Taxation and Household Labor Supply

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Abstract

We evaluate reforms to the U.S. tax system in a life-cycle 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 of married females across skill groups, children, and the structure of marital sorting. We concentrate on two revenue-neutral tax reforms: a proportional income tax and a reform in which married individuals file taxes separately (*separate filing*). Our findings indicate that tax reforms are accompanied by large increases in labor supply that differ across demographic groups, with the bulk of the increase coming from married females. Under a proportional income tax reform, married females account for more than 50% of the changes in hours across steady states, while under separate filing reform, married females account for all the change in hours.

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1 Introduction

Tax reforms have been at the center of numerous debates among academic economists and policy makers. 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, current households are neither a collection of bread-winner husbands and house-maker wives, nor a collection of single people. In 2000, the labor force participation of married women between ages 25 and 54 was about 69%. Furthermore, their participation rate increases markedly by educational attainment, and is known to respond strongly to hourly wages. Moreover, the economic environment that these households face does not feature wages that are gender-neutral. Hourly earnings of females relative to males, the gender-gap, is of about 72% nowadays and has been around this value for some time.[2]

These observations have long been deemed important in discussions of tax reforms, but are largely unexplored in dynamic equilibrium analyses in the macroeconomic and public-finance literatures. We fill this void in this paper. We quantify the effects of tax reforms taking carefully into account the labor supply of married females as well as the current demographic structure. 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 that is consistent with the current U.S. demographics.

We consider a life-cycle economy populated with males and females who differ in their labor market productivities. Individuals start economic life as either *married* or *single* and do not change their marital status as they age. Married couples and single females have children that appear exogenously along their life-cycle; they can be childless or have these children early or late in their life-cycle. Singles decide how much to work and how much to save out of their total after-tax income. Married households decide on the labor hours of each household member, and like singles, how much to save. A novel feature in our analysis is the explicit modeling of the participation decision of married females in two-earner households and its interplay with the structure of heterogeneity and taxation. In the model, female labor-force participation is not a trivial decision for a household. First, children are associated to fixed time costs. Furthermore, if a female with a child decides to work, the household incurs

[1] See Auerbach and Hassett (2005) for a review.

[2] Our calculations. See Section 4 for details.

child care expenses. Second, her labor market productivity depreciates if she chooses not to participate. Finally, if a married female enters the labor force, the household faces a utility cost. This cost allows us to capture residual heterogeneity in labor force participation. It represents heterogeneity in the additional difficulty of coordinating multiple household activities, taste for children and home production or any other utility cost that might arise when two adults work instead of one. As a result, females in married households may choose *not* to work at all. This is a key feature of our analysis since the structure of taxation can affect the participation decision of married females, and available evidence suggests that it does so significantly.

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, which results in high tax rates on secondary earners. 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 as well as the presence of children in a two-earner household affect joint labor supply decisions as well as the reactions to changes in the tax structure. 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. Tax reforms in the 1980's have been shown to affect female labor supply behavior significantly, but have relatively small effects on males (Bosworth and Burtless (1992), Triest (1990), and Eissa (1995)).[3] 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*, not individuals, react to taxes much more than previously thought, the potential effects of tax reforms can be more significant.

We use our framework to conduct a set of hypothetical tax reform experiments, and then ask: What is the importance of the labor supply responses of married females in these experiments? What is the importance of micro labor supply elasticities for the long-run effects on output and the labor input?

We concentrate on two revenue-neutral tax reforms. The first one eliminates all progressivity via a *proportional* income tax. This is a prototypical reform, which allows us to highlight and quantify the forces at work within the model. In our second reform, *separate*

[3] More recently, Eissa and Hoynes (2006) 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).

filing, we keep the progressivity and the tax base of the current system, but married individuals file their taxes separately. This reform, which arises naturally in our environment, shifts the unit of taxation from households to *individuals*. As a result, it can drastically change marginal tax rates within married households, while effectively eliminating tax penalties (and bonuses) associated to marital status built into the current tax code.

A central finding of our exercises is that the differential labor supply behavior of different groups is key for an understanding of the aggregate effects of tax reforms. The related finding is that married females account for a disproportionate fraction of the changes in hours and labor supply. Furthermore, the relative importance of the labor supply responses of married females increases sharply for *low* values of the intertemporal elasticity of labor supply.

Replacing current income taxes by a proportional tax increases aggregate output by about 7.2% across steady states. This increase is accompanied by differential effects on labor supply: while hours per worker increase by about 3.5%, the labor force participation of married females increases by about 4.8% and married females increase their total hours by 9%, with a significant response in participation rates of married females with children. The labor force participation of married females with young, 0 to 5 years old, children increase by 12.3%, more than twice the overall increase in married female labor force participation.

Our results show that *separate filing* goes a long way in generating significant aggregate output effects. With separate filing, aggregate output goes up by about 4.2%, which is more than half of the increase from a proportional income tax reform. The increase in aggregate output mainly comes from the rise in aggregate hours by married females. The labor force participation of married females rises more than twice as it does under a proportional income tax reform: an increase of 10.1% versus 4.8%. The rise in labor force participation of married females with young children is even stronger, it increases by 30.1% with separate filing. In contrast, male hours per worker remains nearly constant across steady states.

In answering the first question posed above, "what is the importance of the labor supply responses of married females in these experiments?", we find that married females account for a disproportionate fraction of the changes in hours and labor supply. Under proportional taxes, married females account for about 51% of the total increase in labor hours, and about 48% of the aggregate increase in labor supply (efficiency units). With separate filing almost all of the rise in hours and labor supply comes from married females. Hence, considering explicitly the behavior of this group is key in assessing the effects of tax reforms on labor supply.

In answering the second question, "what is the importance micro labor supply elasticities for the long-run effects on output and the labor input?", we find that when reducing the intertemporal elasticity from the benchmark value of 0.4 to 0.2, the long-run response of aggregate hours and output to tax changes is *not* critically affected. This occurs as while households react much less to tax changes along the intensive margin under a low elasticity parameter, they respond disproportionately via changes in labor force participation. Then, a central finding is that the value of this preference parameter is of second-order importance in assesing the effects on labor supply associated to tax reforms.

Related Literature Our work largely builds on two main strands of literature. First, our evaluation of tax reforms using a dynamic model with heterogeneity follows the work by Ventura (1999), Altig, Auerbach, Kotlikoff, Smetters and Walliser (2001), Castañeda, Díaz-Jiménez and Ríos-Rull (2003), Díaz-Jiménez and Pijoan-Mas (2005), Nishiyama and Smetters (2005), Conesa and Krueger (2006), Erosa and Koreshkova (2007), and Conesa, Kitao and Krueger (2009) among others. In contrast to these papers, we study economies populated with married and single households, where married households can have one or two earners. In this vein, Kaygusuz (2009) studies the effects of the 1980s tax reforms on female labor force participation in the U.S. Hong and Ríos-Rull (2007) and Kaygusuz (2006) study social security in environments with an explicit role for two-member households. Chade and Ventura (2002) study the effects of tax reforms on labor supply and assortative matching in a model with heterogenous individuals and endogenous marriage decisions. They abstract, however, from the extensive margin in labor supply, among other things. Alesina, Ichino and Karabarbounis (2009) study the Ramsey optimal taxation problem of a two-earner household within a static environment, where lower tax rates for females emerge. Kleven, Kreiner and Saez (2009) study a similar optimal taxation of problem in Mirrlessian framework, where second earner makes an explicit labor force participation decision. Second, as Cho and Rogerson (1988), Mulligan (2001), and Chang and Kim (2006), we study the aggregate effects of changes in labor supply along the extensive margin. As Rogerson and Wallenius (2009), we differ from these papers by explicitly analyzing the role of the extensive margin for public policy.

Our paper is also related to two recent literatures. First, it is related to recent work that argues that the structure of taxation can significantly affect labor choices, and play a central role in accounting for cross-country differences in labor supply behavior. Prescott (2004), Rogerson (2006), Ohanian, Raffo and Rogerson (2008), and Olovsson (2009) are examples of papers in this group. Our paper is also related to recent work that studies female labor supply in macroeconomic setups; Jones, Manuelli and McGrattan (2004), Greenwood, Seshadri and Yorukoglu (2005), Erosa, Fuster, Restuccia (2005), Albanesi and Olivetti (2007), Knowles

(2007), Attanasio, Low and Sánchez Marcos (2008), and Greenwood and Guner (2009) are representative papers in this group.

The paper is organized as follows. Section 2 presents an example that highlights the role of taxation with two-earner households, and motivates the parameterization of the model economy. Section 3 presents the model economy. Section 4 discusses the parameterization of the model and the mapping to data. Results from tax reforms are presented in section 5. Section 6 quantifies the role of married females and the extensive margin in labor supply. Section 7 discusses the implications of a lower labor supply elasticity. Section 8 concludes.

2 Taxation, Two-Earner Households and the Extensive Margin

In this section, we present a simple static example that illustrates how taxes affect labor supply decisions with two-earner households with and without children, with an emphasis on the effects on the potential changes in labor force participation. The example serves to highlight key features of our general environment. It also helps in understanding some of the calibration choices we make later.

A one-earner household Consider a married couple. The household decides whether only one or both members should work and if so, how much. Let x and z denote the labor market productivities (wage rates) of males and females, respectively. Let τ be a proportional tax on labor income. The household can be childless ($k = 0$) or have children ($k = 1$). Couples with children have to pay for child care services *only* if both household members works. Taking care of children costs $d > 0$ units of consumption.

Consider first the problem if only one member (husband) works. For couples with and without children, the household problem is given by

$$\max_{l_{m,1}}\{2[\underbrace{\log((1-\tau)zl_{m,1}+T)}_{=\log(c)}] - W(l_{m,1})\},$$

where $l_{m,1}$ is the labor choice of the primary earner (husband) and T is a transfer received from the government. The subscript 1 represents the choices of a one-earner household. The function $W(.)$ stands for the instantaneous disutility associated to work time. The function $W(.)$ is differentiable and strictly convex.

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 effects cancel out; the same occurs under the linear tax system that we consider.

Household utility when only one member works is given by

$$V_1(\tau) = 2[\log((1-\tau)zl^*_{m,1} + T)] - W(l^*_{m,1}),$$

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

A two-earner household Now consider the case when both members work and no children are present. When both members work, the household incurs a utility cost q, drawn from a distribution with cumulative distribution function $\zeta(q)$. Then the problem is given by

$$\max_{l_{m,2},l_{f,2}} \quad \{2[\underbrace{\log((1-\tau)(zl_{m,2} + xl_{f,2}) + T)}_{=\log(c)}] \\ -W(l_{m,2}) - W(l_{f,2}) - q\},$$

where the subscript 2 represents the choices of a two-earner household. Let the solutions to this problem be denoted by $l^*_{m,2}(k=0)$ and $l^*_{f,2}(k=0)$. Household utility in this case equals

$$\begin{aligned} V_2(\tau, k=0) - q &= 2[\log((1-\tau)(zl^*_{m,2}(k=0) + xl^*_{f,2}(k=0)) + T)] \\ &\quad -W(l^*_{m,2}(k=0)) - W(l^*_{f,2}(k=0)) - q. \end{aligned}$$

If children are present, with optimal choices $l^*_{m,2}(k=1)$ and $l^*_{f,2}(k=1)$, household utility is

$$\begin{aligned} V_2(\tau, k=1) - q &= 2[\log((1-\tau)(zl^*_{m,2}(k=1) + xl^*_{f,2}(k=1)) + T - d)] \\ &\quad -W(l^*_{m,2}(k=1)) - W(l^*_{f,2}(k=1)) - q. \end{aligned}$$

Taxes and the extensive margin in labor supply A married household is indifferent between having one and two earners for a sufficiently high value of the utility cost. Hence, there exist values of q, $q^*(k=0)$ and $q^*(k=1)$ that obey $q^*(k=0) = V_2(\tau, k=0) - V_1(\tau)$ and $q^*(k=1) = V_2(\tau, k=1) - V_1(\tau)$. For households with a q higher than the corresponding threshold value, it is optimal to have only one earner, while for those with a q lower than the threshold it is optimal to be a two-earner household. Since children are costly (i.e. $\frac{\partial V_2}{\partial d} < 0$), it follows immediately that $q^*(k=0) > q^*(k=1)$. Hence, everything else the same, childless couples are more likely to have two members working in the market than couples with children.

From the above expressions, it is clear that the thresholds will change as taxes change. In order to determine how exactly they will change with taxes, we appeal to the envelope theorem. For couples without children, it follows that

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

After some algebra, one can show that this derivative is negative if and only if

$$(1-\tau) + \frac{T}{(zl^*_{m,1})} > (1-\tau) + \frac{T}{(zl^*_{m,2}(k=0) + xl^*_{f,2}(k=0))}. \tag{1}$$

or,

$$\frac{zl^*_{m,2}(k=0) + xl^*_{f,2}(k=0)}{zl^*_{m,1}} > 1, \tag{2}$$

which necessarily holds in our case. That is, $q^*(k=0)$ and as a result, the labor force participation of married females without children, will be lower when taxes are high if and only if the above condition holds. Thus, as long as condition (1) 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.

