters calibrated at the first stage

| Parameter | Description | Value | Source |
|---|---|---|---|
| $a_R$ | Retirement age: 65 years | 41 | Standard |
| $A$ | Maximum age: 100 years | 76 | Standard |
| $\zeta_a$ | Survival probability | Table E.1 | NCHS |
| $\xi$ | Adult equivalence scale | 1.7 | OECD |
| $\varpi$ | Share of married couples | 0.77 | Guner et al. (2012a) |
| $\eta$ | Leisure curvature | 2 | Erosa et al. (2016) |
| $\delta_h$ | Human capital depreciation | 0.02 | Mincer and Ofek (1982) |
| $\gamma_1^m$, $\gamma_2^m$, $\gamma_3^m$ | Age-efficiency profile, males | Text | PSID |
| $\gamma_1^f$, $\gamma_2^f$, $\gamma_3^f$ | Experience-efficiency profile, females | Text | PSID |
| $\rho^m$, $\rho^f$ | Productivity shock, persistence | 0.937, 0.939 | PSID |
| $\sigma_{\varepsilon^m}$, $\sigma_{\varepsilon^f}$ | Productivity shock, st.dev. | 0.187, 0.145 | PSID |
| $\sigma_{\upsilon^m}$, $\sigma_{\upsilon^f}$ | Permanent ability. st.dev. | 0.332 | PSID |
| $\alpha$ | Technology | 0.36 | Capital share |
| $\delta$ | Capital depreciation rate | 0.0799 | BEA, $I/K = 9.74\%$ |
| $\mu$ | Growth rate | 0.0175 | U.S. data |
| $\tau_{ss}$ | Social security tax | 0.106 | Kitao (2010) |
| $t_c$ | Consumption tax | 0.052 | Mendoza et al. (1994) |
| $\tau_s$, $\tau_j$ | Tax progressivity | 0.125, 0.147 | PSID, NBER TAXSIM |
| $G/Y$ | Government consumption | 0.17 | U.S. data |

**Labor Productivity.** I estimate the age-efficiency profile for the wages of males ($\gamma_1^m$, $\gamma_2^m$, and $\gamma_3^m$) and experience-efficiency profile for the wages of females ($\gamma_1^f$, $\gamma_2^f$, and $\gamma_3^f$) using the PSID data. To control for selection into the labor market, I use a two-step Heckman approach. Having estimated the returns to age and experience, I use the residuals from regressions together with the panel structure of the PSID data to estimate the parameters of the productivity shock processes ($\rho^m$, $\sigma^2_{\varepsilon^m}$, $\rho^f$, and $\sigma^2_{\varepsilon^f}$) and the variance of permanent ability ($\sigma^2_{\upsilon^m}$ and $\sigma^2_{\upsilon^f}$), following the identification strategy by Storesletten et al. (2004). I normalize $\gamma_0^f = 1$ and estimate $\gamma_0^m$ in the second stage.[13]

**Production.** I set $\alpha = 0.36$ to match the capital share. Furthermore, I set the capital depreciation rate $\delta = 0.0799$ to match the average U.S. investment-capital ratio of 9.74% reported by the U.S. Bureau of Economic Analysis (BEA) for 2012-2016. To match the long-run growth rate of the U.S. GDP per capita, I set $\mu = 0.0175$ (Conesa and Krueger, 2006).

[13] Note that $\gamma_0^m$ should not be interpreted as the gender wage gap between 25-year-old males and females. This is due to the fact that the age-efficiency profile for men starts at 25 years, while the experience-efficiency profile for women starts at 0 years.

**Government.** Following Kitao (2010), I set the payroll tax rate to $\tau_{ss} = 10.6\%$. The retirement benefit $ss$ is determined endogenously from the Social Security system budget constraint (48), and the resulting replacement rate is about 45%. Next, using the estimate from Mendoza et al. (1994), I set consumption tax rate to $t_c = 5.2\%$. Finally, I estimate the parameters of the tax and transfer functions (19) and (20) using the PSID data for waves 2013, 2015, and 2017 combined with the NBER TAXSIM (Feenberg and Coutts, 1993). The resulting values for the degree of tax progressivity are $\tau_s = 0.125$ and $\tau_j = 0.147$. Appendix B.2 discusses the estimation in detail. I choose the level of government consumption $G$ so that in a balanced growth path its share in GDP is equal to 17%.

Table 1 summarizes the parameter values selected in the first stage.

## 4.2 Second-Stage Estimation

In the second stage, I estimate parameters $\left(\beta, \psi, \gamma_0^m, \left(\alpha_0^{i,\iota}, \alpha_1^{i,\iota}, \alpha_2^{i,\iota}\right), \bar{L}_\iota^i\right)$. I choose the following moments from the U.S. data to pin down these parameters: capital-output ratio, average female-to-male hourly wage ratio, labor market participation (employment) of single and married men and women between age 25 and age 65, and hours of work (conditional on working) of single and married men and women between age 25 and age 65. Table 2 summarizes the parameter values estimated in the second stage.[14]

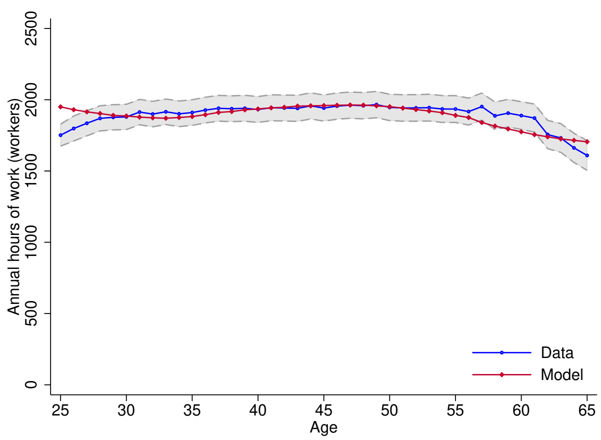
## 4.3 Model Fit

In this section, I briefly discuss whether the model fits the data well. Figure 3 reports the life-cycle profile of hours of work (conditional on working) for single men and women and married men and women. As in the data, both male and female workers do not significantly vary the hours of work over the life cycle. Figure 4 reports the life-cycle profile of labor participation. As in the data, women (especially married) choose to enter the labor market relatively later than men. Overall, the model fits the targeted data well.

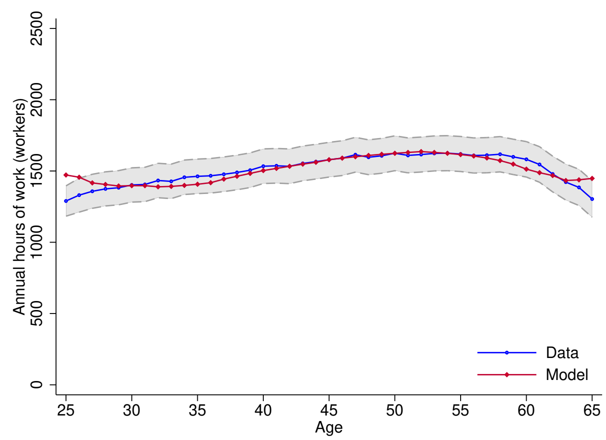
[14] Net time endowments are expressed as fractions of the net time endowment for single males that I normalize to 112 hours.

Table 2: Parameters estimated by the Method of Simulated Moments

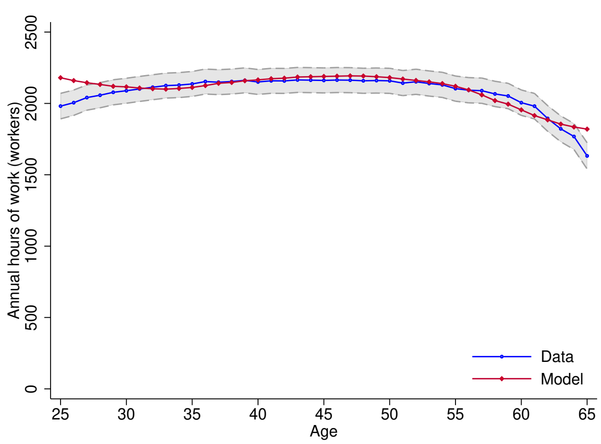
| | Description | Value | Moment |
|---|---|---|---|
| $\beta$ | Discount factor | 0.996 | Capital-output ratio |
| $\psi$ | Taste for leisure | 7.31 | Working hours |
| $\gamma_0^m$ | Male wage parameter | -1.092 | Average gender wage gap |
| $\bar{L}_c^m$ | Time endowment, married men | 0.91 | Working hours, married men |
| $\bar{L}_s^f$ | Time endowment, single women | 0.99 | Working hours, single women |
| $\bar{L}_c^f$ | Time endowment, married women | 0.80 | Working hours, married women |
| $\alpha_0^{i,\iota}, \alpha_1^{i,\iota}, \alpha_2^{i,\iota}$ | Fixed costs of work | Text | Labor participation rates |



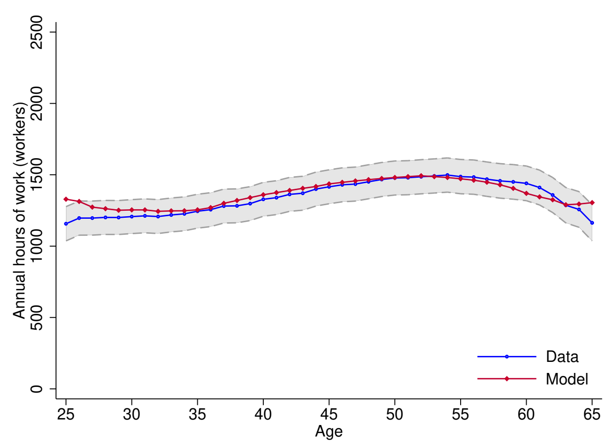

(a) Single men




(b) Single women



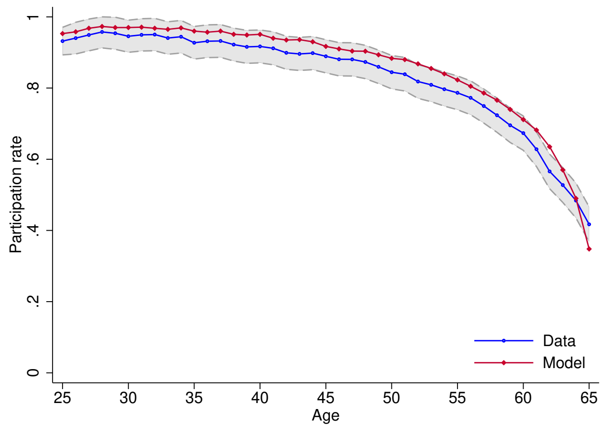

(c) Married men



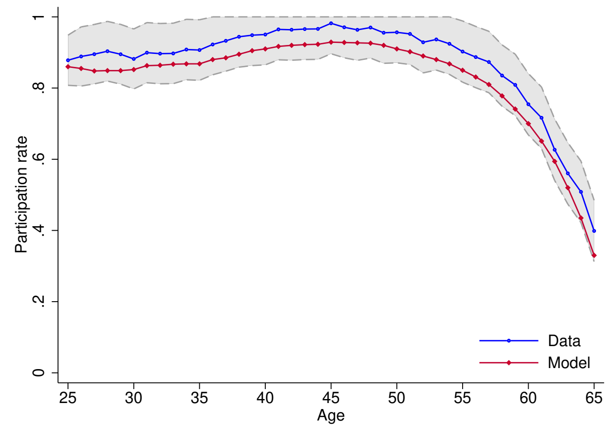

(d) Married women

Figure 3: Hours of work (for workers) over the life cycle, model and data

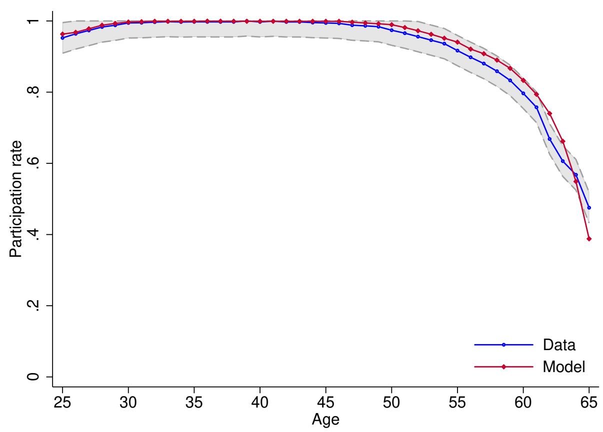
Notes: The shaded area represents the 95% confidence interval.



