Taxation, Aggregates and the Household

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Abstract

We evaluate hypothetical reforms to the U.S. tax system in a dynamic setup with heterogeneous married and single households, and with an operative extensive margin in labor supply. We restrict our model with observations on gender and skill premia, labor force participation across skill groups, and the structure of marital sorting. Replacing current income taxes by a proportional consumption tax increases steady-state output by about 10.5%. This increase is accompanied by differential effects on labor supply: while per-worker hours increase by about 3.0%, the labor force participation of secondary earners increases by 4.6% and married females increase their total hours by 7.6%. Married females account for 51% of the total increase in labor hours and for 45% of the increase in labor supply. When current income taxes are replaced by a progressive consumption tax, married females account for a larger share of the total increase in labor hours and labor supply – 65% and 54%, respectively.

JEL Classifications: E62, H31, J12, J22
Key Words: Taxation, Two-earner Households, Labor Force Participation.

1 Introduction

Tax reforms have been at the center of numerous debates among academic economists and policy makers. These debates have been fueled by equity and economic efficiency trade-offs, by theoretical results establishing that taxing capital income is not efficient, and by the fact that the current U.S. tax structure is complicated and distortionary. As a part of this debate, there have been calls for tax reforms that would simplify the tax code, change the tax base from income to consumption, and adopt a more uniform marginal tax rate structure.[1]

In the existing literature, the decision maker is typically an individual who decides how much to work, how much to save and in some cases, how much human capital investments to make. Yet, the current household structure in the U.S. should force us to think beyond single-earner household paradigm. Consider how different U.S. households look today compared to 1960. To begin with, a much smaller proportion of the adult population is married. Almost 90% of women between ages 25 and 64 were married then whereas about 74% of them are today. Second, married women devote a much larger fraction of their available time to work outside the home. Using Current Population Survey (CPS) data, we calculate that the labor force participation of secondary earners in married households was about 43% in 1960 while it is about 74% today. Third, earnings per-hour of females relative to males (gender gap) have grown considerably; from around 40% in 1960 to about 73% nowadays. Overall, these changes resulted in a major shift in the structure of a typical U.S. household; a shift away from households with a bread-winner husband and house-maker wife. The macroeconomic consequences of this transformation are arguably of first-order importance. We clearly live in a different world.

In this paper, we quantify the effects of tax reforms taking seriously the labor supply of secondary earners as well as the current demographic (household) structure. These features have long been deemed important in discussions of tax reforms, but are largely unexplored in equilibrium analyses in the macroeconomic and public-finance literatures. For these purposes, we develop a dynamic, equilibrium model with an operative extensive margin in labor supply and a structure of individual and household heterogeneity consistent with a host of demographic data. We then use this framework to evaluate the importance of labor sup-

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[1] Among such reform proposals, one can list Hall and Rabushka's (1995) flat tax, Bradford's (1986) X-tax, a simple proportional income tax or a proportional consumption tax – see Auerbach and Hassett (2005) for a review.

ply responses of secondary earners and the other non-standard features in quantifying the long-run consequences of such reforms.

The model economy we consider is populated with males and females who differ in their potential earnings, and who exhibit life-cycle behavior. They are born as workers and stochastically transit into retirement, and once retired, into death. At any point in time agents are either married or single. Hence, in the model agents differ along their gender, earnings, and marital status. Each period, single agents are exogenously matched according to probabilities that depend on individual types and assets, and form two-person households. Similarly, each period married agents divorce according to an exogenous process and become single. Singles decide how much to work and how much to save out of their total after-tax income. Married agents' decisions are more involved. They decide whether both or only one of the household members should work, and if so, how much. If both agents work in a married household, they face a utility cost, which represents the additional difficulty originating from the need to better coordinate household activities, potential child-care costs, etc. As a result, it is possible that one of the agents in a married couple household may choose not to work at all. This is a key aspect of the environment as it permits to model parsimoniously the labor supply of a married household along the extensive margin. Like singles, married agents also decide how much to save out of their after-tax total income. Finally, there is a simple pay-as-you-go social security system that taxes workers labor income and provide benefits to retired individuals.

A few features of this model are important to highlight here. First, we model explicitly the participation decision of secondary earners in two-person households. This is novel in dynamic models with heterogeneity. It is also key, since the structure of taxation affects the participation decision of individuals, and available evidence suggests that it does so significantly. The model thus allows us to separate changes in labor supply that take place at extensive and intensive margins. Second, since we aim at a realistic picture of U.S. households, the model is developed so that it can reproduce *exactly* who is married to whom in the data. This feature is of importance for our purposes, since different households face different marginal tax rates, and reactions of different households to a tax reform are potentially not the same. Third, the fact that in the model agents save and accumulate assets allows us to capture the effects of tax reforms on the aggregate capital stock. This is obviously in order since the federal government in the United States taxes both labor and

capital income, and capital income is taxed further via the corporate income tax. Thus, comprehensive tax reforms will affect the marginal tax rates on both types of income and the incentives to accumulate capital.

We restrict model parameters so that our benchmark economy is consistent with relevant aggregate and cross-sectional features of the U.S. economy. Three aspects of our parameterization are critical. First, using data on tax returns we estimate effective tax functions for married and single households. These functions relate taxes paid to reported incomes and hence capture the complex relation between households incomes and taxes in a parsimonious way. Second, we construct our benchmark economy to be consistent with the data on the labor force participation of secondary earners. In particular, since each married household in the model economy is characterized by the labor market productivity levels of its two members, we select parameter values so that the labor force participation of secondary earners for each household type is in line with the data. Third, the demographic structure of the model is tightly mapped to U.S. demographics. In the model, individuals face exogenous marital transitions during their working-age years. The structure of our model allows us to select these marital transitions so that marital structure of the benchmark economy (who is single, who is married, and who is married with whom) matches exactly the structure observed in the U.S. economy. Altogether, our framework is then a rich, yet still tractable model of household formation and dissolution.

In line with existing literature, we find that tax reforms can lead to large effects across steady states on macroeconomic variables, such as output and capital intensity. However, our results indicate that the labor supply behavior of different groups is key for an understanding of the aggregate effects. Replacing current income taxes by a flat consumption (income) tax results in an increase in aggregate output of about 10.5% (6.0%). This output increase is accompanied by differential effects on labor supply: while hours along the intensive margin increase by about 3.0% (2.6%), the labor force participation of secondary earners increases by about 4.6% (4.6%) and married females increase their total hours by 7.6% (7.2%). Overall, married females account for about 51-52% of the total increase in labor hours, and about 44-45% of the aggregate increase in labor supply (efficiency units).

The effects of a progressive consumption tax reform, which replaces the current income tax structure by a common marginal tax rate and an exemption level below which the tax rate is zero as in many proposals (e.g. Hall and Rabushka (1995)), are different. The aggregate

effects are more moderate and the positive effects on labor force participation of secondary earners are much less pronounced. Replacing current income taxes by a consumption tax with these properties, results in an increase in aggregate output of about 7.3% across steady states and a change in labor force participation of only 1.9%. Nevertheless, we find that the contribution of married females to the total increase in labor hours and labor supply is much more significant under a progressive consumption tax; about 65% and 54%, respectively.

Background There are several reasons that point to the relevance of our analysis. First, in the current U.S. tax system the household (not the individual) constitutes the basic unit of taxation. This determines that the tax rates facing otherwise identical single and married households can differ. A single woman's taxes depend only on her own income. Yet, when a married female considers entering the labor market, the first dollar of her earned income is taxed at her husband's current marginal rate. Second, from a conceptual standpoint, wages of each member in a two-person household affects critically the joint labor supply decisions as well as the reactions to changes in the tax structure. Thus, the degree of marital sorting (*who is married to whom*) could greatly affect the aggregate responses to alternative tax rules. Finally, a common view among many economists has been that tax changes may have moderate impacts on labor supply. This view is supported by empirical findings on the low or near zero labor supply elasticities of prime-age males. Recent developments, however, started to challenge this wisdom. Two recent major tax reforms, i.e. Economic Recovery Tax Act of 1981 (ERTA) and Tax Reform Act of 1986 (TRA), have been shown to affect female labor supply behavior significantly, but have relatively small effects on males (Burtless (1991), Bosworth and Burtless (1992), Triest (1990), and Eissa (1995)). More recently, Eissa and Hoynes (2004) show that the disincentives to work embedded in the Earned Income Tax Credit (EITC) for married women are quite significant (effectively subsidizing some married women to stay at home). These findings are consistent with ample empirical evidence that female labor supply in general, and female labor force participation in particular are quite elastic (Blundell and MaCurdy (1999)). If households react to taxes much more than previously thought, the potential effects of tax reforms can be much more significant.

Our work is largely related to four strands of literature. First, our evaluation of tax reforms using dynamic models with heterogenous agents is related to the work by Altig, Auer-

bach, Kotlikoff, Smetters and Walliser (2001), Chade and Ventura (2002), Díaz-Jiménez and Pijoan-Mas (2005), Erosa and Koreshkova (2007), Nishiyama and Smetters (2005), Conesa and Krueger (2006), and Ventura (1999) among others. In contrast to these papers, we study economies populated with married and single households, where the married households can have one or two earners.[2] Second, the current paper is related to recent papers that show that taxes can play a significant role in accounting for cross-country differences in labor supply behavior. Prescott (2004), Olovsson (2003), Davis and Henrekson (2003), Rogerson (2006) and Kaygusuz (2006a) are examples of papers in this group. Third, the current paper is related to papers that studied the macroeconomic effects of changes in labor supply along the extensive margin; Cho and Rogerson (1988), Cho and Cooley (1994), Mulligan (2001), Attanasio, Low and Sánchez Marcos (2004), Chang and Kim (2006) and Kaygusuz (2006b) are examples. Finally, it is related to recent papers on the macroeconomics of the family; Regalia and Ríos-Rull (1999), Aiyagari, Greenwood and Guner (2000), Fernández and Rogerson (2001), Cubeddu and Ríos-Rull (2003), Greenwood and Guner (2004), Fernández, Guner and Knowles (2005) and Knowles (2005), are representative of papers in this group.

2   The Economic Environment

The economy we study is populated by a continuum of males and a continuum of females. The total mass of agents in each gender is normalized to one. As in Gertler (1999), individuals have finite lives, that are divided in two stages, work and retirement. In particular, each agent is born as a worker and faces each period a constant probability of retirement ρ so that average time spent as a worker is $1/\rho$. Once an agent retires, he faces a constant risk of death δ every period so that average time spent in retirement is $1/\delta$.

Each agent is indexed by a labor market productivity level (type), which remains constant throughout his/her life. Agents also differ by their marital status: they can be single or married. The marital status of agents change *exogenously* in the way we detail below. For simplicity, we assume that members of a married household experience identical life-cycle dynamics, i.e. they retire and die together.

Each period working households (married or single) make joint labor supply, consumption

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[2]Kleven and Kreiner (2006) study optimal taxation of two-person households when households face an explicit labor force participation decision.

and savings decisions. As in Cho and Rogerson (1988), among other papers, if both members of a married household supply positive amounts of market work, then members incur a utility cost. This utility cost is drawn once and for all from a given distribution when the household is formed and remains constant until the household either breaks up, or their members retire. Households save in the form of a one-period, risk-free asset. If a household breaks up, each member gets half of the total household assets. Retired agents are not allowed to work, so their only decision is about their savings. There is a pay-as-you-go social security system in place that provides social security payments to households. We assume that there are three levels of social security benefits, one for retired married, one for retired single female, and one for retired single male households. Retired individuals who die are replaced by *single* workers with the same productivity level and zero assets. We assume for simplicity that assets of the deceased are not distributed among the surviving population.