For couples with children,

$$\frac{\partial q^*(k=1)}{\partial \tau} = \frac{\partial V_2(\tau, k=1)}{\partial \tau} - \frac{\partial V_1(\tau)}{\partial \tau} < 0,$$

Again after some algebra, this condition becomes

$$\frac{T-d}{T} < \frac{(zl^*_{m,2}(k=1) + xl^*_{f,2}(k=1))}{zl^*_{m,1}}. \tag{3}$$

Now, note that like condition (1), this condition is always satisfied as well, so the implication of tax changes for labor force participation holds regardless of the presence of children. In order to see this, first note that $\frac{T-d}{T} < 1$. Furthermore, since child care is costly, children generate a negative income effect and as a result,

$$\frac{zl^*_{m,2}(k=1) + xl^*_{f,2}(k=1)}{zl^*_{m,1}} \geq \frac{zl^*_{m,2}(k=0) + xl^*_{f,2}(k=0)}{zl^*_{m,1}} > 1. \tag{4}$$

We note at this point four 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 of 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, 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 is essential for the movement in q^*, as condition (1) shows. When a transfer is present, and of course more generally under progressive taxation, changes in marginal tax rates affect not only q^*, but labor supply along the intensive margin. This occurs as income and substitution effects no longer cancel out. Third, households responses to tax changes depend critically on the presence of children. To see this, note that (4) implies

$$|\frac{\partial q^*(k=1)}{\partial \tau}| > |\frac{\partial q^*(k=0)}{\partial \tau}|.$$

Hence, the participation *response* of married couples with children to tax changes is larger than for couples without children.

Finally, from this analysis, changes in labor supply (in efficiency units) in response to tax rate changes can be decomposed in two parts: there are changes in labor supply from males and females currently working (intensive margin), and changes due to female labor force participation (extensive margin). Assuming that couples differ only in terms of the number of children and the utility cost they face, and that the distribution of utility costs is the same for households with and without children, aggregate labor supply of married couples (L), can be written as

$$L = \sum_{k=0,1} N_k \left\{ \zeta(q^*(k))[zl^*_{m,2}(k) + xl^*_{f,2}(k)] + (1-\zeta(q^*(k)))zl^*_{m,1} \right\}$$

where N_0 and N_1 is the number of households without and with children, respectively. Hence, the change in aggregate labor supply from tax rate changes is given by

$$\frac{\partial L}{\partial \tau} = \underbrace{\sum_{k=0,1} N_k \left\{ \zeta(q^*(k))[z\frac{\partial l^*_{m,2}(k)}{\partial \tau} + x\frac{\partial l^*_{f,2}(k)}{\partial \tau}] + (1-\zeta(q^*(k)))z\frac{\partial l^*_{m,1}}{\partial \tau} \right\}}_{\text{intensive margin}} \quad (5)$$

$$+ \underbrace{\sum_{k=0,1} N_k \left\{ \zeta'(q^*(k))[zl^*_{m,2}(k) + xl^*_{f,2}(k) - zl^*_{m,1}]\frac{\partial q^*}{\partial \tau} \right\}}_{\text{extensive margin}}. \quad (6)$$

This example has important implications for the mapping of our model economy to the data. On the one hand, the relative size of households with and without children affects the size of labor supply response. On the other hand, as the bottom panel of Figure 1 shows, exactly how much the labor force participation of married females will increase depends on the shape of $\zeta(q)$. Therefore, selecting the functional form for the distribution of utility costs will be a key part of the model parameterization; the magnitude of the response along the extensive margin depends on slope $\zeta'(q)$ as equation (6) illustrates. We capture this slope by exploiting the observed changes in female labor force participation in response to changes in the gender gap, x/z. The key to this procedure is that an increase in x, for a given z, implies an increase in labor force participation whose magnitude hinges precisely on the magnitude of $\zeta'(q)$.

3 The Economic Environment

We study a stationary overlapping generations economy populated by a continuum of males (m) and a continuum of females (f). Let $j \in \{1, 2, ..., J\}$ denote the age of each individual. Population grows at rate n. Individuals differ in terms of their marital status: they are born as either single or married, and their marital status does not change over time.

Married households and single females also differ in terms of the number of children attached to them. Married households and single females can be childless or endowed with two children. These children appear either *early* or *late* in the life-cycle exogenously, and affect the resources available to households for three periods. Children do not provide any utility.

The life-cycle of agents is split into two parts. Each agent starts life as a worker and at age J_R, individuals retire and collect pension benefits until they die at age J. We assume that married households are comprised by individuals who are of the same age. As a result, members of a married household experience identical life-cycle dynamics.

Each period, working households (married or single) make labor supply, consumption and savings decisions. Children imply a fixed time cost for females. If a female with children, married or single, works, then the household also has to pay child care costs. Not working for a female is *costly*; if she does not work, she experiences losses of labor efficiency units for next period. Furthermore, if the *female* member of a married household supplies positive amounts of market work, then the household incurs a utility cost. As a result of these assumptions, married males (almost) always work in this economy, while there is a labor-force participation decision for married females.

Heterogeneity and Demographics Individuals differ in terms of their labor efficiency units. At the start of life, each *male* is endowed with an exogenous type z, where $z \in Z$ and $Z \subset R_{++}$ is a finite set. The type of a male agent remains constant over his life cycle. Let the age-j productivity of a type-z agent be denoted by the function $\varpi_m(z, j)$. Let $\Omega_j(z)$ denote the fraction of age-j, with $\sum_{z \in Z} \Omega_j(z) = 1$.

Each female starts her working life with a particular intrinsic type. As males, this type is fixed over time and is denoted by $x \in X$, where $X \subset R_{++}$ is a finite set. Let $\Phi_j(x)$ denote the fractions of age-j, type-x females in female population, with $\sum_{x \in X} \Phi_j(x) = 1$.

As women enter and leave the labor market, their labor market productivity levels evolve *endogenously*. Each female starts life with an initial productivity level that depends on her intrinsic type, $h_1 = \eta(x) \in H$. The next period's productivity level (h') depends on the female's intrinsic type x, her age, the current level of h and current labor supply (l). Formally, for $j \geq 1$,

$$h' = G(x, h, l, j)$$

all $h \in H$. The function G is increasing in h and x and non-decreasing in l. It captures the combined effects of a female intrinsic type, age and labor supply decisions on her labor market productivity. We specify this function in detail in section (4).

Let $M_j(x, z)$ denote the fraction of marriages between an age-j, type-x female and an age-j type-z male, and let $\omega_j(z)$ and $\phi_j(x)$ be the number of single type-z males and the number of single type-x females, respectively. Then, the following accounting identity must hold

$$\Omega_j(z) = \sum_{x \in X} M_j(x, z) + \omega_j(z). \tag{7}$$

Furthermore, since the marital status does not change, $M_j(x, z) = M(x, z)$ and $\omega_j(z) = \omega(z)$ for all j, which implies $\Omega_j(z) = \Omega(z)$. Similarly, for age-j females, we have

$$\Phi_j(x) = \sum_{z \in Z} M_j(x, z) + \phi_j(x). \tag{8}$$

Since marital status does not change $\phi_j(x) = \phi(x)$ and $\Phi_j(x) = \Phi(x)$ for all j

We assume that each cohort is $1 + n$ bigger than the previous one. These demographic patterns are stationary so that age j agents are a fraction μ_j of the population at any point in time. The weights are normalized to add up to one, and obey the recursion, $\mu_{j+1} = \mu_j/(1+n)$.

Children Children are assigned stochastically to married couples and single females at the start of life, depending on the intrinsic type of parents. Each married couple and single female can be of three types: *early* child bearers, *late* child bearers, and those *without* any children. Early and late child bearers have *two* children for three periods. Early child bearers have these children in ages $j = 1, 2, 3$ while late child bearers have children attached to them in ages $j = 2, 3, 4$. For married couples, let $\lambda_b^M(x, z)$ be the fraction of type-(x, z) couples who have childbearing type b, where $b \in \{0, 1, 2\}$ denotes no children, early childbearing and late childbearing, respectively, and $\sum_b \lambda_b^M(x, z) = 1$. Similarly, let $\lambda_b^S(x)$ be the fraction of type-x single females who have childbearing type b, with $\sum_b \lambda_b^S(x) = 1$.

Child Care Costs We assume that if a female with children works, married or single, then the household has to pay for child care costs. Child care costs depend on the age of the child (s). For a female with children of age $s \in \{1, 2, 3\}$, the household needs to purchase $d(s)$ units of (child care) labor services for their two children. Since the competitive price of child care services is the wage rate w, the total cost of child care services for two children equals $wd(s)$.

Utility Cost of Joint Work We assume that at the start of their lives married households draw a $q \in Q$, where $Q \subset R_{++}$ is a finite set. These values of q represent the *utility costs* of joint market work for married couples. For a given household, the initial draw of a utility cost depends on the labor productivity of the husband. Let $\zeta(q|z)$ denote the probability that the cost of joint work is q, with $\sum_{q \in Q} \zeta(q|z) = 1$.

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

$$U_f^S(c, l, k) = \log(c) - B(l + k\varkappa)^{1+\frac{1}{\gamma}},$$

where c is consumption, l is time devoted to market work, and $\varkappa$ is fixed time cost having two children for a female. Here $k = 0$ stands for the absence of children in the household, whereas $k = 1$ stands for children being present. Since a single male does not have any children, his utility function is simply given by

$$U_m^S(c, l) = \log(c) - B(l)^{1+\frac{1}{\gamma}}.$$

Married households maximize the sum of their members utilities. We assume that when the female member of a married household works, the household incurs a utility cost q. Then, the utility function for a married female is given by

$$U_f^M(c, l_f, q, k) = \log(c) - B(l_f + k\varkappa)^{1+\frac{1}{\gamma}} - \frac{1}{2}\chi\{l_f\}q,$$

while the one for a married male reads as

$$U_m^M(c, l_m, l_f, q) = \log(c) - Bl_m^{1+\frac{1}{\gamma}} - \frac{1}{2}\chi\{l_f\}q,$$

where $\chi\{.\}$ denote the indicator function. Note that consumption is a public good within the household. Note also that the parameter $\gamma > 0$, the intertemporal elasticity of labor supply, and B, the weight on disutility of work, are independent of gender and marital status.

Production and Markets There is an aggregate firm that operates a constant returns to scale technology. The firm rents capital and labor services from households at the rate R and w, respectively. Using K units of capital and L_g units of labor, firms produce $F(K, L_g) = K^\alpha L_g^{1-\alpha}$ units of consumption (investment) goods. We assume that capital depreciates at rate δ_k. Households save in the form of a risk-free asset that pays the competitive rate of return $r = R - \delta_k$.

Incomes, Taxation and Social Security Let a stand for household's assets. Then, the total pre-tax resources of a single working male of age j and a single female worker of age j without any children are given by $a+ra+w\varpi_m(z,j)l_m$ and $a+ra+whl_f$, respectively. For a single female worker with children, they amount to $a + ra + whl - wd(s)\chi\{l_f\}$. The pre-tax total resources for a married working couple with children are given by $a + ra + w\varpi_m(z,j)l_m + whl_f - wd(s)\chi\{l_f\}$, while they are $a + ra + w\varpi_m(z,j)l_m + whl_f$ for those without children.

Retired households have access to social security benefits. We assume that social security payments are increasing in agents' intrinsic types, i.e. initially more productive agents receive larger social security benefits. This allows us to capture in a parsimonious way the positive relation between lifetime earnings and social security transfers, as well as the intra-cohort redistribution built into the system. Let $p_f^S(x)$, $p_m^S(z)$, and $p^M(x,z)$ indicate the level of social security benefits for a single female of type x, a single male of type z and a married retired household of type (x,z), respectively. Hence, retired households pre-tax resources are simply $a + ra + p_f^S(x)$ and $a + ra + p_m^S(z)$ for singles, and $a + ra + p^M(x,z)$ for married ones.

Income for tax purposes, I, is defined as total labor and capital income. Hence, for a single male worker, it equals $I = ra+w\varpi_m(z,j)l_m$, while for a single female worker, it reads as $I = ra+whl_f$. For a married working household, taxable income equals $I = ra+w\varpi_m(z,j)l_m + whl_f$. We assume that social security benefits are not taxed, so income for tax purposes is simply given by ra for retired households. The total income tax liabilities of married and single households are affected by the presence of children in the household, and are represented by tax functions $T^M(I,k)$ and $T^S(I,k)$, respectively, where again $k=0$ stands for the absence of children in the household, whereas $k=1$ stands for children being present. These functions are continuous in I, increasing and convex. This representation captures the actual variation in tax liabilities associated to the presence of children in households.

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.

