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TAXATION AND THE HOUSEHOLD

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Abstract

This thesis consists of three chapters. The first chapter is about implications of tax reforms of 1980's on married females' labor force participation. The Economic Recovery Act of 1981 and the Tax Reform Act of 1986 changed the U.S. income tax structure in a dramatic fashion. These two reforms reduced the marginal tax rates for married households. In this paper I build a heterogeneous agent model populated by married households. Households differ by age and educational attainment levels of their members and decide whether the second earner, the wife, should participate in the market. I select parameter values so that the model economy is consistent with the 1980 U.S. economy in terms of income tax structure, wages (skill premium and gender gap), marital sorting (who is married with whom), and female labor force participation. In order to find the contribution of tax reforms to the rise in married female labor force participation, I simulate an economy with taxes of 1980 and allow wages and marital sorting take 1990 values. I show that about 28% of the rise in married female labor force participation (from 59% to 70%) between 1980 and 1990 can be accounted for by the changes in the income tax structure.

The second chapter, written with Nezih Guner and Gustavo Ventura, studies the aggregate implications of different tax reforms with a new perspective. We develop a dynamic setup with heterogeneous married and single households, and with an operative extensive margin in labor supply. We restrict our model with observations on gender and skill premia, labor force participation across skill groups, and the structure of marital

sorting. We then use this model to evaluate hypothetical reforms to the U.S. tax system. Replacing current income taxes by a proportional consumption tax increases steady-state output by about 10.5%. This increase is accompanied by differential effects on labor supply: while per-worker hours increase by about 3.0%, the labor force participation of secondary earners increases by 4.6% and married females increase their total hours by 7.6%. Married females account for about 51% of the total increase in labor hours. When current income taxes are replaced by a progressive consumption tax, married females account for a much larger (65.2%) share of the total increase in labor hours. Our results also show that the extent of the labor force participation by secondary earners, the wage structure (gender gap and skill premia), as well as the composition of pool of married individuals (who is married with whom) in the pre-reform economy affect aggregate outcomes in significant ways.

The final chapter studies the implications of two important rules of Social Security System. The existing social security system in the U.S. has a special provision for married households: a spouse can choose between own benefits and half of the spouse's benefits. Another feature of the system is the progressive calculation of benefits: benefits are determined by a concave function of past mean earnings. I develop an equilibrium life-cycle model to quantify the aggregate, cross-sectional, and welfare implications of three alternatives: elimination of the spousal benefit, elimination of the progressivity of benefits, and the two combined. Agents start out as permanently married or single and with education levels and wage profiles, where the latter depend both on education and gender. The household is the decision maker and decides on the labor supply of its member(s) and saving. The aggregate production function has as inputs capital and

labor aggregated by efficiency. Eliminating the spousal benefit provision has substantial effects. The labor force participation of married women increases by 4.5% and households composed of men with relatively high education and women with relatively low education experience significant welfare losses. When only progressivity is eliminated, there is a decline in labor force participation of married females and households composed of men with relatively high education and women with relatively low education experience significant welfare gains. When both are eliminated, the labor force participation of married women increases and households composed of two members with high education gain most.

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I dedicate this thesis to my mother Leyla, my sister Gulsah, my brother Ahmet, my aunt Gul and to my love Esra.

Chapter 1

Taxes and Female Labor Supply

1.1 Introduction

The U.S. income tax structure has changed dramatically during the 1980s. This change was result of two landmark legislations, the Economic Recovery Tax Act of 1981 (ERTA) and the Tax Reform Act of 1986 (TRA). These reforms lowered marginal statutory tax rates significantly and reduced the number of tax brackets from 16 to 4. Figure 1.1 shows marginal statutory income tax schedules for married households filing jointly before and after each tax reform. Although these changes affected all tax payers, high income earners realized the largest benefits from these reforms. The top marginal tax rate declined from 70 percent to 31 percent whereas marginal tax rate that a married household with mean income faces dropped from 37 percent to 28 percent.

A critical aspect of these tax reforms is their effect on labor supply behavior. Possibly the most important recent change in the U.S. labor markets is the drastic rise in labor force participation of married women. In the second half of the twentieth century the participation rate of married women more than tripled. In particular, between 1980 and 1990, the decade of these tax reforms, the labor force participation of married women between ages 20 and 59 has increased from 59 to 70 percent. During the same period weekly market hours per working married women increased from about 32 hours per week to 36 hours as well.

A reduction in income tax rate affects labor supply behavior in two ways. First, it increases the rewards of supplying additional hours for workers. This may or may not increase the labor supply depending on whether the substitution or the income effect dominates. The second effect is on participation margin. For people who are out of the labor force, benefit of participating in the labor market increases with lower taxes. A well-known feature of the U.S. tax system is that primary and secondary earners in a married household are not treated equally. The marginal tax rate that the second earner faces for the first dollar of her/his earnings is the rate that the primary earner faces for the last dollar of his/her earnings. As a result, a large reduction in the marginal tax rates can create significant participation incentives for secondary earners if she/he is not in the labor force.[1] Since the majority of secondary earners are married women, about 96 percent were even in 1990, ERTA and TRA were likely to play an important role in 11 percentage point rise in labor force participation of married women between 1980 and 1990.

During the 1980s, along with these tax reforms, there were also other changes in the U.S. economy that possibly affected the labor force participation rate of married women. First, the educational composition of married population has changed. During this period fraction of college graduate females has increased, while the fraction of females with less than a high school degree has declined.[2] Moreover, the degree of marital sorting

[1] For a review of incentive effects of the U.S. tax structure for married women, see McCaffery (1997).

[2] Overall, the fraction of college graduate individuals increased by almost 7 percentage points from 1980 to 1990; see Gottschalk (1997).

has increased.[3] Second, there were changes in the wage structure. Gender gap declined as the hourly earnings of married females have improved relative to hourly earnings of married men. This increased the opportunity cost of staying at home for married women. In this decade college premium has also increased.[4] Undoubtedly, these changes created additional incentives for the wives to enter the labor force as secondary earners.

In this paper I evaluate the contribution of the decline in the income tax rates, the changes in earnings and the changes in the educational composition of married population to 11 percentage point increase in the labor force participation of married women between 1980 and 1990. To do this, I first document, using the Current Population Survey (CPS) data, how earnings (by education, gender and age), and educational composition of households changed from 1980 to 1990. Then, I estimate effective tax functions for 1980 and 1990. I use the income tax data from Internal Revenue Service to estimate a smooth effective tax function which relates taxes paid to household income and allows me to determine the tax rate that households face at any income level. Next, I build a heterogeneous agent model populated by married households, in which households differ by age and educational attainment levels of their members. A household makes labor supply decisions for its members. Following Cho and Rogerson (1988), I assume that if the husband and the wife both participate in the labor market, the household incurs a fixed utility cost. I select parameter values so that the model economy is consistent with the 1980 U.S. economy in terms of income tax structure, wages (skill premium

[3] Schwartz and Mare (2005) documents the increase in marital sorting that took place since 1980s. See Fernandez and Rogerson (2001) for an analysis of the relation between rising marital sorting and long run income inequality in the U.S.

[4] See Gottschalk (1997) for an overview of changes in the U.S. earnings structure during this period.

and gender gap), marital sorting (who is married with whom), and female labor force participation. Then, I ask the following question: *If the households of the 1990 were taxed at 1980 rates, how much lower the participation rate of wives would be?*

The simulations suggest a substantial amount: about 28 percent of the increase in labor force participation of married women is due to the decline in the income tax rates. The remainder of the increase comes from the changes in wage profiles, while changes in the educational composition of households do not play a significant role. Furthermore, the decline in taxes account for about 22 percent of the rise in weekly hours per working married women, while the rest is again accounted for by changes in the earnings structure. Finally, the results show that higher labor force participation of married women results in lower own wage elasticities for married women in 1990 economy. This is consistent with the recent declines in own wage elasticities for married women, as documented by Blau and Khan (2005) and Heim (2005).

The impact of 1980's tax reforms on individual labor supply behavior is analyzed by a number of empirical papers. Burtless (1991) and Bosworth and Burtless (1992) investigate the labor supply effects of tax reforms in 1980's. They analyze the trend in labor supply for different demographic groups, from 1968 to 1988 and from 1968 to 1990, respectively, and find a significant break in labor supply trend of married women starting in 1981. They argue that this was a result of the Economic Recovery Act of 1981. Eissa (1995) studies the impact of Tax Reform Act of 1986 on labor supply responsiveness of married women. She shows that the labor supply of high-income married women increased as a result of this reform.[5] Moreover her results suggest that more than half of the responsiveness of the labor supply was on the participation margin. In a recent paper, Eissa, Kleven and Kreiner (2004) study labor supply and the welfare effects of more recent tax reforms, which include the introduction of Earned Income Tax Credit (EITC), on single mothers. Although the emphasis of their study is different, their results also show that distinguishing between intensive and extensive margin is critical and there is a large participation response by single mothers.[6]

The current paper is also related to several recent literatures. First, it is related to recent papers that look at the role of taxes in accounting for cross-country differences in labor supply behavior, e.g. Prescott (2004), Olovsson (2003), and Davis and Henrekson (2004), and Rogerson (2006).[7] Second, it is related to several papers that build general equilibrium models of fiscal policy. Using a general equilibrium framework, Ventura (1999) explores quantitative implications of a revenue neutral tax reform in which the current income and capital income tax structure in the U.S. is replaced by a flat tax. Finally, Altig and Carlstrom (1999) analyze the effects of 1986 tax reforms on income distribution. Both Ventura (1999) and Altig and Carlstrom (1999) use life-cycle frameworks with heterogenous, but single person, households.[8] Finally, it is related to papers

[5] In particular, Eissa (1995) looks at the labor supply response of married women in richest 1% of married households.

[6] Ziliak and Kniesner (2005) estimate labor supply effects of recent tax reforms within a life-cycle model. They show that even with a single-agent framework, the estimated wage elasticities can be quite high if one allows for complementarities between consumption and labor in utility.

[7] There is also a large literature that tries to explain the long run changes in the labor supply behavior of married women. See, among others, Greenwood, Seshadri, and Yorukoglu (2005), Fernandez, Fogli, and Olivetti (2004), and Jones, Manuelli, and McGrattan (2003). Guner and Greenwood (2004) study joint evolution of marriage and divorce together with rising market hours for married households.

[8] Among other recent paper that study tax reforms within dynamic heterogenous agent models with single-earner households, see Altig et al (2001), Conesa and Kruger (2006) and Diaz-Gimenez

that analyze aggregate implications of the participation (extensive) margin. Cho and Rogerson (1988), Cho and Cooley (1994), Mulligan (2001) and Chang and Kim (2006), among others, are examples of the papers in this group. Kleven and Kreiner (2006) study optimal taxation of two-person households when households face an explicit labor force participation decision.