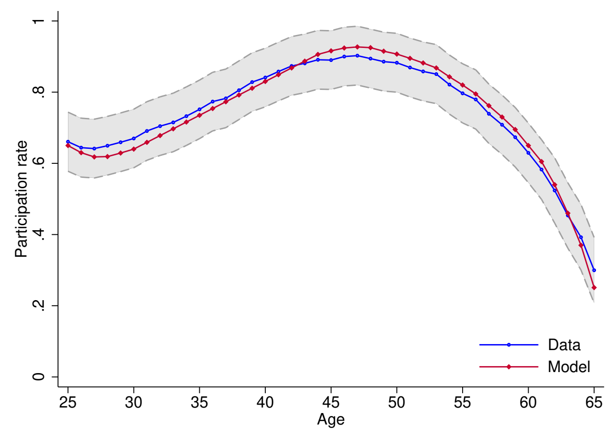

(a) Single men




(b) Single women




(c) Married men




(d) Married women

Figure 4: Participation over the life cycle, model and data

NOTES: The shaded area represents the 95% confidence interval.

Table 3: Model fit

| Moment | Data | Model |
|---|---|---|
| Capital-output ratio | 3.2 | 3.17 |
| Gender wage gap | 0.72 | 0.729 |
| Working hours | See Figure 3 | See Figure 3 |
| Labor participation rates | See Figure 4 | See Figure 4 |

## 4.4 Labor Supply Elasticities

In this section, I verify how my model performs along the dimensions that are not targeted by calibration. In particular, given the crucial importance of labor supply elasticities in evaluating the effects of tax and transfer reforms, I report the model-implied compensated labor supply elasticities. To obtain them, I temporarily increase the wage for a particular gender-marital status-age group (e.g., single men aged 40) by 1%.

Table 4 reports the intensive margin labor supply elasticities for single men and women and married men and women by age groups. Table 5 reports the extensive margin labor supply elasticities for single men and women and married men and women by age groups. Remarkably, elasticities for men are lower than for women. Moreover, there is a substantial variation in extensive margin elasticities over the life cycle. Notably, participation elasticities are very high around the time of retirement. My estimates are consistent with the results from Attanasio et al. (2018).

Table 4: Intensive margin labor supply elasticities generated by the model

| Age | Single men | Single women | Married men | Married women |
|---|---|---|---|---|
| 30 | 0.32 | 0.37 | 0.42 | 0.54 |
| 40 | 0.43 | 0.44 | 0.52 | 0.63 |
| 50 | 0.41 | 0.42 | 0.49 | 0.61 |
| 60 | 0.29 | 0.34 | 0.43 | 0.56 |

Table 5: Extensive margin labor supply elasticities generated by the model

| Age | Single men | Single women | Married men | Married women |
|---|---|---|---|---|
| 30 | 0.16 | 0.57 | 0.02 | 0.96 |
| 40 | 0.21 | 0.42 | 0.11 | 0.73 |
| 50 | 0.47 | 0.45 | 0.19 | 0.64 |
| 60 | 1.24 | 1.92 | 0.71 | 1.13 |

# 5 Optimal Tax and Transfer Policy

In this section, I consider the main quantitative exercise. In particular, I take the Social Security system and consumption tax rate $t_c$ as given and optimize the social welfare over income tax schedules that are allowed to be different for single and married households within a parametric class (1).

## 5.1 Optimal Policy

I use the ex-ante steady state expected utility of newborn households as a measure of social welfare. Formally, the problem of the utilitarian government is given by[15]

$$SWF(\tau_s, \tau_j) = \int_{\{(\tilde{b},h,v,\boldsymbol{u},a):\tilde{b}=0,a=1\}} V^c\left(\tilde{b}, h, v, \boldsymbol{u}, a\right) d\Pi^c + \sum_{i=m,f} \int_{\{(\tilde{b},h,v,u,a):\tilde{b}=0,a=1\}} V^i\left(\tilde{b}, h, v, u, a\right) d\Pi^i \quad (50)$$

For tractability, I fix the ratio between scale parameters $\lambda_j/\lambda_s$ at the benchmark level. Parameter $\lambda_s$ endogenously adjusts to keep the government budget constraint balanced. The government chooses $(\tau_s, \tau_j)$ so that

$$\left(\tau_s^*, \tau_j^*\right) = \underset{\tau_s, \tau_j}{\operatorname{argmax}}\, SWF(\tau_s, \tau_j) \quad (51)$$

Table 6 reports the results. The first finding is that singles ($\tau_s^* = 0.151$) should be taxed more progressively than couples ($\tau_j^* = 0.108$). Second, I find that the optimal tax schedule has a higher degree of progressivity for singles and lower progressivity for couples relative to the actual income tax policy ($\tau_s = 0.125$ and $\tau_j = 0.147$). The optimal tax reform increases the elasticity of post-government to pre-government income from 0.853 (under actual U.S. tax system) to 0.892 (under optimal tax system). This gives rise to an increase in married women participation by 2.6 p.p. (or 3.8%, from 69.2 percent to 71.8 percent). Furthermore, replacing the U.S. tax and transfer system with the optimal schedule is associated with sizable welfare gains of 1.31 percent in terms of consumption equivalent variation.

In addition, I also consider a reform that replaces the current U.S. tax schedule with a flat tax system. In this case, $\tau_s = \tau_j = 0$. Despite the aggregate output and aggregate consumption are higher under this reform relative to the optimal reform, it creates smaller welfare gains (0.51

[15] Several papers challenge the assumption about utilitarian taste for redistribution(Moser and Olea de Souza e Silva, 2019; Heathcote and Tsujiyama, 2021; Wu, 2021). For example, Heathcote and Tsujiyama (2021), using the inverse-optimum approach, conclude that the current U.S. tax and transfer system is characterized by a weaker than utilitarian taste for redistribution.

Table 6: Aggregate effects of tax reforms

| Parameter/Variable | Benchmark | Optimal | Proportional | Fixed $(w, r)$ |
|---|---|---|---|---|
| Progressivity $\tau_s$ | 0.125 | 0.151 | 0 | 0.153 |
| Progressivity $\tau_j$ | 0.147 | 0.108 | 0 | 0.109 |
| Interest rate | 2.77% | 2.41% | 2.12% | 2.77% |
| Wage rate | — | 1.72% | 2.68% | — |
| Aggregate hours | — | 2.71% | 3.72% | 2.66% |
| Married women employment, % | 0.692 | 0.718 | 0.731 | 0.717 |
| Aggregate output | — | 0.76% | 2.04% | 0.67% |
| Aggregate consumption | — | 0.91% | 1.77% | 0.90% |
| Gini (consumption) | 0.314 | 0.325 | 0.354 | 0.325 |
| Welfare gains | — | 1.31% | 0.51% | 1.27% |

NOTES: In this table, I report the percentage change in macroeconomic variables for each tax reform. The changes in interest rate and Gini are reported in terms of percentage points. Column "Benchmark" corresponds to the status-quo economy.

percent). This reflects that there is a strong social demand for redistribution and insurance that the flat tax system cannot provide.

Finally, to evaluate the potential size of the bias that arises because I do not account for the transition to the optimal steady state, I compute the new steady state under optimal $\tau_s^*$ and $\tau_j^*$ but fixing the wage rate and interest rate at their benchmark levels. The last column of Table 6 shows that abstracting from changes in the capital stock between two steady states is not associated with significantly different welfare gains.

## 5.2 Partial Reforms

In the previous section, I consider the reforms that change the tax and transfer schedules for both singles and couples. Now I ask the following question. Is there a welfare-improving reform that replaces the actual U.S. income tax code with a revenue-neutral income tax system so that the schedule for one group (e.g., singles) remains at the benchmark level while the schedule for the other group (e.g., couples) is changed. Table 7 reports the results.

I find that these "partial" reforms deliver aggregate welfare gains. Reforming tax schedule for singles, while keeping the tax schedule for couples fixed, delivers the welfare of 0.71%. On the other hand, reforming the tax schedule only for couples is associated with the welfare gains of 0.52%.

Table 7: Aggregate effects of partial tax reforms

| Parameter/Variable | Benchmark | Optimal | Optimal $\tau_s$ | Optimal $\tau_j$ |
|---|---|---|---|---|
| Progressivity $\tau_s$ | 0.125 | 0.151 | 0.178 | 0.125 |
| Progressivity $\tau_j$ | 0.147 | 0.108 | 0.147 | 0.091 |
| Welfare gains | — | 1.31% | 0.71% | 0.52% |

NOTES: In this table, I report the value of the parameters of the tax and transfer functions (19) and (20) under different reforms. The last line displays the welfare gains in terms of consumption equivalent variation. Column "Benchmark" corresponds to the status-quo economy. Column "Optimal $\tau_s$" corresponds to the policy experiment where I keep progressivity for couples $\tau_j$ at the benchmark level and optimize over progressivity parameter for singles $\tau_s$. Column "Optimal $\tau_j$" corresponds to the policy experiment where I keep progressivity for singles $\tau_s$ at the benchmark level and optimize over progressivity parameter for couples $\tau_j$.

## 5.3 What if We Abstract from Couples?

In this section, I consider the following exercise. Suppose that the government treat all the households as single individuals, and therefore everyone faces the same tax and transfer schedule. Furthermore, assume that the extensive margin of labor supply is not operative, so that everyone chooses to work positive number of hours (therefore, I also abstract away from human capital accumulation). In this environment, couples are treated as richer singles. What is the optimal tax policy recipe in this environment? Table 8 reports the results.

Table 8: Optimal tax policy in an environment where all households are singles

| | Benchmark | Optimal | Benchmark (All Singles) | Optimal (All Singles) |
|---|---|---|---|---|
| Progressivity $\tau_s$ | 0.125 | 0.151 | | |
| Progressivity $\tau_j$ | 0.147 | 0.108 | | |
| Progressivity $\tau$ | | | 0.139 | 0.186 |
| Welfare gains | — | 1.31% | — | 1.12% |

NOTES: In this table, I report the value of the parameters of the tax and transfer functions (19) and (20) under different reforms. The last line displays the welfare gains in terms of consumption equivalent variation. Column "Benchmark" corresponds to the status-quo economy. Column "Benchmark (All Singles)" corresponds to the environment where I assume that economy is populated only by singles. Column "Optimal (All Singles)" corresponds to the optimal policy associated with this environment.

In this case, the government finds it optimal to increase the tax progressivity from $\tau = 0.139$ to $\tau^* = 0.186$. This experiment illustrates that explicitly modeling couples and accounting for the extensive margin of labor supply combined with human capital accumulation is quantitatively important for the design of the optimal policy.

# 6 Extensions

I consider several extensions of the model from Section 3. The goal of this section is to explore whether and how the main results from Section 5.1 change in the alternative environments where I relax some assumptions of the baseline model. As before, the government chooses the optimal tax and transfer schedule by maximizing over parameters of tax functions (19) and (20).

## 6.1 Government Debt

In the baseline version of the model, I assume that the government runs the balanced budget. In this section, I relax this assumption and allow the government to accumulate government debt. In the model, government debt enters the steady state government budget constraint and the market clearing condition for the asset market. As for timing, the government makes interest payments before the remaining tax revenues are redistributed to the households. Table 9 reports the results.

Table 9: Optimal tax policy in an environment with government debt

| | Benchmark | Optimal (Baseline) | Optimal (+ Government Debt) |
|---|---|---|---|
| Progressivity $\tau_s$ | 0.125 | 0.151 | Pending |
| Progressivity $\tau_j$ | 0.147 | 0.108 | Pending |
| Welfare gains | — | 1.31% | Pending |

NOTES: In this table, I report the value of the parameters of the tax and transfer functions (19) and (20) under different reforms. The last line displays the welfare gains in terms of consumption equivalent variation. Column "Benchmark" corresponds to the status-quo economy with no government debt.