3.1 Decision Problem

We now present the decision problem for different types of agents in the recursive language. For single males, the individual state is (a,z,j). For single females, the individual state is given by (a,x,h,b,j). For married couples, the state is given by (a,x,h,z,q,b,j). Note that the dependency of taxes on the presence of children in the household (k) is summarized by age (j) and childbearing status (b): (i) $k=1$ if $b=\{1,2\}$ and $j=\{b,b+1,b+2\}$, and (ii) $k=0$ if $b=2$ and $j=1$, or $b=\{1,2\}$ for all $j>b+2$, or $b=0$ for all j.

The Problem of a Single Male Household Consider now the problem of a single male worker of type (a,z,j). A single worker of type-(a,z,j) decides how much to work and how much to save. His problem is given by

$$V_m^S(a,z,j)=\max_{a',l}\{U_m^S(c,l)+\beta V_m^S(a',z,j+1)\} \tag{9}$$

subject to

$$c+a'=\begin{cases} a(1+r(1-\tau_k))+w\varpi_m(z,j)l(1-\tau_p)-T^S(w\varpi_m(z,j)(j)l+ra,0) & \text{if } j<J_R \\ a(1+r(1-\tau_k))+p_m^S(z)-T^S(ra), \text{ otherwise} & \end{cases},$$

and

$$l\geq 0,\ a'\geq 0 \text{ (with strict equality if } j=J)$$

The Problem of a Single Female Household In contrast to a single male, a single female's decisions also depends on her current human capital h and her child bearing status b. Hence, given her current state, (a,x,h,b,j), the problem of a single female is

$$V_f^S(a,x,h,b,j) = \max_{a',l}\{U_f^S(c,l,k) + \beta V_f^S(a',x,h',b,j+1)\},$$

subject to

(i) <u>With kids:</u> if $b = \{1,2\}$, $j \in \{b, b+1, b+2\}$, then $k = 1$, and

$$c + a' = a(1 + r(1-\tau_k)) + whl(1-\tau_p) - T^S(whl + ra, 1) - wd(j+1-b)\chi(l)$$

(ii) <u>Without kids but not retired:</u> if $b = 0$, or $b = \{1,2\}$ and $b+2 < j < J_R$, or $b = 2$ and $j = 1$, then $k = 0$ and

$$c + a' = a(1 + r(1-\tau_k)) + whl(1-\tau_p) - T^S(whl + ra, 0)$$

(ii) <u>Retired:</u> if $j \geq J_R$, $k = 0$ and

$$c + a' = a(1 + r(1-\tau_k)) + p_f^S(x) - T^S(ra, 0).$$

In addition,

$$h' = G(x,h,l,j),$$

$$l \geq 0,\ a' \geq 0 \text{ (with strict equality if } j = J)$$

Note how the cost of children depends on the age of children. If $b = 1$, the household has children at ages 1, 2 and 3, then $wd(j+1-b)$ denote cost for ages 1, 2 and 3 with $j = \{1,2,3\}$. If $b = 2$, the household has children at ages 2, 3 and 4, then $wd(j+1-b)$ denotes the cost for children of ages 1, 2 and 3 with $j = \{2,3,4\}$.

The Problem of Married Households Like singles, married couples decide how much to consume and how much to save. They also decide whether the female member of the household should work. Their problem is given by

$$\begin{aligned} V^M(a,x,h,z,q,b,j) &= \max_{a',\, l_f,\, l_m} \{[U_f^M(c,l_f,q,k) + U_m^M(c,l_m,l_f,q)] \\ &+ \beta V^M(a',x,h',z,q,b,j+1)\}, \end{aligned}$$

subject to

(i) <u>With kids:</u> if $b = \{1,2\}$, $j \in \{b, b+1, b+2\}$, then $k = 1$ and

$$\begin{aligned} c+a' &= a(1+r(1-\tau_k))+w(\varpi_m(z,j)l_m+hl_f)(1-\tau_p) \\ &- T^M(w\varpi_m(z,j)l_m+whl_f+ra,1)-wd(j+1-b)\chi(l_f) \end{aligned}$$

(ii) Without kids but not retired: if $b=0$, or $b=\{1,2\}$ and $b+2<j<J_R$, or $b=2$, $j=1$, then $k=0$ and

$$\begin{aligned} c+a' &= a(1+r(1-\tau_k))+w(\varpi_m(z,j)l_m+hl_f)(1-\tau_p) \\ &- T^M(w\varpi_m(z,j)l_m+whl_f+ra,0) \end{aligned}$$

(ii) Retired: if $j\geq J_R$, then $k=0$ and

$$c+a'=a(1+r(1-\tau_k))+p^M(x,z)-T^M(ra,0).$$

In addition,

$$h'=G(x,h,l_f,j)$$

$$l_m\geq 0,\ l_f\geq 0, a'\geq 0 \text{ (with strict equality if } j=J)$$

3.2 Stationary Equilibrium

The aggregate state of this economy consists of distribution of households over their types and asset levels. Suppose $a\in A=[0,\overline{a}]$. Let $\psi_j^M(B,x,h,z,q,b)$ be the number (measure) of age j married households of type (x,h,z,q,b), with assets in $B\in\mathcal{A}$, the class of Borel subsets of A. Similarly, let $\psi_{f,j}^S(B,x,h,b)$ be the number of age j single females of type (x,h,b) with assets in B, and let $\psi_{m,j}^S(B,z)$ be the number of single males of type (z), with assets in B.

By construction, $M(x,z)$, the number of age j married households of type (x,z), must satisfy for all ages

$$M(x,z)=\sum_{h,q,b}\int_A\psi_j^M(a,x,h,z,q,b)da.$$

Similarly, the number of single females and males must be consistent with the corresponding measures $\psi_{f,j}^S$ and $\psi_{m,j}^S$. For all ages,

$$\phi(x)=\sum_{h,b}\int_A\psi_{f,j}^S(a,x,h,b)da,$$

and

$$\omega(z) = \int_A \psi^S_{m,j}(a,z)da.$$

In stationary equilibrium, factor markets clear. Aggregate capital (K) and aggregate labor (L) are given by

$$\begin{aligned} K &= \sum_j \mu_j [\sum_{x,h,z,q,b} \int_A a\psi^M_j(a,x,h,z,q,b)da + \sum_z \int_A a\psi^S_{m,j}(a,z)da \\ &+ \sum_{x,h,b} \int_A a\psi^S_{f,j}(a,x,h,b)da] \end{aligned} \tag{10}$$

and

$$\begin{aligned} L &= \sum_j \mu_j [\sum_{x,h,z,q,b} \int_A (hl^M_f(a,x,h,z,q,b,j) + \varpi_m(z,j)l^M_m(a,x,h,z,q,b,j))\psi^M_j(a,x,h,z,q,b)da \\ &+ \sum_z \int_A \varpi_m(z,j)l^S_m(a,z,j)\psi^S_m(a,z)da + \sum_{x,h,b} \int_A hl^S_f(a,x,h,b,j)\psi^S_{f,j}(a,x,b)da] \end{aligned} \tag{11}$$

Furthermore, labor used in the production of goods, L_g, equals

$$\begin{aligned} L_g &= L - [\sum_{x,h,z,q} \sum_{b=1,2} \sum_{j=b,b+2} \mu_j \int_A \chi\{l^M_f\} d(j+1-b)\psi^M_j(a,x,h,z,q,b)da \\ &+ \sum_{x,h} \sum_{b=1,2} \sum_{j=b,b+2} \mu_j \int_A \chi\{l^S_f\} d(j+1-b)\psi^S_{f,j}(a,x,b)da], \end{aligned} \tag{12}$$

where the term in brackets is the measure of labor used in child care services.

In addition, factor prices are competitive so $w = F_2(K, L_g)$, $R = F_1(K, L_g)$, and $r = R - \delta_k$. In the Appendix, we provide a formal definition of equilibria.

4 Parameter Values

We now proceed to assign parameter values to the endowment, preference, and technology parameters of our benchmark economy. To this end, we use aggregate as well as cross-sectional and demographic data from multiple sources. As a first step in this process, we start by defining the length of a period to be 5 years.

Demographics and Endowments We assume that agents start their life at age 25 as workers and work for forty years, corresponding to ages 25 to 64. Hence the first model period ($j = 1$) corresponds to ages 25-29, while the last model period of working life ($j = J_R$) corresponds to ages 60-64. After 8 period of working life, all agents retire at age 65, and live until age 80, i.e. we set $J = 11$. The population grows at the annual rate of 1.1%, the average values for the U.S. economy between 1960-2000.

We set the number of types for males to four. Each type corresponds to an educational attainment level: *less than or equal to high school* (hs), *some college* (sc), *college* (col) and *post-college* education (col+). We use data from the 2000 Consumer Population Survey (CPS) March Supplement to calculate age-efficiency profiles for each male type. Efficiency levels correspond to mean weekly wage rates within an education group, which we construct using annual wage and salary income and weeks worked. We normalize wages by the overall mean weekly wages for all males and females between ages 25 and 64. We include in the sample the civilian adult population who worked as full time workers last year, and exclude those who are self-employed or unpaid workers or make less than half of the minimum wage.[4] Figure 2 shows the second degree polynomials that we fit to the raw wage data. In our quantitative exercises, we calibrate the male efficiency units, $\varpi_m(z, j)$, using these fitted values. Our estimates imply a wage growth of about 60% for college graduates from ages 25-29 to ages 45-49. The corresponding values for high school graduates are about 38%.

We assume that there are four intrinsic female types, corresponding to four education levels. Following the same procedure for males, we also calculate the initial (ages 25-29) efficiency levels for females, which are reported in Table 1. Table 1 also shows the initial male efficiency levels and the corresponding gender wage gap. We use the initial efficiency levels for females to calibrate their initial human capital levels. After ages 25-29, the human capital level of females evolves endogenously according to

$$h' = G(x, h, l, j) = \exp\left[\ln h + \alpha_j^x \chi(l) - \delta(1 - \chi(l))\right]. \quad (13)$$

We calibrate the values for α_j^x and δ following a simple procedure.[5] First, following Eckstein and Wolpin (1989), we set $\delta = 0.0961$ which corresponds to an annual wage loss associated to non-participation of 2%. Then, we select α_j^x so that if a female of a particular type x works in every period, her wage profile has exactly the same shape as males. This procedure takes the initial gender differences as given, and assumes that the wage growth rate for a

[4] Our sample restrictions are standard in the literature and follow Katz and Murphy (1992).

[5] Our formulation of the human capital accumulation process follows Attanasio, Low and Sánchez Marcos (2008).

female who works full time will be the same as for a male worker; hence, it sets α_j^x values equal to the growth rates of male wages at each age. Table 2 shows the calibrated values for α_j^x.

We subsequently determine the distribution of individuals by productivity types for each gender, i.e. $\Omega(z)$ and $\Phi(x)$, using data from the 2000 U.S. Census. For this purpose, we consider all household heads or spouses who are between ages 30 and 39 and for each gender calculate the fraction of population 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 3. Consistent with positive assortative matching by education, the largest entries in each row and column in Table 3 are located along the diagonal.[6]

Given the fractions of individuals in each education group, $\Phi(x)$ and $\Omega(z)$, and the fractions of married households, $M(x, z)$, in the data, we calculate the implied fractions of single households, $\omega(z)$ and $\phi(x)$, from accounting identities (7) and (8). The resulting values are reported in Table 4: about 77% of households in the benchmark economy consists of married households, while the rest (about 23%) are single.

Since we assume that the distribution of individuals by marital status is independent of age, we use the 30-39 age group for our calibration purposes. This age group captures the marital status of recent cohorts during their prime-working years, while being at the same time representative of older age groups.

Childbearing Our model assumes that each single female and each married couple belong to one of three groups: *childless*, *early child bearer* and *late child bearer*. The early child bearers have two children at ages 1, 2 and 3, corresponding to ages 25-29, 30-34 and 35-39, while late child bearers have their two children at ages 2, 3, and 4, corresponding to ages 30-34, 35-39, 40-44. This particular structure captures two key features of the data from the 2002 CPS June supplement.[7] First, conditional on having a child, married couples tend to have two children.[8] Second, these two births occur within a short period of time, mainly between ages 25 and 30 for households with low education and between ages 30 and 35 for households with high education.[9]

[6] See Fernandez, Guner and Knowles (2005) for a study of positive assortative matching by education.

[7] The CPS June Supplement provides data on the total number of live births and the age at last birth for females, which are not available in the U.S. Census.

[8] For married households in which women are above age 25, the total number of live births varies from 2.4 for those households in which both husband and wife have at most high school degrees to 2 for those households in which both husband and wife have more than a college degree. For the majority of households, the total number of children is close to 2.

[9] The average age at first birth is 26.2 for those households in which both husband and wife have at most high school degrees, and 31.1 for those households in which both husband and wife have more than a college

For singles, we use data from the 2002 CPS June supplement and calculate the fraction of 40 to 44 years old single (never married or divorced) females with zero live births. We use these statistics as a measure of lifetime childlessness. Then we calculate the fraction of all single women above age 25 with a total number of two live births who were below age 30 at their last birth. This fraction gives us those who are early child bearers, and the remaining fraction of assigned as late child bearers. The resulting distribution is shown in Tables 5.