The rest of the paper is organized as follows. Section 2 reports some of the crucial changes in the female labor force participation, wages, and the distribution of individuals by educational attainments that took place between 1980 and 1990. Section 3 documents the changes in the U.S. income tax structure that took place in the same period. Section 4 describes the economic environment. Section 5 reports the calibration results and describes the features of the benchmark economy. Section 6 explores the contributions of different factors to the change in the labor force participation of married females. Section 7 concludes.

1.2 Changes in Married Female Labor Force Participation

In this section I document some of the crucial changes in the female labor force participation, wages, and the educational attainment distribution of married households that took place between 1980 and 1990. All the statistics that I report here are based on the Current Population Survey (CPS) as tabulated by IPUMS (Integrated Public Use Microdata Series). Since the main focus of this study is the labor supply behavior of married females, I restrict the analysis to married people. Moreover in order to analyze

and Pijoan-Mas (2006). Chade and Ventura (2002) study differential tax treatment of single and married agents, the so-called marriage tax penalty, within an equilibrium model of marriage and divorce.

people who are potentially in the labor force I consider those who are 20 to 59 years old. I divide the population into three educational categories: less than high school (denoted as $<hs$), high school (denoted as hs), and college (denoted as col). The first category consists of people who have less than a high school degree, the second category consists of people who have a high school degree or some college education, and the final category consists of people who have a college degree or a higher educational attainment. Based on these three categories I construct nine household types by the educational attainments of the husband and the wife.

The labor force participation of married females in each of these nine household types is shown in Table 1.1. Cells in this table report participation rates for different household types, e.g., the participation rate of females in households in which both the husband and the wife have less than a high school degree, i.e. $(<hs,<hs)$ cell, is 47 percent. As expected, given their husbands' education, females' labor force participation is increasing in their own education. When I compare 1980 and 1990, I see that the participation rates have increased for all groups. Overall, in this period the average labor force participation rate of married women increased by 11.17 percentage points (from 58.53 percent to 69.7 percent).

During the same period, average working hours per married working men did not change much, whereas hours per married working women increased. I find that the average hours per married working men is 49.12 hours per week in 1980, and 49.84 hours per week in 1990. On the other hand, the average hours per married working women is 32.14 hours per week in 1980, and 36.04 hours per week in 1990.[9]

Next I construct age-earning profiles. To this end, I first divide married households between ages 20 and 59 into 4 broad age groups, 20-29, 30-39, 40-49, and 50-59. A household belongs to a particular age group if both husband and wife are in the same age bracket.[10] I then find average hourly wages for husbands and wives in each age group. Average hourly wage is calculated as annual salary and wage income divided by total hours worked last year.[11] To make the wages comparable between 1980 and 1990, I normalize the earning profiles by the mean wage rates of the samples in each year.

Tables 1.2 and 1.3 show wage profiles for 1980 and 1990, while Table 1.4 summarizes the percentage changes in average hourly wages from 1980 to 1990.[12] These tables show how the gender gap, and the college premium for men and women changed during this period. For almost all education-age cells, the wages of married women either increased more or declined less than the wages of married men. As a result, the gender gap declined significantly during this period.[13] Meanwhile, the college premium

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[9] To find the average working hours per worker, I first find the mean annual working hours for the group that I consider. Then I multiply this number by 112/5000 and find the average weekly hours per worker. For females and males mean annual working hours per worker are 1435 and 2193, repectively. These numbers are very close to ones reported by Blau and Kahn (2005).

[10] This restriction follows from the modeling decision discussed in Section 4. The number of marriages excluded due to this restriction is about 30.7 percent of the unrestricted sample in 1980.

[11] Average hourly wage is calculated as $\frac{\text{Annual Salary\&Wage Income}}{(\text{\# of weeks worked})(\text{ \# of usual hours worked in a week})}$. I follow Katz and Murphy (1992) for the sample selection. I consider only the full-time workers, exclude people who earn less than the half of the minimum weekly wage, and exclude the people who are self-employed or unpaid workers. The minimum hourly wage rate in 1980 was \$3.10, \$3.80 in 1990 and \$5.15 in 2000 . I find the minimum weekly wage by multiplying these numbers by 40 hours.

[12] Findings in Table 1.2 and 1.3 are consistent with Gottschalk (1997).

[13] Olivetti (2006) also documents a large increase in returns to experience for married women during this period. Her results show that higher returns to experience was a critical determinant

for both genders increased. Interestingly, the premium for men increased more than the one for women. This fact together with the decline of gender gap might look puzzling. However, a closer inspection of Table 1.4 shows that on average the wages of high school graduate men declined, whereas the wages of high school graduate women increased, which attenuated the increase in college premium for women. Finally, Table 1.4 shows that the young and unskilled people experienced the largest decline in the wages.[14]

From 1980 to 1990 the educational composition of the population has also changed. Table 1.5 shows the distributions of married households according to the educational attainments of their members in 1980 and 1990. The fraction of the married households with both members having at least a high school degree increased from 71.67 percent to 81.41 percent. This increase is mostly due to the rise in the percentage of college graduates. The share of female high school graduates did not change much; it was 65.69 percent in 1980 and 65.67 percent in 1990. On the other hand the share of male high school graduates increased from 55.54 percent to 58.02 percent. In contrast, the proportion of the women with a college degree has increased from 15.72 percent to 22.39 percent.

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of rising market hours of married women during recent decades. Since I focus on a static accounting exercise here, I abstract from human capital accumulation aspect of female labor supply behavior.

[14]The analysis here takes a human capital approach to productivity and associates different productivity levels with completed schooling categories. An alternative approach would be to associate different skills with percentiles of schooling distributions, separately for each gender. This would be in line with a signalling approach. When we repeat the current analysis with three skill groups corresponding to bottom, middle and top part of schooling distribution for each gender, the results were similar. It would be interesting, however, to repeat the same analysis with finer divisions of schooling distributions, since with three broad categories both approaches result in similar wage statistics.

This analysis provides the following critical facts for the current study. From 1980 to 1990,

- female labor force participation of married women increased by 11 percentage points, from 59 percent to 70 percent,
- gender gap declined and skill premium increased,
- the proportion of the married households with both members having at least a high school degree increased.

1.3 Changes in the U.S. Tax Structure.

Both the Economic Recovery Act of 1981 and the Tax Reform Act of 1986 changed the U.S. income tax structure significantly. The 1986 reform was particularly significant in generating a much flatter tax schedule. The basic federal schedules that apply to married couples filing jointly for the years 1985 and 1990 are shown in Figure 1.1.[15] While the reduction in the marginal tax rates is clear from Figure 1.1, the statutory taxes does not reflect the effective taxes that people pay. In this section I document changes in the effective tax rates that took place in the 1980s. The analysis is based on the tax data from publications of Statistics of Income Division of IRS. I first document the average tax rates by different income groups. I then use this data to construct tax functions for married couples for 1980, 1985 and 1990.

[15]Data Source: Internal Revenue Service, Statistic of Income Division, Invidual Income Tax Returns (Publication: 1304).

Since the data is tabulated by income brackets, I am only able to calculate the average tax rate faced by an agent who earns the average income in a given income bracket. The data provides us with the following information for each income bracket: 1) the total amount of adjusted gross income, 2) the total amount of income tax paid, 3) the number returns, and 4) the total number of taxable returns.[16] Given this information, I follow Gouveia and Strauss (1994) and calculate average income levels and average taxes paid for each income bracket, and find the *effective* average tax rate for income bracket i as:[17]

$$average\ tax\ rate_i = \frac{\{\frac{total\ amount\ of\ income\ tax\ paid}{number\ of\ taxable\ returns}\}_i}{\{\frac{total\ adjusted\ gross\ income}{number\ of\ returns}\}_i}. \tag{1.1}$$

Finally, to be able to compare the tax functions across years, I have to come up with a measure of income that can be compared across years as well. Therefore I divide the income levels by mean married household income for each year.[18] Figure 1.2 shows the average tax rates calculated according to Equation (1.1).

Next, I fit the following equation to the data points,

$$\frac{\tau(I_i)}{I_i} = \alpha + \beta \log(I_i) + \varepsilon_i, \tag{1.2}$$

[16] The adjusted gross income is equal to taxable income plus the itemized deductions or standard deduction (which ever is bigger). For a tax payer the adjusted income might be very different than total income. For example alimony payments are not counted in the adjusted gross income, whereas they are counted in the total income. See Form 1040 U.S. Individual Income Tax Return for a list of all excluded income types.

[17] All the variables in Equation (1.1) are available for married couples for 1985 and 1990. For 1980, *number of taxable returns* is not available, so we assumed that *the number of taxable returns* is equal to *the number of returns*.

[18] I take the mean married household income data from Census data. Source: http://www.census.gov/hhes/income/histinc/inchhdet.html

where I_i is the normalized average income in the income bracket i, and $\frac{\tau(I_i)}{I_i}$ is the average tax rate paid in the income bracket i.

Table 1.6 shows my estimates for the years that I consider, and the resulting tax functions are shown in Figure 1.3. This figure indicates that there were significant reductions in the average tax rates between 1980 and 1990 for all types of taxpayers who earn more than mean married household income. Another statistic I am interested in is marginal tax rate. This statistic is important for various reasons. Most importantly, it directly affects the marginal benefit of supplying another unit of labor, therefore plays a critical role in the labor supply decision of an agent. Given the average tax function, I compute this statistic as,

$$\frac{\delta(\tau(I_i))}{\delta I_i} = (\alpha + \beta) + \beta \log(I_i). \tag{1.3}$$

In Table 1.7 I report the average tax rates, the marginal tax rates, and the change in marginal tax rates for selected multiples of mean married household income. The first two panels of this table show the average and the marginal tax rates, and the last one shows the changes in the marginal tax rates. As it is evident in Panel C, the change in the marginal tax rates for high income earners is more than the lower ones from 1980 to 1990. More importantly there is a significant reduction in the marginal tax rates for all income levels over the same period. Even for the people who earned half of the mean married household income, the marginal tax rates dropped by 22 percent. The basic pattern I see from the Panel C is that there is a big drop of the marginal tax rates from 1980 to 1990, and that the reduction from 1985 to 1990 is much more significant than the reduction from 1980 to 1985, almost twice as much. In other words the tax reforms of 1981 and 1986 reduced the marginal tax rates significantly, but the reduction after 1986 reform has the bigger role in this reduction.[19]

Although income taxes constitute the most significant part of total tax bill for many households, payroll taxes are not negligible. Furthermore, payroll tax schedule has also changed from 1980 to 1990. Therefore, in the current analysis I also consider payroll taxes to arrive at a more complete picture of total taxes on labor earnings. Workers have to pay payroll taxes proportional to their labor earnings up to a limit earning level. Beyond that level, they don't have to pay payroll tax for their additional earnings. In 1980 workers were taxed at 6.13% up to $31432.04 of earnings. By 1990, the tax rate was increased to 7.65% and the real income cap was increased to $39250.19.[20]

1.4 The Economic Environment

In this section I describe the economic environment that I use in my analysis. I consider an economy populated with a continuum of married households of mass 1. Married households differ by age and labor market productivity (education) of their members.