## 6.2 Marriage and Divorce

In the baseline model, I assume that individuals are born with predetermined marital status and do not change it over the life cycle. Since the labor supply decisions substantially vary by age and marital status, it is desirable to have a plausible distribution of household types by age. In this section, I relax the assumption about fixed marital status, and model marriage and divorce as shocks (Cubeddu and Ríos-Rull, 2003). In particular, assume that married individuals face an age-dependent probability of divorce ($d_a$). In turn, single individuals face an age-dependent probability of getting married ($\vartheta_a$).

I follow the modeling approach of Holter et al. (2019) and allow for assortative mating by permanent ability (education) in the marriage market. In particular, a single male with permanent ability $\upsilon^m$ faces a probability $\phi^f(\upsilon|\upsilon^m;\varrho)$ of marrying a female with permanent ability $\upsilon$. Similarly, a single female with permanent ability $\upsilon^f$ faces a probability $\phi^m\left(\upsilon|\upsilon^f;\varrho\right)$ of marrying a male with permanent ability $\upsilon$. Parameter $\varrho$ captures the degree of assortative mating. When I parameterize the model, I estimate it using the Method of Simulated Moments by matching the correlation of hourly wages for married couples calculated from the CPS. Table 10 reports the results.

Table 10: Optimal tax policy in an environment with marriage and divorce

| | Benchmark | Optimal (Baseline) | Optimal (+ Marriage & Divorce) |
|---|---|---|---|
| Progressivity $\tau_s$ | 0.125 | 0.151 | 0.147 |
| Progressivity $\tau_j$ | 0.147 | 0.108 | 0.117 |
| Welfare gains | — | 1.31% | 1.40% |

NOTES: In this table, I report the value of the parameters of the tax and transfer functions (19) and (20) under different reforms. The last line displays the welfare gains in terms of consumption equivalent variation. Column "Benchmark" corresponds to the status-quo economy without marriage and divorce shocks.

In an environment with marriage and divorce, couples are taxed more progressively relative to the baseline optimal policy. Intuitively, because the estimated $\varrho$ imply that the economy is characterized by positive assortative mating, the government increases the extent of public insurance against ex-post heterogeneity by taxing couples more progressively. The resulting welfare gains are equal to 1.40% which is slightly higher than under the baseline optimal policy. The conclusions from Section 5.1 continue to hold.

## 6.3 Correlated Productivity Shocks of Spouses

In the baseline version of the model, I assume that the draws of idiosyncratic productivity shocks are independent between spouses. In this section, I relax this assumption and allow them to be potentially correlated. In particular, $\left(u^m, u^f\right)$ follow

$$u_a^m = \rho^m u_{a-1}^m + \varepsilon_a^m$$

$$u_a^f = \rho^f u_{a-1}^f + \varepsilon_a^f$$

where $\left(\varepsilon^m, \varepsilon^f\right) \sim \mathcal{N}\left(\mathbf{0}, \mathbf{\Sigma}_{\boldsymbol{\varepsilon}}\right)$ and

$$\mathbf{\Sigma}_{\boldsymbol{\varepsilon}} = \begin{pmatrix} \sigma_{\varepsilon^m}^2 & \rho^\varepsilon \sigma_{\varepsilon^m} \sigma_{\varepsilon^f} \\ \rho^\varepsilon \sigma_{\varepsilon^m} \sigma_{\varepsilon^f} & \sigma_{\varepsilon^f}^2 \end{pmatrix}$$

Using the estimate from Hyslop (2001), I set the correlation between spousal shocks to be $\rho^\varepsilon = 0.25$. Table 11 reports the results.

Table 11: Optimal tax policy in an environment with correlated spousal productivity shocks

| | Benchmark | Optimal (Baseline) | Optimal (+ Correlated Shocks) |
|---|---|---|---|
| Progressivity $\tau_s$ | 0.125 | 0.151 | 0.149 |
| Progressivity $\tau_j$ | 0.147 | 0.108 | 0.119 |
| Welfare gains | — | 1.31% | 1.43% |

NOTES: In this table, I report the value of the parameters of the tax and transfer functions (19) and (20) under different reforms. The last line displays the welfare gains in terms of consumption equivalent variation. Column "Benchmark" corresponds to the status-quo economy with idiosyncratic productivity shocks that are independent between spouses.

In an environment with positively correlated spousal labor productivity shocks, couples are taxed more progressively relative to the baseline optimal policy. Intuitively, this correlation strengthens the redistribution motive in order to insure against ex-post heterogeneity. The resulting welfare gains are slightly higher than under the baseline optimal policy. Nevertheless, the conclusions from Section 5.1 continue to hold.

## 6.4 Joint and Separate Filing for Couples

Despite in reality U.S. married couples can choose between joint and separate filing, almost all choose the former option, and therefore in the baseline model I assume that they are taxed on the basis of combined spousal income.[16] In this section, I consider a version of the model where

[16] There are some situations when filing separately is preferable to joint filing. For example, some high-income couples where both spousal earnings are close to each other, may end up with lower tax liabilities under separate rather than joint filing.

couples can choose between two options. In particular, the tax and transfer function is given

$$T^c\left(y^m, y^f\right) = \min\left\{y^m + y^f - \lambda_j\left(y^m + y^f\right)^{1-\tau_j}, y^m + y^f - \lambda_{sep}\left(y^m\right)^{1-\tau_{sep}} - \lambda_{sep}\left(y^f\right)^{1-\tau_{sep}}\right\} \tag{52}$$

To keep tractability, I make several assumptions. First, I assume that singles and couples filing separately face the same degree of tax progressivity, i.e. $\tau_s = \tau_{sep}$. Second, in my optimal policy exercise, I keep the ratio between scale parameters $\lambda_{sep}/\lambda_s$ at the level corresponding to the benchmark economy. I calibrate parameter $\lambda_{sep}$ to match the fraction of the U.S. married couple filing separately.[17] Table 12 reports the results.

Table 12: Optimal tax policy in an environment with joint and separate filing for couples

| | Benchmark | Optimal (Baseline) | Optimal (+ Separate Filing) |
|---|---|---|---|
| Progressivity $\tau_s$ | 0.125 | 0.151 | 0.147 |
| Progressivity $\tau_j$ | 0.147 | 0.108 | 0.105 |
| Progressivity $\tau_{sep}$ | — | — | 0.147 |
| Welfare gains | — | 1.31% | 1.37% |

Notes: In this table, I report the value of the parameters of the tax and transfer functions (19) and (20) under different reforms. The last line displays the welfare gains in terms of consumption equivalent variation. Column "Benchmark" corresponds to the status-quo economy where couples are always taxed on their joint income.

In an environment where couples can choose between joint and separate filing, couples filing jointly are taxed less progressively than singles and couples filing separately (by construction). The aggregate welfare gains are 1.37% which is slightly higher than under the baseline optimal policy. An obvious shortcoming of this policy exercise is that I assume similar tax progressivity for singles and couples filing separately. Exploring how different are the results if this assumption is relaxed is an interesting avenue for future research.

## 6.5 Future Research

To keep the model tractable, I make some simplifying assumptions. First, I use ex-ante steady state expected utility of newborn households as a measure of social welfare. As Krueger and Ludwig (2016) show, a full characterization of the transition path is very important for policy evaluation. Other recent papers that evaluate welfare over the transition include Bakış et al. (2015), Boar and

[17] Using the SOI data, I calculate that in 2012-2016 the average fraction of these couples was equal to 5.3 percent.

Midrigan (2021), and Dyrda and Pedroni (2021). A natural next step of this paper is to extend the analysis and account for the transition path towards the optimal steady state.

Next, to model couples, I use the unitary model of the households. An important avenue for future research is to characterize the optimal tax and transfer schedule in an environment where couples are modeled using a collective approach (Chiappori, 1988).

In this paper, I follow a Ramsey-style taxation literature and quantify optimal reforms within a parametric class of tax functions. A more general non-parametric Mirrleesian approach will allow to characterize the entire shape of the optimal tax and transfer schedule. One of the challenges that arises when we study the optimal tax schedule under this approach is multidimensional screening (as long as the couple's private type is given by a two-dimensional vector). Recent example of papers that characterize the optimal tax schedule in this environment include Moser and Olea de Souza e Silva (2019) and Alves et al. (2021). On top of that, it is interesting to explore how far are the welfare gains delivered by best policy in the class described by (1) from maximum potential welfare gains (Heathcote and Tsujiyama, 2021).

Finally, in the model, I do not distinguish between cohabiting couples and singles. Empirical studies document strong rise in cohabitation in the United States over the last 50 years (Gemici and Laufer, 2011; Blasutto, 2020). Exploring the implications of this phenomenon for the optimal fiscal policy is another fruitful avenue for future research.

# 7 Conclusion

In this paper, I characterize the optimal income tax schedules for single and married households. To do this, I build and estimate an overlapping generations model that features singles and married couples, uninsurable idiosyncratic labor productivity risk, intensive and extensive margins of labor supply, and human capital accumulation. I show that the model fits the data well, and hence I use it as a laboratory to quantify the optimal tax schedules.

Under utilitarian taste for redistribution, the optimal tax schedule is characterized by lower progressivity for couples than for singles. Comparing it with the U.S. policy, I find that couples should be taxed less progressively than in the actual tax code. In turn, singles should be taxed more progressively than in the actual tax code. The optimal reform results in higher labor force participation for married women and generate welfare gains about 1.3% in terms of consumption equivalent variation. Finally, I show that my results carry over into the other settings. In particular, I allow for the government debt, marriage and divorce, correlated labor productivity shocks between husbands, and choice between joint and separate filing for couples.

My paper contributes to the literature that emphasizes the importance of accounting for heterogeneity in gender and marital status in the quantitative macroeconomic models. As I demonstrate, explicit modeling couples is a crucial element in designing the optimal tax policy.

# References


Akerlof, G. A. (1978): "The Economics of "Tagging" as Applied to the Optimal Income Tax, Welfare Programs, and Manpower Planning," *American Economic Review*, 68, 8–19.

Alesina, A., A. Ichino, and L. Karabarbounis (2011): "Gender-Based Taxation and the Division of Family Chores," *American Economic Journal: Economic Policy*, 3, 1–40.

Alm, J. and L. A. Whittington (1995): "Income Taxes and the Marriage Decision," *Applied Economics*, 27, 25–31.

——— (1999): "For Love or Money? The Impact of Income Taxes on Marriage," *Economica*, 66, 297–316.

Altonji, J. G. and L. M. Segal (1996): "Small-Sample Bias in GMM Estimation of Covariance Structures," *Journal of Business & Economic Statistics*, 14, 353–366.

Alves, C. B. M., C. E. d. Costa, and H. A. Moreira (2021): "Intrahousehold Inequality and the Joint Taxation of Household Earnings," *FGV EPGE Working Paper No. 825*.

Attanasio, O., P. Levell, H. Low, and V. Sánchez-Marcos (2018): "Aggregating Elasticities: Intensive and Extensive Margins of Women's Labor Supply," *Econometrica*, 86, 2049–2082.

Attanasio, O., H. Low, and V. Sánchez-Marcos (2008): "Explaining Changes in Female Labor Supply in a Life-Cycle Model," *American Economic Review*, 98, 1517–52.

Bakiş, O., B. Kaymak, and M. Poschke (2015): "Transitional Dynamics and the Optimal Progressivity of Income Redistribution," *Review of Economic Dynamics*, 18, 679–693.

Bar, M. and O. Leukhina (2009): "To Work or Not to Work: Did Tax Reforms Affect Labor Force Participation of Married Couples?" *The B.E. Journal of Macroeconomics*, 9, 1–30.

Benabou, R. (2002): "Tax and Education Policy in a Heterogeneous-Agent Economy: What Levels of Redistribution Maximize Growth and Efficiency?" *Econometrica*, 70, 481–517.

Bick, A. and N. Fuchs-Schündeln (2017): "Quantifying the Disincentive Effects of Joint Taxation on Married Women's Labor Supply," *American Economic Review: Papers & Proceedings*, 107, 100–104.

Birinci, S. (2019): "Spousal Labor Supply Response to Job Displacement and Implications for Optimal Transfers," *FRB St. Louis Working Paper*.

Blasutto, F. (2020): "Cohabitation vs Marriage: Mating Strategies by Education in the USA," *Working Paper*.

Blundell, R., M. Costa Dias, C. Meghir, and J. Shaw (2016a): "Female Labor Supply, Human Capital, and Welfare Reform," *Econometrica*, 84, 1705–1753.