We follow a similar procedure for married couples, combining data from the CPS June Supplement and the U.S. Census. For childlessness, we use the large sample from the U.S. Census.[10] The Census does not provide data on total number of live births but the total number of children in the household is available. Therefore, as a measure of childlessness we use the fraction of married couples between ages 35-39 who have no children at home.[11] Then, using the CPS June supplement we look at all couples above age 25 in which the female had a total of two live births and was below age 30 at her last birth. This gives us the fraction of couples who are early child bearers, with the remaining married couples labeled as the late ones. Table 6 shows the resulting distributions.

Child Care Costs To calibrate child care costs we use the U.S. Bureau of Census data from the Survey of Income and Program Participation (SIPP).[12] In 2005, the total yearly cost for employed mothers, who have children between ages 0 and 5 and who make child care payments, was about \$6,414.5. We take this figure from the Census as the child care costs for two young children, which represents about 10% of average household income in 2005. The Census estimates of total child care costs for children between 5 and 14 is about \$4851, which amounts to about 7.7% of average household income in 2005. We set $d(1) = d_1$ and $d(2) = d(3) = d_2$ and select d_1 and d_2 so that families with child care expenditures spend about 10% and 7.7% of average household income for young (0-5) and older (5-14) children, respectively.[13]

degree. For the same household types with two children, the average age at second were 26.8 and 31.3, respectively.

[10] The CPS June Supplement is not particularly useful for the calculation of childlessness in married couples. The sample size is too small for females in some married household types for the calculation of the fraction of married females, aged 40-44, with no live births.

[11] Since we use children at home as a proxy for childlessness, we use age 35-39 rather than 40-44. Using ages 40-44 generates more childlessness among less educated people. This is counterfactual, and simply results from the fact that less educated people are more likely to have kids younger, and hence these kids are less likely to be at home when their parents are between ages 40-44.

[12] See Table 6 in http://www.census.gov/population/www/socdemo/child/tables-2006.html

[13] According to the The National Association of Child Care Resources and Referral Agencies, NACCRRA (2008a), the cost of a day care for two young kids, one infant and one toddler, in Utah, the median state with respect to infant care costs, was about \$10,632 per year in 2005. However, NACCRRA (2008b) reports

Technology We specify the production function as Cobb-Douglas, and calibrate the capital share and the depreciation rate using a notion of capital that includes fixed private capital, land, inventories and consumer durables. For the period 1960-2000, the resulting capital to output ratio averages 2.93 at the annual level. The capital share equals 0.343 and the (annual) depreciation rate amounts to 0.055.[14]

Taxation To construct income tax functions for married and single individuals, we estimate *effective taxes* paid as a function of reported income, marital status and children. For these purposes we use tax return micro data from Internal Revenue Service for the year 2000 (Statistics of Income Public Use Tax File). For married households, we estimate tax functions corresponding to the legal category *married filing jointly.* For singles without children, we estimate a tax function from the legal category *singles*; for singles with children, we estimate a tax function from the legal category *head of household.*[15]

We partition the sample in income brackets, and for each of these, we calculate total income taxes paid, total income earned, number of taxable returns and the number of returns. Hence, we find the mean income and the average tax rate corresponding to every income bracket. We calculate the average tax rates as

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

In each case 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 average income in an income bracket equals *income*. We calculate *income* by normalizing average income in each income bracket by the mean household income in 2000. Table 7 shows the estimates of the coefficients for married and single households, with and without children. To estimate the

that about 25% of children have their grandparents and other relatives as primary caregivers. Making this adjustment, the yearly cost is $7,974. This is comparable with the Census data, which includes other cheaper types of child care arrangements (such as family day care). Similarly, according to NACCRRA (2008a) the cost of school-age children is about 60% of infants, which is again in line with Census estimates.

[14] We estimate the capital share and the capital to output ratio following the standard methodology; see Cooley and Prescott (1995). The data for capital and land are from Bureau of Economic Analysis (Fixed Asset Account Tables) and Bureau of Labor Statistics (Multifactor Productivity Program Data).

[15] We use the 'head of household' category for singles with children, since in practice it is clearly advantageous for most unmarried individuals with dependent children to file under this category. For instance, the standard deduction is larger than for the 'single' category, and a larger portion of income is subject to lower marginal tax rates.

tax functions for household with children, we restrict our sample to households in which there are two dependent children for tax purposes. Given these estimates, we calculate the tax liabilities for each household as [*average tax rate* (*income*)] $\times$ (*income* $\times$ *mean household income*).

Figures 3 and 4 display estimated average and marginal tax rates for different multiples of household income. Our estimates imply that a single person without kids (with kids) with twice mean household income in 2000 faces an average tax rate of about 20.7% (18.2%) and a marginal tax rate equal to about 26.4% (27.4%). The corresponding rates for a married household with the same income are about 18.2% (17.0%) and 25.5% (26.0%).

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 $\tau_k = 0.097$.

Social Security 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.[16] Using the 2000 U.S. Census we calculate total Social Security income for all single and married households.[17] Tables 8 and 9 show Social Security incomes, normalized by the level corresponding to single males of the lowest types. Not surprisingly, agents with higher types receive larger payments: a single male with post-college education receives about 30% more than a single male whose education is less than college, while a couple with two members with post-college education receives about 28% more than a couple with two members with less than high school education. Then, given the payroll tax rate, the value of the benefit for a single retired male of the lowest type, $p_m^S(x_1)$, balances the budget for the social security system. The implied value of $p_m^S(x_1)$ for the benchmark economy is about 17.8% of the average household income in the economy.

Preferences There are three utility functions parameters, the intertemporal elasticity of labor supply (γ), the parameter governing the disutility of market work (B), and fixed

[16]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.

[17]Social Security income is all pre-tax income from Social Security pensions, survivors benefits, or permanent disability insurance. Since Social Security payments are reduced for those with earnings, we restrict our sample to those above age 70. For married couples we sum the social security payments of husbands and wives.

time cost of children ($\varkappa$). We consider two values for γ: a low value of 0.2 and a higher value of 0.4. Both values are consistent with recent estimates for males. While $\gamma = 0.2$ is in line with microeconomic evidence reviewed by Blundell and MaCurdy (1999), $\gamma = 0.4$ is contained in the range of recent estimates by Domeij and Floden (2006, Table 5). Domeij and Floden (2006) results are based upon estimates for married males that control for the bias emerging from borrowing constraints.[18] We proceed by presenting first results when the intertemporal elasticity of substitution equals 0.4. In subsequent sections, we discuss the implications of a lower value for this parameter. 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 40.1% of available time in 2000.[19] We set $\varkappa = 0.141$ to match the labor force participation of married females with young, 0 to 5 years old, children. From the 2000 U.S. Census, we calculate the labor force participation of females between ages 25 to 40 whose oldest child is less than 5 as 55.7%. We select the fixed cost such that the labor force participation of married females with children less than 5 years (i.e. early child bearers between ages 25 and 30 and late child bearers between ages 30 and 35), has the same value.[20] Finally, we choose 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 (2.930).

This leaves us with the utility cost of joint work, q, to determine. Note that even without this utility cost, married females face a non-trivial labor force participation decision due to child care costs and human capital accumulation. The presence of utility costs associated to joint work allows to capture residual heterogeneity among couples, beyond heterogeneity in endowments and children, that can be critical to generate observed labor supply behavior, and in particular, labor force participation. As we explain in Section 2, all else the same, couples for which utility costs are high will have one earner whereas those with low costs will have both members in the labor force. Public policy via taxes and transfers will affect this decision and thus, the resulting degrees of labor force participation.

[18] Rupert, Rogerson and Wright (2000) provide estimates within a similar range in the presence of a home production margin. Heathcote, Storesletten and Violante (2007) report an estimate of 0.2, using a model with incomplete markets.

[19] The numbers are for people between ages 25 and 54 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. We assume that each person has an available time of 5000 hours per year. Our target for hours corresponds to 2005 hours in the year 2000.

[20] Our calibrated value for $\varkappa$ is in the ballpark of available estimates in the literature. Hotz and Miller (1988) estimate that the time cost of a newborn is about 660 hours per year and this cost declines at 12% per year. This would imply that parents spend about 520 hours per children, who are between ages 0 and 5. With 5000 available hours per year, this is more than 10% per child.

We assume that the utility cost parameter is distributed according to a (flexible) gamma distribution, with parameters k_z and θ_z. Thus, conditional on the husband's type z,

$$q \sim \zeta(q|z) \equiv q^{k_z-1}\frac{\exp(-q/\theta_z)}{\Gamma(k_z)\theta_z^{k_z}},$$

where $\Gamma(.)$ is the Gamma function. By proceeding in this way, we exploit the information contained in the *differences* in the labor force participation of married females as their own wage rate differ with education (for a given husband type). We emphasize that this allows us to control the slope of the distribution of utility costs, which is potentially critical in assessing the effects of tax changes on labor force participation.

Using CPS data, we calculate that the employment-population ratio of married females between ages 25 and 54, for each of the educational categories defined earlier.[21] Table 10 shows the resulting distribution of the labor force participation of married females by the productivities of husbands and wives for married households. The aggregate labor force participation for this group is 69.4%, and it increases from 60.1% for the lowest education group to 81.4% for the highest. Our strategy is then to select the two parameters governing the gamma distribution, for every husband type, so as to reproduce each of the rows (five entries) in Table 10 as closely as possible. Altogether, this process requires estimating 10 parameters (i.e. a pair (θ, k) for each husband educational category).

Table 11 summarizes our parameter choices. Table 12 shows the performance of the benchmark model in terms of the targets we impose for B, β and $\varkappa$. The table also shows how well the benchmark calibration matches the labor force participation of married females. The model has no problem in reproducing jointly these observations as the table demonstrates.

4.1 The Benchmark Economy

Before proceeding to investigate the effects of tax reforms, we report on properties of the benchmark economy, and compare these with the corresponding values from data. This is critical for the questions at hand: to conduct tax reforms within our framework we want to be confident that it offers a good model of female labor supply. We focus on two key aspects of the model economy here. First, how does female labor force participation change by age and the presence of children? Second, what is the gender gap in our model economy? The answer to the first question is important since the interaction between children and female labor force participation plays a key role in our model. The answer to the second question is also critical, since married females in our economy have a non-trivial labor force

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

participation decision which results in an endogenous gender gap. In assessing the model performance, it is important to bear in mind that the empirical targets for the model are the levels of aggregate participation rates by marriage type, and the participation rates of women with young children. No age-related statistics are used, so the match between model and data in this dimension is due to the forces governing household labor supply within the model.

At the aggregate level, the model is in conformity with data. The model reproduces, by construction, the labor force participation rate of women with young children and the economy-wide level of participation, as it targets participation rates by type. It also captures the consequences of the presence of children on participation rates. Participation rates of women with children are lower than those without children, both in the model and in the data; about 64.2% versus 67.4%. Females without children participate more, their labor force participation are 82.9% and 82.5% in the model and in the data, respectively.

Figure 5 shows married female labor force participation by age and by the presence of children. As the figure shows, the labor force participation of married females with children increases monotonically with age both in the model and the data, and its level is always below that for women without children. Both in the model economy and the data, those who have their children early on, at ages 25-30, are women with low levels of education; not surprisingly, their labor force participation is low. Those who have their children in later ages tend to be skilled women, whose labor force participation is higher. Furthermore, those who have their children early are more likely to participate in the labor market in later ages, since their children age and the associated child care costs decline. The participation rate of women without children, on the other hand, declines slightly between ages 25-30 to 40-45. The decline in later ages is mainly due to women who had their children in the first period and enter the labor force in later ages as these children age. Since these women are mainly from lower education groups and could not accumulate human capital in the initial years, they have low labor force participation.

Figure 6 displays the wage gender gap in the model and the data. The model does a very good job in generating both the levels and age patterns of the wage gender gap. In interpreting these results, it is important to bear in mind that wage gender gap is critically determined by labor force participation decisions. Moreover, we have selected the parameters of human capital accumulation process for females a priori without targeting any endogenous variables. Both in the data and the model, the gender gap starts at about 20%, and increases monotonically as women age, with an total life-cycle gap, for ages 25 to 64 of about 28%. As women with children decide to stay out of the labor force, their human capital declines generating endogenously a larger gender gap in later ages.

5 Tax Reforms

We now consider two hypothetical reforms to the current U.S. tax structure: a proportional income tax and a move from joint to separate filing for married couples. The first reform flattens the current income tax schedule while keeping the household as unit subject to taxation. The second reform reintroduces progressivity into the system, but changes the unit of taxation from households to *individuals*. The proportional income tax allows us to illustrate the effects of a rather well-studied case within the current framework, and relate our results with the existing literature. The second reform, which is impossible to analyze within a standard single-earner framework, illustrates the value-added of the model features of the current framework.