[19] The effective tax rates might not capture the full cost of taxation if high taxes encourage households to incur costs to shelter their income from taxes. Between 1980 and 1990 the fraction of households that claimed standard reduction was roughly constant, 42 and 45% respectively. The fraction of households who itemized any contributions also remained constant at around 12%. Hence, although the current analysis does not capture the cost of tax sheltering, there does not seems to be much change in such activities between 1980 and 1990.

[20] The nominal income cap is adjusted with the CPI to get the real income cap. Source for tax rates: http://www.ssa.gov/OACT/ProgData/taxRates.html. Source for nominal income cap values: http://www.ssa.gov/OACT/COLA/cbb.html

Each member of the household is characterized by a given productivity level. Let $x(k,j)$ and $z(i,j)$ denote the age$-j$ labor productivity of a female of skill level k and a male of skill level i, respectively. I assume that $z(i,j)$ and $x(k,j)$ take a finite number of possible values in the sets Z and X, respectively. Suppose there are J different age groups and N different education groups in the economy, so that there are JN elements in sets X and Z. I assume that a husband and a wife have the same age. As a result, at any point in time, there are JN^2 different types of couples (by age and productivity of members) in the economy.

Agents value consumption, c, and leisure, $1-h$. Utility function of a household is sum of its members' utility functions, and is given by

$$u(c) + \nu(1 - h^m) + u(c) + \nu(1 - h^f) - \mu(h^m, h^f)q,$$

where h^m and h^f denote labor supply of the husband and the wife, respectively. When both members of a household supply labor, i.e. $\mu(h^m, h^f) = 1$, I assume that the household incurs a fixed utility cost $q \geq 0$. I assume q is randomly distributed according to a cumulative distribution function F. The households know their utility costs before making any decisions. This utility cost, as in Cho and Rogerson (1988), is meant to capture a utility loss due to joint work of two household members, originating from, for example, inconvenience for scheduling joint work, home production and leisure activities or spending less family time with children.[21]

[21] Cogan (1981) finds that fixed costs of work are significant in determining the labor supply behavior married women. In a recent paper, Erosa, Fuster and Restuccia (2005) use a similar approach to model labor participation decisions.

Consider a j year old household with a type i male and a type k female. In this world, every individual is endowed with 1 unit of labor. When the male and the female works h^m and h^f hours, respectively, total earnings of the couple will be $I = z(i,j)h^m + x(k,j)h^f$. The households pay income tax and payroll tax. The tax function, $\tau(.)$, determines the income tax payment. The payroll tax payment is given by the function $\tau_p(.)$. Unlike the income tax, the payroll tax depends on the individual earnings of the members. I assume that tax revenue is simply wasted.

Each period households solve a static problem and decide on male's labor supply, h^m, female's labor supply, h^f, and on consumption, c. To simplify the analysis, I further assume h^m is always positive, i.e. females are the secondary earners in each household.[22] The problem of a married household is then summarized as

$$\max_{\{c,h^m,h^f\}} \{u(c) + \nu(1-h^m) + u(c) + \nu(1-h^f) - \mu(h^m,h^f)q\},$$

subject to

$$c = z(i,j)h^m + x(k,j)h^f - \tau(I) - \tau_p(z(i,j)h^m) - \tau_p(x(k,j)h^f)$$

where

$$0 < h^m \leq 1, \;\; 0 \leq h^f \leq 1, \; and \; c \geq 0,$$

[22] In about 99.9 percent of the households in 1980 and in about 96 percent of them in 1990, the husband had a higher labor market efficiency than his wife. Hence, this assumption is quite innocuous.

and

$$\mu(h^m, h^f) = \begin{cases} 1 & if\ h^m h^f > 0 \\ 0 & otherwise \end{cases} .$$

As a last object, I denote $\psi(i, k, j)$ as the mass of age j, type (i, k) households. Since I assume that the mass of households is 1, the following adding-up constraint holds

$$\sum_{j=1}^{J} \sum_{i=1}^{N} \sum_{k=1}^{N} \psi(i, k, j) = 1$$

Note that it is very straightforward to calculate aggregate statistics for this economy as we take wages, taxes, and distribution of agents as given and focus on the key endogenous variables: labor force participation decisions and hours worked.

1.5 Benchmark Economy

I calibrate the model economy using 1980 U.S. data and taxes. I assume that there are four periods in the model ($J = 4$) corresponding to age groups 20-29, 30-39, 40-49, and 50-59. In order to calibrate the sets Z and X, I use the 1980 wage profiles from Table 1.2 in Section 2. I assume that there are 3 productivity types in the model economy, i.e. $N = 3$, corresponding to three educational groups in Table 1.2, i.e. less than high school, high school, and college. For each educational group I simply set the values of x and z to their corresponding values in Table 1.2.

Next I pin down $\psi(i,k,j)$, the distribution of households by the type and by the age of the household. Tables 1.8 and 1.9 show the distributions that I find for 1980 and 1990, respectively. I use 1980 values in the calibration of the benchmark economy.

In the benchmark economy, I use the effective income and payroll tax functions for 1980, given by

$$\tau(I) = (0.0971 * log(I) + 0.1345)I,$$

and

$$\tau_p(I_{labor}) = \min(I_{labor}, 1.8609\bar{I}_{labor})0.0613,$$

where I is household income, I_{labor} is the individual labor income and $\bar{I}_{labor}$ is the average individual labor income in the economy.[23]

Next, I specify per period utility functions as

$$u(c) + v(1-h^m) = \log(c) + \frac{(1-h^m)^{1-\sigma_m}}{1-\sigma_m}$$

for males and as

$$u(c) + v(1-h^f) = \log(c) + \frac{(1-h^f)^{1-\sigma_f}}{1-\sigma_f}$$

for females, where c is the consumption, h^m and h^f denote the labor supply of a male and a female, respectively. Finally, I assume that F is an exponential distribution with

[23]The income cap for 1980 is 1.8609 multiple of mean labor income of same year. I find the mean labor income using CPS data, and I follow the same restrictions that I impose when I construct earning profiles.

mean $\bar{q}$

$$F(q;\bar{q}) = 1 - e^{-q/\overline{q}}.$$

This procedure leaves us with three parameters to be determined, σ_m, σ_f, and $\overline{q}$. I select σ_m and σ_f to match the average working hours of married men and women. In particular, when σ_m is 2.1 and σ_f is 1.97, married working men in the model economy works on average 49.23 hours per week, while the same number for married women is 32.40. In the data married men work 49.12 hours per week, and married women work 32.14 hours per week on average. I set the mean utility cost level $\overline{q}$ so that the benchmark economy mimics the married female labor force participation in the data. In 1980, the labor force participation of married women was 58.53%. When I set the mean utility cost level to 0.087, 58.02% of the females in the benchmark economy participate in the market. The benchmark model yields the statistics summarized in Table 1.11.

1.6 From 1980 to 1990

Recall that the average female labor force participation rate for married females was 58.53 percent in 1980 and 69.70 percent in 1990. There is an 11.17 percentage point increase from 1980 to 1990. In this section I investigate the possible factors that may contribute to this increase. In particular, I consider: 1) the changes in the tax structure, 2) the changes in the composition of the married population in terms of educational attainment, 3) the changes in the earning profiles of the people in the economy.

To this end, I first simulate the model using the taxes, the earning profiles, and the distribution of households from 1990. The results are reported in Table 1.12. In the 1990 economy 71.78 percent of the females participate in the market, a 13.76 percentage point rise from the benchmark economy. Hence, the model is successful in generating the rise in married female labor force participation that I observe in the data. Furthermore, as in the data, the average market hours of married women increases by about 4 hours per week between 1980 and 1990 in the model, while the average market hours of married men remains relatively constant.

To decompose the increase in the female labor force participation that the model generates, I simulate the model under the following scenarios: 1) with 1990 taxes, but with 1980 wage profile and household distribution, 2) with 1990 taxes and 1990 household distribution, but with 1980 wage profile, 3) with 1990 taxes and wage profile, but with 1980 household distribution.

The results from the first set of simulations are reported in Table 1.13. These simulations suggest that if people of 1980 were taxed at 1990 tax levels, the female labor force participation would be 61.85 percent. Given the 13.76 percentage points increase that the model implies from 1980 to 1990, this change accounts for almost 28 percent of the total change. There are positive responses to lower taxes on the intensive margin, too. Average weekly hours worked would be 49.84 for men and 33.32 for women, respectively. According to the model, from 1980 to 1990, working women increase their labor by 4.21 hours per week. Hence, taxes alone account for almost 22 percent of this change.

From the second simulation I get the results in Table 1.14. The results here reflect the combined effect of the changes in taxes and the educational composition of the economy. In this economy, the female labor force participation is 60.67 percent. Adding the change in the distribution results in a 1.18 percentage points reduction in the participation rate. In order to understand this reduction note that the fraction of the older married households in population are relatively larger in 1990 than it is in 1980. Thus, in the new distribution the weight on the older households with lower average female participation rate is larger. This simulation implies that the men work 50.01 hours per week on average, and the women work 33.04 hours per week on average.

The third simulation shows the effects of a change in the tax scheme together with a change in earning profiles. I report the results in Table 1.15. The female labor force participation implied by the model is 71.87 percent. Together with the other simulations, this exercise suggests that the changes in wages account for the bulk of the increase in labor force participation rate of married women. In addition, changes in wages have the biggest role in the change in working hours of married women. In this economy, hours for men and women are 48.21 hours per week and 36.67 per week, respectively.