Blundell, R., L. Pistaferri, and I. Preston (2008): "Consumption Inequality and Partial Insurance," *American Economic Review*, 98, 1887–1921.

Blundell, R., L. Pistaferri, and I. Saporta-Eksten (2016b): "Consumption Inequality and Family Labor Supply," *American Economic Review*, 106, 387–435.

Boar, C. and V. Midrigan (2021): "Efficient Redistribution," *NBER Working Paper No. 27622.*

Borella, M., M. De Nardi, and F. Yang (2021): "Are Marriage-Related Taxes and Social Security Benefits Holding Back Female Labor Supply?" *NBER Working Paper No. 26097.*

Bronson, M. A. and M. Mazzocco (2021): "Taxation and Household Decisions: An Intertemporal Analysis," *Working Paper.*

Busch, C., D. Domeij, F. Guvenen, and R. Madera (2021): "Skewed Idiosyncratic Income Risk over the Business Cycle: Sources and Insurance," *American Economic Journal: Macroeconomics (forthcoming).*

Chakraborty, I., H. A. Holter, and S. Stepanchuk (2015): "Marriage Stability, Taxation and Aggregate Labor Supply in the US vs. Europe," *Journal of Monetary Economics*, 72, 1–20.

Chiappori, P.-A. (1988): "Rational Household Labor Supply," *Econometrica*, 56, 63–90.

Cogan, J. F. (1981): "Fixed Costs and Labor Supply," *Econometrica*, 49, 945–963.

Conesa, J. C., S. Kitao, and D. Krueger (2009): "Taxing Capital? Not a Bad Idea after All!" *American Economic Review*, 99, 25–48.

Conesa, J. C. and D. Krueger (2006): "On the Optimal Progressivity of the Income Tax Code," *Journal of Monetary Economics*, 53, 1425–1450.

Cremer, H., F. Gahvari, and J.-M. Lozachmeur (2010): "Tagging and Income Taxation: Theory and an Application," *American Economic Journal: Economic Policy*, 2, 31–50.

Cubeddu, L. and J.-V. Ríos-Rull (2003): "Families as Shocks," *Journal of the European Economic Association*, 1, 671–682.

Duffie, D. and K. J. Singleton (1993): "Simulated Moments Estimation of Markov Models of Asset Prices," *Econometrica*, 929–952.

Dyrda, S. and M. Pedroni (2021): "Optimal Fiscal Policy in a Model with Uninsurable Idiosyncratic Income Risk," *Unpublished Manuscript.*

Eika, L., M. Mogstad, and B. Zafar (2019): "Educational Assortative Mating and Household Income Inequality," *Journal of Political Economy*, 127, 2795–2835.

Eissa, N. and H. W. Hoynes (2004): "Taxes and the Labor Market Participation of Married Couples: The Earned Income Tax Credit," *Journal of Public Economics*, 88, 1931–1958.

Eissa, N. and J. B. Liebman (1996): "Labor Supply Response to the Earned Income Tax Credit," *Quarterly Journal of Economics*, 111, 605–637.

Erosa, A., L. Fuster, and G. Kambourov (2016): "Towards a Micro-Founded Theory of Aggregate Labour Supply," *Review of Economic Studies*, 83, 1001–1039.

Feenberg, D. and E. Coutts (1993): “An Introduction to the TAXSIM Model,” *Journal of Policy Analysis and Management*, 12, 189–194.

Fernandez, R., N. Guner, and J. Knowles (2005): “Love and Money: A Theoretical and Empirical Analysis of Household Sorting and Inequality,” *Quarterly Journal of Economics*, 120, 273–344.

Fisher, H. (2013): “The Effect of Marriage Tax Penalties and Subsidies on Marital Status,” *Fiscal Studies*, 34, 437–465.

Flood, S., M. King, R. Rodgers, S. Ruggles, and J. R. Warren (2020): “Integrated Public Use Microdata Series, Current Population Survey: Version 8.0 [dataset],” *Minneapolis, MN: IPUMS, 2020. https://doi.org/10.18128/D030.V8.0*.

Frankel, A. (2014): “Taxation of Couples under Assortative Mating,” *American Economic Journal: Economic Policy*, 6, 155–77.

French, E. (2005): “The Effects of Health, Wealth, and Wages on Labour Supply and Retirement Behaviour,” *Review of Economic Studies*, 72, 395–427.

Gayle, G.-L. and A. Shephard (2019): “Optimal Taxation, Marriage, Home Production, and Family Labor Supply,” *Econometrica*, 87, 291–326.

Gemici, A. and S. Laufer (2011): “Marriage and Cohabitation,” *New York University Working Paper.*

Gourinchas, P.-O. and J. A. Parker (2002): “Consumption over the Life Cycle,” *Econometrica*, 70, 47–89.

Greenwood, J., N. Guner, G. Kocharkov, and C. Santos (2014): “Marry Your Like: Assortative Mating and Income Inequality,” *American Economic Review: Papers & Proceedings*, 104, 348–53.

Guner, N., R. Kaygusuz, and G. Ventura (2012a): “Taxation and Household Labour Supply,” *Review of Economic Studies*, 79, 1113–1149.

——— (2012b): “Taxing Women: A Macroeconomic Analysis,” *Journal of Monetary Economics*, 59, 111–128.

Heathcote, J., K. Storesletten, and G. L. Violante (2017): “Optimal Tax Progressivity: An Analytical Framework,” *Quarterly Journal of Economics*, 132, 1693–1754.

——— (2020): “Optimal Progressivity with Age-Dependent Taxation,” *Journal of Public Economics*, 189, 104074.

Heathcote, J. and H. Tsujiyama (2021): “Optimal Income Taxation: Mirrlees Meets Ramsey,” *Journal of Political Economy*, 129.

Holter, H. A., D. Krueger, and S. Stepanchuk (2019): “How Do Tax Progressivity and Household Heterogeneity Affect Laffer Curves?” *Quantitative Economics*, 10, 1317–1356.

Hyslop, D. R. (2001): "Rising US Earnings Inequality and Family Labor Supply: The Covariance Structure of Intrafamily Earnings," *American Economic Review*, 91, 755–777.

Immervoll, H., H. J. Kleven, C. T. Kreiner, and N. Verdelin (2011): "Optimal Tax and Transfer Programs for Couples with Extensive Labor Supply Responses," *Journal of Public Economics*, 95, 1485–1500.

Jakobsson, U. (1976): "On the Measurement of the Degree of Progression," *Journal of Public Economics*, 5, 161–168.

Jones, L. E., R. E. Manuelli, and E. R. McGrattan (2015): "Why Are Married Women Working So Much?" *Journal of Demographic Economics*, 81, 75–114.

Karabarbounis, M. (2016): "A Road Map for Efficiently Taxing Heterogeneous Agents," *American Economic Journal: Macroeconomics*, 8, 182–214.

Keane, M. P. (2011): "Labor Supply and Taxes: A Survey," *Journal of Economic Literature*, 49, 961–1075.

Kimberlin, S., J. Kim, and L. Shaefer (2015): "An Updated Method for Calculating Income and Payroll Taxes from PSID Data using the NBER's TAXSIM, for PSID Survey Years 1999 through 2011," *Unpublished Manuscript, University of Michigan.*

King, R. G., C. I. Plosser, and S. T. Rebelo (2002): "Production, Growth and Business Cycles: Technical Appendix," *Computational Economics*, 20, 87–116.

Kitao, S. (2010): "Labor-Dependent Capital Income Taxation," *Journal of Monetary Economics*, 57, 959–974.

Kleven, H. J., C. T. Kreiner, and E. Saez (2009): "The Optimal Income Taxation of Couples," *Econometrica*, 77, 537–560.

Krueger, D. and A. Ludwig (2016): "On the Optimal Provision of Social Insurance: Progressive Taxation versus Education Subsidies in General Equilibrium," *Journal of Monetary Economics*, 77, 72–98.

List, J. A. (2011): "The Market for Charitable Giving," *Journal of Economic Perspectives*, 25, 157–80.

Lundberg, S. (1985): "The Added Worker Effect," *Journal of Labor Economics*, 3, 11–37.

Mendoza, E. G., A. Razin, and L. L. Tesar (1994): "Effective Tax Rates in Macroeconomics: Cross-Country Estimates of Tax Rates on Factor Incomes and Consumption," *Journal of Monetary Economics*, 34, 297–323.

Mincer, J. and H. Ofek (1982): "Interrupted Work Careers: Depreciation and Restoration of Human Capital," *Journal of Human Resources*, 3–24.

Moser, C. and P. Olea de Souza e Silva (2019): "Optimal Paternalistic Savings Policies," *Opportunity and Inclusive Growth Institute Working Paper 17.*

Musgrave, R. A. (1959): *The Theory of Public Finance: A Study in Public Economy*, Kogakusha Co.

Pakes, A. and D. Pollard (1989): "Simulation and the Asymptotics of Optimization Estimators," *Econometrica*, 1027–1057.

Park, S. and D. Shin (2020): "Welfare Consequences of Rising Wage Risk in the United States: Self-Selection into Risky Jobs and Family Labor Supply Adjustment," *Unpublished Manuscript.*

Pencavel, J. (1998): "Assortative Mating by Schooling and the Work Behavior of Wives and Husbands," *American Economic Review*, 88, 326–329.

Persson, P. (2020): "Social Insurance and the Marriage Market," *Journal of Political Economy*, 128, 252–300.

Song, J., D. J. Price, F. Guvenen, N. Bloom, and T. Von Wachter (2019): "Firming Up Inequality," *Quarterly Journal of Economics*, 134, 1–50.

Storesletten, K., C. I. Telmer, and A. Yaron (2004): "Consumption and Risk Sharing over the Life Cycle," *Journal of Monetary Economics*, 51, 609–633.

Weinzierl, M. (2011): "The Surprising Power of Age-Dependent Taxes," *Review of Economic Studies*, 78, 1490–1518.

Whittington, L. A. and J. Alm (1997): "'Til Death or Taxes Do Us Part: The Effect of Income Taxation on Divorce," *Journal of Human Resources*, 388–412.

Wu, C. (2021): "More Unequal Income but Less Progressive Taxation," *Journal of Monetary Economics*, 117, 949–968.

Wu, C. and D. Krueger (2021): "Consumption Insurance against Wage Risk: Family Labor Supply and Optimal Progressive Income Taxation," *American Economic Journal: Macroeconomics*, 13, 79–113.

# Appendix A: Proofs

## A.1 Proof of Proposition 1

I prove a more general version of Proposition 1. In particular, I also consider the case when married couples file separately and hence spouses are taxed based on their individual income.

**Single Households.** Suppose $q = 0$ and $\tilde{T} = 0$. Consider the problem of a single individual given in (2). Denoting by $\mu$ the Lagrange multiplier, I obtain the following first-order conditions:

$$\frac{1}{c} = \mu \tag*{[c]}$$

$$\psi n_i^{\eta} = \mu \lambda_s \left(1 - \tau_s\right) w_i^{1-\tau_s} n_i^{-\tau_s} \tag*{[n]}$$

Plugging the budget constraint into the FOC for consumption and then plugging the resulting expression into the FOC for working hours, I obtain

$$n = \left(\frac{1 - \tau_s}{\psi}\right)^{\frac{1}{1+\eta}} \tag{A.1}$$

Next, the optimal labor income and consumption are given by

$$y = \left(\frac{1 - \tau_s}{\psi}\right)^{\frac{1}{1+\eta}} w_i \tag{A.2}$$

$$c = \lambda_s \left(\frac{1 - \tau_s}{\psi}\right)^{\frac{1-\tau_s}{1+\eta}} \left(w_i\right)^{1-\tau_s} \tag{A.3}$$

Taking logarithms, I obtain the elasticities of consumption, working hours, and labor income to wage shock (transmission coefficients):

$$\frac{d \log(c)}{d \log\left(w_i\right)} = 1 - \tau_s \tag{A.4}$$

$$\frac{d \log(n)}{d \log\left(w_i\right)} = 0 \tag{A.5}$$

$$\frac{d \log(y)}{d \log\left(w_i\right)} = 1 \tag{A.6}$$

This completes the proof of Proposition 1 for singles.