The findings we report are based on steady-state comparisons of pre and post-reform economies. In all cases, we keep the additional tax rate on capital income (τ_k) and the social security tax rate unchanged.[22] The exercises are in all cases *revenue neutral*.[23]

5.1 A Proportional Income Tax

Table 13 reports the key findings from this exercise. To assess these results, the reader should bear in mind that by construction, a proportional income tax makes marginal and average tax rates equal for all households. Before the reform average and marginal tax rates covered a wide range, as indicated in Figures 3 and 4; in the new steady state, the uniform tax rate that balances the budget equals 13.6%. Thus, via the removal of distortions associated with a progressive income tax, this reform leads to substantial effects on output and factor inputs. The capital-to-output ratio increases by about 4.7% across steady states, leading to changes in the wage rate of about 2.6%. Total labor supply (hours adjusted by efficiency units) increases by 4.8%. As a result of these changes, aggregate output increases substantially by about 7.2%.

Our economy allows us to identify and quantify differential responses in labor supply to tax changes that take place at the intensive margin for both males and females, as well as at the *extensive* margin for married females. Recall that in the benchmark economy, the tax structure generates non-trivial disincentives to work since average and marginal tax

[22] The constancy of the social security tax rate implies that benefits adjust with the reforms under consideration.

[23] Results when the tax rate on capital income is also eliminated are available upon request.

rates increase with incomes. In addition, married females who decide to enter the labor force are taxed at their partner's current marginal tax rate. With the elimination of these disincentives, the change in labor supply of married females is substantially larger than the aggregate change in hours. The introduction of a flat-rate income tax implies that the labor force participation of married females increases by about 4.8%, while hours per worker rise by about 3.8% for females, and about 3.1% for males. Due to changes along the intensive and the extensive margins, total hours for married females increase by about 9.0%. This is a dramatic rise and is nearly three times the changes 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, and take place despite the equilibrium increase in the cost of child care (i.e. the wage rate goes up).

It is important to highlight three aspects of the results emerging from this experiment. First, as the simple model in Section 2 suggests, the response of married females with children is larger than those without children as Table 13 illustrates. With a flat-rate income tax, the labor force participation of married females with young, 0 to 5 years old, children increases by 12.3%, more than twice as much as the overall rise in married female labor force participation.

Second, as we show in Table 14, low-type married females increase their labor supply much more than high-type females. Over the life cycle, females with the lowest intrinsic type (those with high school education or less) increase their labor force participation by 8.0%, while highest types (those with post-college education) increase theirs only by 2.1%. This might come as a surprise, since a proportional income tax reform would likely increase marginal tax rates for lower types and reduce them for high types. In order to understand this outcome, we note first that the labor force participation of high-type married females is quite large in the benchmark economy to begin with, leaving relatively little room to react to tax changes. Furthermore, lower types are more likely to have children and married females with children react more strongly to taxes. This is shown in the lower panel of Table 14: while for married females who are childless the labor force participation increased by about 2.3%, the rise is much larger, 7.6%, for those who are early child bearer. Finally, relative to the benchmark economy, marginal tax rates effectively drop or remain relatively constant for low and middle income households after the introduction of the proportional income tax. In the benchmark economy, the marginal tax rate on a household with an income equal to one half average income is about 13.6%, approximately the same as the rate after the reform, while the marginal rate amounts to about 19.8% for those with a mean income level. In other words, a proportional tax leads to a reduction in marginal tax rates *even* for low and middle-income households in the new steady state.

Finally, the increasing labor force participation of married females leads to higher efficiency units (human capital) for this group. These changes result in an aggregate reduction in the wage gender gap of about 2.2%. As we document in Table 14, the decline of the gender gap is larger for lower types and those with children, which reflects the changes in labor force participation,. It is about 4.2% for those with less than high school education, in contrast to nearly 1% for those with post-college education.

5.2 Separate Filing

A prominent feature of the current U.S. tax system is that it treats married and single individuals differently. The problem arises since the unit subject to taxation is the *household*, not the individual, with tax schedules that differ according to marital status. This creates much discussed marriage-tax penalties and bonuses, affecting the marginal tax rates that married individuals face. In particular, note that when a married female enters the labor market the first dollar of her earned income is taxed at her husband's current marginal rate, potentially distorting her labor supply in a critical way. This reasoning motivates our second experiment, where we move from the current system to one in which each individual files his/her taxes separately. We label this hypothetical reform experiment *separate filing*.

We assume that a married person's tax liabilities consists of his/her labor income plus half of household's asset income, and each working member of a married household with children declares one of the two children for tax purposes. In particular, for a married household without children we use the same tax function that singles without children face in the benchmark economy. For married households with children, we use a tax function from the legal category *head of household* (with one child) for each member. In addition, in order to collect the same amount of tax revenue as the benchmark economy, we assume that each individual faces an additional proportional tax (or subsidy) on his/her income.[24]

The possibility of separate filing can lower taxes on married females significantly. To see this, consider a married household with kids with total income equal to twice mean household income, and suppose earnings of both members are equal. Under the current system, this household faces a marginal tax rate of about 26.0%. The marginal tax rate declines to about 21% if the household income is split equally between husband and wife. The gain is larger for the majority of wives who earn less than their husbands.

The effects of a move from the current system to separate filing are substantial. Table 13 shows that aggregate output goes up by about 4.2%, and aggregate labor by 2.6%. This is

[24] We estimate a tax function for heads of households with one child, resulting in parameters $\eta_1 = 0.128$ and $\eta_2 = 0.082$. In stationary equilibrium after the reform, a tax of 0.3% is needed to achieve revenue-neutrality.

more than half of the increase associated with a proportional income tax reform. In contrast to a proportional income tax reform, however, the increase in aggregate labor is almost fully driven by the rise in aggregate hours by married females. The labor force participation of married females rises by 10.1% (more than twice as much as it does with a proportional income tax), and aggregate hours by married females increase by about 11.2%. In contrast, hours by male workers decline slightly. As it is shown in Table 14, separate filing generates significant increases in labor force participation and declines in gender gap for exactly the same groups that were affected by proportional taxes, married females with less education and with children, but with much larger magnitudes.

Why does married female labor force participation react so much with separate filing? The key is that separate filing reduces the tax burden associated with female labor force participation dramatically. Table 15 shows the *extra* taxes that a household has to pay as a fraction of the extra income that a female generates for younger households (aged 25-34). In the benchmark economy, the tax burden associated with female labor force participation is quite similar for females with different characteristics. It is larger for females with more education and for those who do not have any children. With separate filing, the situation is radically different.[25] Now females with lower education as well as those with children face much lower tax rates associated with movements along the extensive margin. Not surprisingly, their labor force participation increases dramatically. Incidentally, these are the groups that have the largest potential response to a tax reform.

The main message from this policy experiment is quite clear. A move from the current system to one in which individuals (not households) are the basic unit of taxation goes a long way in generating significant effects on aggregate labor and output. These effects take place without eliminating tax progressivity, or the taxation of capital income, and depend critically on the response of married females. These and previous findings motivate us to explicitly quantify the relative importance of married females as a group for our results. We do this in the next section.

6 The Role of Married Females

We now discuss in more detail the impact of changes in labor supply of married females. We ask: what is the overall contribution of married females to changes in labor supply? What is the importance of labor supply changes along the extensive margin?

[25] In the proportional tax reform case, the extra taxes associated to further labor market participation naturally amount to the equilibrium tax rate (13.6%).

In answering these questions, we first note that the type of the tax reform under consideration is critical. As expected from the results in the previous section, the role of married females is largest with a move to separate filing. Table 16 makes these points clear. In this table we report the contribution of married females to changes in total hours and total labor supply under our benchmark calibration. For proportional income taxes, the contribution of married females to changes in total hours (labor supply) is around 51% (49%). Under separate filing they contribute to more than 100% of the changes in total hours and labor supply, as some groups effectively reduce their hours (e.g. men). We conclude from these findings that the overall contribution of married females to hours and labor supply changes is substantial; they contribute disproportionately given their share of the working age population (about 37.5%).

In the bottom panel of Table 16 we focus on the role of the extensive margin and report its contribution to the rise in hours and total labor supply. In order to calculate the role of extensive margin, we count both the hours worked by married females who enter the labor market, taking into account those who may stop participating. Concretely, for each age and (a, x, h, z, q, b)-type married woman, we first determine if labor force participation for this type is different between the pre and post reform economies. If the change in participation is positive and a married woman enters the labor force after a reform, we weigh the change in participation by the hours she works (or the total labor she supplies) under the new tax system. Summing up over all such households gives us the total rise in hours (or in labor supply) due to extensive margin. If, on the other hand, the change is negative and a married woman stops working, we weigh the change in participation by the hours she worked (or total labor she supplied) in the benchmark economy. The difference between these two sums gives us the *net* change in hours (or total labor supply) due to the extensive margin. Using this measure, the extensive margin contributes about 41% of the changes in total hours under a proportional income taxes, and nearly all changes in hours under separate filing. For changes in labor supply, the contributions are about 40% and more than 100%, respectively. By this measure, these calculations suggest that the bulk of the rise in the labor supply of married females can be attributed to movements along the extensive margin.

Married Females with Children How much of the increase in extensive margin and aggregates hours can be attributed to married females with children? As our results in Tables 13 and 14 show their labor supply increase more than married females without children. In order to highlight the role of females with children, we report in Table 16 the contribution of married females with children to overall changes in hours and labor supply.

As the table demonstrates, the contribution of this group is substantial. Under a proportional tax, married females with children account for about 21% and 19% of the changes in hours and labor supply. In line with our previous discussion, these figures are bigger under a single-filing reform: 60% and 38%, respectively.

To isolate further the contribution of married females with children we focus on the separate filing case, and consider the following version of it. Suppose only married females *without children* are allowed to file separately, while married females with children file taxes as they did in our benchmark economy. Not surprisingly, labor supply responses are much more muted with this reform. The labor force participation of married females increases by 1.9% (in contrast to 10.1% in separate filing reform) and aggregate labor supply increases by 0.9% (in contrast to 2.6%), respectively. Hence, when we do not allow married females with children to file separately the effect on married female labor force participation is about 80% smaller, while the effects on aggregate labor are smaller by 75%. Hence, not only married females account for a large part of the changes in labor supply, a large part of this change comes from married females with children.

7 The Importance of the Intertemporal Elasticity

We now turn our attention to the role of the preference parameter γ; the *micro* intertemporal elasticity of labor supply. For these purposes, we report results for the value on the low side of the empirical estimates for this parameter ($\gamma = 0.2$), and calibrate the rest of the parameters following the procedure discussed in Section 4. The main results are summarized in Table 17. Our central findings are that while changes in hours per-worker are lower than under $\gamma = 0.4$, the relative importance of changes along the extensive margin is *larger* under $\gamma = 0.2$. As a result, the response of aggregate hours (and output) across steady states is *not* critically affected by a lower intertemporal elasticity.

Consider first the proportional income tax reform. As we have documented in Table 16, with $\gamma = 0.4$ at least 40% of the increase in aggregate labor supply was due to higher labor force participation by married females (i.e. due to extensive margin), while the rest came from higher per-worker hours. With a lower γ, changing labor supply along the intensive margin is more costly and therefore, changes along this margin are now about 50% lower than they were with a higher γ. However, aggregate hours (output) still increase by as much as 3.7% (5.8%), or about 77% (79%) of its increase with a high γ. This occurs since the increase along the extensive margin is now higher; the labor force participation of married females increases by 5.8% in contrast to a 4.9% increase under the high γ value. The net result is that the increase in aggregate hours by married females is not much affected by a lower γ. With an extensive margin playing a larger role now, the contribution of married females to changes in labor hours and labor supply goes up. As Table 17 shows, while the contribution of married females to changes in hours was 51.9% under $\gamma = 0.4$, it is now 63.3%.

The effects of a lower γ are of a similar nature for the separate filing case. Again, households react much less along the intensive margin and the bulk of the adjustment takes place via changes in labor force participation. While hours per-working female are now constant across steady states, aggregate hours increase by 2.9% which is about 80% of the increase with high γ. With changes in hours not much affected, the effects on output is nearly the same for low and high γ values (4.1% versus 4.2%).

The message from this experiment is clear. Since adjusting along the intensive margin is costlier with a low γ, married households find it optimal to adjust hours worked largely along the extensive margin. This, in conjunction with the fact that the model under $\gamma = 0.2$ has still to respect the underlying data on labor force participation, renders the substantial response of married females, which results in the similar changes in aggregate hours and output discussed above.

8 Concluding Remarks

In this paper we study the consequences of tax reforms for the US economy, taking seriously into account the life-cycle labor supply decisions of married females, the presence of children, 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, where two-earner households face explicit labor supply decisions along both intensive and extensive margins.

Our results have clear implications for policy. First, our analysis demonstrates that reforms that change the unit of taxation from households to individuals can have substantial consequences on labor supply and output. Reforms of this sort respect the underlying nature of tax progressivity and do not rely on the elimination of taxes on capital income. They do not require large changes in other taxes to balance the budget, and can be easily implemented out of existing tax schedules. As a result, such reforms could be politically easier to undertake, while delivering large effects on output and labor supply.