A representative firm rents capital and labor services to produce a single consumption good, and pays a wage rate per effective unit of labor and a rental rate for capital. Finally, there is a government that taxes labor and capital income each period, and consumes the aggregate amount G and runs the social security system. There are three different taxes in this economy: a graduated income tax on labor and capital incomes, an additional flat-rate tax on capital incomes, as well as a payroll tax on labor earnings. Taxation is the only source of government revenue, and is used to finance G as well as social security payments. Income taxes and the additional tax on capital incomes are used to finance G, while payroll taxes are used to finance social security transfers.

From the previous assumptions, at any point in time the economy is populated by single and married households who differ by their labor market status, market productivity of their member(s), asset levels, and the utility cost of joint work (if married and working). The state for a household in this economy consists of its assets, productivity of its members and the per-period utility cost of joint work. The aggregate state for this economy consists of distribution of households by their types and asset levels. We describe in detail below a stationary environment in which these distributions and factor prices are constant. We provide a formal definition of equilibria in the Appendix.

Heterogeneity The labor productivity of a female is denoted by $x \in X$, where $X \subset R_{++}$ is a finite set. Similarly, let the labor productivity of a male be denoted by $z \in Z$,

where $Z \subset R_{++}$ is a finite set. Each agent is born with a particular z or x that remains constant throughout his/her life. Let $\Phi(x)$ and $\Omega(z)$ denote the fractions of type-x females in female population and of type-z males in male population, respectively. Since population of each gender is normalized to one, $\sum_{x \in X} \Phi(x) = 1$ and $\sum_{z \in Z} \Omega(z) = 1$.

Preferences   The momentary utility function for a single person is given by

$$U^S(c, l) = \log(c) - Bl^{1+\frac{1}{\gamma}},$$

where c is consumption and l is time devoted to market work.

For a person of gender $i = \{f, m\}$ who is married to a person from gender $j \neq i$, the momentary utility function reads as

$$U_i^M(c, l_i, l_j, q) = \log(c) - Bl_i^{1+\frac{1}{\gamma}} - \frac{1}{2}\chi(l_i, l_j)q,$$

where c is aggregate consumption of the household. Note that the parameter $\gamma > 0$, independent of gender and marital status, is the intertemporal elasticity of labor supply.

Households are assumed to maximize sum of their members utilities. We assume that when both members of a married household work, the household incurs a utility costs q, and let $\chi(l_i, l_j)$ be an indicator function for joint work, i.e.

$$\chi(l_i, l_j) = \begin{cases} 1, & \text{if } l_i l_j > 0 \\ 0, & \text{otherwise} \end{cases}.$$

We assume that $q \in Q$, where $Q \subset R_{++}$ is a finite set. We assume that for a given household the distribution function for q depends on labor market productivity of household members. Let $\zeta(q|x, z)$ denote the probability that the cost of joint work is q, with $\sum_{q \in Q} \zeta(q|x, z) = 1$ for all x and z, for a household with productivity levels x and z. When a married household is formed, the household draws its q, which remains constant until the marriage ends. We assume that each member of the household incurs half of this total utility cost.

Production   There is a single firm in the economy that operates a constant returns to scale technology. This firm rents capital and labor services from households. Using aggregate capital, K, and aggregate efficiency units of labor, L, the firm produces $F(K, L) = K^\alpha L^{1-\alpha}$ units of consumption good. We assume that the capital depreciates at rate δ_k.

Incomes and Taxation   Let w be the wage rate per effective units of labor and r be the rental rate of capital. Let a represent household's assets. Then, the total pre-tax resources of a single working male are given by $a + ra + wzl$, whereas for a single female worker they amount to $a + ar + wzl$. The pre-tax total resources for a married working couple are given $a + ra + wzl_m + wxl_f$. Let b_i^S and b^M indicate the level of social security benefits for singles, for $i = f, m$, and married retired households, respectively. Then, retired households pre-tax resources are simply $a + ra + b_i^S$ for single retired households and $a + ra + b^M$ for married ones.

Income for tax purposes, I, is defined as total labor and capital income; hence for a single male worker $I = ra + wzl$, while for a single female worker $I = ra + wxl$. For a married working household, taxable income equals $I = ra + wzl_m + wxl_f$. We assume that social security benefits are not taxed, so the income for tax purposes is simply given by ra for retired households. The total income tax liabilities of married and single households are represented by tax functions $T^M(I)$ and $T^S(I)$, respectively. These functions are continuous in I, increasing and convex. There is also a (flat) payroll tax that taxes individual labor incomes, represented by τ_p, to fund social security transfers. Besides the income and payroll taxes, each household pays an additional flat capital income tax for the returns from his/her asset holdings, denoted by τ_k.

Demographics   Each period agents from each gender are either single or married. Let $M(x, z)$ denote the number of marriages between a type-x female worker and a type-z male worker, and let $\omega(z)$ and $\phi(x)$ denote the number of single type-z male workers and the number of single type-x female workers, respectively. Let $M^r(x, z)$, $\omega^r(z)$ and $\phi^r(x)$ denote the similar quantities for retirees. Then, the following two accounting identities

$$\Phi(x) \equiv \sum_z M(x, z) + \phi(x) + \sum_z M^r(x, z) + \phi^r(x), \tag{1}$$

and

$$\Omega(z) \equiv \sum_x M(x, z) + \omega(z) + \sum_x M^r(x, z) + \omega^r(z), \tag{2}$$

hold by construction.

Each agent is born as a single worker with zero assets, and his/her marital status changes exogenously as long as he/she remains a worker. We assume that each period agents first face

retirement shocks and then, if they do not retire, experience marriage and divorce shocks. Once retired, marital status of agents remain constant until he/she dies.

In particular, each period working single agents match with other single workers of opposite sex according to exogenous probabilities. To this end, let $\pi_m(z)$ be the probability that a single male worker of type z is matched with a female worker, and $\pi_f(x)$ denote the probability that a single female worker of type x matches with another male worker. Given that a single type-z male is matched, let $P_m(x|z)$ be the conditional probability that his match is type-x. Similarly, let $P_f(z|x)$ be the conditional probability that a single female of type x is matched with a type-z male. Each period working married households, independent of their members' types, face an exogenous divorce probability denoted by λ. Divorced agents have to remain single one period before they match with other singles.

Aggregate Consistency   The aggregate state of this economy consists of distribution of households over their types and asset levels. Suppose $a \in A = [0, \bar{a}]$. Consider first workers. Let $\psi^M(x, z, a, q)$ be the number of working married households of type (x, z, a, q), $\psi_f^S(x, a)$ be the number of working single females of type (x, a), and similarly let $\psi_m^S(z, a)$ be the number of single working males of type (z, a). By construction, $M(x, z)$, the number of married working households of type (x, z), must satisfy

$$M(x, z) = \sum_q \int_A \psi^M(a, x, z, q) da.$$

Similarly, the number of single households (agents) must be consistent with $\psi_f^S(x, a)$ and $\psi_m^S(z, a)$, i.e. $\phi(x)$ and $\omega(z)$ must satisfy

$$\phi(x) = \int_A \psi_f^S(x, a) da,$$

and

$$\omega(z) = \int_A \psi_m^S(z, a) da.$$

Finally, note that given $\psi_f^S(x, a)$ and $\psi_m^S(z, a)$, the probability that a random type-x single female worker has assets a, and a random type-z single male worker has assets a are given by

$$\varphi_f(a|x) = \frac{\psi_f^S(x, a)}{\phi(x)}, \tag{3}$$

and

$$\varphi_m(a|z) = \frac{\psi_m^S(z,a)}{\omega(z)}. \tag{4}$$

Since retired agents are not allowed to work, they only differ by their marital status and asset holdings. Let $\psi^{M,r}(a)$, $\psi_f^{S,r}(a)$ and $\psi_m^{S,r}(a)$ denote the asset distribution among retired married, retired single female and retired single male households, respectively. Like their counterparts for workers, these distributions must be consistent with $M^r(x,z)$, $\phi^r(x)$ and $\omega^r(z)$.

2.1 The Problem of a Single Household

We are now ready to define the problem of single and married households. First consider the problem of a retired single agent and without loss of generality focus on the problem of a single retired male with asset level a. A single retired male simply decides how much to save, a', and his problem is given by

$$V_m^{S,r}(a) = \max_{a'}\{U^s(c,0) + (1-\delta)\beta V_m^{S,r}(a')\}, \tag{5}$$

subject to

$$c + a' = a + ra + b_m^S - T^s(ra) - \tau_k ra.$$

The value of being a single retired female of type a, $V_f^{S,r}(a)$, is defined in a similar way.

Consider now the problem of a single male worker of type (z,a). A single worker of type-(z,a) decides how much to work and how to save. If he does not retire at the start of the next period, which happens with probability $1-\rho$, then he gets married with probability $\pi_m(z)$. In that event, agent is matched with a female of type $(x,\bar{a})$ with some probability and the newly-married couple draw a value for q from $\zeta(q|x,z)$; forming a type-$(x,z,\bar{a}+a',q)$ married household. Let $V_m^M(x,z,\bar{a}+a',q)$ denote the expected lifetime utility of being married for a male worker, which will be defined below. Then, the problem of a single male worker is given by

$$V_m^S(z,a) = \max_{a',\, l_m^S}\{U^S(c,l_m^S)+$$

$$(1-\rho)\beta[\pi_m(z)\sum_{q,\,x}\zeta(q|x,z)P_m(x|z)\int_A V_m^M(x,z,a'+\bar{a},q)\varphi_f(\bar{a}|x)d\bar{a}$$

$$+ (1-\pi_m(z))V_m^S(z,a')] + \rho\beta V_m^{S,r}(a')\}, \tag{6}$$

11

subject to

$$c + a' = a + wzl_m^S + ra - \tau_p wzl_m^S - T^S(wzl_m^S + ra) - \tau_k ra,$$

and

$$l_m^S \geq 0,\ a' \geq 0.$$

The value of being a single female worker $V_f^S(x, a)$ can be defined in a similar fashion.