1.6.1 Declining Female Labor Supply Elasticities

In a recent paper, Blau and Khan (2005) analyze changes in labor supply behavior of married women between 1980 and 2000 and document a significant decline in married women's own wage elasticity. In particular, according to their estimates, women's own wage elasticity fell almost by 25 percent (from about 0.8 to 0.6) between from 1980 and 1990.[24]

What can the current model tell us about this decline? In order to calculate own wage elasticity of women in the model, I first find per-person working hours by age and education of the women. Then, I regress hours on the log of earnings and use these estimates to calculate the own wage elasticity of women.[25] I find that at the mean earnings for married women the model implies a 40.5 percent reduction (from 0.72 to 0.43) from 1980 to 1990. Indeed, as a possible explanation for the recent decline in female labor elasticity Blau and Khan (2005) point out to the recent rise in female labor force participation rate. In the current model, given a fixed distribution for q (utility cost of joint work), changes in taxes and earnings between 1980 and 1990 result in a higher threshold value of q that separates participants from non-participants. While in 1980, there was a large pool of potential entrants, this is not the case in 1990. As a result of the higher threshold, those who do not participate in 1990 are much less responsive to wages, and this contributes to the low responsiveness of overall female labor supply to wages in 1990 economy, generating a lower measured elasticity.

1.7 Conclusions

The 1980s witnessed two dramatic tax reforms that lowered tax rates for high income earners. During the same period, there were significant changes in the earnings

[24]Heim (2005) also investigates the changes in own wage elasticity of married women from 1979 to 2003. His findings are very similar to the ones by Blau and Khan (2005).

[25]My method of finding the own wage elasticity of married women is consistent with Blau and Khan (2005).

of the workers in favor of women and college graduates. Moreover, the fraction of the college graduates in the population increased significantly. Combination of these factors altered work incentives for the second earners, who are mostly women, in married couple households. The labor force participation rate of married women increased by 11 percentage points between 1980 and 1990. At the same time market hours per married working women increased by about 4 hours per week. In this paper I build a heterogeneous agents model with two-member households in which members decide whether to work or not, and if they do how much to work in the market. I use this model to evaluate the contribution of the changes in the individual income tax structure to the 11 percentage point rise in married female labor force participation. The simulations suggests that the change in the tax rates accounts for about 28 percent of the increase in the participation rate of married women. Furthermore, the changes in the taxes account for about 22 percent of the rise in working hours of married women.

The current analysis can be extended in several dimensions. The model here is simple in order to undertake a clean decomposition analysis with labor supply, both at extensive and intensive margins, as the key endogenous variable. A natural extension is to consider a framework which allows for more realistic life-cycle transitions such as marriage and divorce, as well as capital accumulation. Guner, Kaygusuz and Ventura (2006) develop such a framework to study the aggregate and cross-sectional effects of hypothetical tax reforms for the U.S. economy. There are other government policies, besides taxes, that can only be studied within a framework that allows for two-earner households. Kaygusuz (2006) builds a life-cycle model with one and two-earner households to study the effects of the spousal benefit provision in the U.S. social security system and its interaction with the progressive calculation of the retirement benefits.

Table 1.1. Female Labor Force Participation for 1980 and 1990 (%)

1980				1990			
	Female's Education				Female's Education		
Male's Education	<hs	hs	col	Male's Education	<hs	hs	col
<hs	47	59	81	<hs	48	68	91
hs	47	62	73	hs	55	72	86
col.	43	54	66	col.	54	66	74

Table 1.2. Age-Earnings Profiles, 1980

	Male			Female		
Age	<hs	hs	col	<hs	hs	col
20-29	0.84	1.03	1.10	0.63	0.66	0.84
30-39	0.99	1.31	1.57	0.57	0.74	1.05
40-49	1.10	1.45	1.82	0.61	0.74	0.97
50-59	1.14	1.40	1.98	0.60	0.78	1.13

Table 1.3. Age-Earning Profiles, 1990

	Male			Female		
Age	<hs	hs	col	<hs	hs	col
20-29	0.65	0.84	1.19	0.47	0.62	0.94
30-39	0.79	1.12	1.57	0.55	0.74	1.16
40-49	0.98	1.32	1.83	0.65	0.81	1.24
50-59	0.94	1.31	1.92	0.57	0.81	1.25

Table 1.4. Percentage Change in Earning Levels from 1980 to 1990

	Male			Female		
Age	<hs	hs	col	<hs	hs	col
20-29	-23.06	-18.06	8.41	-25.65	-6.31	10.94
30-39	-20.66	-14.34	0.13	-3.49	1.12	11.08
40-49	-11.15	-9.25	0.59	5.77	9.44	26.91
50-59	-16.98	-6.55	-2.81	-5.66	4.01	10.88

Table 1.5. Distribution of Married Households by Educational Attainment (%)

1980					1990				
Male's Education	Female's Education				Male's Education	Female's Education			
	<hs	hs	col	totals:		<hs	hs	col	totals:
<hs	11.21	9.48	0.26	20.95	<hs	6.95	6.38	0.27	13.6
hs	6.99	44.67	3.88	55.54	hs	4.72	47.29	6.01	58.02
col.	0.38	11.54	11.58	23.50	col.	0.27	12	16.11	28.38
Totals:	18.58	65.69	15.72	100	Totals:	11.94	65.67	22.39	100

Table 1.6. Tax Functions, Coefficients

Years	α	β	R^2
1990	0.1096	0.0592	0.98
	(0.005)	(0.003)	
1985	0.1258	0.0776	0.98
	(0.002)	(0.002)	
1980	0.1345	0.0971	0.99
	(0.005)	(0.003)	

Note: The terms in the parentheses are standard errors

Table 1.7. Tax Statistics (%)

Panel A

Average Tax Rate			
Income	1980	1985	1990
0.5	7	7	7
1	13	13	11
2	20	18	15
3	24	21	17
5	29	25	20
10	36	30	25

Panel B

Marginal Tax Rate			
Income	1980	1985	1990
0.5	16	15	13
1	23	20	17
2	30	26	21
3	34	29	23
5	39	33	26
10	46	38	31

Panel C

Change in The Marginal Tax Rate			
Income	80->85	85->90	80->90
0.5	-9	-15	-22
1	-12	-17	-27
2	-14	-18	-30
3	-15	-19	-31
5	-15	-20	-32
10	-16	-20	-33

Table 1.8. Distribution of Houesholds By Educational Attainment of Members, By Age, 1980

Age:	1			2			3			4		
	Female			Female			Female			Female		
Male	$<hs$	hs	col	$<hs$	hs	col	$<hs$	hs	col	$<hs$	hs	col
$<hs$	0.0206	0.0205	0.0004	0.0221	0.0220	0.0007	0.0293	0.0229	0.0008	0.0388	0.0285	0.0007
hs	0.0204	0.1518	0.0119	0.0181	0.1361	0.0139	0.0131	0.0863	0.0067	0.0182	0.0745	0.0066
col	0.0008	0.0246	0.0256	0.0010	0.0423	0.0531	0.0012	0.0254	0.0229	0.0008	0.0231	0.0146
												Total:1.00

Table 1.9. Distribution of Houesholds By Educational Attainment of Members, By Age, 1990

Age:	1			2			3			4		
	Female			Female			Female			Female		
Male	$<hs$	hs	col	$<hs$	hs	col	$<hs$	hs	col	$<hs$	hs	col
$<hs$	0.0153	0.0138	0.0005	0.0175	0.0161	0.0011	0.0167	0.0162	0.0008	0.0197	0.0174	0.0003
hs	0.0088	0.1033	0.0110	0.0142	0.1734	0.0269	0.0126	0.1180	0.0152	0.0115	0.0778	0.0070
col	0.0002	0.0134	0.0227	0.0010	0.0444	0.0676	0.0008	0.0401	0.0501	0.0007	0.0225	0.0212
												Total:1.00

Table 1.10. Parameter Values

$\overline{q}$	0.087
σ_m	2.1
σ_f	1.97

Table 1.11. Benchmark Statistics

	Benchmark	1980 data
Female labor force participation rate:	58.02%	58.53%
Working hours of men:	49.23 hrs/week	49.12 hrs/week
Working hours of women:	32.40 hrs/week	32.14 hrs/week

Table 1.12. Simulation Results, 1990 Economy

	Simulation	1990 data
Female labor force participation rate:	71.78%	69.70%
Working hours of men:	48.10 hrs/week	49.84 hrs/week
Working hours of women:	36.61 hrs/week	36.09 hrs/week

Table 1.13. Simulation Results, 1980 Wage Data, 1980 Household Distribution, 1990 Taxes

	Benchmark	Simulation 1
Female labor force participation rate:	58.20%	61.85 %
Working hours of men:	49.23 hrs/week	49.84 hrs/week
Working hours of women:	32.40 hrs/week	33.32 hrs/week

Table 1.14. Simulation Results, 1980 Wages, 1990 Household Distribution, 1990 Taxes

	Benchmark	Simulation 2
Female labor force participation rate:	58.20%	60.67%
Working hours of men:	49.23 hrs/week	50.01 hrs/week
Working hours of women:	32.40 hrs/week	33.04 hrs/week

Table 1.15. Simulation Results, 1990 Wages, 1980 Household Distribution, 1990 Taxes

	Benchmark	Simulation 3
Female labor force participation rate:	58.20%	71.87%
Working hours of men:	49.23 hrs/week	48.21 hrs/week
Working hours of women:	32.40 hrs/week	36.67 hrs/week