A second implication relates to the interplay between distorting taxes, and other non-tax barriers to female labor force participation. Such barriers include the restrictive regulation of temporary work, and product market distortions such as restrictions on shopping hours, that are common in several developed economies. If married females drive the bulk of hour changes associated to tax reforms, these obstacles to increasing participation can interact with changes in the tax structure, and prevent the large predicted changes in labor supply to materialize. From this perspective, a more complete analysis of taxation and labor supply should study these issues. We leave this and other extensions for future work.

8.1 Appendix: Definition of Equilibrium

Let $\psi_j^M(B,x,h,z,q,b)$ denote the number of married individuals of age j with assets $a \in B$, when the female is of type x and h, the male is of type z, the household faces a utility cost q of joint work, and is of child bearing type b. This function (measure) is defined for all Borel sets $B \in \mathcal{A}$, all $x,h,z,q,b \in X \times H \times Z \times Q \times \{0,1,2\}$. The measures $\psi_{f,j}^S(B,x,h,b)$ (single females) and $\psi_{m,j}^S(B,z)$ (single males) are defined in similar way.

Let $\chi\{.\}$ denote the indicator function. Let the functions $g^S(a,x,h,b,j)$ and $g^M(a,x,h,z,q,b,j)$ describe the evolution of the female type x over the life cycle. For $j>1$,

$$g^M(a,x,h,z,q,b,j) = G(x,h,l_f^M(a,x,h,z,q,b,j-1),j-1)$$

$$g^S(a,x,h,b,j) = G(x,h,l_f^S(a,x,h,b,j-1),j-1)$$

The measures defined above obey the following recursions:

Married agents

$$\psi_j^M(B,x,h',z,q,b) = \sum_h \int \psi_{j-1}^M(a,x,h,z,q,b)\chi\{a^M(.\ ,\ j-1) \in B,\ h' = g^M(.\ ,\ j-1))\}da,$$

for $j>1$, and

$$\psi_1^M(B,x,h,z,q,b) = \begin{cases} M(x,z)\lambda_b^M(x,z)\zeta(q|z) \text{ if } 0 \in B,\ h=\eta(x) \\ 0,\ \text{otherwise} \end{cases}$$

Single female agents

$$\psi_{f,j}^S(B,x,h',b) = \sum_h \int \psi_{f,j-1}^S(a,x,h,b)\chi\{a_f^S(.\ ,\ j-1) \in B, h' = g^S(.\ ,\ j-1)\}da,$$

for $j>1$, and

$$\psi_{f,1}^S(B,x,h,b) = \begin{cases} \phi(x)\lambda_b^S(x) \text{ if } 0 \in B,\ h=\eta(x) \\ 0,\ \text{otherwise} \end{cases}.$$

Single male agents

$$\psi_{m,j}^S(B,z) = \int \psi_{m,j-1}^S(a,z)\chi\{a_m^S(.\ ,\ j-1) \in B\}da,$$

for $j>1$, and

$$\psi_{m,1}^S(B,z) = \begin{cases} \omega(z) \text{ if } 0 \in B \\ 0,\ \text{otherwise} \end{cases}.$$

Equilibrium Definition For a given government consumption level G, social security tax benefits $p^M(x,z)$, $p_f^S(x)$ and $p_m^S(z)$, 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 $\Omega(z)$, $\Phi(x)$, $M(x,z)$, a *stationary equilibrium* consists of prices r and w, aggregate capital (K), aggregate labor (L), labor used in the production of goods (L_g), household decision rules $l_f^M(a,x,h,z,q,b,j)$, $l_m^M(a,x,h,z,q,b,j)$, $l_m^S(a,z,j)$, $l_f^S(a,x,h,b,j)$, $a^M(a,x,h,z,q,b,j)$, $a_m^S(a,z,j)$ and $a_f^S(a,x,h,b,j)$, measures ψ_j^M, $\psi_{f,j}^S$, and $\psi_{m,j}^S$, such that

1. Given tax rules and factor prices, the decision rules of households are optimal.
2. Factor prices are competitively determined; i.e. $w = F_2(K, L_g)$, and $r = F_1(K, L_g) - \delta_k$.
3. Factor markets clear; i.e. equations (10), (11) and (12) in the text hold.
4. The measures ψ_j^M, $\psi_{f,j}^S$, and $\psi_{m,j}^S$ are consistent with individual decisions.
5. The Government Budget and Social Security Budgets are Balanced; i.e.,

$$\begin{aligned} G &= \sum_j \mu_j [\sum_{x,h,z,q,b} \int_A T^M(.)\psi_j^M(a,x,h,z,q,b)da + \sum_z \int_A T^S(.)\psi_{m,j}^S(a,z)da \\ &+ \sum_{x,h,b} \int_A T^S(.)\psi_{f,j}^S(a,x,h,b)da + \tau_k K], \end{aligned}$$

and

$$\begin{aligned} &\sum_{j \geq J_R} \mu_j [\sum_{x,h,z,q,b} \int_A p^M(x,z)\psi_j^M(a,x,h,z,q,b)da + \sum_{x,b} \int_A p_f^S(x)\psi_{f,j}^S(a,x,h,b)da \\ &+ \sum_z \int_A p_m^S(z)\psi_{m,j}^S(a,z)da] \\ = \;& \tau_p w L \end{aligned}$$

Table 1: Initial Productivity Levels, by Type, by Gender

	Males (z)	Females (x)	x/z
hs	0.640	0.511	0.799
sc	0.802	0.619	0.771
col	1.055	0.861	0.816
col+	1.395	1.139	0.817

Note: Entries are the productivity levels of males and females, ages 25-29, using 2000 data from the U.S. Census. These levels are constructed as weekly wages for each type –see text for details.

Table 2: Labor Market Productivity Process for Females (α_j^x)

	hs	sc	col	col+
25-29	0.129	0.153	0.207	0.145
30-34	0.091	0.109	0.134	0.111
35-39	0.061	0.076	0.013	0.085
40-44	0.036	0.050	0.043	0.064
45-49	0.014	0.027	0.009	0.047
50-54	-0.008	0.006	-0.025	0.032
55-60	-0.029	-0.014	-0.062	0.019

Note: Entries are the parameters α_j^x for process governing labor efficiency units of females over the life cycle – see equation (13). These parameters are the growth rates of male wages.

Table 3: Distribution of Married Working Households by Type

	Females			
Males	hs	sc	col	col+
hs	26.38	10.9	2.63	0.7
sc	8.01	14.54	5.21	1.38
col	2.13	5.55	9.59	2.79
col+	0.59	1.77	4.1	3.73

Note: Entries show the fractions of marriages out of the total married pool, by wife and husband educational categories. The data used is from the 2000 U.S. Census, ages 30-39. Entries add up to 100. –see text for details.

Table 4: Fraction of Agents by Type, by Gender and Marital Status

	Males			Females		
	All	Married	Singles	All	Married	Singles
hs	40.63	31.27	9.36	37.18	28.57	8.61
sc	29.16	22.44	6.72	33.21	25.23	7.99
col	20.23	15.45	4.78	20.71	16.59	4.12
col+	9.98	7.85	2.13	8.90	6.61	2.29

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.

Table 5: Childbearing: Single Females

	Childless	Early	Late
hs	29.44	59.27	11.29
sc	34.80	48.40	16.80
col	53.04	31.45	15.31
col+	70.56	8.33	21.11

Note: Entries show the distribution of childbearing among single females, using data from the CPS-June supplement. See text for details.

Table 6: Childbearing: Married Couples

Childless					Early				
	Females					Females			
Male	hs	sc	col	col+	male	hs	sc	col	col+
hs	9.29	10.63	14.63	18.47	hs	68.03	59.90	42.14	42.39
sc	10.44	10.29	12.95	15.30	sc	60.74	59.91	38.72	29.38
col	8.05	10.64	11.48	13.85	col	59.78	54.13	32.46	19.62
col+	7.79	9.89	8.99	13.13	col+	56.73	39.50	31.30	23.98

Note: Entries show the distribution of childbearing among married couples. For childlessness, data used is from the CPS-June supplement. For early childbearing, the data used is from the U.S. Census. Values for late childbearing can be obtained residually for each cell. See text for details.

Table 7: Tax Function Parameters

	$\widehat{\eta}_1$	$\widehat{\eta}_2$	R^2
Married (no children)	0.132	0.073	0.998
Married (two children)	0.108	0.090	0.992
Single (no children)	0.168	0.057	0.976
Single (two children)	0.118	0.092	0.947

Note: Entries show the parameter estimates for the postulated tax function. These result from regressing effective average tax rates against household income, using 2000 micro data from the U.S. Internal Revenue Service. For singles with two children, the data used pertains to the 'Head of Household' category – see text for details.

Table 8: Social Security Incomes: Singles

	Males	Females
hs	1	0.914
sc	1.173	1.059
col	1.213	1.067
col+	1.291	1.066

Note: Entries show Social Security incomes, normalized by the mean Social Security income of the lowest type male, using data from the 2000 U.S. Census. See text for details.

Table 9: Social Security Incomes: Married

	Females			
Males	hs	sc	col	col+
hs	1.755	1.874	1.969	1.879
sc	1.888	1.996	1.978	2.141
col	2.012	2.057	2.096	2.200
col+	2.033	2.110	2.175	2.254

Note: Entries show the Social Security income, normalized by the Social Security income of the single lowest type male, using data from the 2000 U.S. Census. See text for details.

Table 10: Labor Force Participation of Married Females, 25-54

	Females			
Males	hs	sc	col	col+
hs	58.2	75.9	82.7	82.3
sc	64.6	74.8	82.9	88.4
col	61.6	68.7	73.2	83.2
col+	55.0	62.1	63.5	78.7
Total	59.7	73.4	74.8	82.1

Note: Each entry shows the labor force participation of married females ages 25 to 54, calculated from the 2000 U.S. Census. The outer row shows the weighted average for a fixed male or female type.

Table 11: Parameter Values

Parameter	Value	Comments
Population Growth Rate (n)	1.1	U.S. Data - see text.
Discount Factor (β)	0.976	Calibrated - matches K/Y
Intertemporal Elasticity (Labor Supply) (γ)	0.4	Literature estimates.
Disutility of Market Work (B)	8.03	Calibrated - matches hours per worker
Time cost of Children ($\varkappa$)	0.141	Calibrated – matches LFP of married females with young children
Dep. of human capital, females (δ)	0.0961	Eckstein and and Wolpin (1989)
Growth of human capital, females (α_j^x)	-	Calibrated - see text.
Capital Share (α)	0.343	Calibrated - see text.
Depreciation Rate (δ_k)	0.055	Calibrated - see text.
Payroll Tax Rate (τ_p)	0.086	U.S. Data - see text.
Social Security Income ($p_m^S(x_1)$) (lowest type single male)	17.8%	% household income - balances budget
Capital Income Tax Rate (τ_k)	0.097	Calibrated - matches corporate tax collections
Distribution of utility costs $\zeta(.\vert z)$	–	Gamma Distribution - matches LFP by education conditional on husband's type

Table 12: Model and Data

Statistic	Data	Model
Capital Output Ratio	2.93	2.96
Labor Hours Per-Worker	0.401	0.401
Labor Force Participation of Married Females with Young Children (%)	55.7	56.2
Participation rate of Married Females (%), 25-54		
Less than High School	59.7	59.9
Some Collge	73.4	72.6
College	74.8	79.4
More than College	82.1	81.3
Total	69.4	70.1
With Children	67.4	64.2
Without Children	82.5	82.9

Note: Entries summarize the performance of the benchmark model in terms of empirical targets and key aspects of data. Total participation rates, with children and without children are not explicitly targeted.

Table 13: Tax Reforms

	Proportional Income	Separate Filing
Married Female LFP	4.8	10.1
Married Female LFP with young children	12.3	30.1
Aggregate Hours	4.8	2.8
Aggregate Hours (married females)	9.0	11.2
Hours per worker (female)	3.8	0.5
Hours per worker (male)	3.1	-0.2
Aggregate Labor	4.8	2.6
Capital/Output	4.7	3.0
Aggregate Output	7.2	4.2
Tax Rate	13.6	0.3

Note: Entries show the steady-state effects of replacing current income taxes via the specified reforms. The values for "Tax Rate" correspond to the proportional rates that are necessary to achieve budget balance.

Table 14: Effects on Labor Force Participation and Gender Gap

	Proportional Income Tax		Separate Filing	
	LFP (increase)	Gender Gap (decline)	LFP LFP (increase)	Gender Gap (decline)
Education				
High School	8.0	4.2	19.8	10.5
Some Collge	4.5	1.9	8.3	4.3
College	1.8	0.8	3.1	1.9
More than College	2.1	0.9	2.9	1.5
Child Bearing Status				
$b = 0$, childless	2.3	0.7	2.0	0.9
$b = 1$, early child bearer	7.6	3.5	14.6	7.2
$b = 2$, late child bearer	1.9	0.7	7.1	2.9

Note: Entries show the steady-state effects of replacing current income taxes on labor force participation rates and the wage gender gap (defined as the ratio of average wages within each group).