2.2 The Problem of a Married Household

Again first consider the problem of a retired couple of type a. Their problem is given by

$$\max_{a'}\{U_m^M(c, 0, 0, q) + U_f^M(c, 0, 0, q) + (1 - \delta)\beta(V_m^{M,r}(a') + V_f^{M,r}(a'))\}, \tag{7}$$

subject to

$$c + a' = a + ra + b^M - T^M(ra) - \tau_k ra.$$

Hence, if $\widehat{a}'$ and $\widehat{c}$ denote the optimal decision in this problem, then

$$V_m^{M,r}(a) = U_m^M(\widehat{c}, 0, 0, q) + (1 - \delta)\beta V_m^{M,r}(\widehat{a}),$$

and

$$V_f^{M,r}(a) = U_f^M(\widehat{c}, 0, 0, q) + (1 - \delta)\beta V_f^{M,r}(\widehat{a}).$$

Consider now the problem of a married working household of type (x, z, a, q). A married working household solves a joint maximization problem given by

$$\max_{a',\ l_f^M,\ l_m^M,\ c} \{[U_m^M(c, l_m^M, l_f^M, q) + U_f^M(c, l_m^M, l_f^M, q)] \tag{8}$$
$$+ (1 - \rho)\beta[\lambda V_m^S(z, a'/2) + (1 - \lambda)V_m^M(x, z, a', q)$$
$$+ (\lambda V_f^S(x, a'/2) + (1 - \lambda)V_f^M(x, z, a', q)]$$
$$+ \rho\beta[V_m^{M,r}(a') + V_f^{M,r}(a')]\},$$

subject to

$$c + a' = a + wzl_m^M + wxl_f^M + ra - \tau_p wzl_m^M - \tau_p wxl_f^M$$
$$- T^M(wzl_m^M + wxl_f^M + ra) - \tau_k ra,$$

and

$$l_m^M \geq 0,\ \ l_f^M \geq 0,\ a' \geq 0.$$

Like singles, a married couple decides how much to work and how much to save. Unlike singles, they might choose zero market hours for one of the members. This will occur if q is too high, given their market productivity levels and asset holding. If they do not retire at the start of the next period, the couple faces an exogenous probability of divorce. If divorce occurs, then the household splits their assets equally and becomes single households next period.

Let $\hat{l}_m^M$, $\hat{l}_f^M$, $\hat{c}$, and $\hat{a}'$ be the optimal decisions associated with problem (8). Then, the lifetime utility of being married, $V_m^M(x, z, a, q)$ and $V_f^M(x, z, a, q)$, are given by

$$V_f^M(x, z, a, q) \equiv U_f^M(\hat{c}, \hat{l}_m^M, \hat{l}_f^M, q) + (1 - \rho)\beta[\lambda V_f^S(x, \hat{a}'/2) + (1 - \lambda)V_f^M(x, z, \hat{a}', q)]$$
$$+ \rho\beta V_f^{M,r}(\hat{a}'),$$

and

$$V_m^M(x, z, a, q) \equiv U_m^M(\hat{c}, \hat{l}_m^M, \hat{l}_f^M, q) + (1 - \rho)\beta[\lambda V_m^S(z, \hat{a}'/2) + (1 - \lambda)V_m^M(x, z, \hat{a}', q)]$$
$$+ \rho\beta V_m^{M,r}(\hat{a}').$$

2.3   Marriage Accounting

To solve households' dynamic problems, it is necessary to specify exogenous marriage transitions. These exogenous transitions consists of the probabilities that single agents get married, $\pi_m(z)$ and $\pi_f(x)$, the chances that they meet a particular type from the opposite sex if they get married, $P_m(x|z)$, and $P_f(z|x)$, and a probability of divorce, λ. We show next that if we assume a *stationary population structure*, then, for a given divorce rate, the exogenous transitions for singles can be constructed in a straightforward way.

A stationary population puts structure on the relationship between the number of individuals of a given type by gender, $\Phi(x)$ and $\Omega(z)$, the number of marriages of working age by type, $M(x, z)$, and the distribution of single worker, $\phi(x)$ and $\omega(z)$. First, given that retired agents' marital status does not change over time, we have

$$M^{r'}(x, z) = (1 - \delta)M^r(x, z) + \rho M(x, z), \tag{9}$$

which implies the following steady state condition

$$\delta M^r(x, z) = \rho M(x, z). \tag{10}$$

Therefore, in a steady state retired couples who die must be replaced by retiring couples of the same type. Similarly, for single retired males and females, the following steady state relations must hold

$$\delta\phi^r(x) = \rho\phi(x), \tag{11}$$

and

$$\delta\omega^r(z) = \rho\omega(z). \tag{12}$$

Using the steady state restrictions implied by equations (10), (11) and (12), we can rewrite equation (1) as

$$\Phi(x) = \sum_z M(x,z) + \frac{\rho}{\delta}\sum_z M(x,z) + \phi(x) + \frac{\rho}{\delta}\phi(x). \tag{13}$$

This equation restricts how $\Phi(x)$, $M(x,z)$, and $\phi(x)$ are related. Similarly, the steady state version of equation (2) is given by

$$\Omega(z) = \sum_x M(x,z) + \frac{\rho}{\delta}\sum_x M(x,z) + \omega(z) + \frac{\rho}{\delta}\omega(z). \tag{14}$$

Our strategy is to treat $\Phi(x)$, $\Omega(z)$, and $M(x,z)$ as the primitives and select $\phi(x)$ and $\omega(z)$ to satisfy the stationarity assumption. Hence, these two equations allow us to pin down $\phi(x)$ and $\omega(z)$ given the data on $\Phi(x)$, $\Omega(z)$, and $M(x,z)$.

We are now ready to construct the exogenous marriage transitions. To this end, first remember that each period married working couples who do not retire divorce with probability λ. Hence, out of $M(x,z)$ marriages between type-x females and type-z males, $(1-\rho)(1-\lambda)M(x,z)$ survives to the next period. There are also new marriages that are formed between type-x females and type-z males. In particular, given our assumptions on the formation and dissolution of households, each period there will be an exogenous fraction $\theta_m(x,z)$ of type-z single males marrying type-x single females, and an exogenous fraction $\theta_f(x,z)$ of type-x single females marrying type-z single males. Then, the following equations characterize the law of motion for the mass of married households

$$M'(x,z) = (1-\rho)(1-\lambda)M(x,z) + \theta_f(x,z)(1-\rho)\phi(x), \tag{15}$$

or

$$M'(x,z) = (1-\rho)(1-\lambda)M(x,z) + \theta_m(x,z)(1-\rho)\omega(z). \tag{16}$$

14

In a steady state, the measure of a given type of married household is constant over time, i.e., $M'(x, z) = M(x, z)$. The steady state versions of these conditions then determine $\theta_m(x, z)$ and $\theta_f(x, z)$ in terms of $M(x, z)$, $\phi(x)$ and $\omega(z)$ as

$$M(x, z) = \frac{\theta_m(x, z)(1 - \rho)\omega(z)}{1 - (1 - \rho)(1 - \lambda)}, \tag{17}$$

and

$$M(x, z) = \frac{\theta_f(x, z)(1 - \rho)\phi(x)}{1 - (1 - \rho)(1 - \lambda)}. \tag{18}$$

Note that given $M(x, z)$, $\omega(z)$, $\phi(x)$, λ, and ρ, equations (17) and (18) determine $\theta_m(x, z)$ and $\theta_f(x, z)$. Furthermore, $\theta_m(x, z)$ and $\theta_f(x, z)$ are all we need to determine the exogenous transition probabilities for singles. In particular, we can find the probability of marriage for a type x female with a type z male conditional on the event of marriage, $P_f(z|x)$ as

$$P_f(z|x) = \frac{\theta_f(x, z)\phi(x)}{\sum_z \theta_f(x, z)\phi(x)} = \frac{\theta_f(x, z)}{\sum_z \theta_f(x, z)}. \tag{19}$$

Similarly, $P_m(x|z)$ will be

$$P_m(x|z) = \frac{\theta_m(x, z)\omega(z)}{\sum_x \theta_m(x, z)\omega(z)} = \frac{\theta_m(x, z)}{\sum_x \theta_m(x, z)}. \tag{20}$$

The probability of getting married and the probability of remaining single for a particular type individual can also be expressed in terms of $\theta_f(x, z)$ and $\theta_m(x, z)$. The probability of marriage for a type-x single female, $\pi_f(x)$, is the ratio of the total number of single females of type x who get married to the number of single females of type x. This is given by

$$\pi_f(x) = \frac{\sum_z \theta_f(x, z)\phi(x)}{\phi(x)} = \sum_z \theta_f(x, z). \tag{21}$$

Moreover, the probability of remaining single for a given type of single female is $1 - \pi_f(x)$. The corresponding probabilities for a single male are defined in a similar fashion as

$$\pi_m(z) = \frac{\sum_x \theta_m(x, z)\omega(z)}{\omega(z)} = \sum_x \theta_m(x, z). \tag{22}$$

2.3.1   Discussion

It is important to point out that we take the rates at which individuals transit from singlehood to marriage, $\theta_i(x, z)$, $i = f, m$, as *exogenous*. This is the simplifying assumption we

make in relation to how households are formed. This allows us to write the law of motion for the stock of married people $M(x, z)$ in a simple way, as shown in equations (15) and (16).

The stationary environment we consider further allows us to tightly map the model to demographic data, since there is a trivial mapping between the flows into marriage and the number of married households by type, given the exogenous transition rates ρ and λ, as shown by equations (17) and (18). Therefore, we can nicely calibrate the model by *reverse-engineering*: we observe who is married-with-whom by type and recover the rates at which individuals transit into marriage in a stationary environment.

More specifically, we observe the number of individuals of a given type by gender, $\Phi(x)$ and $\Omega(z)$, as well as the number of marriages of working age by type, $M(x, z)$. We subsequently calculate the number of single individuals using the basic accounting identities in Equations (13) and (14). Using the resulting number of single workers, $\phi(x)$ and $\omega(z)$, and the life-cycle transition probabilities, ρ and λ, we then back out the rates $\theta_i(x, z)$, $i = f, m$ using Equations (17) and (18). Once we construct $\theta_i(x, z)$, we have enough structure to pin down the exogenous probabilities of household formation.

3   Taxation and the Extensive Margin: A Two-period Illustration

In the model economy, married households face a nontrivial labor force participation for their secondary earners. Given taxes, the state of the household and the cost of joint work q, each household decides whether only one or both members should work. Abstracting from assets, for any (x, z)-type household there will be a threshold q, call it q^*, that will separate single-earner households from two-earners ones. As taxes change, this threshold level might change as well, inducing a change in labor force participation. In this section, we present a simple two-period example that illustrates how taxes affect labor supply, with an emphasis on the effects on q^* and labor force participation. The example highlights key features of our general environment, and helps understanding the mapping of the model to data described in the next section.

A one-earner household   Consider a married household that lives for two periods; young (y) and old (o). Suppose household members can only work in the first period and

retire in the second one. The household decides whether only one or both members should work in the first period, and how much to save for the retirement. Let R be the gross interest rate on savings, and let τ_l be a proportional labor tax on first period's labor income.

Suppose $z/x > 1$, and consider first the problem if only one member (husband) works. The household problem is given by

$$\max_{l_{m,1},s_1} \left\{ 2[\underbrace{U((1-\tau_l)zl_{m,1} - s_1 + T)}_{=U(c_y)} + \beta\underbrace{U(s_1 R)}_{= U(c_o)}] - B(l_{m,1}) \right\}$$

where $l_{m,1}$ is the labor choice of the primary earner (husband), s_1 are assets for next period (savings) and T is a transfer received from the government in the first period. The functions $U(.)$ and $B(.)$ stand for the instantaneous utility and disutility, associated to household consumption and worktime, respectively. The subscript 1 represents the choices of a one-earner household.

We introduce government transfers in order to capture and illustrate in a simple way the role of progressive taxation. This follows as household choices under non-linear, progressive taxes are equivalent to choices under a linear tax system that combines a proportional tax rate plus a lump-sum transfer. Under a progressive tax system, changes in marginal tax rates affect labor choices even for preferences for which income and substitution cancel out; the same occurs under the linear tax system that we consider.