**Married Couples (Joint Taxation).** Suppose $q = 0$ and $\tilde{T} = 0$. Consider the problem of a married couple given in (2). Denoting by $\mu$ the Lagrange multiplier, I obtain the following first-order conditions:

$$\frac{2}{c} = \mu \qquad [c]$$

$$\psi n_m^{\eta} = \mu \lambda_j \left(1 - \tau_j\right) w_m \left(w_m n_m + w_f n_f\right)^{-\tau_j} \qquad [n_m]$$

$$\psi n_f^{\eta} = \mu \lambda_j \left(1 - \tau_j\right) w_f \left(w_m n_m + w_f n_f\right)^{-\tau_j} \qquad [n_f]$$

Plugging the budget constraint into the FOC for consumption and then plugging the resulting expression into the FOCs for working hours, I obtain

$$\psi n_m^{\eta} = 2 \left(1 - \tau_j\right) w_m \left(w_m n_m + w_f n_f\right)^{-1}$$

$$\psi n_f^{\eta} = 2 \left(1 - \tau_j\right) w_f \left(w_m n_m + w_f n_f\right)^{-1}$$

It follows from the FOCs for working hours that

$$\frac{n_m}{n_f} = \left(\frac{w_m}{w_f}\right)^{\frac{1}{\eta}}$$

Using this relation in the equations above, I obtain

$$\psi n_m^{1+\eta} = 2 \left(1 - \tau_j\right) \left[1 + \left(\frac{w_f}{w_m}\right)^{\frac{1+\eta}{\eta}}\right]^{-1}$$

$$\psi n_f^{1+\eta} = 2 \left(1 - \tau_j\right) \left[1 + \left(\frac{w_m}{w_f}\right)^{\frac{1+\eta}{\eta}}\right]^{-1}$$

Finally, the optimal working hours, labor income, and consumption are given by

$$n_i = \left(\frac{2(1 - \tau_j)}{\psi}\right)^{\frac{1}{1+\eta}} \left[1 + \left(\frac{w_{-i}}{w_i}\right)^{\frac{1+\eta}{\eta}}\right]^{-\frac{1}{1+\eta}} \qquad \text{(A.7)}$$

$$y_i = \left(\frac{2(1 - \tau_j)}{\psi}\right)^{\frac{1}{1+\eta}} \left[1 + \left(\frac{w_{-i}}{w_i}\right)^{\frac{1+\eta}{\eta}}\right]^{-\frac{1}{1+\eta}} w_i \qquad \text{(A.8)}$$

$$c = \lambda_j \left( \frac{2(1-\tau_j)}{\psi} \right)^{\frac{1-\tau_j}{1+\eta}} \left[ (w_m)^{\frac{1+\eta}{\eta}} + (w_f)^{\frac{1+\eta}{\eta}} \right]^{\frac{\eta(1-\tau_j)}{1+\eta}} \tag{A.9}$$

where I denote the gender of a spouse by $-i$.

Taking logarithms, I obtain the elasticities of consumption, individual $i$'s labor income, and his/her spouse's labor income to individual $i$'s wage shock (transmission coefficients):

$$\frac{d\log(c)}{d\log(w_i)} = \frac{(w_i)^{\frac{1+\eta}{\eta}}}{(w_i)^{\frac{1+\eta}{\eta}} + (w_{-i})^{\frac{1+\eta}{\eta}}} (1-\tau_j) < 1 - \tau_j \tag{A.10}$$

$$\frac{d\log(y_i)}{d\log(w_i)} = \underbrace{1}_{\text{direct wage effect}} + \underbrace{\frac{1}{\eta} \cdot \frac{(w_{-i})^{\frac{1+\eta}{\eta}}}{(w_i)^{\frac{1+\eta}{\eta}} + (w_{-i})^{\frac{1+\eta}{\eta}}}}_{\text{labor supply effect}} > 1 \tag{A.11}$$

$$\frac{d\log(y_{-i})}{d\log(w_i)} = -\frac{1}{\eta} \cdot \frac{(w_i)^{\frac{1+\eta}{\eta}}}{(w_i)^{\frac{1+\eta}{\eta}} + (w_{-i})^{\frac{1+\eta}{\eta}}} < 0 \tag{A.12}$$

This completes the proof of Proposition 1 for married couples under joint taxation.

**Married Couples (Separate Taxation).** Consider the problem of a married couple given by

$$\max_{c, n_m, n_f} 2\log(c) - \psi \frac{n_m^{1+\eta}}{1+\eta} - \psi \frac{n_f^{1+\eta}}{1+\eta} \tag{A.13}$$

$$\text{s.t.} \quad c = \lambda_{sep} (w_m n_m)^{1-\tau_{sep}} + \lambda_{sep} (w_f n_f)^{1-\tau_{sep}}$$

Denoting by $\mu$ the Lagrange multiplier, I obtain the following first-order conditions:

$$\frac{2}{c} = \mu \tag*{[c]}$$

$$\psi n_m^{\eta} = \mu \lambda_{sep} (1-\tau_{sep}) w_m^{1-\tau_{sep}} n_m^{-\tau_{sep}} \tag*{[n_m]}$$

$$\psi n_f^{\eta} = \mu \lambda_{sep} (1-\tau_{sep}) w_f^{1-\tau_{sep}} n_f^{-\tau_{sep}} \tag*{[n_f]}$$

Plugging the budget constraint into the FOC for consumption and then plugging the resulting expression into the FOCs for working hours, I obtain

$$\psi n_m^{\eta+\tau_{sep}} = 2(1-\tau_{sep}) w_m^{1-\tau_{sep}} \left[ (w_m n_m)^{1-\tau_{sep}} + (w_f n_f)^{1-\tau_{sep}} \right]^{-1}$$

$$\psi n_f^{\eta+\tau_{sep}} = 2\left(1-\tau_{sep}\right) w_f^{1-\tau_{sep}} \left[\left(w_m n_m\right)^{1-\tau_{sep}} + \left(w_f n_f\right)^{1-\tau_{sep}}\right]^{-1}$$

It follows from the FOCs for working hours that

$$\frac{n_m}{n_f} = \left(\frac{w_m}{w_f}\right)^{\frac{1-\tau_{sep}}{\eta+\tau_{sep}}}$$

Using this relation in the equations above, I obtain

$$\psi n_m^{1+\eta} = 2\left(1-\tau_{sep}\right)\left[1+\left(\frac{w_f}{w_m}\right)^{\frac{(1+\eta)(1-\tau_{sep})}{\tau_{sep}+\eta}}\right]^{-1}$$

$$\psi n_f^{1+\eta} = 2\left(1-\tau_{sep}\right)\left[1+\left(\frac{w_m}{w_f}\right)^{\frac{(1+\eta)(1-\tau_{sep})}{\tau_{sep}+\eta}}\right]^{-1}$$

Finally, the optimal working hours, labor income, and consumption are given by

$$n_i = \left(\frac{2(1-\tau_{sep})}{\psi}\right)^{\frac{1}{1+\eta}}\left[1+\left(\frac{w_{-i}}{w_i}\right)^{\frac{(1+\eta)(1-\tau_{sep})}{\tau_{sep}+\eta}}\right]^{-\frac{1}{1+\eta}} \tag{A.14}$$

$$y_i = \left(\frac{2(1-\tau_{sep})}{\psi}\right)^{\frac{1}{1+\eta}}\left[1+\left(\frac{w_{-i}}{w_i}\right)^{\frac{(1+\eta)(1-\tau_{sep})}{\tau_{sep}+\eta}}\right]^{-\frac{1}{1+\eta}} w_i \tag{A.15}$$

$$c = \lambda_{sep}\left(\frac{2(1-\tau_{sep})}{\psi}\right)^{\frac{1-\tau_{sep}}{1+\eta}}\left[w_m^{\frac{(1+\eta)(1-\tau_{sep})}{\tau_s+\eta}} + w_f^{\frac{(1+\eta)(1-\tau_{sep})}{\tau_{sep}+\eta}}\right]^{\frac{\tau_{sep}+\eta}{1+\eta}} \tag{A.16}$$

where I denote the gender of a spouse by $-i$.

Taking logarithms, I obtain the elasticities of consumption, individual $i$'s labor income, and his/her spouse's labor income to individual $i$'s wage shock (transmission coefficients):

$$\frac{d\log(c)}{d\log\left(w_i\right)} = \frac{w_i^{\frac{(1+\eta)(1-\tau_{sep})}{\tau_{sep}+\eta}}}{w_i^{\frac{(1+\eta)(1-\tau_{sep})}{\tau_{sep}+\eta}} + w_{-i}^{\frac{(1+\eta)(1-\tau_{sep})}{\tau_{sep}+\eta}}}\left(1-\tau_{sep}\right) < 1-\tau_{sep} \tag{A.17}$$

$$\frac{d\log(y_i)}{d\log(w_i)} = \underbrace{1}_{\text{direct wage effect}} + \underbrace{\frac{1-\tau_{sep}}{\tau_{sep}+\eta} \cdot \frac{w_{-i}^{\frac{(1+\eta)(1-\tau_{sep})}{\tau_{sep}+\eta}}}{w_i^{\frac{(1+\eta)(1-\tau_{sep})}{\tau_{sep}+\eta}} + w_{-i}^{\frac{(1+\eta)(1-\tau_{sep})}{\tau_{sep}+\eta}}}}_{\text{labor supply effect}} > 1 \tag{A.18}$$

$$\frac{d\log(y_{-i})}{d\log(w_i)} = -\frac{1-\tau_{sep}}{\tau_{sep}+\eta} \cdot \frac{w_i^{\frac{(1+\eta)(1-\tau_{sep})}{\tau_{sep}+\eta}}}{w_i^{\frac{(1+\eta)(1-\tau_{sep})}{\tau_{sep}+\eta}} + w_{-i}^{\frac{(1+\eta)(1-\tau_{sep})}{\tau_{sep}+\eta}}} < 0 \tag{A.19}$$

This completes the proof of Proposition 1. ■

## A.2 Proof of Proposition 2

First, consider the case when a single individual works. Solving problem (2) along the lines of the proof of Proposition 1, I obtain the indirect utility:

$$V_1^s(c_1^*, n^*; q) = \log\left(\lambda_s (wn^*)^{1-\tau_s} + \tilde{T}\right) - \psi \frac{(n^*+q)^{1+\eta}}{1+\eta} \tag{A.20}$$

where $c_1^*$ and $n^*$ denote the optimal decisions.

Next, in the case when a single individual does not work, the indirect utility is given by

$$V_0^s(c_0^*, 0; q) = \log\left(\tilde{T}\right) \tag{A.21}$$

Define a threshold on the fixed cost of work $\bar{q}_s$ through the following equation:

$$V_1^s(c_1^*, n^*; \bar{q}_s) = V_0^s(c_0^*, 0; q) \tag{A.22}$$

Using (A.20) and (A.21), I obtain

$$\log\left(\lambda_s (wn^*)^{1-\tau_s} + \tilde{T}\right) - \psi \frac{(n^*+\bar{q}_s)^{1+\eta}}{1+\eta} = \log\left(\tilde{T}\right) \tag{A.23}$$

Equation (A.23) implicitly defines $\bar{q}_s$ as a function of $\tau_s$. Using the envelope theorem, it follows that

$$\frac{\partial V_1^s(c_1^*, n^*; \bar{q}_s)}{\partial \tau_s} + \frac{\partial V_1^s(c_1^*, n^*; \bar{q}_s)}{\partial q} \cdot \frac{\partial \bar{q}_s}{\partial \tau_s} = \frac{\partial V_0^s(c_0^*, 0; q)}{\partial \tau_s} = 0 \tag{A.24}$$

I have

$$\frac{\partial V_1^s\left(c_1^*, n^*; \bar{q}_s\right)}{\partial q} < 0 \tag{A.25}$$

Furthermore,

$$\frac{\partial V_1^s\left(c_1^*, n^*; \bar{q}_s\right)}{\partial \tau_s} > 0 \tag{A.26}$$

since $wn^* < 1$, i.e. the individual earns less than average income.