Table 15: Tax Burden from Female Labor Force Participation, 25-30

	Benchmark Economy	Separate Filing
Education		
High School	17.2	5.3
Some Collge	18.0	6.5
College	19.8	10.0
More than College	21.0	12.4
Child Bearing Status		
$b = 0$, childless	19.2	13.0
$b = 1$, early child bearer	17.6	4.5
$b = 2$, late child bearer	19.2	9.1

Note: Entries show the *additional* taxes associated to labor force participation for younger workers, in the benchmark economy and in the separate filing case. Additional taxes are reported as a fraction of household income.

Table 16: Role of Females

	Proportional Income	Separate Filing
Panel A: Total Changes		
Δ in Married Female Hours	51.1	108.3
(% of Total Δ in Hours)		
Δ in Married Female (w/ children) Hours	21.4	59.5
(% of Total Δ in Hours)		
Δ in Married Female Labor	48.5	108.3
(% of Total Δ in Labor)		
Δ in Married Female (w/ children) Labor	18.6	51.0
(% of Total Δ in Hours)		
Panel B: Extensive Margin		
Δ in Married Female Hours	40.8	106.5
(% of Total Δ in Hours)		
Δ in Married Female Labor	39.7	105.6
(% of Total Δ in Labor)		

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 17: Reforms with Low Intertemporal Elasticity

	Proportional Income	Separate Filing
Married Female LFP	5.8	10.1
Married Female LFP with young children	9.1	26.7
Aggregate Hours	3.7	2.9
Aggregate Hours (married females)	8.1	10.5
Hours per worker (female)	2.1	0
Hours per worker (male)	1.9	-0.2
Capital/Output	4.2	2.9
Aggregate Labor	3.5	2.7
Aggregate Output	5.8	4.1
Δ in Married Female Hours (% of Total Δ in Hours)	63.3	1.038
Δ in Married Female Labor (% of Total Δ in Labor)	59.0	1.031

Note: Entries show the steady-state effects of replacing current income taxes via the specified reforms under a low value of the intertemporal elasticity parameter ($\gamma = 0.2$). The values for "Tax Rate" correspond to the proportional rates that are necessary to achieve budget balance.

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Figure 1: Taxes and Labor Force Participation of Secondary Earners

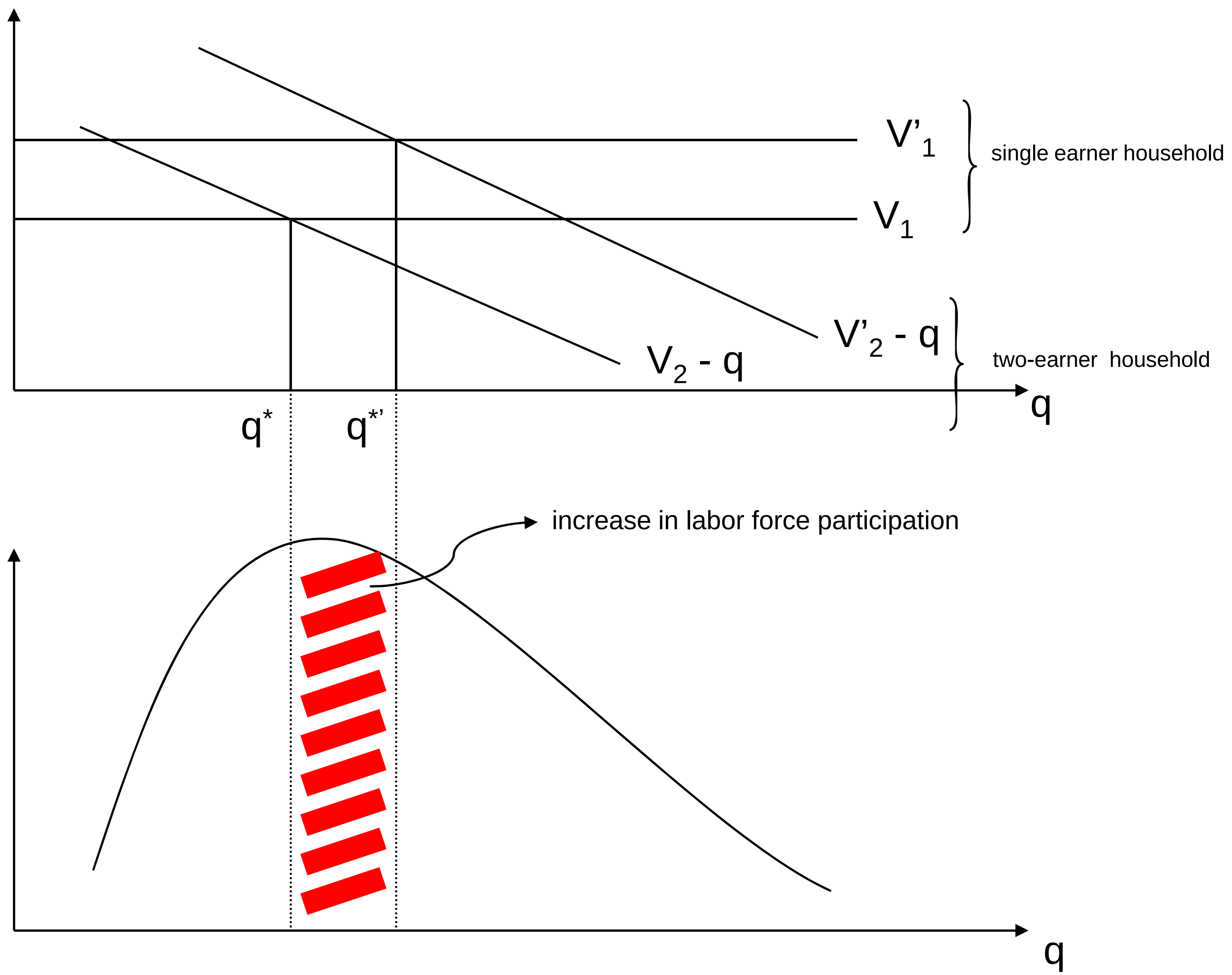
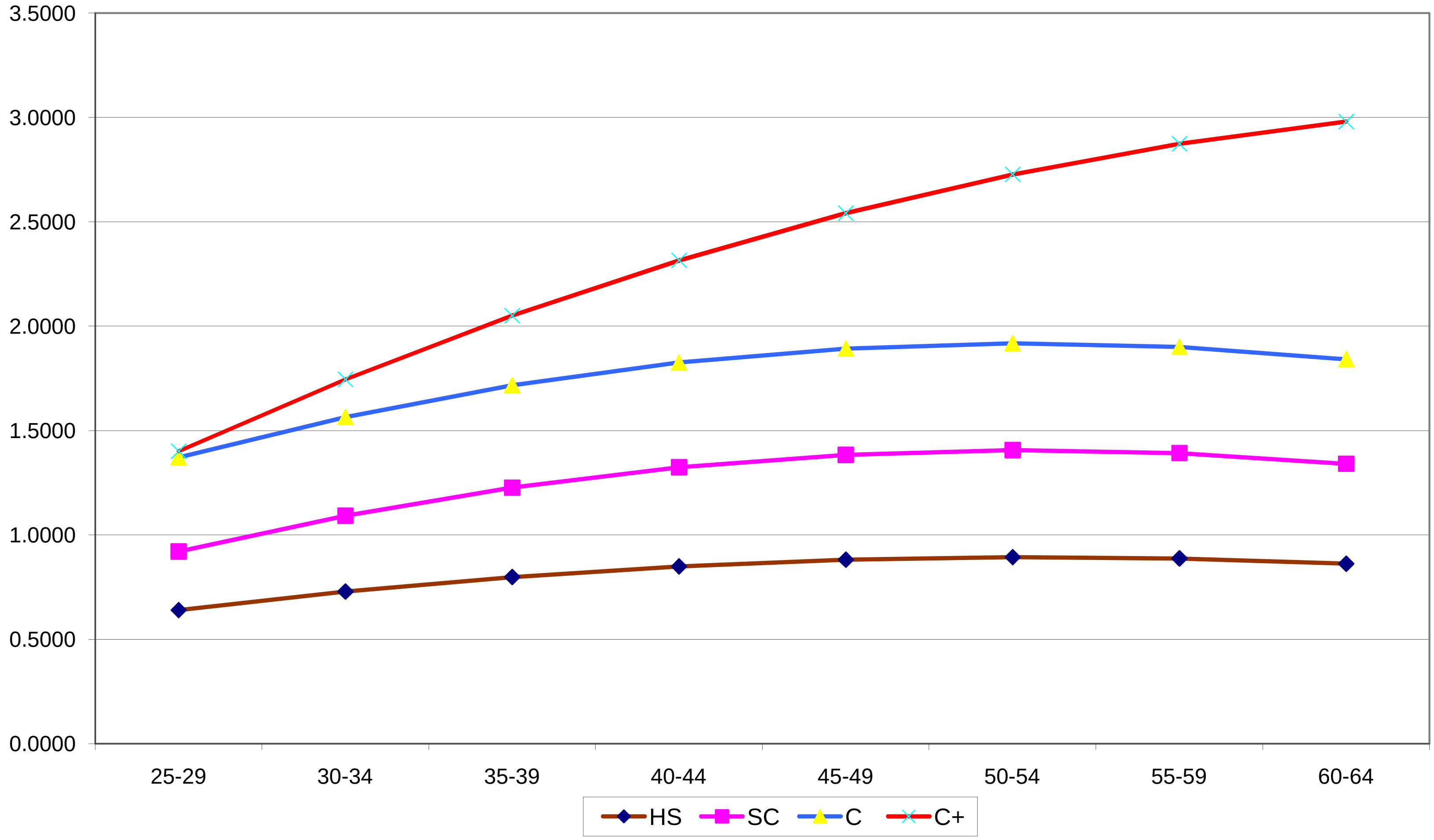