Household utility when only one member works is given by

$$V_1(\tau_l) = 2[U((1-\tau_l)zl^*_{m,1} - s^*_1 + T) + \beta U(s^*_1 R)] - B(l^*_{m,1}),$$

where a $'*'$ denotes an optimal choice.

A two-earner household Now consider the case when both members work and let q be the cost of joint work. Then the problem is given by

$$\max_{l_{m,2},l_{f,2},s_2} \left\{ 2[\underbrace{U((1-\tau_l)(zl_{m,2} + xl_{f,2}) - s_2 + T)}_{=U(c_y)} + \beta\underbrace{U(s_2 R)}_{=U(c_o)}] \right.$$
$$\left. - B(l_{m,2}) - B(l_{f,2}) \right\},$$

Household utility in this case equals

$$V_2(\tau_l, \tau_k) = 2[U((1 - \tau_l)(zl^*_{m,2} + xl^*_{f,2}) - s^*_2 + T) + \beta U(s^*_2 R)]$$
$$-B(l^*_{m,2}) - B(l^*_{f,2}).$$

Taxes and the extensive margin in labor supply   Since q^* obeys $q^* = V_2(\tau_l, \tau_k) - V_1(\tau_l, \tau_k)$, the threshold level of q will change as we change taxes. In order to determine how exactly q^* changes with taxes, we appeal to the envelope theorem. Note that

$$\frac{\partial V_1(\tau_l)}{\partial \tau_l} = -2U'((1 - \tau_l)zl^*_{m,1} - s^*_1 + T)(zl^*_{m,1}) < 0.$$

Similarly,

$$\frac{\partial V_2(\tau_l)}{\partial \tau_l} = -2U'((1 - \tau_l)(zl^*_{m,2} + xl^*_{f,2}) - s^*_2 + T)(zl^*_{m,2} + xl^*_{f,2}) < 0$$

Henceforth,

$$\frac{\partial q^*}{\partial \tau_l} = \frac{\partial V_2(\tau_l)}{\partial \tau_l} - \frac{\partial V_1(\tau_l)}{\partial \tau_l} < 0$$

if and only if

$$\frac{U'((1 - \tau_l)(zl^*_{m,2} + xl^*_{f,2}) - s^*_2 + T)}{U'((1 - \tau_l)(zl^*_{m,1} - s^*_1 + T))} > \frac{zl^*_{m,1}}{zl^*_{m,2} + xl^*_{f,2}}$$

Notice that in our case of interest, $U(c) = \log(c)$, then the above condition reduces to

$$\frac{(1 - \tau_l)(zl^*_{m,1}) - s^*_1 + T}{(1 - \tau_l)(zl^*_{m,2} + xl^*_{f,2}) - s^*_2 + T} > \frac{zl^*_{m,1}}{zl^*_{m,2} + xl^*_{f,2}}$$

After algebra, the above condition can be rewritten as

$$(1 - \tau_l) + \frac{T}{(zl^*_{m,1})} > (1 - \tau_l) + \frac{T}{(zl^*_{m,2} + xl^*_{f,2})} \tag{23}$$

Thus, as long as condition (23) holds, lower (higher) taxes on labor will *increase* (decrease) the threshold q^*, and generate a higher (lower) labor force participation of the household's secondary earner. This is illustrated in the top panel of Figure 1. Thus, a change in tax rates affects not only the intensive margin in labor supply but also the *extensive* margin.

18

Notice that the above condition necessarily holds in our case. If the transfer and the marginal tax rate are not contingent on the number of earners in the household (as modeled here), then for a given household type, the labor income in the two earner case will be higher than in the first earner case. This follows simply from concavity of the utility function.

It worth noting here three things. First, the fact that the transfer and the marginal tax rate are not contingent on the number of earners in the household captures U.S. tax rules that take the *household* as the unit subject to taxation. From this perspective, a reduction in the marginal tax rate on the household is effectively a reduction on the tax rate on secondary earners that may prompt a movement along the extensive margin. Second, note that the threshold q^* changes in response to changes in the tax rate even under log-preferences for consumption, for which income and substitution effects usually cancel out. Here, the presence of the common transfer above is essential for the movement in q^*, as condition (23) shows. When a transfer is present, more generally under progressive taxation, changes in marginal rates affect not only q^*, but labor supply along the intensive margin. This occurs as income and substitution effects no longer cancel out.

Altogether, the example has a number of important implications for the mapping of our model economy to data. First, as the bottom panel of Figure 1 shows, exactly how much the labor force participation of secondary earners will increase depends on the shape of $\zeta(q|x, z)$, the distribution function for q. Therefore, selecting the functional form for $\zeta(q|x, z)$ will be a key part of the model parameterization. Second, since the response of q^* depends on the gender gap, z/x. This in turn suggests that the aggregate labor supply response will hinge upon the magnitude of this gap as well as well as the structure of marital sorting (i.e. who is married with whom). We specially take care of these issues in the next section.

4   Parameter Values

We now proceed to assign parameter values to the endowment, preferences and technology parameters of our benchmark economy. We use cross-sectional, aggregate as well as demographic data. As a first step in this process, we start by defining the length of a period to be a year.

Demographics and Endowments   We assume that agents are workers for forty years, corresponding to ages 25 to 64, and set $\rho = 1/40$ accordingly. Absent population growth in the model, we set δ so that the model is consistent with the observed fraction of retired individuals (65 years and above), as a fraction of the population 25 years and older. From the 2000 Census, we calculate that this fraction was 0.203. Hence, given the value assumed for ρ, we set δ equal to 0.0982.

We set the number of productivity types (labor endowments) to five. Each productivity type corresponds to an educational attainment level: less than high school ($<$ hs), high school (hs), some college (sc), college (col) and post-college education ($>$ col). We use data from the Consumer Population Survey (CPS) to calculate efficiency levels for all types of agents. Efficiency levels correspond to mean hourly wage rates within an education group, which we construct using annual wage and salary income, weeks worked, and usual hours worked data.[3] We include in the sample household heads and spouses between 25 and 64, and exclude those who are self-employed or unpaid workers. Table 1 shows the estimated efficiency levels for the corresponding types, and also reports the observed gender gap in hourly wage rates for each educational group. Wage rates for each type and gender are normalized by the overall mean hourly wages in the sample.

We subsequently determine the distribution of individuals by productivity types for each gender, i.e. $\Omega(z)$ and $\Phi(x)$, using the 2000 Census. For this purpose, we assume an underlying stationary demographic data, and *assume* that the distribution of retired agents by educational attainment equals the observed distribution of agents prior to retirement. We consider all household heads or spouses who are between ages 25 and 64 and for each gender calculate the fraction of people in each education cell. For the same age group, we also construct $M(x, z)$, the distribution of married working couples, as shown in Table 2. Finally, given the fractions of individuals, $\Phi(x)$ and $\Omega(z)$, and the fractions of married working households, $M(x, z)$ in the data, we calculate the implied fractions of single working households, $\omega(z)$ and $\phi(x)$, reported in Table 3. This table also shows $\omega(z)$ and $\phi(x)$ that we construct from 2000 data. The mismatch between implied and actual values of $\omega(z)$ and $\phi(x)$ are really small, suggesting that stationary population structure is not an unrealistic assumption.

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[3]We find the mean hourly wages as $\frac{\text{annual wage and salary income}}{(\text{usual hours worked})(\text{number of weeks worked})}$.

We set the divorce probability in order to match the divorce rates for married individuals for this age group. We estimate this probability as the divorce rate for married households aged between 25 and 64. Using data from the National Center for Health Statistics, we calculate that this rate was 2.1% in the 2000. Thus, we set $\lambda = 0.021$.

Technology　We specify the production function as Cobb-Douglas with capital share equal to 0.317. In the absence of population growth and growth in labor efficiency, we set the depreciation rate equal to 0.07. These values are consistent with a notion of capital that excludes residential capital, consumer durables and government owned capital for the period 1960-2000. The corresponding notion of output is then GDP accounted for by the business sector. Altogether, this implies a capital to output ratio of about 2.325.[4]

Taxation　To construct income tax functions for married and single individuals, we estimate *effective taxes* paid by married and single households as a function of their reported income. We use tabulated data from the Internal Revenue Service Data by income brackets.[5] For each income bracket, total income taxes paid, total income earned, number of taxable returns and number of returns data are publicly available. Using these we find the mean income and the average tax rate corresponding to every income bracket. We find the average tax rates as

$$average\ tax\ rate = \frac{\left\{\frac{total\ amount\ of\ income\ tax\ paid}{number\ of\ taxable\ returns}\right\}}{\left\{\frac{total\ adjusted\ gross\ income}{number\ of\ returns}\right\}}.$$

We follow Gouveia and Strauss (1994) and estimate the effective tax functions both for married and single households. In particular, we fit the following equation to the data,

$$average\ tax\ rate\ (income) = \eta_1 + \eta_2 \log(income) + \varepsilon,$$

where *average tax (income)* is the average tax rate that applies when income equals *income*. We normalize income with mean household income in 2000 to find *income*. Table 4 shows the estimates of the coefficients for married and single households.

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[4]See Guner, Ventura and Yi (2005) for details.

[5]Source: Internal Revenue Service (2000), Statistic of Income Division, Individual Income Tax Returns Bulletin (Publication 1304). See Kaygusuz (2006a) for further details.

Given these estimates, we specify the tax functions in the benchmark model as

$$
\begin{aligned}
T^M(income) &= [0.1023 + 0.0733 \log(income)]income \\
T^S(income) &= [0.1547 + 0.0497 \log(income)]income.
\end{aligned}
$$

Figures 2 and 3 display estimated average and marginal tax rates for different multiples of household income. Our estimates imply that a single person with twice mean household income in 2000 faces an average tax rate of about 18.9% and a marginal tax rate equal to about 23.9%. The corresponding rates for a married household with the same income are about 15.3% and 22.6%.

Finally, we need to assign a value for the (flat) capital income tax rate τ_k, which we use to proxy the corporate income tax. We estimate this tax rate as the one that reproduces the observed level of tax collections out of corporate income taxes after the major reforms of 1986. For the period 1987-2000, such tax collections averaged about 1.92% of GDP. Using the technology parameters we calibrate in conjunction with our notion of output (business GDP), we obtain $\tau_k = 0.124$. In the benchmark economy total taxes, income taxes on labor and capital and the additional tax on capital, amount to 13.1% of aggregate output.

Social Security We start by estimating the payroll tax from data. We calculate $\tau_p = 0.086$, as the average value of the social security contributions as a fraction of aggregate labor income for 1990-2000 period.[6]

Using Social Security Beneficiary Data, we calculate that during this same period a retired single woman obtained old-age benefits of about 0.77 of a single retired male, while a retired couple averaged benefits of about 1.5 times those of a retired single male. Thus, given the payroll tax rate, the value of the benefit for a single retired male, b_m^S, balances the budget for the social security system.