Fig. 1.1. Statutory Marginal Tax Rates For Married Households

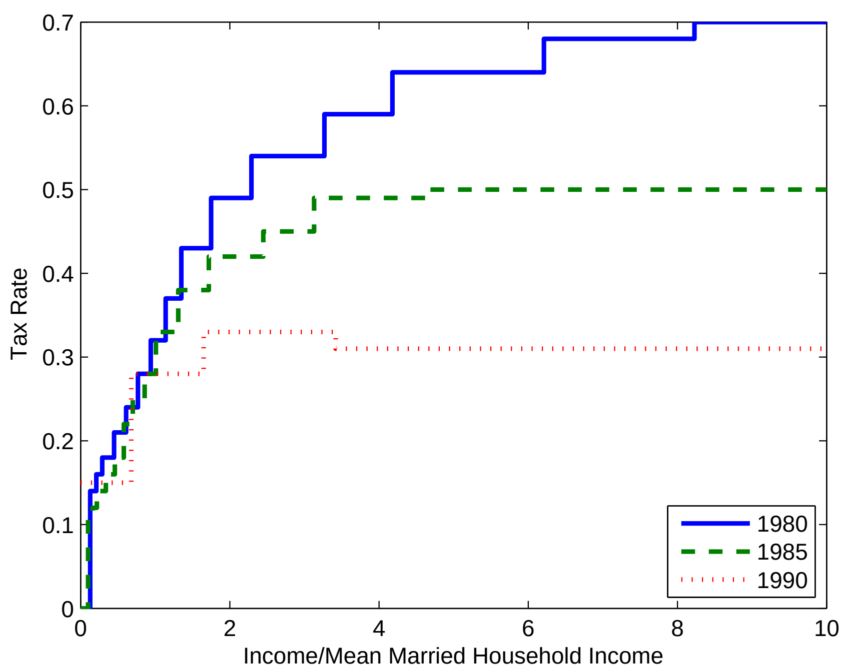


Fig. 1.2. Average Tax Rate Schedules

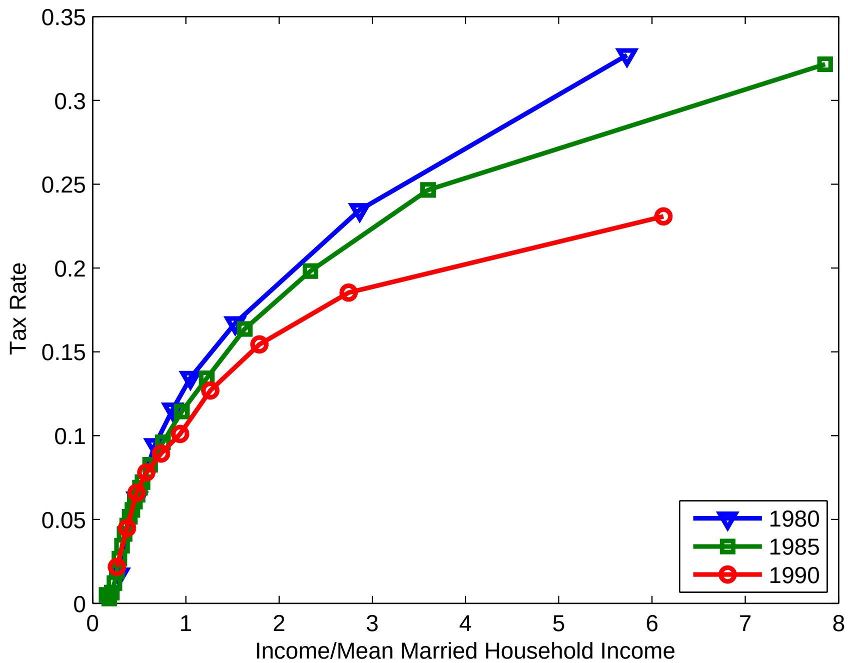
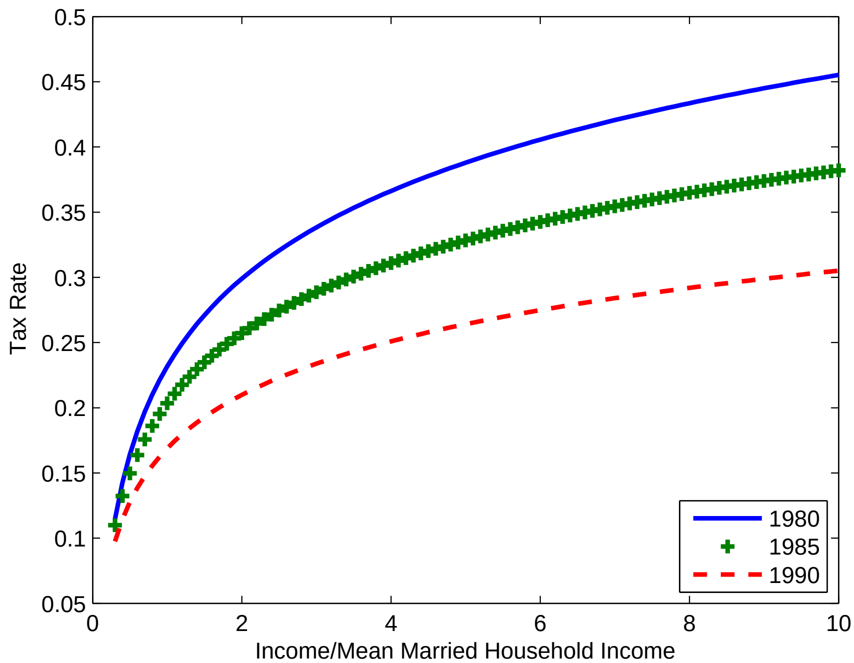


Fig. 1.3. Estimated Tax Functions



Chapter 2

Taxation, Aggregates and The Household

2.1 Introduction

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

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

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

with a bread-winner husband and house-maker wife. The macroeconomic consequences of this transformation are arguably of first-order importance. We clearly live in a different world.

Our aim in this paper is twofold. We study tax reforms in dynamic economies with an operative extensive margin in labor supply, and a demographic (household) structure in line with data. This is novel in the macroeconomic and public-finance literatures. In addition, we evaluate the quantitative importance of each of the non-standard features we consider to quantify the long-run consequences of such reforms.

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

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

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

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

The effects of a progressive consumption tax reform, which replaces the current income tax structure by a common marginal tax rate and an exemption level below which the tax rate is zero as in many proposals (e.g. Hall and Rabushka (1995)), are quite different. The aggregate effects are more moderate and the positive effects on labor force participation of secondary earners are much less pronounced. Replacing current income taxes by a consumption tax with these properties, results in an increase in aggregate output of about 7.3% across steady states and a change in labor force participation of only 1.9%. Nevertheless, the contribution of married females to the total increase in labor hours is much more significant under a progressive consumption tax (65.2%).

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

Our work is largely related to four literatures. First, our evaluation of tax reforms using dynamic models with heterogenous agents is related to the work by Altig, Auerbach, Kotlikoff, Smetters and Walliser (2001), Chade and Ventura (2002), Díaz-Jiménez and Pijoan-Mas (2005), Erosa and Koreshkova (2007), Nishiyama and Smetters (2005), Conesa and Krueger (2006), and Ventura (1999) among others. In contrast to these papers, we study economies populated with married and single households, where the married households can have one or two earners. Kleven and Kreiner (2006) study optimal taxation of two-person households when households face an explicit labor force participation decision. Second, the current paper is related to recent papers that show that taxes can play a significant role in accounting for cross-country differences in labor supply behavior. Prescott (2004), Olovsson (2003), Davis and Henrekson (2003), Rogerson (2006) and Kaygusuz (2006a) are examples of papers in this group. Third, the current paper is related to papers that studied the macroeconomic effects of changes in labor supply along the extensive margin; Cho and Rogerson (1988), Cho and Cooley (1994), Mulligan (2001), Attansio, Low and Sánchez Marcos (2004), Chang and Kim (2006) and Kaygusuz (2006b) are examples. Finally, it is related to recent literature on macroeconomics of the family; Regalia and Ríos-Rull (1999), Aiyagari, Greenwood and Guner (2000), Fernández and Rogerson (2001), Cubeddu and Ríos-Rull (2003), Greenwood and Guner (2004), Fernández, Guner and Knowles (2005), and Knowles (2005).

2.2 The Economic Environment

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$\Phi(x) \equiv \sum_z M(x, z) + \phi(x) + \sum_z M^r(x, z) + \phi^r(x), \tag{2.1}$$

and

$$\Omega(z) \equiv \sum_x M(x, z) + \omega(z) + \sum_x M^r(x, z) + \omega^r(z), \tag{2.2}$$

hold by construction.

Each agent is born as a single worker with zero assets, and his/her marital status changes exogenously as long as he/she remains a worker. We assume that each period agents first face retirement shocks and then, if they do not retire, experience marriage and divorce shocks. Once retired, marital status of agents remain constant until he/she dies.

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

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

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

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

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

and

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

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

$$\varphi_f(a|x) = \frac{\psi_f^S(x,a)}{\phi(x)}, \tag{2.3}$$

and

$$\varphi_m(a|z) = \frac{\psi_m^S(z,a)}{\omega(z)}. \tag{2.4}$$

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

2.2.1 The Problem of a Single Household

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

$$V_m^{S,r}(a) = \max_{a'} \{U^s(c,0) + (1-\delta)\beta V_m^{S,r}(a')\}, \tag{2.5}$$

subject to

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

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

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

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

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

$$+ (1-\pi_m(z)) V_m^S(z, a')] + \rho\beta V_m^{S,r}(a')\}, \tag{2.6}$$

subject to

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

and

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

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

2.2.2 The Problem of a Married Household

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

$$\max_{a'} \{U_m^M(c,0,0,q) + U_f^M(c,0,0,q) + (1-\delta)\beta(V_m^{M,r}(a') + V_f^{M,r}(a')\}, \tag{2.7}$$

subject to

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

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

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

and

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

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

$$\begin{aligned} \max_{a',\, l_f^M,\, l_m^M,\, c} & \{[U_m^M(c, l_m^M, l_f^M, q) + U_f^M(c, l_m^M, l_f^M, q)] \\ & +(1-\rho)\beta[\lambda V_m^S(z, a'/2) + (1-\lambda)V_m^M(x, z, a', q) \\ & +(\lambda V_f^S(x, a'/2) + (1-\lambda)V_f^M(x, z, a', q)] \\ & +\rho\beta[V_m^{M,r}(a') + V_f^{M,r}(a')]\}, \end{aligned} \tag{2.8}$$

subject to

$$\begin{aligned} c + a' = {} & a + wzl_m^M + wxl_f^M + ra - \tau_p wzl_m^M - \tau_p wxl_f^M \\ & - T^M(wzl_m^M + wxl_f^M + ra) - \tau_k ra, \end{aligned}$$

and

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

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

Let $\hat{l}_m^M$, $\hat{l}_f^M$, $\hat{c}$, and $\hat{a}'$ be the optimal decisions associated with problem (2.8). Then, the lifetime utility of being married, $V_m^M(x,z,a,q)$ and $V_f^M(x,z,a,q)$, are given by

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

and

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

2.2.3 Marriage Accounting

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

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

$$M^{r\prime}(x,z) = (1-\delta)M^r(x,z) + \rho M(x,z), \tag{2.9}$$

which implies the following steady state condition

$$\delta M^r(x,z) = \rho M(x,z). \tag{2.10}$$

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

$$\delta \phi^r(x) = \rho \phi(x), \tag{2.11}$$

and

$$\delta \omega^r(z) = \rho \omega(z). \tag{2.12}$$

Using the steady state restrictions implied by equations (2.10), (2.11) and (2.12), we can rewrite equation (2.1) as

$$\Phi(x) = \sum_z M(x,z) + \frac{\rho}{\delta} \sum_z M(x,z) + \phi(x) + \frac{\rho}{\delta}\phi(x). \tag{2.13}$$