Figure 2 -- Labor Productivity Levels, Males



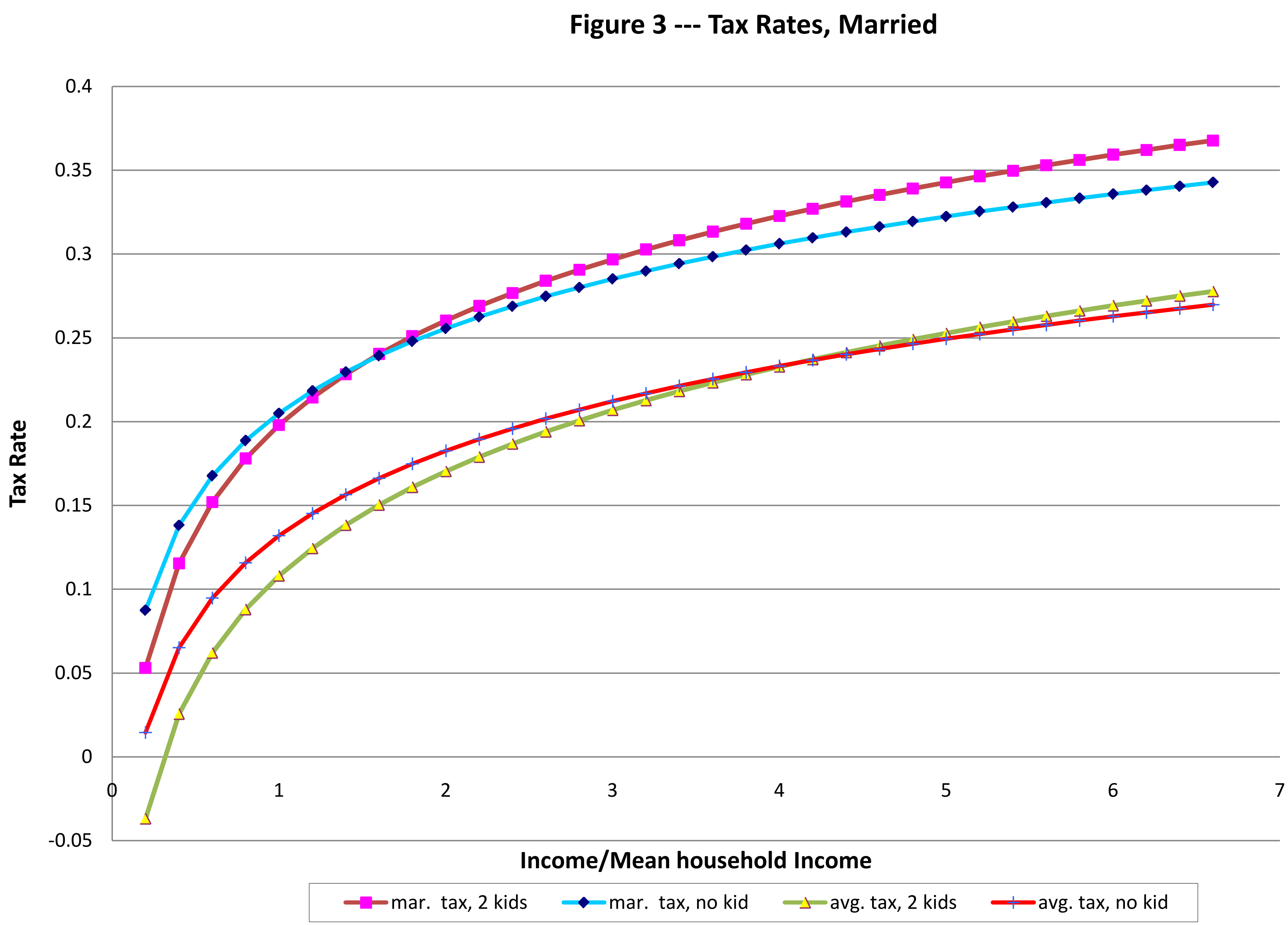
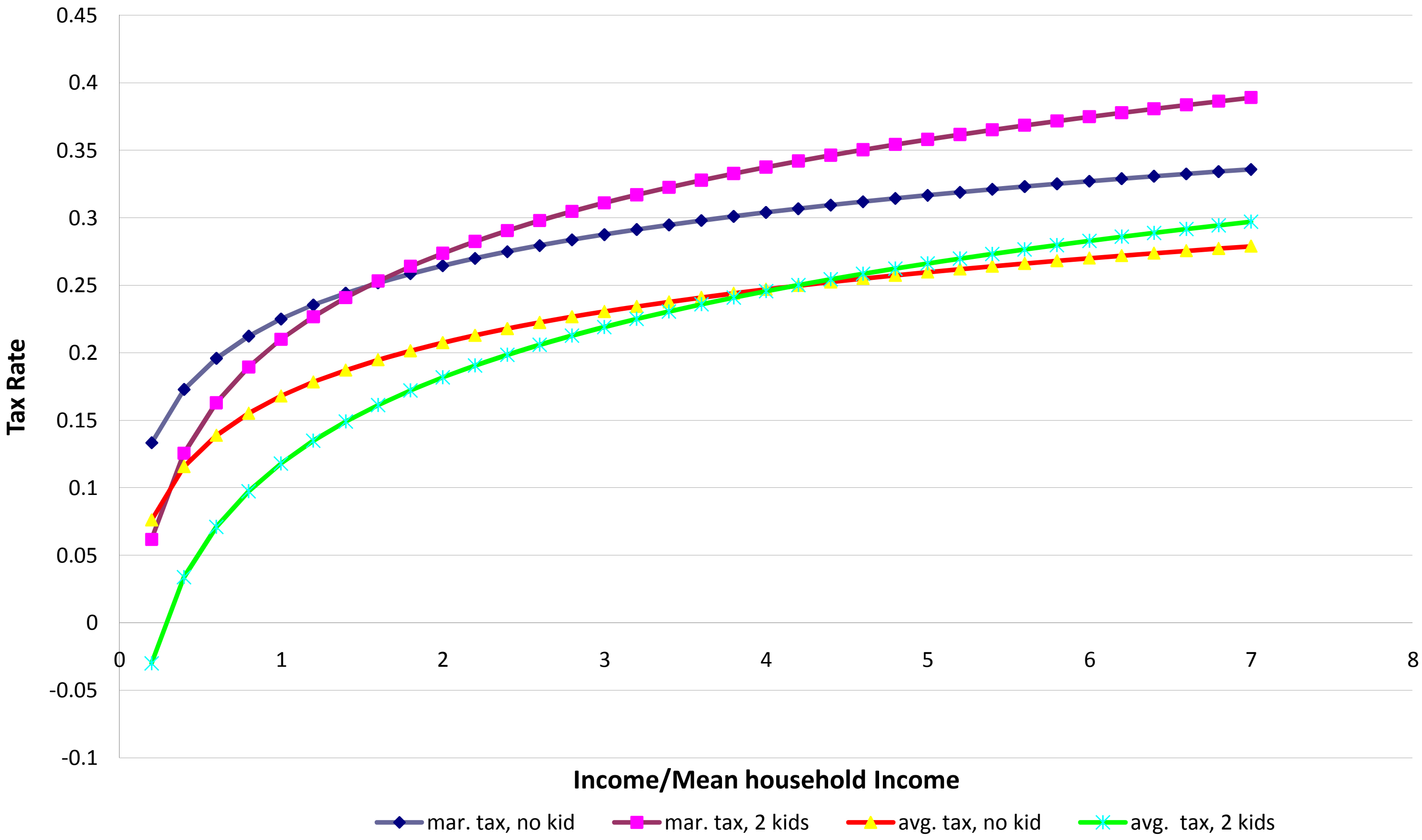


Figure 3 --- Tax Rates, Married
Tax Rate
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
-0.05
0
1
2
3
4
5
6
7
Income/Mean household Income
mar. tax, 2 kids
mar. tax, no kid
avg. tax, 2 kids
avg. tax, no kid

Figure 4 --- Taxes, Singles



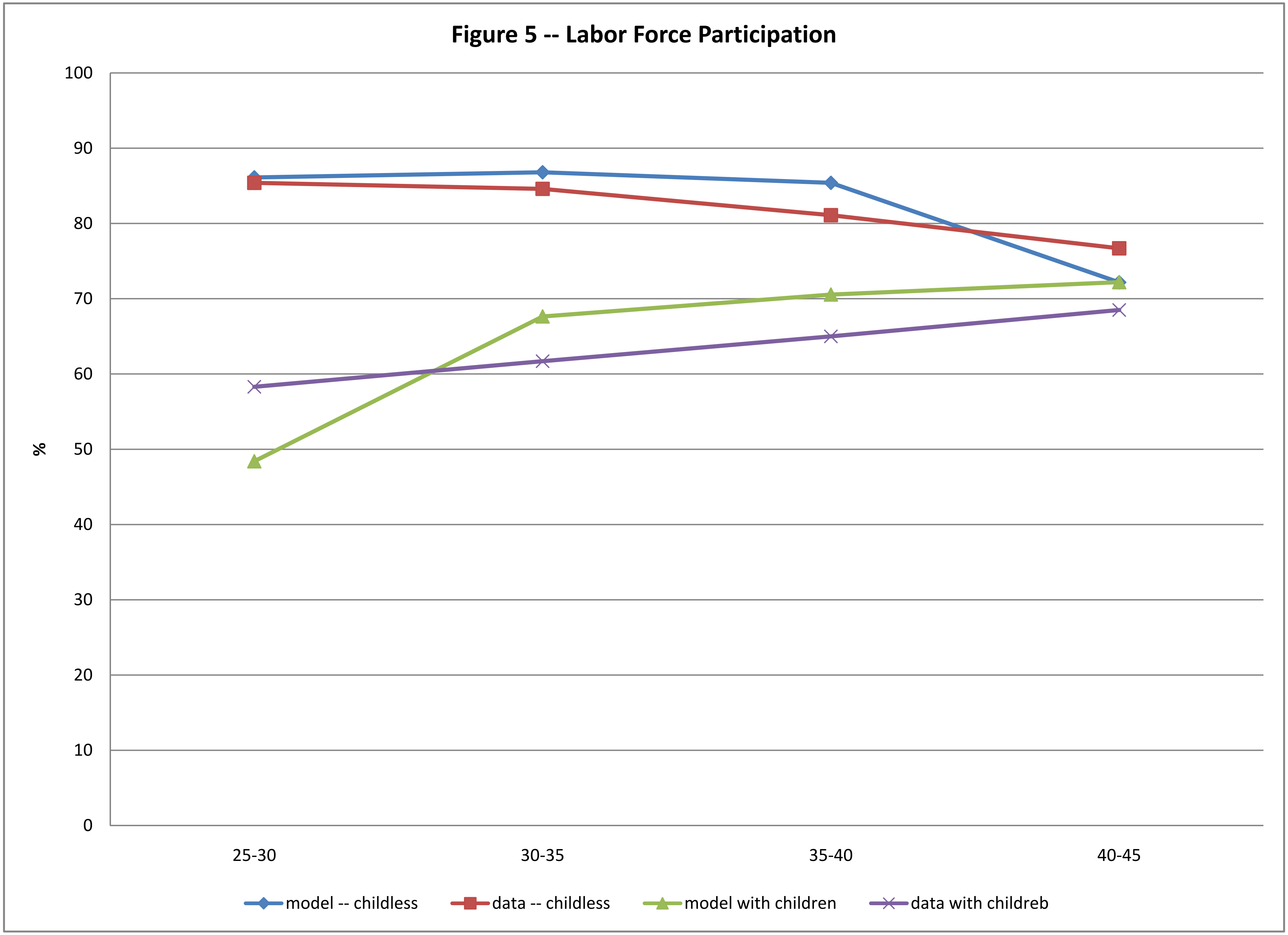


Figure 5 -- Labor Force Participation
100
90
80
70
60
50
40
30
20
10
0
%
25-30
30-35
35-40
40-45
model -- childless
data -- childless
model with children
data with childreb

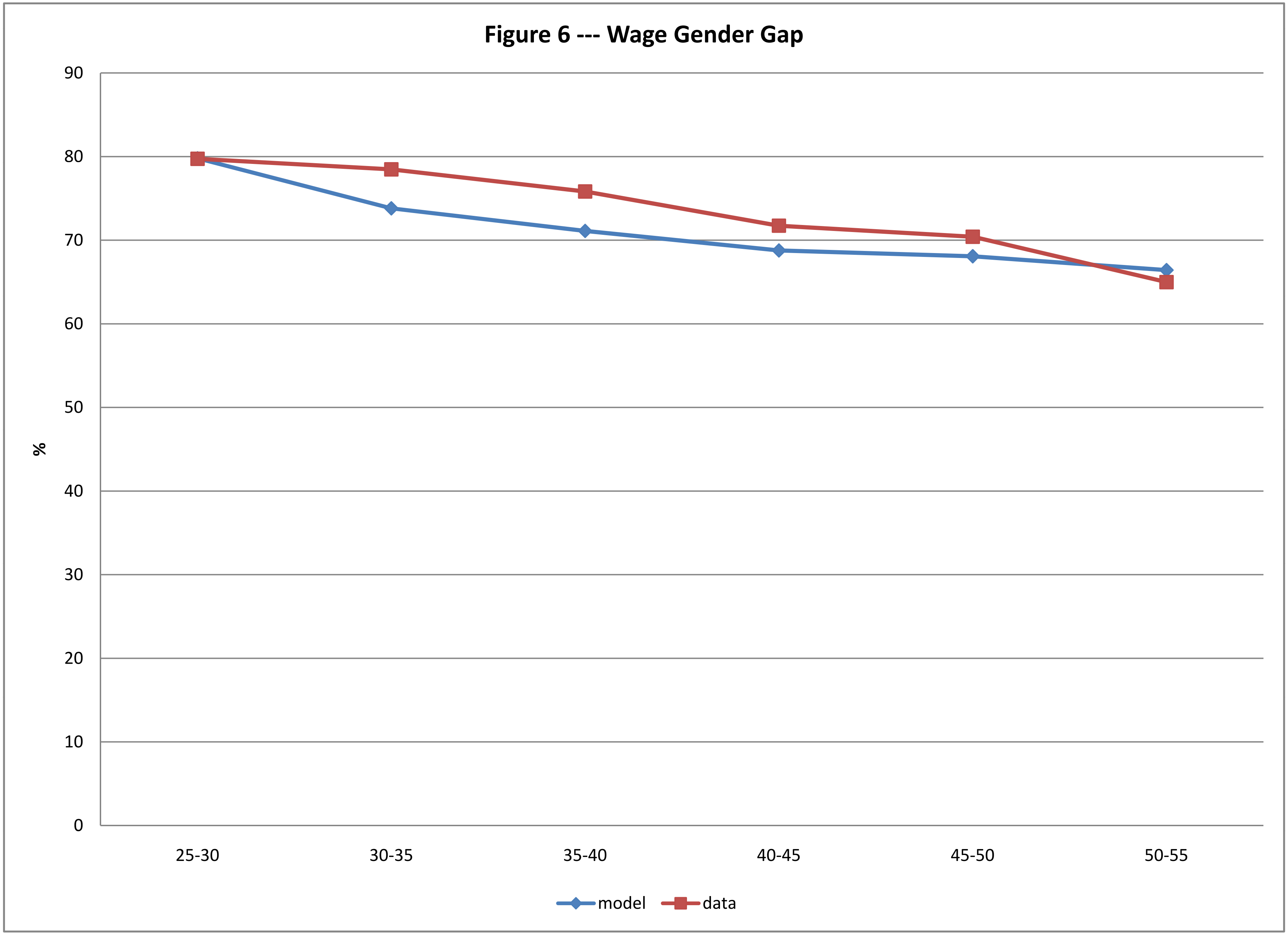


Figure 6 --- Wage Gender Gap
90
80
70
60
50
40
30
20
10
0
%
25-30
30-35
35-40
40-45
45-50
50-55
model
data