Combining (A.26) and (A.25) and plugging them into (A.24), I obtain

$$\frac{\partial \bar{q}_s}{\partial \tau_s} = -\frac{\partial V_1^s\left(c_1^*, n^*; \bar{q}_s\right)/\partial \tau_s}{\partial V_1^s\left(c_1^*, n^*; \bar{q}_s\right)/\partial q} > 0 \tag{A.27}$$

This completes the proof of Proposition 2. ■

## A.3 Proof of Proposition 3

First, consider the case when both spouses work. Solving problem (3) along the lines of the proof of Proposition 1, I obtain the indirect utility:

$$V_2^c\left(c_2^*, n_{m,2}^*, n_f^*; q\right) = 2\log\left(\lambda_j\left(w_m n_{m,2}^* + w_f n_f^*\right)^{1-\tau_j}\right) - \psi\frac{\left(n_{m,2}^*\right)^{1+\eta}}{1+\eta} - \psi\frac{\left(n_f^* + q\right)^{1+\eta}}{1+\eta} \tag{A.28}$$

where $c_2^*$, $n_{m,2}^*$, and $n_f^*$ denote the optimal decisions.

Next, in the case of a single-earner couple, the indirect utility is given by

$$\begin{aligned} V_1^c\left(c_1^*, n_{m,1}^*, 0\right) = 2\log\left(\lambda_j\left(w_m n_{m,1}^*\right)^{1-\tau_j}\right) - \psi\frac{\left(n_{m,1}^*\right)^{1+\eta}}{1+\eta} = \\ 2\left[\log(\lambda_j) + \frac{1-\tau_j}{1+\eta}\log\left(\frac{2\left(1-\tau_j\right)}{\psi}\right) + \left(1-\tau_j\right)\log\left(w_m\right)\right] - \frac{1-\tau_j}{1+\eta} \end{aligned} \tag{A.29}$$

where $c_1^*$ and $n_{m,1}^*$ denote the optimal decisions.

Define a threshold on the fixed cost of work $\bar{q}_c$ through the following equation:

$$V_2^c\left(c_2^*, n_{m,2}^*, n_f^*; \bar{q}_c\right) = V_1^c\left(c_1^*, n_{m,1}^*, 0\right) \tag{A.30}$$

Using (A.28) and (A.29), I obtain

$$2\log\left(\lambda_j\left(w_m n_{m,2}^* + w_f n_f^*\right)^{1-\tau_j}\right) - \psi\frac{\left(n_{m,2}^*\right)^{1+\eta}}{1+\eta} - \psi\frac{\left(n_f^* + \bar{q}_c\right)^{1+\eta}}{1+\eta} = 2\log\left(\lambda_j\left(w_m n_{m,1}^*\right)^{1-\tau_j}\right) - \psi\frac{\left(n_{m,1}^*\right)^{1+\eta}}{1+\eta} \quad \text{(A.31)}$$

Equation (A.31) implicitly defines $\bar{q}_c$ as a function of $\tau_j$. Using the envelope theorem, it follows that

$$\frac{\partial V_2^c\left(c_2^*, n_{m,2}^*, n_f^*; \bar{q}_c\right)}{\partial \tau_j} + \frac{\partial V_2^c\left(c_2^*, n_{m,2}^*, n_f^*; \bar{q}_c\right)}{\partial q} \cdot \frac{\partial \bar{q}_c}{\partial \tau_j} = \frac{\partial V_1^c\left(c_1^*, n_{m,1}^*, 0\right)}{\partial \tau_j} \quad \text{(A.32)}$$

I have

$$\frac{\partial V_2^c\left(c_2^*, n_{m,2}^*, n_f^*; \bar{q}_c\right)}{\partial q} < 0 \quad \text{(A.33)}$$

Furthermore,

$$\frac{\partial V_1^c\left(c_1^*, n_{m,1}^*, 0\right)}{\partial \tau_j} - \frac{\partial V_2^c\left(c_2^*, n_{m,2}^*, n_f^*; \bar{q}_c\right)}{\partial \tau_j} < 0 \quad \text{(A.34)}$$

because household consumption of a dual-earner couple is higher than consumption of a single-earner couple.

Combining (A.34) and (A.33) and plugging them into (A.32), I obtain

$$\frac{\partial \bar{q}_c}{\partial \tau_j} = -\frac{\partial V_1^c\left(c_1^*, n_{m,1}^*, 0\right)/\partial \tau_j - \partial V_2^c\left(c_2^*, n_{m,2}^*, n_f^*; \bar{q}_c\right)/\tau_j}{\partial V_2^c\left(c_2^*, n_{m,2}^*, n_f^*; \bar{q}_c\right)/\partial q} < 0 \quad \text{(A.35)}$$

This completes the proof of Proposition 3. ■

# Appendix B: Tax and Transfer Function

## B.1 Properties of Tax and Transfer Function

As discussed in the main text, I use the tax and transfer function

$$T(y) = y - \lambda y^{1-\tau} \tag{B.1}$$

that is characterized by two parameters. Parameter $\tau$ stands for the degree of tax progressivity. Parameter $\lambda$ governs the average level of taxes.

Parameter $\tau$ is tightly related to the coefficient of residual income progression (Musgrave, 1959; Jakobsson, 1976). In particular,

$$1 - \underbrace{\frac{1 - MTR}{1 - ATR}}_{\text{residual income progression}} = 1 - \frac{(1-\tau)\lambda y^{-\tau}}{\lambda y^{-\tau}} = \tau \tag{B.2}$$

where $MTR$ is the marginal tax rate and $ATR$ is the average tax rate.

Furthermore, from

$$\underbrace{\log\left(y - T(y)\right)}_{\text{log post-government income}} = \log(\lambda) + (1-\tau) \times \underbrace{\log(y)}_{\text{log pre-government income}}$$

it follows that the elasticity of post-government to pre-government income is equal to $1 - \tau$.

In the case of $\tau \in (0, 1]$, the tax and transfer system is progressive. In the context of (B.2), it means that marginal tax rates always exceed average tax rates. More progressive tax system, i.e. higher $\tau$, reduces the elasticity of post-government to pre-government income. In turn, when $\tau < 0$, the tax and transfer system is regressive. Finally, in the case of $\tau = 0$, the tax and transfer system is flat, and the marginal and average tax rates are equal to $1 - \lambda$. The function (B.1) allows for transfers. In particular, if the gross household income $y$ is below the break-even level $\lambda^{\frac{1}{\tau}}$, then $T(y) < 0$.

In Appendix B.2, I discuss the details of the estimation of parameters $\tau$ and $\lambda$.

## B.2 Estimation of Tax and Transfer Function Parameters

Taking logarithms on both sides of $y - T(y) = \lambda y^{1-\tau}$, I obtain

$$\log\left(y - T(y)\right) = \log(\lambda) + (1-\tau)\log(y) \tag{B.3}$$

Using (B.3), I estimate parameters $\lambda$ and $\tau$ by regressing the logarithm of post-government household income on the logarithm of the pre-government taxable household income. Importantly, when I estimate the tax functions and use them in my model, I express $y$ relative to average wage earnings. I estimate $\lambda$ and $\tau$ separately for single households and married couples.

I use the data from the Panel Study of Income Dynamics (PSID) for survey years 2013, 2015, and 2017. For each household in the sample, I construct the measures of pre-government and post-government income. Having done that, I use the NBER TAXSIM (Feenberg and Coutts, 1993) to calculate the corresponding tax liabilities. To prepare the inputs for the NBER TAXSIM, I follow Kimberlin et al. (2015) and Heathcote et al. (2017). The pre-government gross household income is defined as the sum of all income received in a given tax year, including labor income, self-employment income, property income, interest income, dividends, retirement income, and private transfers. The pre-government taxable household income is defined as the difference between the pre-government gross household income and deductible expenses (medical expenses, mortgage interest, state taxes, and charitable contributions)[18] plus the employment share (50%) of the Federal Insurance Contribution Act (FICA) tax. The post-government income is defined as pre-government taxable income plus public transfers minus tax liabilities (federal, state, and FICA) calculated by NBER TAXSIM.

I take the data on medical expenses, mortgage interest, and state taxes directly from the PSID. Medical expenses are comprised of nursing home and hospital bills, doctor, outpatient surgery, and dental bills, and prescriptions, in-home medical care, special facilities, and other medical services.[19] As for the mortgage interest, I use the amount reported in response to the PSID question:

[18] Given the value of deductions, NBER TAXSIM calculates whether it is better to take the standard deduction or itemize deductions.

[19] Variables ER57491, ER64613, ER70689 (expenditures on nursing home and hospital bills), ER57497, ER64619, ER70694 (expenditures on doctor, outpatient surgery, and dental bills), ER57503, ER64625, ER70698 (expenditures on prescriptions, in-home medical care, special facilities, and other services).

"About how much is the remaining principal on this mortgage?"[20] I cap this amount at $1 million. Next, to obtain the interest payments, I multiply it by 3.87% which is the average 30-year conventional annual mortgage rate over 2012-2016.[21] Because the PSID does not have data on the charitable contributions, I impute them. From the SOI data, I obtain that in 2012 charitable contributions constitute about 3% of income for individuals with income above $75000.[22]

As stated above, I add the employment share (50%) of the FICA tax to the measure of pre-government taxable income. The FICA tax is comprised of the Old-Age, Survivors, and Disability Insurance (OASDI) tax and the Medicare Hospital Insurance (HI) tax. In 2012-2016, the OASDI tax rate was set at 6.2% for employees and employers, each. It is applicable up to an earnings limit which varied from $110100 in 2012 to $118500 in 2016 (in nominal USD).[23] In 2012-2016, the HI tax rates were 1.45% for employees and employers. There was no earnings limit.

In constructing the measure of post-government income, I add the present value imputed gain in social security benefits ($\widetilde{ssb}_{\tilde{a}}^{i}$) that individual $i$ accrues from working at age $\tilde{a}$ to the measure of public transfers. To calculate its value, I follow Heathcote et al. (2017). In particular, for every individual in the sample, I estimate an age-earnings profile $\varphi(a; g, e)$ conditional on gender $g$ and education $e$ using a cubic polynomial in age. I consider four education categories: less than high-school, high-school degree, some college, and college degree and above. Estimated earnings in age $a^*$ are then given by

$$\hat{y}_{a^*}^{i} = \frac{\varphi(a^*; g, e)}{\varphi(a; g, e)} y_a^i$$

Denote the Average Index of Monthly Earnings (AIME) by $AIME_i$. When individual $i$ works from age $a = 1$ to retirement age $a_R = 41$ (from age 25 to age 65 in the data), it is given by

$$AIME_i = \frac{1}{12} \cdot \left( \frac{\sum_{a=1}^{a_R} \hat{y}_a^i}{a_R} \right)$$

[20] Variables ER53048, ER60049, and ER66051.

[21] Source: https://fred.stlouisfed.org/series/MORTG

[22] Table 2.1 "Returns with Itemized Deductions: Sources of Income, Adjustments, Itemized Deductions by Type, Exemptions, and Tax Items." The resulting fraction, 3%, is consistent with the evidence from List (2011) and Heathcote et al. (2017).

[23] Source: https://www.ssa.gov/oact/COLA/cbb.htmlSeries

Next, define the counterfactual AIME that is calculated under the assumption that an individual doesn't work in age $\tilde{a}$:

$$AIME_i^{\tilde{a}} = AIME_i - \frac{1}{12} \cdot \frac{y_{\tilde{a}}^i}{a_R}$$

The associated annualized gain in social security benefits from working at age $\tilde{a}$ is given by

$$ssb_{\tilde{a}}^i = \left[PIA\left(AIME_i\right) - PIA\left(AIME_i^{\tilde{a}}\right)\right] \cdot 12$$

where $PIA$ is the "Primary Insurance Amount" (PIA) formula that determines monthly benefits as a function of AIME.[24]

Assuming the annual interest rate $R = 1.04$ and the maximum possible age $A = 100$, I calculate the present value of individual $i$'s pension gain resulted from working at age $\tilde{a}$

$$\widetilde{ssb}_{\tilde{a}}^i = \left(\frac{1}{a_R}\right)^{a_R - \tilde{a}} \cdot ssb_{\tilde{a}}^i \cdot \sum_{a=a_R}^{A} \left(\frac{1}{R}\right)^{a - a_R} \zeta_{\tilde{a},a}$$

where $\zeta_{\tilde{a},a}$ is the survival probability from age $\tilde{a}$ to age $a$ (see Table E.1 for ages 65-100). I add the value $\widetilde{ssb}_{\tilde{a}}^i$ to the measure of post-government income as part of the public transfers.

[24] See https://www.ssa.gov/oact/COLA/piaformula.html for the details.