Preferences There are two utility functions parameters, the intertemporal elasticity of substitution (γ) and the parameter governing the disutility of market work (B). For our benchmark calculations, we set γ equal to 0.4, which is within the range of estimates in Domeij and Floden (2006), Table 5. Our choice is based upon estimates for married

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[6]The contributions considered are those from the Old Age, Survivors and DI programs. The Data comes from the Social Security Bulletin, Annual Statistical Supplement, 2005, Tables 4.A.3.

males that control for the bias emerging from borrowing constraints. Given γ, we select the parameter B to reproduce average market hours per worker observed in the data. These average hours per worker amounted to about 40.8% of available time in 2000.[7]

We assume that the utility cost parameter q is exponentially distributed with mean $1/\bar{q}(x, z)$. We choose $\bar{q}(x, z)$ so that the labor force participation of secondary earners in the benchmark economy is consistent with data. Both in the data and in the model, we label an individual as a secondary earner if his/her hourly wage is less than his/her partner. Using CPS, we calculate that the employment-population ratio of secondary earners is 73.75% for married individuals between ages 25 and 55.[8] Table 5 shows the distribution of secondary earner's labor force participation by productivities of husbands and wives for married households. Our strategy is select 25 values of $\bar{q}(x, z)$ to match 25 entries in Table 5 as closely as possible. Table 6 shows the labor force participation of secondary earners in the model economy.

Finally, we choose the remaining preference parameter, the discount factor β, so that the steady-state capital to output ratio matches the value in the data consistent with our choice of the technology parameters (2.325).

Table 7 summarizes our parameter choices. Table 8 shows the performance of the model in terms of the targets we impose for B and β, and the aggregate participation rate of secondary earners. The model has no problem in reproducing jointly these observations as the table demonstrates.

5 Tax Reforms

We now consider three hypothetical revenue-neutral reforms to the current U.S. tax structure: a proportional consumption tax reform, a proportional income tax reform and a progressive consumption tax reform. The first reform flattens the current income tax schedule and changes the tax base from income to consumption, effectively eliminating taxes on interest income. The second reform only flattens the tax schedule while keeping income as the tax

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[7]The numbers are for people between ages 25 and 55 and are based on data from the Consumer Population Survey. We find mean yearly hours worked by all males and females by multiplying usual hours worked in a week and number of weeks worked. Married males work 2294 hours per year, and married females work 1741 hours per year. We assume that each person has an available time of 5000 hours per year. Our target for hours corresponds to 2040 hours per-year.

[8]We consider all individuals who are *not* in armed forces

base. Finally, the third reform reintroduces progressivity into a proportional consumption tax system.

For each reform we study two cases. A *complete* reform replaces both federal income taxes and the additional proportional tax on capital income. A *partial* reform, on the other hand, only replaces federal income taxes and keeps the additional proportional capital income tax intact. These partial experiments are relevant since elimination of additional tax on capital, which is meant to capture corporate income taxes, might not easily be a part of a reform that aims to change the current structure of income taxation. Furthermore, this experiment highlights the separate role that this tax play on capital accumulation. In all reforms we keep the social security system unchanged. The results reported below are based on steady state comparisons of pre and post-reform economies.

A Proportional Consumption Tax   The first reform replaces current income taxes (partially or fully) with a proportional consumption tax. We select this new tax rate so that the amount of tax collections are the same in the new steady state as in the pre-reform economy. With a proportional consumption tax, all households face the same marginal tax rates. In addition, a consumption tax by construction eliminates the distortions on capital accumulation built into the income tax; when a complete reform is considered, all tax distortions on capital accumulation are removed.

Table 9 reports key findings from this exercise. In line with existing literature, the effects of a consumption tax on aggregates are dramatic. With a partial reform, aggregate output increases by about 10.5%. As a result, a flat consumption tax of 21.5% is all that is needed to generate revenue neutrality. The rise in output is fueled by significant rises in factor inputs, with the capital-to-output ratio and the wage rate increasing by about 14.2% and 6.4%, respectively, in the post-reform steady state. Total hours in turn increase by 4.2%. The aggregate effects of a complete reform are more pronounced since the elimination of additional 12.4% flat tax on capital provides further incentives for capital accumulation. Aggregate output increases in this case by 12.7%, the capital-to-output ratio by more than 19.5% and the wage rate by about 8.7%.

Our economy allows us to identify and quantify *differential* responses in labor supply to tax changes that takes place at the intensive margin for both males and females as well as at the extensive margin for secondary earners. In the benchmark economy tax structure

generates significant disincentives to work since marginal tax rates increase with incomes. In particular, secondary earners who decide to enter the labor force are taxed at their partner's current marginal tax rate. With the elimination of these disincentives, in conjunction with the partial or complete removal of capital income taxation, the change in labor supply of secondary earners is substantially larger than the aggregate change in hours. In the partial (full) reform case, the labor force participation of secondary earners increases by nearly 4.6% (5.9%), while hours along the intensive margin rise by nearly 2.9% (2.9%) for females and about 3% (2.8%) for males. Since the bulk of secondary earners are women, the total hours for married females, however, increase by more than 7.6%. This is more than *twice* the change in total male hours. These results are especially worth noting as the parameter governing intertemporal substitution of labor is the *same* for males and females. Summing up, there are substantial changes in hours of different groups of different magnitudes underlying the aggregate hour changes.

A Proportional Income Tax The second reform is similar to the first one but introduces a proportional income tax instead of a proportional consumption tax. The consequences of this reform could then be viewed as the consequences of simply flattening-out the current income tax schedule.

Results from this reform are reported in Table 10. The most important effect of this reform is the rise in overall labor supply, of magnitudes that are similar to the consumption tax case. This suggests that the main contribution to labor input comes from the flattening of tax schedule. In the partial reform case, labor force participation of secondary earners rise by 4.6%, a number very close to the effect with a proportional consumption tax. Hours per worker, both for males and females, increase by about 2.6%. As a result, total hours increase by about 3.9%. Again, the rise in total hours by married females is much more pronounced, in excess of 7.2%, as most of the secondary earner are females.

In relation to the case with a proportional consumption tax, the effects on capital accumulation are now less pronounced. This is expected: an income tax, differently from a consumption tax, still affects capital accumulation decisions. Consequently, the capital-to-output ratio increases by just 5% with the partial reform and by 10.1% with the complete reform. Overall, the effects on aggregate output are substantial, but smaller than under a proportional consumption tax. Under a partial (complete) reform, the change in output

amounts to about 6.0% (8.2%), whereas under proportional consumption taxes the effects amounted to about 10.5% (12.7%).

A Progressive Consumption Tax In our final exercise we consider a progressive consumption tax. The progressive consumption tax consists of an exemption level below which agents do not pay taxes and a proportional tax rate applied above this level. We set the exemption level as 1/3 of aggregate consumption in our benchmark economy for single households, and 1/2 of aggregate consumption in our benchmark economy for married ones.[9] We emphasize that these exemption levels are defined as multiples of consumption in the benchmark case; as a result, they do *not* vary when consumption changes (increases) as a result of the reform in question.

The results from a partial reform are reported in Table 11. Now a partial reform requires a marginal tax rate of 28.0%; the corresponding rate under a proportional consumption tax was 21.5%. A comparison between proportional and progressive consumption cases (Tables 9 and 11) is quite revealing. The effects on the capital stock are comparable under both reforms. This should not be surprising since most of capital is owned by households who are above the exemption levels and they are affected in a similar way in both reforms; both reforms eliminate the effects of income taxes on their asset accumulation decisions. The effect on aggregate output in the long run, however, is smaller. This is due to the smaller rise in labor input; total hours increase by 1.4% instead of 4.2%.

It is important to understand why the change in aggregate labor is smaller under a progressive consumption tax than under a proportional one. First, for households at the top of the skill distribution and therefore above the exemption threshold, the relevant marginal tax distorting labor choices is larger than under a proportional consumption tax. This high marginal tax rate, in conjunction with the implicit transfer associated to a progressive tax, results in a lower response from these households in terms of work hours. In turn, the effect on households at the top has an important effect on aggregate labor in efficiency units, as these households have a disproportionate contribution to this variable. Second, we also note that labor force participation of secondary earners increases *less* with a progressive consumption-tax reform. The key for this related finding is the structure of taxes we consider, which

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[9]In 2005, consumption per-person 25 years old and above was about $45,110. The value of exemption for a married couple is then approximately $22,555.

combines an exemption level *and* a common marginal tax rate above it. The interplay of these features discourages changes in labor force participation in married households with relatively less skilled members. It turns out that these households were the ones that respond the most under proportional tax reforms; see below.

6   The Role of Married Females and the Extensive Margin

We now discuss in some detail the changes in labor supply of secondary earners, a group largely comprised by married females. What is the overall contribution of married females to changes in labor supply? To answer this question, we use the model to quantify the relative importance of changes in labor supply of this group, both that the intensive and extensive margin, in accounting for the changes in labor supply.

In answering the question, we first note that the type of the tax reform under consideration is critical. Although the aggregate effects on labor supply are smaller under progressive consumption tax relative to a proportional one, the rise in married females's labor supply becomes a much more important component of the overall rise in labor supply (i.e. labor in efficiency units). Table 12 makes this point clear. In this table we report the contribution of married female to changes in total hours, and total labor supply. In each reform, except with progressive consumption tax, the contribution of married females to changes in total hours is around 51-52%. However, the contribution of married females to total hours is much higher under the progressive consumption tax, about 65%. This occurs as changes in labor supply for other groups are of smaller magnitude under a progressive consumption tax. The contributions of married females to total labor supply follow a similar pattern, but the magnitudes are smaller. This occurs since females on average are less skilled than men, and as the rise in female labor supply is concentrated among low skilled ones, an issue that we elaborate below. The results in Table 12 indicate married females account for about 44-45% of the changes in labor supply under flat rate taxes, and about 54% of the changes under a progressive consumption tax. We conclude that the overall contribution of married females is substantial; they contribute disproportionately to changes in labor supply given their share of the working age population (37.5%).

The rise in married female labor supply is a combination of movements along the extensive

and intensive margins. In the bottom panel of Table 12, we focus on the role of extensive margin and report its contribution to the rise in total hours and total labor supply. Across different experiments, the extensive margin contributes to about 30% to 33% of the changes in total hours and to 23% to 30% of the changes in total labor supply. This suggest that more than half of the overall rise in married females labor supply comes from the movements in the extensive margin.

A central finding emerging from our exercises is that the increase in labor force participation of secondary earners becomes larger as we move towards the bottom of the distribution of skills. Table 13 illustrates this point. In the table, households are arranged according to the skill type of the female member (from high school education or less to post-college education), and the resulting change in the labor force participation of the secondary earner is displayed. Under a proportional consumption tax reform for instance, the percentage increase in labor force participation *decreases* monotonically from about 8.8% to about 2.1%. Similar results hold for proportional income tax reform. Thus, the bulk of the changes along the extensive margin take place in households with relatively less skilled members.

The results with a progressive consumption tax are somehow different. In this case, the labor force participation of the lowest skill types is lower. The behavior of secondary earners is affected significantly here, as higher labor force participation can move these households above the exemption threshold. This generates disincentive for the labor force participation of secondary earners. Once we move to households with a female member who has more than high school education, the pattern is similar to what we observe with proportional income or consumption taxes.

Overall, our results suggest that effects of tax reforms can depend critically on *who* increases labor supply. The results also suggest that the wage structure (gender gap and skill premia), the skill distribution as well as marital sorting (who is married with whom) can play important roles, since they affect households' labor supply along both intensive and extensive margins. The next section illustrates these points in a systematic way.