This equation restricts how $\Phi(x)$, $M(x,z)$, and $\phi(x)$ are related. Similarly, the steady state version of equation (2.2) is given by

$$\Omega(z) = \sum_x M(x,z) + \frac{\rho}{\delta} \sum_x M(x,z) + \omega(z) + \frac{\rho}{\delta}\omega(z). \tag{2.14}$$

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

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

$$M'(x,z) = (1-\rho)(1-\lambda)M(x,z) + \theta_f(x,z)(1-\rho)\phi(x), \tag{2.15}$$

or

$$M'(x,z) = (1-\rho)(1-\lambda)M(x,z) + \theta_m(x,z)(1-\rho)\omega(z). \tag{2.16}$$

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

$$M(x,z) = \frac{\theta_m(x,z)(1-\rho)\omega(z)}{1-(1-\rho)(1-\lambda)}, \tag{2.17}$$

and

$$M(x,z) = \frac{\theta_f(x,z)(1-\rho)\phi(x)}{1-(1-\rho)(1-\lambda)}. \tag{2.18}$$

Note that given $M(x,z)$, $\omega(z)$, $\phi(x)$, λ, and ρ, equations (2.17) and (2.18) determine $\theta_m(x,z)$ and $\theta_f(x,z)$. Furthermore, $\theta_m(x,z)$ and $\theta_f(x,z)$ are all we need to determine the exogenous transition probabilities for singles. In particular, we can find the probability of marriage for a type x female with a type z male conditional on the event of marriage, $P_f(z|x)$ as

$$P_f(z|x) = \frac{\theta_f(x,z)\phi(x)}{\sum_z \theta_f(x,z)\phi(x)} = \frac{\theta_f(x,z)}{\sum_z \theta_f(x,z)}. \tag{2.19}$$

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

$$P_m(x|z) = \frac{\theta_m(x,z)\omega(z)}{\sum_x \theta_m(x,z)\omega(z)} = \frac{\theta_m(x,z)}{\sum_x \theta_m(x,z)}. \tag{2.20}$$

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

$$\pi_f(x) = \frac{\sum_z \theta_f(x,z)\phi(x)}{\phi(x)} = \sum_z \theta_f(x,z). \tag{2.21}$$

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

$$\pi_m(z) = \frac{\sum_x \theta_m(x,z)\omega(z)}{\omega(z)} = \sum_x \theta_m(x,z). \tag{2.22}$$

2.2.3.1 Discussion

It is important to point out that we take the rates at which individuals transit from singlehood to marriage, $\theta_i(x,z)$, $i = f, m$, as *exogenous*. This is the simplifying assumption we make in relation to how households are formed. This allows us to write the law of motion for the stock of married people $M(x,z)$ in a simple way, as shown in equations (2.15) and (2.16).

The stationary environment we consider further allows us to tightly map the model to demographic data, since there is a trivial mapping between the flows into marriage and the number of married households by type, given the exogenous transition rates ρ and λ, as shown by equations (2.17) and (2.18). Therefore, we can nicely calibrate the model by *reverse-engineering*: we observe who is married-with-whom by type and recover the rates at which individuals transit into marriage in a stationary environment.

More specifically, we observe the number of individuals of a given type by gender, $\Phi(x)$ and $\Omega(z)$, as well as the number of marriages of working age by type, $M(x,z)$. We subsequently calculate the number of single individuals using the basic accounting identities in Equations (2.13) and (2.14). Using the resulting number of single workers, $\phi(x)$ and $\omega(z)$, and the life-cycle transition probabilities, ρ and λ, we then back out the rates $\theta_i(x, z)$, $i = f, m$ using Equations (2.17) and (2.18). Once we construct $\theta_i(x, z)$, we have enough structure to pin down the exogenous probabilities of household formation.

2.3 Parameter Values

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

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

We set the number of productivity types (labor endowments) to five. Each productivity type corresponds to an educational attainment level: less than high school ($<$ hs), high school (hs), some college (sc), college (col) and post-college education ($>$ col). We use data from the Consumer Population Survey (CPS) to calculate efficiency levels for all types of agents. Efficiency levels correspond to mean hourly wage rates within an education group, which we construct using annual wage and salary income, weeks worked, and usual hours worked data.[2] We include in the sample household heads and spouses between 25 and 64, and exclude those who are self-employed or unpaid workers. Table 2.1 shows the estimated efficiency levels for the corresponding types, and also reports the observed gender gap in hourly wage rates for each educational group. Wage rates for each type and gender are normalized by the overall mean hourly wages in the sample.

We subsequently determine the distribution of individuals by productivity types for each gender, i.e. $\Omega(z)$ and $\Phi(x)$, using the 2000 Census. For this purpose, we assume

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

an underlying stationary demographic data, and *assume* that the distribution of retired agents by educational attainment equals the observed distribution of agents prior to retirement. We consider all household heads or spouses who are between ages 25 and 64 and for each gender calculate the fraction of people in each education cell. For the same age group, we also construct $M(x, z)$, the distribution of married working couples, as shown in Table 2.2. Finally, given the fractions of individuals, $\Phi(x)$ and $\Omega(z)$, and the fractions of married working households, $M(x, z)$ in the data, we calculate the implied fractions of single working households, $\omega(z)$ and $\phi(x)$, reported in Table 2.3. This table also shows $\omega(z)$ and $\phi(x)$ that we construct from 2000 data. The mismatch between implied and actual values of $\omega(z)$ and $\phi(x)$ are really small, suggesting that stationary population structure is not an unrealistic assumption.

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

Technology We specify the production function as Cobb-Douglas with capital share equal to 0.317. In the absence of population growth and growth in labor efficiency, we set the depreciation rate equal to 0.07. These values are consistent with a notion of capital that excludes residential capital, consumer durables and government owned capital for the period 1960-2000. The corresponding notion of output is then GDP accounted for by the business sector. Altogether, this implies a capital to output ratio of about 2.325.[3]

Taxation To construct income tax functions for married and single individuals, we estimate *effective taxes* paid by married and single households as a function of their reported income. We use tabulated data from the Internal Revenue Service Data by

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

income brackets.[4] For each income bracket, total income taxes paid, total income earned, number of taxable returns and number of returns data are publicly available. Using these we find the mean income and the average tax rate corresponding to every income bracket. We find the average tax rates as

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

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

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

where *average tax* (*income*) is the average tax rate that applies when income equals *income*. We normalize income with mean household income in 2000 to find *income*. Table 2.4 shows the estimates of the coefficients for married and single households.

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

$$T^M(income) = [0.1023 + 0.0733 \log(income)]income$$

$$T^S(income) = [0.1547 + 0.0497 \log(income)]income.$$

Figures 2.1 and 2.2 display estimated average and marginal tax rates for different multiples of household income. Our estimates imply that a single person with twice mean household income in 2000 faces an average tax rate equal to 15.3% and a marginal tax rate equal to about 26.0%. The corresponding rates for a married household with the same income are about 18.7% and 23.6%.

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

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

Social Security We start by estimating the payroll tax from data. We calculate $\tau_p = 0.086$, as the average value of the social security contributions as a fraction of aggregate labor income for 1990-2000 period.[5]

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

Preferences There are two utility functions parameters, the intertemporal elasticity of substitution (γ) and the parameter governing the disutility of market work (B). For our benchmark calculations, we set γ equal to 0.4, which is within the range of estimates in Domeij and Floden (2006), Table 2.5. Our choice is based upon estimates for married males that control for the bias emerging from borrowing constraints. Given γ, we select the parameter B to reproduce average market hours per worker observed in the data. These average hours per worker amounted to about 40.8% of available time in 2000.[6]

We assume that the utility cost parameter q is exponentially distributed with mean $1/\bar{q}(x,z)$. We choose $\bar{q}(x,z)$ so that the labor force participation of secondary

[5] 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.

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

earners in the benchmark economy is consistent with data. Both in the data and in the model, we label an individual as a secondary earner if his/her hourly wage is less than his/her partner. Using CPS, we calculate that the employment-population ratio of secondary earners is 73.75% for married individuals between ages 25 and 55.[7] Table 2.5 shows the distribution of secondary earner's labor force participation by productivities of husbands and wives for married households. Our strategy is select 25 values of $\bar{q}(x, z)$ to match 25 entries in Table 2.5 as closely as possible. Table 2.6 shows the labor force participation of secondary earners in the model economy.

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

Table 2.7 summarizes our parameter choices. Table 2.8 shows the performance of the model in terms of the targets we impose for B and β, and the aggregate participation rate of secondary earners. The model has no problem in reproducing jointly these observations as the table demonstrates.

2.4 Tax Reforms

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

For each reform we study two cases. A *complete* reform replaces both federal income taxes and the additional proportional tax on capital income. A *partial* reform, on the other hand, only replaces federal income taxes and keeps the additional proportional capital income tax intact. These partial experiments are relevant since elimination of

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

additional tax on capital, which is meant to capture corporate income taxes, might not easily be a part of a reform that aims to change the current structure of income taxation. Furthermore, this experiment highlights the separate role that this tax play on capital accumulation. In all reforms we keep the social security system unchanged. The results reported below based on steady state comparisons of pre and post reform economies.

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

Table 2.9 reports key findings from this exercise. In line with existing literature, the effects of a consumption tax on aggregates are dramatic. With a partial reform, aggregate output increases by about 10.5%. As a result, a flat consumption tax of 21.5% is all that is needed to generate revenue neutrality. The rise in output is fueled by significant rises in factor inputs, with the capital-to-output ratio and the wage rate increasing by about 14.2% and 6.4%, respectively, in the post-reform steady state. Total hours in turn increase by 4.2%. The aggregate effects of a complete reform are more pronounced since the elimination of additional 12.4% flat tax on capital provides further incentives for capital accumulation. Aggregate output increases in this case by 12.7%, the capital-to-output ratio by more than 19.5% and the wage rate by about 8.7%.

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

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

Results from this reform are reported in Table 2.10. The most important effect of this reform is the rise in overall labor supply, of magnitudes that are similar to the consumption tax case. This suggests that the main contribution to labor input comes from the flattening of tax schedule. In the partial reform case, labor force participation of secondary earners rise by 4.6%, a number very close to the effect with a proportional consumption tax. Hours per worker, both for males and females, increase by about 2.6%. As a result, total hours increase by about 3.9%. Again, the rise in total hours by married females is much more pronounced, in excess of 7.2%, as most of the secondary earner are females.

In relation to the case with a proportional consumption tax, the effects on capital accumulation are now less pronounced. This is expected: an income tax, differently from a consumption tax, still affects capital accumulation decisions. Consequently, the capital-to-output ratio increases by just 5% with the partial reform and by 10.1% with the complete reform. Overall, the effects on aggregate output are substantial, but smaller than under a proportional consumption tax. Under a partial (complete) reform, the change in output amounts to about 6.0% (8.2%), whereas under proportional consumption taxes the effects amounted to about 10.5% (12.7%).