# Appendix C: Data and Parameterization

## C.1 Data

My main data sources include the Panel Study of Income Dynamics (PSID) and the Current Population Survey (CPS).[25] The PSID is the longest-running representative household panel of the U.S. individuals and the family units in which they reside. The waves are annual from 1968 to 1997, and biennial starting from 1999. I use the PSID to estimate the tax and transfer function and the labor productivity processes for men and women. My sample consists of single and married individuals (heads and wives) aged 24-70 who are observed at least twice over the period of 1968-2017. The CPS is the source of official U.S. government statistics on employment, and is designed to be representative of the civilian non-institutional population. I use the CPS to construct the life-cycle profiles for working hours and participation. My sample consists of single and married individuals aged 24-70 over the period of 1968-2017.

In addition, I use the data from the Congressional Budget Office (data on the progressivity of the U.S. tax and transfer system) and the National Center for Health Statistics (data on the age-dependent survival probabilities).

## C.2 Method of Simulated Moments

I estimate my model using a two-stage procedure. In the first stage, I estimate the vector of parameters $\boldsymbol{\chi}$ without explicitly using the model. For example, as discussed by Gourinchas and Parker (2002), rather than estimate the variance of permanent and transitory income shocks from average consumption and income profiles, where identification might prove difficult in practice, I use time-series moment conditions and true household-level panel data on income. In the second stage, I use the Method of Simulated Moments (MSM) (Pakes and Pollard, 1989; Duffie and Singleton, 1993) to estimate the remaining parameters $\boldsymbol{\Theta}$:

$$\boldsymbol{\Theta} = \left(\beta, \psi, \gamma_0^m, \left(\alpha_0^{i,\iota}, \alpha_1^{i,\iota}, \alpha_2^{i,\iota}\right), \bar{L}_\iota^i\right)$$

In particular, given the parameters obtained in the first stage, I use the model to simulate

[25] The CPS data is extracted from IPUMS at https://cps.ipums.org/cps. See Flood et al. (2020).

the life-cycle profiles of a representative population of people, and then choose the parameter values that minimize the distance between the simulated profiles and empirical profiles. I use the capital-income ratio, the male-female earnings ratio, and the age profiles for working hours and participation for single men and women, and married men and women ages 25-65. Suppose there is data on $n$ individuals, each is observed for up to $T$ years. Denote by $g\left(\boldsymbol{\Theta};\boldsymbol{\chi}_0\right)$ the vector of the moment conditions, and $\hat{g}_n\left(\boldsymbol{\Theta};\boldsymbol{\chi}_0\right)$ is its sample analog. The MSM estimator minimizes over $\boldsymbol{\Theta}$ and is given by

$$\hat{\boldsymbol{\Theta}} = \underset{\boldsymbol{\Theta}}{\operatorname{argmin}}\, \hat{g}_n\left(\boldsymbol{\Theta};\boldsymbol{\chi}_0\right)' \widehat{\boldsymbol{W}}_n \hat{g}_n\left(\boldsymbol{\Theta};\boldsymbol{\chi}_0\right) \tag{C.1}$$

where $\widehat{\boldsymbol{W}}_n$ is a $T\times T$ weighting matrix. In the case when $\widehat{\boldsymbol{W}}_n$ is the identity matrix, the estimation procedure is equivalent to minimizing the sum of squared residuals. Following the literature that uses the MSM, I treat vector of parameters $\boldsymbol{\chi}_0$ as known.

Under the regularity conditions stated in Pakes and Pollard (1989) and Duffie and Singleton (1993), the MSM estimator $\hat{\boldsymbol{\Theta}}$ is both consistent and asymptotically normally distributed:

$$\sqrt{n}\left(\widehat{\boldsymbol{\Theta}} - \boldsymbol{\Theta}_0\right) \rightsquigarrow \mathcal{N}\left(0, \boldsymbol{V}\right) \tag{C.2}$$

The variance-covariance matrix is given by

$$\boldsymbol{V} = \left(\boldsymbol{\Gamma}'\boldsymbol{W}\boldsymbol{\Gamma}\right)^{-1}\boldsymbol{\Gamma}'\boldsymbol{W}\boldsymbol{\Sigma}\boldsymbol{W}\boldsymbol{\Gamma}\left(\boldsymbol{\Gamma}'\boldsymbol{W}\boldsymbol{\Gamma}\right)^{-1} \tag{C.3}$$

where $\boldsymbol{\Sigma}$ is the variance-covariance matrix of the data, $\boldsymbol{\Gamma}$ is the gradient matrix of the population moment vector

$$\boldsymbol{\Gamma} = \frac{\partial g\left(\boldsymbol{\Theta};\boldsymbol{\chi}_0\right)}{\partial \boldsymbol{\Theta}'}\Big|_{\boldsymbol{\Theta}=\boldsymbol{\Theta}_0} \tag{C.4}$$

and

$$\boldsymbol{W} = \underset{n\to\infty}{\operatorname{plim}}\, \widehat{\boldsymbol{W}}_n \tag{C.5}$$

When $\boldsymbol{W} = \boldsymbol{\Sigma}^{-1}$, then

$$\boldsymbol{V} = \left(\boldsymbol{\Gamma}'\boldsymbol{\Sigma}^{-1}\boldsymbol{\Gamma}\right)^{-1} \tag{C.6}$$

When $\widehat{\boldsymbol{W}}_n$ converges to $\boldsymbol{\Sigma}^{-1}$, the weighting matrix is asymptotically efficient. As Altonji and Segal (1996) emphasize, the optimal weighting matrix can suffer from small sample bias, and the correlation between sampling errors in the second moments and the sample weighting matrix generates bias in the optimal minimum distance estimator. I use a weighting matrix that contains the elements of $\mathbf{\Sigma}$ on the diagonal and zeros off the diagonal. I estimate $\mathbf{\Gamma}$ and $\boldsymbol{W}$ using their sample analogs.

# Appendix D: Additional Figures

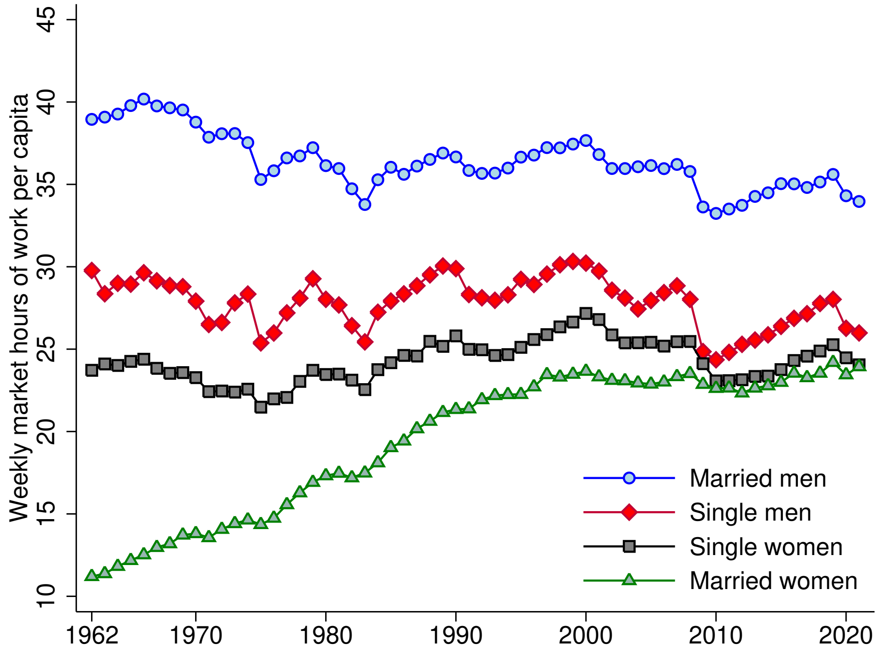
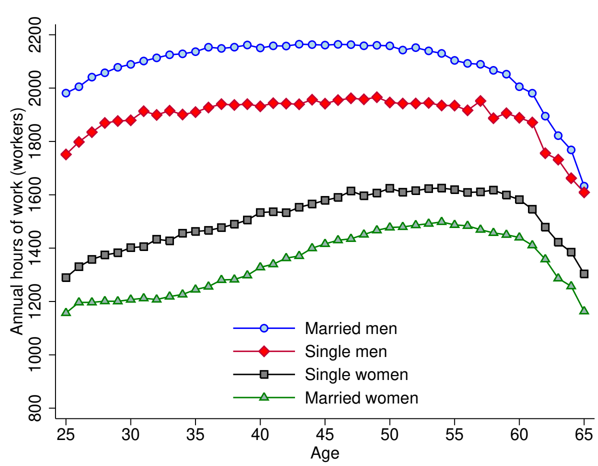
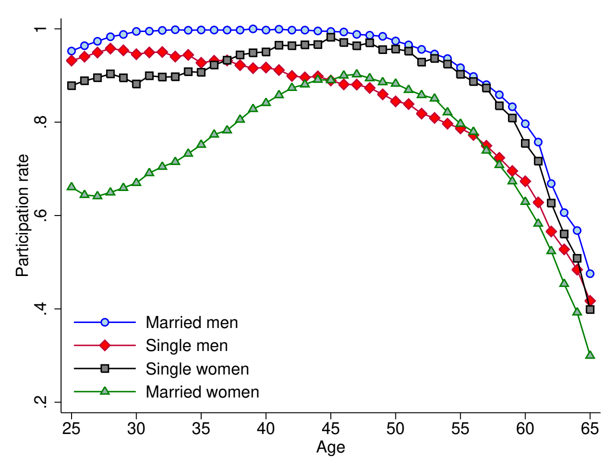



Figure D.1: Weekly market hours of work by gender and marital status, United States

NOTES: I use the data from the Current Population Survey (CPS). The time series are constructed using reported hours worked in previous week by persons aged 20-65.

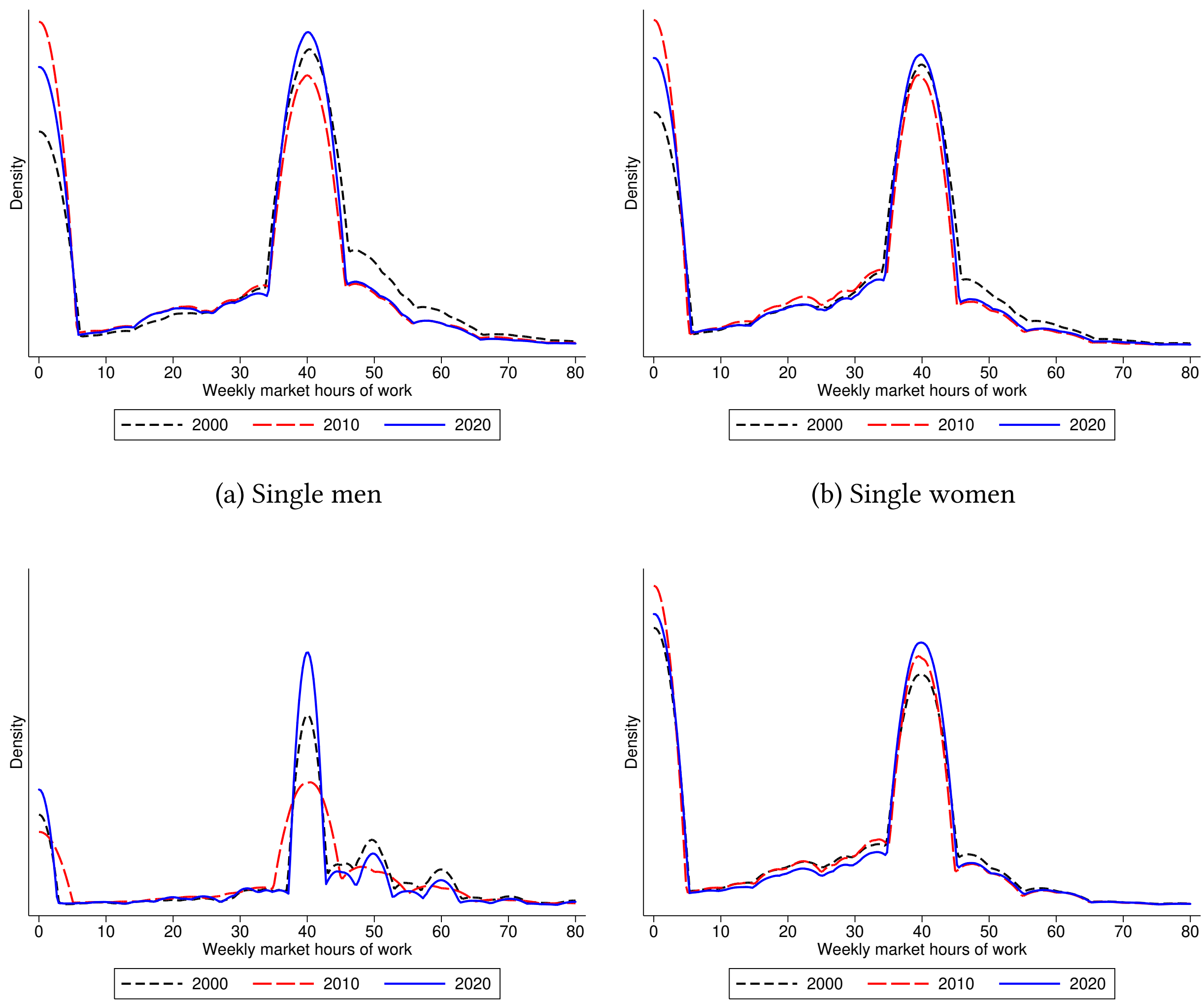



(a) Annual hours of work (for workers) by gender and marital status




(b) Participation by gender and marital status

NOTES: I use the data from the Current Population Survey (ASEC CPS) for persons aged 25-65. The annual hours of work are constructed by multiplying the usual hours worked per week (last year) by the number of weeks worked last year. The participation rate is constructed using reported hours worked in previous week.