7   The Role of New Features

In this section, we attempt to further isolate the quantitative contribution of the non-standard aspects in the current environment for the effects of tax reforms. In order to

do this, we conduct tax reform exercises in economies that are parameterized to observations pertaining to gender productivity differences, labor force participation levels and a demographic structure that are different from the U.S. in 2000.

We focus on a (partial) progressive consumption tax, and analyze how (i) labor force participation of secondary earners, (ii) the wage structure, and (iii) the skill and marital distribution of agents in pre-reform economy affect reform outcomes. For these purposes, we parameterize our benchmark economy to the U.S. economy in 1960, an economy that differed substantially from the 2000 case in terms of the features we focus on. Our exercises then shed light on the differential effects of a hypothetical tax reform in the U.S. in the past. These exercises also illustrate and quantify the potential effects of tax reforms for economies that are different from the today's U.S. economy in terms of labor force participation of secondary earners, wage structure and marital sorting.

Table 14 shows the labor force participation of secondary earners in 1960. As expected, they are much lower than the 2000 values reported in Table 5. The average labor force participation of secondary earners was 43.4% in 1960 while it was around 74.7% in 2000. For households with females with college education and above, only 52.5% and 70.6% participated in 1960; in 2000, the corresponding participation rates were respectively 79.5% and 83.9%. Table 15 the shows productivity levels in 1960. In 1960 wages were much more compressed across education categories. The skill premium, defined as wages ratio of college to high school graduates, was only about 1.5 in 1960 while it is around 2 in 2000. The gender gap was also higher (except the highest skill level which is most probably due to small sample size we have). Finally, the fraction of the working population married was much higher: 89.3% in 1960 vs. 74.0% in 2000. In terms of the composition of the marriage pool, Table 16 shows the distribution of married agents across skill types. Note that there relatively more low-skilled agents in 1960. Indeed, almost 70% of all households were composed of partners who either had less than high school education, or only a high school degree.

We proceed as follows. We unbundle our 2000 benchmark economy piece-by-piece so that it looks more and more like the U.S. economy in 1960. We first set labor force participation of secondary earners to their 1960 values. We keep all other exogenous variables (e.g. taxes, distribution of agents across skill types etc.) intact, and recalibrate the benchmark economy to match labor force participation of secondary earners in 1960. We label this *Case I*. Second, we change both the labor force participation of secondary earners and productivity levels

to their 1960 values and recalibrate our economy again. This is *Case II*. Finally, on top of previous changes we introduce the skill distribution and the structure of marital sorting from 1960 and then recalibrate our benchmark economy. This is *Case III*, the 1960 economy.[10] For each of these three cases, we replace existing income taxes with a progressive consumption tax.

Table 17 shows the effects of a progressive consumption tax reform for these three cases and compares its effects with those on 2000 benchmark. When we only introduce 1960 labor force participation of secondary earner values, a partial progressive consumption tax reform has larger effects on the labor force participation of secondary earners than it did for 2000 economy. With such a reform, the labor force participation of secondary earners increase by about 2.3% in Case *I*, while the increase was about 1.9% for 2000 economy. Note that the only difference between 2000 economy and Case *I* is the initial level of labor force participation of secondary earners, which is much lower for Case *I* economy. Therefore, there is more room for secondary earners to increase their labor force participation; in particular, without hitting the tax exemption threshold. This can be seen clearly in Table 18 which reports the changes in the labor force participation of secondary earners. In 2000 economy, the labor force participation of secondary earners declines for the lowest education type, while it increases in Case *I*. Indeed, the rise in labor force participation is higher for each category in Table 18. Note, however, that although the rise in female labor force participation is higher now than in the 2000 economy, the rise in aggregate hours is quite comparable as the increase in female labor force participation is concentrated among low-skill females. As a result, output now grows by 7.9%, only slightly higher than 7.3%.

When we introduce 1960 wages as well, the effects are even larger for the labor force participation of secondary earners; it now increase by 4.9% instead of 2.3% as in Case *I*. With 1960 wages, the gender gap is larger across the board. A larger gender gap increases the incentives for females to enter the labor force as secondary earners, again possibly without hitting the tax exemption threshold. With 1960 wages, however, the wage distribution is much more concentrated. Therefore, the potential impact of eliminating progressive taxation on capital income is lower, which translates into a rise in the aggregate capital stock that is smaller than in the 2000 economy and Case *I*. Therefore, while the labor input increases

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[10]The new parameter values are $B = 23.5$ and $\beta = 0.974$ for Case I, $B = 23.5$ and $\beta = 0.9745$ for Case II, and $B = 25$ and $\beta = 0.9735$ for Case III.

more in Case *II*, aggregate output increases less than it did in Case *I*.

The effects are largest in Case *III*. In this case we move to skill and marital distributions pertaining to 1960 as well, effectively replicating the 1960 economy completely.[11] Recall from our previous discussion that substantially more people were married in 1960. Due to these larger share of married households, the number of households that can benefit from the elimination of high tax rates on capital income are now larger than in the previous case. This contributes towards a larger increase in the capital stock relative to Case *II* economy. Overall, our results imply an 8.3% increase in aggregate output for the economy in 1960, relative to a 7.3% for 2000 economy.

We conclude from these exercises that the explicit consideration of the novel features in the analysis is of quantitative importance. Our findings demonstrate that the output gains from the *same* tax reform would be non-trivially larger in an economy with the characteristics of the U.S. in 1960. The implications for potential reforms across countries are clear: output gains from tax reforms applied to economies with lower levels of female labor force participation and a larger gender gap are potentially larger than for the current U.S. economy.

8   Concluding Remarks

In this paper we study the aggregate effects tax reforms for the US economy, taking seriously into account the labor supply decisions of secondary earners and the underlying structure of household heterogeneity. For these purposes, and differently from the existing literature, our model economy consists of one and two-earner households, and two-earner households face explicit labor supply decisions along both intensive and extensive margins.

We find that tax changes can lead to large effects across steady states on aggregate variables. We quantify the relative importance of changes in the labor supply of different groups, and find that secondary earners play an important role in these changes. We find that when current taxes are replaced by proportional taxes, married females account for about 51-52% of the total increase in labor hours, and about 44-45% of the aggregate increase in labor in efficiency units. When current taxes are replaced by progressive consumption taxes,

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[11]Note that given our procedure to calculate marriage formation rates, when we change the underlying skill distribution and marital sorting, i.e. when we change $\Omega(z)$, $\Phi(x)$, and $M(x,z)$, the economy is characterized by new matching rates.

married females contribute even more to changes in hours and labor supply (65% and 54%). About half of the fraction of changes accounted for by secondary earners can be attributed to movements along the extensive margins.

Our findings suggest that the structure of pre-reform economy plays an important role. Economies that differ in terms of the labor force participation of secondary earners, wages, and marital composition react differently to the reforms we consider.

8.1   Appendix: Definition of Equilibrium

For a given government consumption level G, social security tax benefits b^M, b_f^S and b_m^S, tax functions $T^S(.)$, $T^M(.)$, a payroll tax rate τ_p, a capital tax rate τ_k, and an exogenous demographic structure represented by $\Omega(z)$, $\Phi(x)$, $M(x,z)$ and implied matching rates $\theta_f(x,z)$, $\theta_m(x,z)$, a *stationary equilibrium* consists of factor prices r and w, aggregate capital (K) and labor (L) inputs, decision rules for labor supply and asset holdings of married and single households $l_f^M(x,z,a,q)$, $l_m^M(x,z,a,q)$, $l_m^S(z,a)$, $l_f^S(x,a)$, $a^M(x,z,a,q)$, $a_m^S(z,a)$, $a_f^S(x,a)$, $a^{M,r}(a)$, $a_m^{S,r}(a)$, and $a_f^{S,r}(a)$ and measures $\psi^M(x,z,a,q)$, $\psi_f^S(x,a)$, $\psi_m^S(x,a)$, $\psi^{M,r}(a)$, $\psi_f^{S,r}(a)$ and $\psi_m^{S,r}(a)$ such that

1. Given tax rules, the demographic structure, and factor prices w and r, the decision rules of households solve the corresponding dynamic problems.

2. Factor prices are determined by the profit maximization problem of the representative firm; i.e.,

$$w = F_2(K,L),$$

and

$$r = F_1(K,L) - \delta_k.$$

3. Factor markets clear; i.e.,

$$
\begin{aligned}
K &= \sum_{x,\,z,\,q} \int_A a^M(x,z,a,q)\psi^M(x,z,a,q)da \\
&+ \sum_z \int_A a_m^S(z,a)\psi_m^S(z,a)da + \sum_x \int_A a_m^S(z,a)\psi_f^S(x,a)da \\
&+ \int_A a^{M,r}(a)\psi^{M,r}(a)da + \int_A a_m^{S,r}(a)\psi_m^{S,r}(a)da \\
&+ \int_A a_f^{S,r}(a)\psi_f^{S,r}(a)da,
\end{aligned}
$$

and

$$L = \sum_{x,\,z,\,q} \int_A (x l_f^M(x,z,a,q) + z l_m^M(a,x,z,q)) \psi^M(x,z,a,q) da +$$
$$\sum_z \int_A z l_m^S(z,a) \psi_m^S(z,a) da + \sum_x \int_A x l_f^S(x,a) \psi_f^S(x,a) da.$$

4. The measures $\psi^M(x,z,a,q)$, $\psi_f^S(x,a)$, $\psi_m^S(x,a)$, $\psi^{M,r}(a)$, $\psi_f^{S,r}(a)$ and $\psi_m^{S,r}(a)$ are consistent with individual decisions.

Married working agents: for any $a' \in A$

$$\psi^M(x,z,a',q) = (1-\rho)(1-\lambda) \int_{\mathcal{A}} \psi^M(x,z,a,q) da$$
$$+ (1-\rho)\zeta(q|x,z) \int_{\mathcal{B}} \theta_m(x,z) \varphi_f(a_2|x) \psi_m^S(a_1,z) da_2 da_1,$$

where $\mathcal{A} = \{a : a^M(x,z,a,q) = a'\}$, and $\mathcal{B} = \{a_1, a_2 : a_m^S(z,a_1) + a_f^S(x,a_2) = a'\}$

Single working agents: if $a' \neq 0$,

$$\psi_f^S(x,a') = (1-\rho)\lambda \sum_{q,\,z} \int_{\mathcal{C}} \psi^M(x,z,a,q) da + (1-\rho)(1-\pi_f(x)) \int_{\mathcal{D}} \psi_f^S(x,a) da,$$

and

$$\psi_m^S(z,a') = (1-\rho)\lambda \sum_{q,\,x} \int_{\mathcal{C}} \psi^M(x,z,a,q) da + (1-\rho)(1-\pi_m(z)) \int_{\mathcal{E}} \psi_m^S(z,a) da,$$

Single working agents: if $a' = 0$,

$$\psi_f^S(x,0) = (1-\rho)\lambda \sum_{q,\,z} \int_{\mathcal{C}} \psi^M(x,z,a,q) da$$
$$+ (1-\rho)(1-\pi_f(x)) \int_{\mathcal{D}} \psi_f^S(x,a) da + \delta(\phi^r(x) + M^r(x,z))$$

and

34

$$\psi_m^S(z,0) = (1-\rho)\lambda \sum_{q,\,x} \int_{\mathcal{C}} \psi^M(x,z,a,q)da$$

$$+(1-\rho)(1-\pi_m(z))\int_{\mathcal{E}} \psi_m^S(z,a)da + \delta(\omega^r(z) + M^r(x,z)),$$

where $\mathcal{C} = \{a : a' = \frac{g^M(x,z,a,q)}{2}\}$, $\mathcal{D} = \{a : a' = a_f^S(x,a)\}$ and $\mathcal{E} = \{a : a' = a_m^S(z,a)\}$.