A Progressive Consumption Tax In our final exercise we consider a progressive consumption tax. The progressive consumption tax consists of an exemption level below which agents do not pay taxes and a proportional tax rate applied above this level. We set the exemption level as 1/3 of aggregate consumption in our benchmark economy for single households, and 1/2 of aggregate consumption in our benchmark economy for married ones.[8] We emphasize that these exemption levels are defined as multiples of consumption in the benchmark case; as a result, they do *not* vary when consumption changes (increases) as a result of the reform in question.

The results from a partial reform are reported in Table 2.11. Now a partial reform requires a marginal tax rate of 28.0%; the corresponding rate under a proportional consumption tax was 21.5%. A comparison between proportional and progressive consumption cases (Tables 2.9 and 2.11) is quite revealing. The effects on the capital stock are comparable under both reforms. This should not be surprising since most of capital is owned by households who are above the exemption levels and they are affected in a similar way in both reforms; both reforms eliminate the effects of income taxes on their asset accumulation decisions. The effect on aggregate output in the long run, however, is smaller. This is due to the smaller rise in labor input; total hours increase by 1.4% instead of 4.2%.

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

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

The interplay of these features discourages changes in labor force participation in married households with relatively less skilled members. It turns out that these households were the ones that respond the most under proportional tax reforms; see below.

The Role of Married Females We now discuss in some detail the changes in labor supply of secondary earners, a group largely comprised by married females. A central finding emerging from our exercises is that the increase in labor force participation of secondary earners becomes larger as we move towards the bottom of the distribution of skills. Table 2.12 illustrates this point. In the table, households are arranged according to the skill type of the female member (from high school education or less to post-college education), and the resulting change in the labor force participation of the secondary earner is displayed. Under a proportional consumption tax reform for instance, the percentage increase in labor force participation *decreases* monotonically from about 8.8% to about 2.1%. Similar results hold for proportional income tax reform. Thus, the bulk of the changes along the extensive margin take place in households with relatively less skilled members.

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

What is the overall contribution of married females to changes in labor supply? To answer this question, we find that the type of the tax reform under consideration is critical. Although the aggregate effects on labor supply are smaller under progressive consumption tax relative to a proportional one, the rise in married females's labor supply becomes a much more important component of the overall rise in labor supply. Table 2.13 makes this point clear. In this table we report the contribution of married female hours to changes in total hours. In each reform, except with progressive consumption tax, the contribution of married females is around 51-52%. However, the contribution of married females is much higher under the progressive consumption tax, about 65.2%. This occurs as changes in labor supply for other groups are of smaller magnitude under a progressive consumption tax.

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

2.5 The Role of New Features

In this section, we attempt to isolate the quantitative contribution of the non-standard aspects in the current environment for the effects of tax reforms. In order to do this, we conduct tax reform exercises in economies that are parameterized to observations pertaining to gender productivity differences, labor force participation levels and a demographic structure that are different from the U.S. in 2000.

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

Table 2.14 shows the labor force participation of secondary earners in 1960. As expected, they are much lower than the 2000 values reported in Table 2.5. The average labor force participation of secondary earners was 43.4% in 1960 while it was around 74.7% in 2000. For households with females with college education and above, only 52.5% and 70.6% participated in 1960; in 2000, the corresponding participation rates were respectively 79.5% and 83.9%. Table 2.15 the shows productivity levels in 1960. In 1960 wages were much more compressed across education categories. The skill premium, defined as wages ratio of college to high school graduates, was only about 1.5 in 1960 while it is around 2 in 2000. The gender gap was also higher (except the highest skill level which is most probably due to small sample size we have). Finally, the fraction of the working population married was much higher: 89.3% in 1960 vs. 74.0% in 2000. In terms of the composition of the marriage pool, Table 2.16 shows the distribution of married agents across skill types. Note that there relatively more low-skilled agents in 1960. Indeed, almost 70% of all households were composed of partners who either had less than high school education, or only a high school degree.

We proceed as follows. We unbundle our 2000 benchmark economy piece-by-piece so that it looks more and more like the U.S. economy in 1960. We first set labor force participation of secondary earners to their 1960 values. We keep all other exogenous variables (e.g. taxes, distribution of agents across skill types etc.) intact, and recalibrate the benchmark economy to match labor force participation of secondary earners in 1960. We label this *Case I.* Second, we change both the labor force participation of secondary earners and productivity levels to their 1960 values and recalibrate our economy again. This is *Case II.* Finally, on top of previous changes we introduce the skill distribution and the structure of marital sorting from 1960 and then recalibrate our benchmark economy. This is *Case III*, the 1960 economy.[9] For each of these three cases, we replace existing income taxes with a progressive consumption tax.

Table 2.17 shows the effects of a progressive consumption tax reform for these three cases and compares its effects with those on 2000 benchmark. When we only introduce 1960 labor force participation of secondary earner values, a partial progressive consumption tax reform has larger effects on the labor force participation of secondary earners than it did for 2000 economy. With such a reform, the labor force participation of secondary earners increase by about 2.3% in Case *I*, while the increase was about 1.9% for 2000 economy. Note that the only difference between 2000 economy and Case *I* is the initial level of labor force participation of secondary earners, which is much lower for

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

Case *I* economy. Therefore, there is more room for secondary earners to increase their labor force participation; in particular, without hitting the tax exemption threshold. This can be seen clearly in Table 2.18 which reports the changes in the labor force participation of secondary earners. In 2000 economy, the labor force participation of secondary earners declines for the lowest education type, while it increases in Case *I*. Indeed, the rise in labor force participation is higher for each category in Table 2.18. Note, however, that although the rise in female labor force participation is higher now than in the 2000 economy, the rise in aggregate hours is quite comparable as the increase in female labor force participation is concentrated among low-skill females. As a result, output now grows by 7.9%, only slightly higher than 7.3%.

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

The effects are largest in Case *III*. In this case we move to skill and marital distributions pertaining to 1960 as well, effectively replicating the 1960 economy completely.[10] Recall from our previous discussion that substantially more people were married in 1960. Due to these larger share of married households, the number of households that can benefit from the elimination of high tax rates on capital income are now larger than in the previous case. This contributes towards a larger increase in the capital stock relative to Case *II* economy. Overall, our results imply an 8.3% increase in aggregate output for the economy in 1960, relative to a 7.3% for 2000 economy.

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

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

2.6 Concluding Remarks

In this paper we study aggregate and cross-sectional effects fundamental tax reforms for the US economy. In contrast to the existing literature, our model economy consists of one and two-earner households, and two-earner households face explicit labor force participation decisions.

We find that tax changes can lead to large effects across steady states on aggregate variables. We quantify the changes in labor supply of different groups, and find that secondary earners play an important role in these changes. More generally, our findings suggest that the structure of pre-reform economy plays an important role. Economies that differ in terms of the labor force participation of secondary earners, wages, and marital composition react differently to the reforms we consider.

2.6.1 Appendix: Definition of Equilibrium

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

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

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

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

and

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

3. Factor markets clear; i.e.,

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

and

$$L = \sum_{x,\ z,\ q} \int_A (x l_f^M(x,z,a,q) + z l_m^M(a,x,z,q)) \psi^M(x,z,a,q) da +$$

$$\sum_z \int_A z l_m^S(z,a) \psi_m^S(z,a) da + \sum_x \int_A x l_f^S(x,a) \psi_f^S(x,a) da.$$

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

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

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

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

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

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

   and

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

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

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

and

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

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

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

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

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

Single retired agents:

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

and

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

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

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

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

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

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

$$= \tau_p(wL)$$

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

Table 2.1. Productivity Levels, by Type, by Gender

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

Table 2.2. Distribution of Married Working Households by Type, %

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

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

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

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

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

Table 2.3. Fraction of Agents By Type, By Gender, and Marital Status

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

Table 2.4. Tax Parameters Estimates

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

Table 2.5. Labor Force Participation of Secondary Earners, Data, %

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

Table 2.6. Labor Force Participation of Secondary Earners, Model, %

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

Table 2.7. Parameter Values

Discount Factor (β)	0.973
Intertemporal Elasticity (Labor Supply) (γ)	0.4
Disutility of Market Work (B)	21
Capital Share (α)	0.317
Depreciation Rate (δ_k)	0.07
Probability of Retirement	1/40
Mortality rate (δ)	0.0982
Divorce Rate (λ)	0.021
Payroll Tax Rate (τ_p)	0.086
Capital Income Tax Rate (τ_k)	0.124

Table 2.8. Model and Data

Statistic	Data	Model
Capital Output Ratio	2.325	2.321
Labor Hours Per-Worker	0.408	0.408
Participation rate of Secondary Earners (%)	73.75	72.9

Table 2.9. Proportional Consumption Tax (% change)

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

Table 2.10. Proportional Income Tax (% change)

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

Table 2.11. Progressive Consumption Tax (% change)

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

Table 2.12. Percentage Change in LFP of Secondary Earners, by type of female

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

Table 2.13. Contribution of Married Female Hours to Changes in Total Hours (%)

	Prop. Con. (Partial)	Prop. Inc. (Partial)	Prog. Con. (Partial)
Δ in Mar. Fem. Hours (relative to Δ in Tot. Hours)	51.0	52.5	65.2

Table 2.14. Labor Force Participation of Secondary Earners in 1960, Data, (%)

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

Table 2.15. Productivity Levels, by Type, by Gender in 1960

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

Table 2.16. Distribution of Married Working Households by Type in 1960, (%)

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

Table 2.17. Progressive Consumption Tax Reform in Different Economies (% change)

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

Table 2.18. Percentage Change in LFP of Secondary Earners in Different Economies, by type of female