(a) Single men

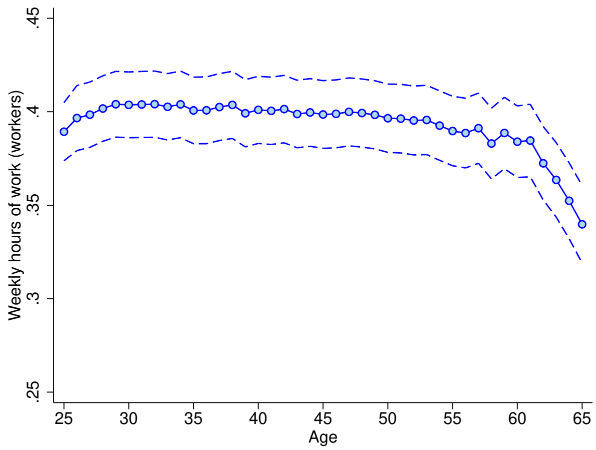
(b) Single women

(c) Married men

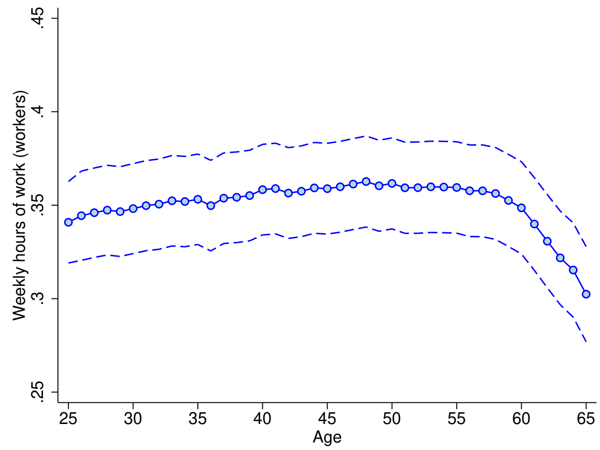
(d) Married women

Figure D.3: Distribution of weekly market hours of work by gender and marital status

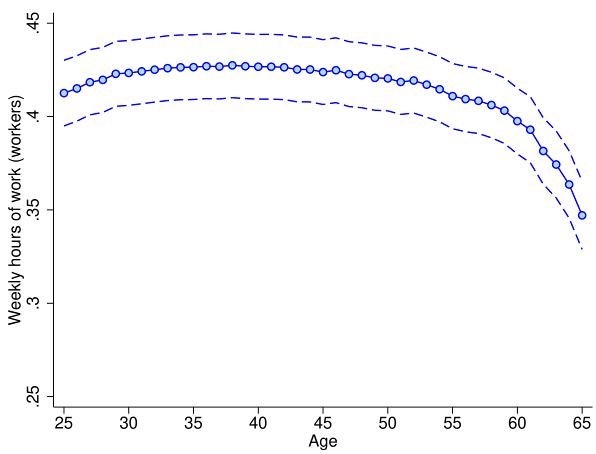
Notes: I use the data from the Current Population Survey (ASEC CPS). The figures are constructed using reported hours worked in previous week by persons aged 20-65.



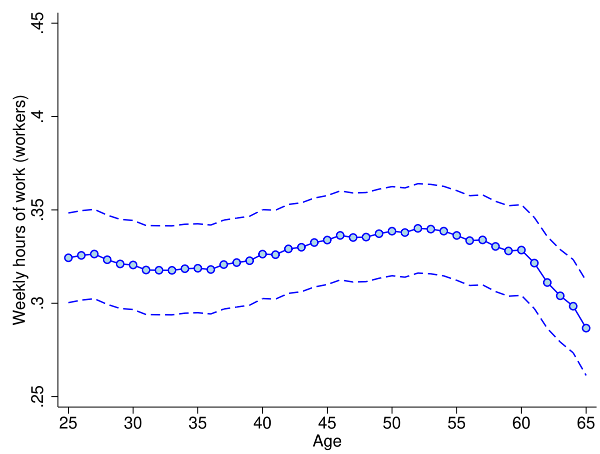

(a) Single men




(b) Single women




(c) Married men




(d) Married women

Figure D.4: Life-cycle profiles of weekly hours of work (for workers) by gender and marital status

NOTES: I use the data from the Current Population Survey (ASEC CPS). The figures are constructed using reported hours worked in previous week by persons aged 25-65. The weekly hours are normalized to the weekly time endowment of single men (112 hours).

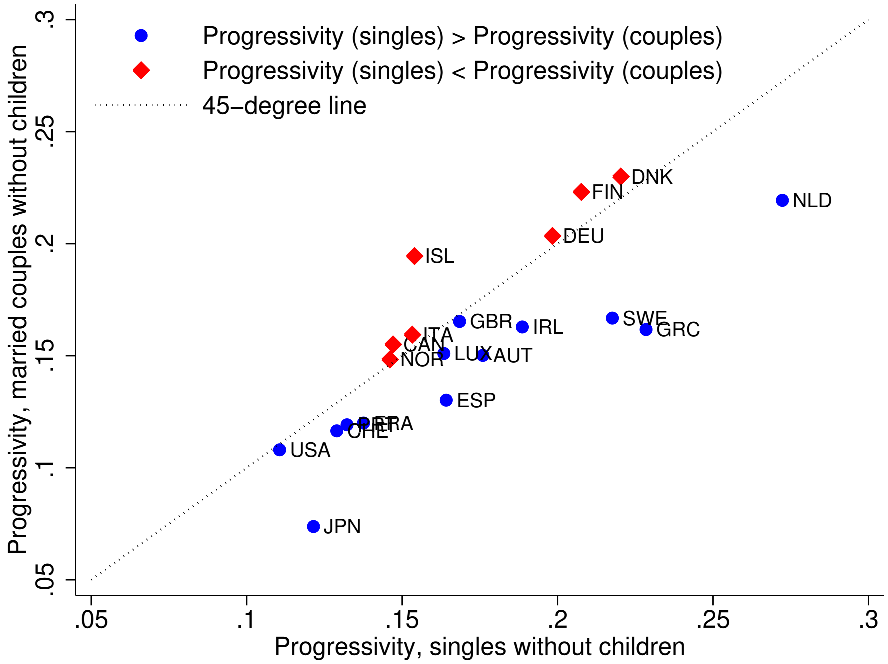



Figure D.5: Progressivity for singles and married couples by country

Notes: Progressivity of the tax and transfer system is measured by parameter $\tau$ in (1). The dotted line is a 45 degree line. The cross-country estimates are from Holter et al. (2019) who use the OECD Tax-Benefit calculator for the period of 2000-2007.

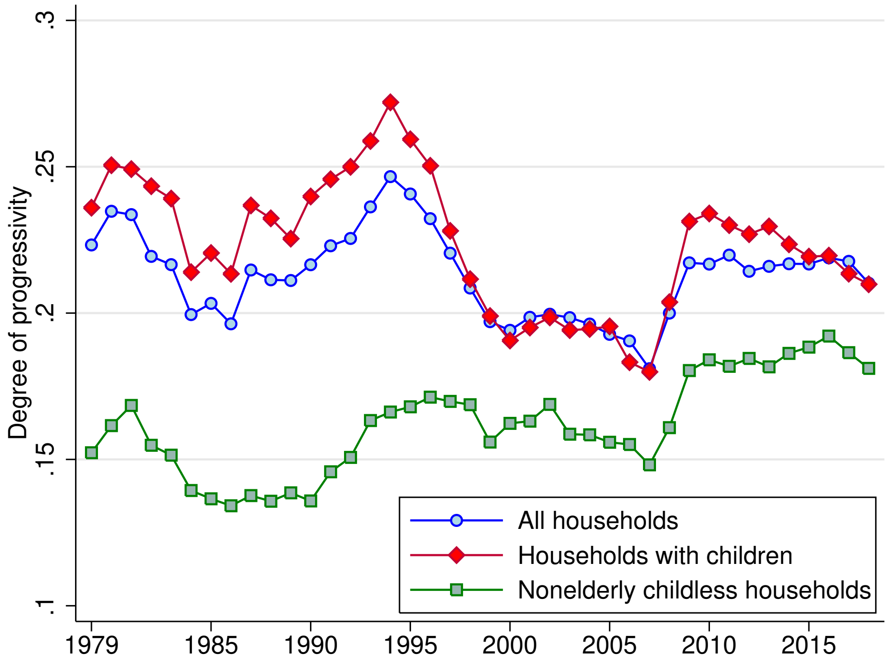



Figure D.6: Tax progressivity for U.S. households with and without children

NOTES: Progressivity of the tax and transfer system is measured by parameter $\tau$ in (1). The data is from the Congressional Budget Office and covers the period of 1979-2018.

# Appendix E: Additional Tables

Table E.1: Age-dependent probability of dying and survival probability in the United States, 2014

| Age $a$ | Probability of dying | Survival probability $\zeta_a$ |
|---|---|---|
| 65-66 | 0.0125 | 0.9875 |
| 66-67 | 0.0134 | 0.9866 |
| 67-68 | 0.0144 | 0.9856 |
| 68-69 | 0.0156 | 0.9844 |
| 69-70 | 0.0170 | 0.9830 |
| 70-71 | 0.0187 | 0.9813 |
| 71-72 | 0.0205 | 0.9795 |
| 72-73 | 0.0226 | 0.9774 |
| 73-74 | 0.0247 | 0.9753 |
| 74-75 | 0.0270 | 0.9730 |
| 75-76 | 0.0295 | 0.9705 |
| 76-77 | 0.0323 | 0.9677 |
| 77-78 | 0.0357 | 0.9643 |
| 78-79 | 0.0395 | 0.9605 |
| 79-80 | 0.0439 | 0.9561 |
| 80-81 | 0.0488 | 0.9512 |
| 81-82 | 0.0540 | 0.9460 |
| 82-83 | 0.0597 | 0.9403 |
| 83-84 | 0.0664 | 0.9336 |
| 84-85 | 0.0739 | 0.9261 |
| 85-86 | 0.0820 | 0.9180 |
| 86-87 | 0.0915 | 0.9085 |
| 87-88 | 0.1020 | 0.8980 |
| 88-89 | 0.1135 | 0.8865 |
| 89-90 | 0.1260 | 0.8740 |
| 90-91 | 0.1395 | 0.8605 |
| 91-92 | 0.1540 | 0.8460 |
| 92-93 | 0.1696 | 0.8304 |
| 93-94 | 0.1861 | 0.8139 |
| 94-95 | 0.2036 | 0.7964 |
| 95-96 | 0.2220 | 0.7780 |
| 96-97 | 0.2412 | 0.7588 |
| 97-98 | 0.2611 | 0.7389 |
| 98-99 | 0.2815 | 0.7185 |
| 99-100 | 0.3024 | 0.6976 |
| 100+ | 1 | 0 |