Married retired agents: for any $a' \in A$

$$\psi^{M,r}(a') = (1-\delta)\int_{\mathcal{F}} \psi^{M,r}(a)da + \rho \sum_{x,z,q} \int_{\mathcal{A}} \psi^M(x,z,a,q)da,$$

where $\mathcal{F} = \{a : a^{M,r}(a) = a'\}$ and $\mathcal{A} = \{a : a^M(x,z,a,q) = a'\}$.

Single retired agents:

$$\psi_f^{S,r}(a') = (1-\delta)\int_{\mathcal{G}} \psi_f^{S,r}(a)da + \rho \sum_{x} \int_{\mathcal{D}} \psi_f^S(x,a)da,$$

and

$$\psi_m^{S,r}(a') = (1-\delta)\int_{\mathcal{I}} \psi_m^{S,r}(a)da + \rho \sum_{z} \int_{\mathcal{E}} \psi_m^S(z,a)da,$$

where $\mathcal{G} = \{a : a_f^{S,r}(a) = a'\}$, $\mathcal{I} = \{a : a_m^{S,r}(a) = a'\}$, $\mathcal{D} = \{a : a' = a_f^S(x,a)\}$ and $\mathcal{E} = \{a : a' = a_m^S(z,a)\}$.

5. The Government Budget and Social Security Budgets are Balanced; i.e.,

$$G = \sum_{x,z,q} \int_A T^M(.)\psi^M(x,z,a,q)da + \sum_{z} \int_A T^S(.)\psi_m^S(z,a)da$$

$$+ \sum_{x} \int_A T^S(.)\psi_f^S(x,a)da + \tau_k K,$$

$$\int_A b^M \psi^{M,r}(a)da + \int_A b_f^S \psi_f^{S,r}(a)da + \int_A b_m^S \psi_m^{S,r}(a)da$$
$$= \tau_p(wL)$$

Remarks A few comments are in order regarding the definition of equilibria. Note that the law of motion for the measure of married working agents, $\psi^M(.)$ reflects the fact that upon forming a married household, individuals combine their assets. In similar fashion, the laws of motion for the measures of single working individuals, $\psi_i^S(.)$, $i = m, f$, reflect the assumption made previously that upon dissolving a married household, assets are divided equally between spouses. Finally, in the case of singles, note that when next period assets are zero, we include the terms $\delta(\phi^r(x) + M^r(x, z))$ and $\delta(\omega^r(z) + M^r(x, z))$. These terms amount to the number of retired males and females who die per period. Thus, the addition reflects the assumption that when single or married retired individuals die, they are replaced by identical *single* agents with zero assets.

Table 1: Productivity Levels, by Type, by Gender

	Males (z)	Females (x)	x/z
<hs	0.709	0.505	0.712
hs	0.920	0.669	0.727
sc	1.113	0.799	0.718
col	1.447	1.052	0.727
>col	1.809	1.326	0.733

Note: Entries are the productivity levels of males and females, using 2000 data from the Consumer Population Survey. These levels are constructed as hourly wages for each type, ages 25-64 –see text for details.

Table 2: Distribution of Married Working Households by Type, %

	Female				
Male	<hs	hs	sc	col	>col
<hs	6.76	4.24	2.32	0.39	0.17
hs	3.15	13.49	7.29	1.83	0.68
sc	1.75	7.44	13.51	4.32	1.56
col	0.39	2.36	5.76	7.58	2.61
>col	0.17	0.90	2.63	4.42	4.27

Note: Entries show the fractions of the total married pool, by wife and husband educational categories. The data used is from the U.S. 2000 Census –see text for details.

Table 3: Fraction of Agents By Type, By Gender, and Marital Status

	Males				Females			
	All	Married	Singles	Singles (data)	All	Married	Singles	Singles (data)
<hs	0.1439	0.1028	0.0411	0.0386	0.1360	0.0904	0.0456	0.0403
hs	0.2659	0.1958	0.0701	0.0703	0.2793	0.2105	0.0688	0.0679
sc	0.2891	0.2115	0.0776	0.0773	0.3159	0.2331	0.0828	0.0848
col	0.1858	0.1384	0.0474	0.0488	0.1760	0.1373	0.0387	0.0423
>col	0.1153	0.0915	0.0238	0.0250	0.0928	0.0687	0.0241	0.0247
Total:	1.0000	0.74	0.26	0.26	1.0000	0.74	0.26	0.26

Note: Entries show the fraction of individuals in each educational category, by marital status, constructed under the assumption of a stationary population structure –see text for details. The last column in each panel shows the corresponding values in U.S. 2000 Census data.

Table 4: Tax Parameters

	$\widehat{\eta}_1$	$\widehat{\eta}_2$
Married	0.1023	0.0733
R^2		0.99
Single	0.1547	0.0497
R^2		0.93

Note: Entries show the parameter estimates for the postulated tax function. These result from regressing effective average tax rates against household income, using 2000 data from the U.S. Internal Revenue Service – see text for details.

Table 5: Labor Force Participation of Secondary Earners, Data, %

Male	Female <hs	hs	sc	col	>col	Total
<hs	51.82	65.17	70.08	82.46	71.43	59.14
hs	55.61	73.55	79.78	87.61	89.17	75.18
sc	53.53	72.09	77.35	85.03	86.41	76.59
col	57.69	67.67	69.07	78.63	85.81	75.19
>col	60.00	68.12	73.35	72.22	81.07	75.30
Total	53.29	71.60	75.78	79.78	83.83	73.75

Note: Each entry shows the labor force participation of secondary earners, calculated from 2000 data from the Consumer Population Survey –see text for details. The outer rows show the weighted average for a fixed male or female type.

Table 6: Labor Force Participation of Secondary Earners, Model, %

Male	Female <hs	hs	sc	col	>col	Total
<hs	51.40	65.50	69.03	82.78	71.84	59.82
hs	55.35	72.85	79.15	86.96	89.07	73.87
sc	53.95	71.70	77.87	85.38	87.13	76.43
col	56.05	66.86	67.88	78.61	85.48	74.30
>col	59.93	68.11	73.21	71.99	81.55	75.10
Total	53.06	70.80	75.30	79.53	83.95	72.87

Note: Each entry shows the labor force participation of secondary earners, calculated within the model.

Table 7: Parameter Values

Parameter	Value	Comments
Discount Factor (β)	0.973	Calibrated - matches K/Y
Intertemporal Elasticity (Labor Supply) (γ)	0.4	Literature estimates.
Disutility of Market Work (B)	6	Calibrated - matches hours per worker
Capital Share (α)	0.317	Calibrated - see text.
Depreciation Rate (δ_k)	0.07	Calibrated - see text.
Probability of Retirement	1/40	Calibrated - implies average working life of 40 years
Mortality rate (δ)	0.0982	Calibrated - implies fraction of retired people in data.
Divorce Rate (λ)	0.021	Calibrated - matches divorce rate
Payroll Tax Rate (τ_p)	0.086	Calibrated - balances budget
Capital Income Tax Rate (τ_k)	0.124	Calibrated - Matches corporate tax collections
Distribution of utility costs $\zeta(.|x,z)$	–	Exponential distribution with mean $\bar{q}(x,z)$ –matches labor force participation by household type.

Table 8: Model and Data

Statistic	Data	Model
Capital Output Ratio	2.325	2.321
Labor Hours Per-Worker	0.408	0.408
Participation rate of Secondary Earners (%)	73.75	72.87

Note: Entries summarizes the performance of the benchmark model in terms of the stated targets.

Table 9: Proportional Consumption Tax (% change)

	Partial Reform	Complete Reform
Participation of Secondary Earner	4.57	5.93
Total Hours	4.23	4.04
Total Hours (Married Females)	7.62	7.09
Hours per worker (female)	2.87	2.87
Hours per worker (male)	3.04	2.80
Capital/Output	14.17	19.52
Aggregate output	10.54	12.72
Wage rate	6.35	8.70
Flat tax rate (%)	21.5	24.7

NOTE: The results for a "complete reform" pertain to the revenue-neutral replacement of both income and capital income taxes by a proportional consumption tax. The results for a "partial reform" pertain to the revenue-neutral replacement of only the income tax system by a proportional consumption tax.

Table 10: Proportional Income Tax (% change)

	Partial Reform	Complete Reform
Participation of Secondary Earner	4.56	6.14
Total Hours	3.90	3.80
Total Hours (Married Females)	7.23	6.99
Hours per worker (female)	2.61	2.61
Hours per worker (male)	2.57	2.57
Capital/Output	5.08	10.08
Aggregate output	6.00	8.18
Wage rate	2.39	4.55
Flat tax rate (%)	12.74	14.5

NOTE: The results for a "complete reform" pertain to the revenue-neutral replacement of both income and capital income taxes by a proportional income tax. The results for a "partial reform" pertain to the revenue-neutral replacement of only the income tax system by a proportional income tax.

Table 11: Progressive Consumption Tax (% change)

	Partial Reform
Participation of Secondary Earner	1.88
Total Hours	1.39
Total Hours (Married Females)	3.21
Hours per worker (female)	0.78
Hours per worker (male)	1.17
Capital/Output	12.80
Aggregate output	7.31
Wage rate	5.82
Flat tax rate (%)	28.00

NOTE: The results for a "partial reform" pertain to the revenue-neutral replacement of only the income tax system by a progressive consumption tax. The latter consists of an exemption level and a common tax rate applied above this level. The exemption levels correspond to 1/3 aggregate consumption for single individuals, and 1/2 mean consumption for married households in the benchmark economy.

Table 12: Contribution of Married Female Hours to Changes in Labor Supply (%)

	Prop. Consumption (Partial)	Prop. Income (Partial)	Prog. Consumption (Partial)
Panel A: Total Changes			
Δ in Married Female Hours (relative to Δ in Total Hours)	51.0	52.5	65.2
Δ in Married Female Labor (relative to Δ in Total Labor)	45.2	43.9	54.1
Panel B: Extensive Margin			
Δ in Married Female Hours (relative to Δ in Total Labor)	30.0	33.0	27.9
Δ in Married Female Labor (relative to Δ in Total Labor)	23.3	25.5	30.0

NOTE: The entries show the contribution of changes in the labor supply of married females relative to total changes in labor supply, both in terms of raw hours changes as well as in terms of labor in efficiency units. The top panel shows the contribution of total changes. The bottom panel shows only the contribution of changes along the extensive margin.

Table 13: Percentage Change in LFP of Secondary Earners (by female type)

Female Type	Prop. Con. (Partial)	Prop. Inc. (Partial)	Prog. Con. (Partial)
<hs	8.84	5.97	-2.55
hs	4.32	5.11	2.83
sc	4.95	5.03	2.06
col	3.66	3.40	2.60
>col	2.08	2.78	1.22

Table 14: Labor Force Participation of Secondary Earners in 1960, Data, (%)

	Female					
Male	<hs	hs	sc	col	>col	Total
<hs	40.15	46.23	55.50	74.51	82.35	42.58
hs	40.21	44.09	53.46	61.43	72.73	44.63
sc	39.66	43.04	46.67	49.41	60.00	44.10
col	25.00	29.92	32.12	45.78	77.42	35.72
>col	35.00	31.54	42.61	50.00	68.09	44.70
Total	39.97	43.18	46.60	52.47	70.65	43.39

Table 15: Productivity Levels, by Type, by Gender in 1960

	Males (z)	Females (x)	x/z
<hs	0.990	0.582	0.587
hs	1.120	0.743	0.663
sc	1.235	0.811	0.657
col	1.551	0.969	0.624
>col	1.489	1.418	0.953

Table 16: Distribution of Married Working Households by Type in 1960, (%)

Male	Female				
	<hs	hs	sc	col	>col
<hs	40.34	12.82	2.2.6	0.49	0.15
hs	6.97	13.46	2.40	0.67	0.18
sc	1.85	4.27	2.35	0.70	0.19
col	0.51	2.18	1.61	1.42	0.23
>col	0.3	1.31	1.40	1.26	0.70

Table 17: Progressive Consumption Tax Reform in Different Economies (% change)

	2000. Economy	Case I	Case II	Case III
Aggregate Output	7.31	7.89	7.47	8.30
Participation of Secondary Earner	1.88	2.25	4.94	3.56
Aggregate Hours	1.39	0.91	2.00	1.45
Aggregate Hours (Married Females)	3.21	3.08	6.53	5.02
Capital/Output	12.80	15.19	12.11	14.67

NOTE: Case I refers to an economy with 1960 labor force participation of secondary earners. Case II refers to Case I economy with 1960 wages. Case III refers to Case II economy with 1960 skill distribution and marital sorting. In each case, we keep all other exogenous features as our benchmark economy and recalibrate the parameters to match newly introduced exogenous features.

Table 18: Percentage Change in LFP of Secondary Earners in Different Economies, by type of female

Female Type	2000. Economy	Case I	Case II	Case III
<hs	-2.55	1.60	4.77	3.22
hs	2.83	2.74	3.98	3.72
sc	2.06	1.77	6.44	4.03
col	2.60	2.88	4.26	4.63
>col	1.22	2.01	4.52	3.16

NOTE: Case I refers to an economy with 1960 labor force participation of secondary earners. Case II refers to Case I economy with 1960 wages. Case III refers to Case II economy with 1960 skill distribution and marital sorting. In each case, we keep all other exogenous features as our benchmark economy and recalibrate the parameters to match newly introduced exogenous features.

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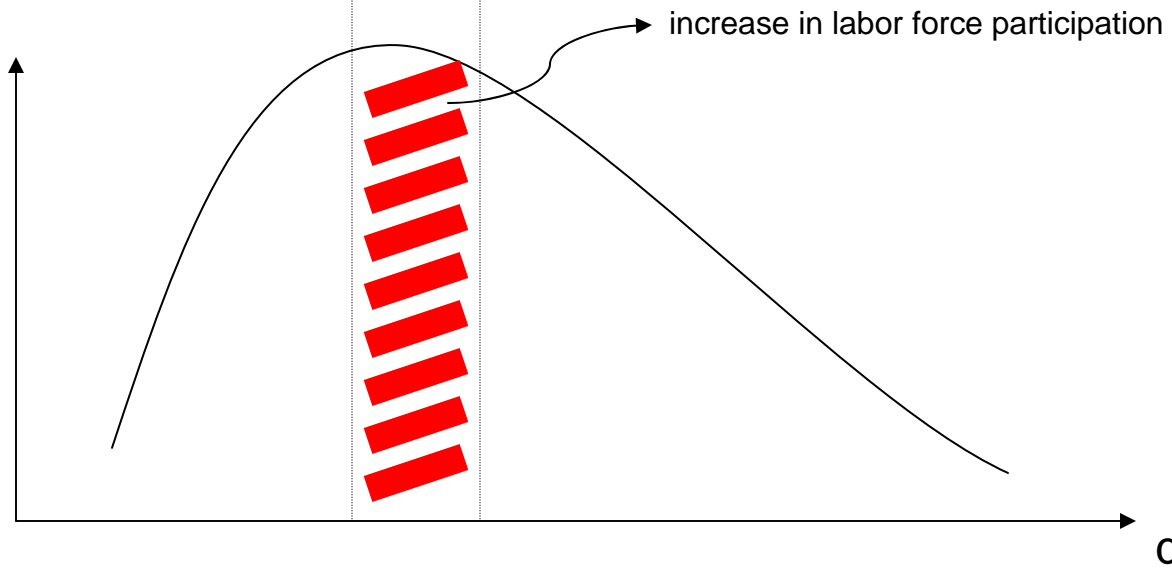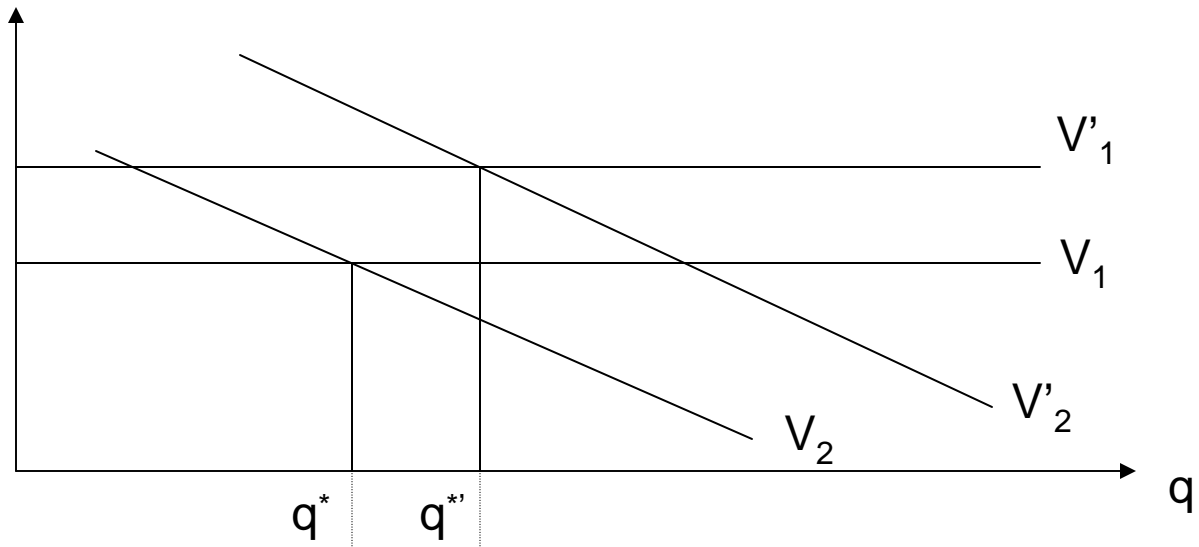# Figure 1: Taxes and Labor Force Participation of Secondary Earners

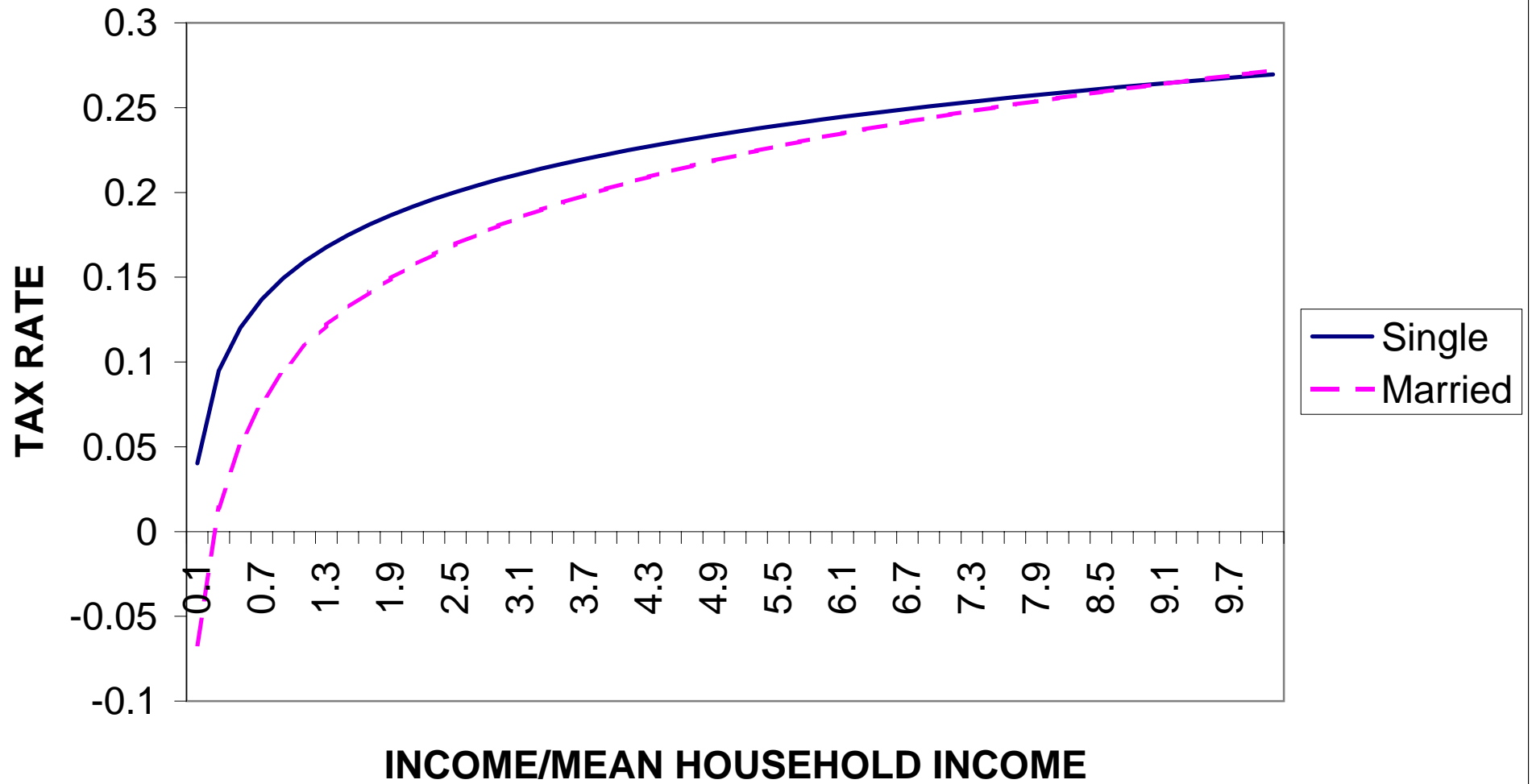**Figure 2: AVERAGE TAX RATES**

TAX RATE

INCOME/MEAN HOUSEHOLD INCOME

Single
Married

Figure 3: MARGINAL TAX FUNCTIONS

Y-axis: MRG. TAX RATE

X-axis: INCOME/MEAN HOUSEHOLD INCOME

Legend: Single, Married