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

Fig. 2.1. Average Tax Rates

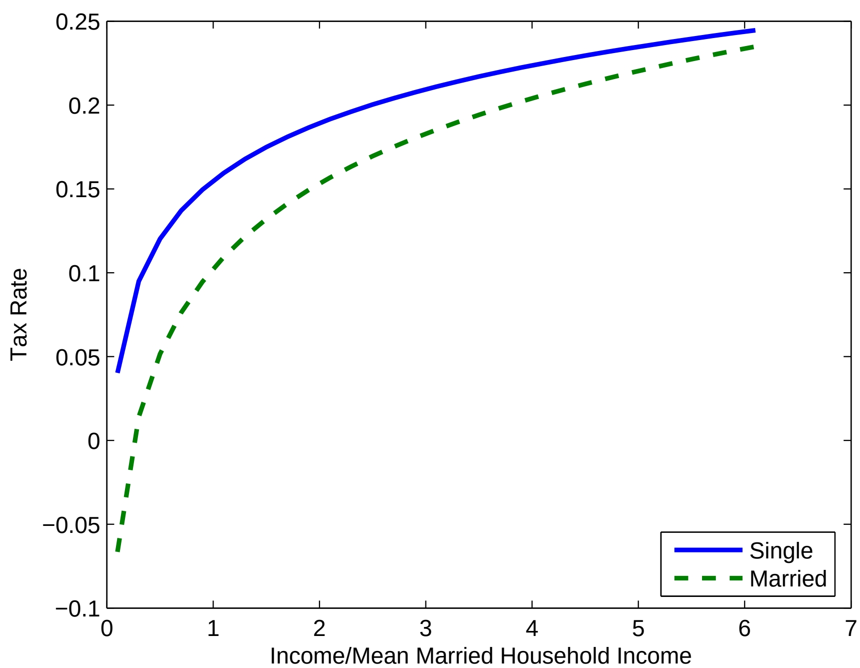
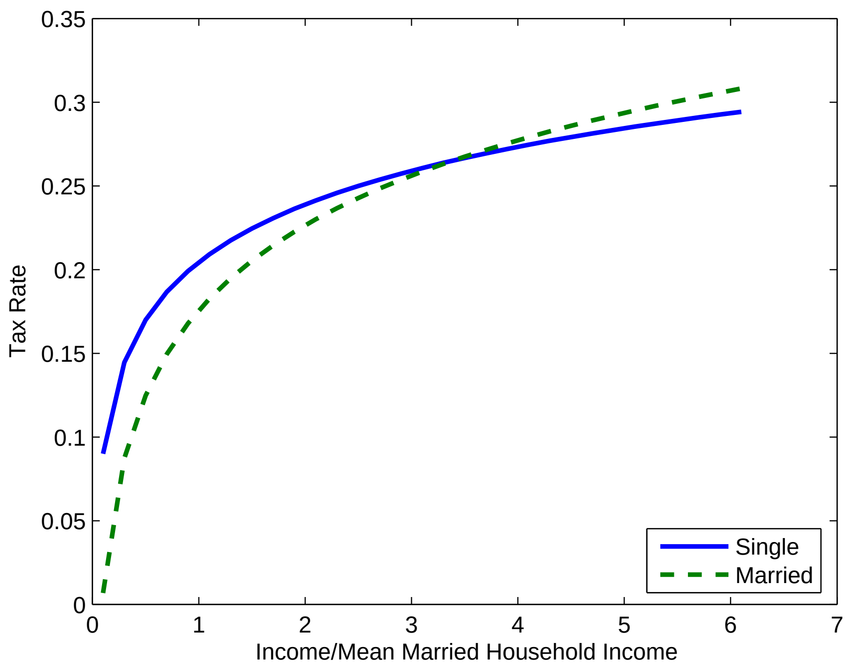


Fig. 2.2. Marginal Tax Rates



Chapter 3

Social Security and Two-Earner Households

3.1 Introduction

The implications of the U.S. public pension system has been a very active area of research. The existing literature has extensively studied the aggregate consequences of a number of potential changes, and in recent years, has explored the cross-sectional implications of current arrangements. This paper studies the aggregate, cross-sectional and welfare implications of the spousal benefit provision and the progressive nature of social security benefit calculation. In addition, the paper investigates how the spousal benefit interacts with the progressive calculation of benefits.

The social security system in the U.S. treats married households and single households asymmetrically via the spousal benefit provision. The current system is a pay-as-you-go system that taxes workers at a flat rate up to a certain level of earnings. The tax rate and the maximum amount of taxable income do not depend on the workers' marital status. However, retirement benefit collections depend on the marital status of individuals. In essence, each worker is entitled to a certain amount of monthly benefit payment, called Primary Insurance Amount (PIA), that is a function of past mean labor earnings. Married households, however, are offered a special option. If the PIA of one spouse in the household is lower than half of the PIA of the other one, then she/he can claim half of her/his spouse's PIA as the spousal benefit instead of claiming her/his own benefit. In this case, the household gets 150 percent of the higher PIA as total benefit payment.[1]

[1] Until recently, the number of retired wives who had the option of choosing between spousal and own benefits was quite low. In 1960 only 2.4% of women beneficiaries were so called dually entitled. The number today is much higher, about 12% (Rix and Williamson (1999)).

As a result, a spouse who has never participated in the labor market can still earn social security income. Therefore, this rule tends to discourage labor force participation of secondary earners, who are mostly women. Moreover, since the spousal benefit and primary earner's benefit grow at the same rate, the rule is considered to be regressive.[2] Understanding implications of this particular provision requires a model economy that explicitly deals with labor force participation decisions of wives in different households.

Another feature of the social security system that is important for married households is its progressive structure. The benefit formula is a piecewise-linear concave function of past mean earnings. Hence, the replacement rate for workers with low earnings is higher than the one for workers with high earnings. Furthermore, the degree of progressivity built into the benefit formula affects the number of married households who claim spousal benefits. In particular, for households with one high-wage and one low-wage spouse, the progressive benefit formula results in social security benefits that are more similar than their earnings. This makes the spousal benefit less attractive. As a result, a *less* progressive system is likely to result in more married households getting spousal benefits.

With these considerations in mind, I build and calibrate a general-equilibrium overlapping generations model with capital. Agents start out as married or single, and their marital status do not change over the life-cycle. Agents have certain education levels and wage profiles, where the latter depend on agents' education and gender. The household is the decision maker, and decides on labor supply of its member(s) and saving. The labor supply decision of a married household is a joint decision, and involves a labor market participation decision for the female. The households with two working members incur fixed utility costs, where the costs differ across households. After retirement, all households face mortality risks. Besides income and capital incomes taxes, workers pay social security taxes, and after retirement, they collect social security benefits. As in the current system, the benefit of a retiree is determined by a piecewise-linear concave

[2] In particular, households with two similar but low earnings can be at a disadvantage compared to households with only one earner with high earning. Using detailed earnings histories, Gustman and Steinmeier (2001) calculate that although the basic benefit formula in the current social security system is progressive, its progressivity declines significantly once spousal and survivor benefits are taken into account.

function. Total benefit collection of a household depends on its marital type and past mean labor earnings of its members.[3] The calibrated model economy closely resembles features of the 2000 U.S. economy. The model is consistent with observations on gender and wage premia across schooling groups, labor force participation and the structure of marital sorting, under a structure of taxation that resembles the structure currently prevailing in the U.S.

I consider *three* changes to the current social security rules. In each change I keep the pay-as-you-go character of the social security system, and compare the steady states of benchmark and reformed economies. First, the spousal benefit provision is eliminated. In this economy, regardless of marital status every worker gets what she/he is entitled to as benefit. Second, the progressive benefit function is replaced with a *linear* function. The aim of this change is to investigate implications of the progressive nature of the benefit function in an environment in which the participation decisions of married women is modeled. Finally, the special treatment to married households is eliminated together with replacement of the progressive benefit function by a linear function. The main findings of the paper can be summarized as follows:

- *Eliminating the spousal benefit.* After the change, the married households who claim spousal benefits experience losses in retirement income. The largest response comes from single-earner married households. The wives in these households enter the labor force. As a result, the labor force participation of married females increases by 4.5%. This increase is critical for the change in aggregate labor, as hours worked by males or females do not change much. Most of the increase in married females labor force participation comes from females with low education, especially from the ones who are married to men with high education. These households also increase their savings. Aggregate capital stock increases by about

[3] This paper is not the first paper to model the benefit calculation function as in the current system. Kotlikoff, Smetters and Walliser (1998a), Hugget and Ventura (1999), Nishiyama and Smetters (2005) and Fuster, İmrohoroğlu and İmrohoroğlu (2006) are some of the papers that model progressive benefit functions that return benefits as a function of past mean earnings. Kotlikoff, Smetters and Walliser (1998) approximates the function with a sixth order polynomial whereas the others use the piecewise linear function. Since Kotlikoff, Smetters and Walliser (1998a) and Nishiyama and Smetters (2005) use only single-earner households in their models, they scale up benefits in an attempt to capture the spousal benefit.

2.3% and aggregate output increases by 1.25%. Moreover, the results suggest that the spousal benefit provision favors traditional single-earner households (composed of a low-skilled wife and a high-skilled husband), since for these households the reform results in large *welfare losses*.

- *Eliminating the progressivity of the benefit calculation.* This change increases the retirement benefits of workers with high labor earnings and decreases benefits of workers with low labor earnings. Interestingly, number of married households claiming spousal benefits increases by 41% and the participation rate of married women decreases by 1.8%. This is a result of the increase in benefits for men with high education relative to those for women with low education. Therefore, for females in such households, the opportunity cost of participating in the market increases, and they leave the labor force. For these households, the resulting rise in the benefits also lowers their savings. In aggregate, the capital stock *decreases* by about 0.8% and the output decreases by 0.4%. While with the first change, the traditional households were losers (in terms of welfare), they are the biggest winners with the current reform.

- *Eliminating the spousal benefit together with the progressivity of the benefit calculation.* This one eliminates the spousal benefit in addition to the replacement of the progressive benefit function. Contrary to the second reform the participation rate of married women increases by about 3.5%. As in the first reform, both the capital stock and the output increase. The aggregate capital stock *increases* by 0.8%, while the aggregate output increases by 0.55%. The biggest winners (in terms of welfare) are the married households with two high-wage earning members.

In all three changes, the participation response of the married females is the major component of the changes in labor supply. The first one shows that the spousal benefits discourage married women from labor market participation. The second and third changes demonstrate that the spousal benefit plays a critical role in determining implications of removing the progressivity of the benefit calculation. More importantly, these alternatives help us understand the degree of redistribution built into the system.

Related Literature – This paper is related to two strands of literature. First, it builds on papers that analyze aggregate and cross-sectional implications of various reforms to the current pay-as-you-go social security system. Recent contributors include Auerbach and Kotlikoff (1987), İmrohoroğlu, İmrohoroğlu and Joines (1995), Kotlikoff, Smetters and Walliser (1998a), Huggett and Ventura (1999), Conesa and Kruger (1999), Fuster (1999), Storesletten, Telmer and Yaron (1999), Nishiyama and Smetters (2005), Gustman and Steinmeier (2004), Fuster, İmrohoroğlu and İmrohoroğlu (2006), and Huggett and Parra (2006). Second, it is related to papers that analyze macroeconomic implications of the participation (extensive) margin. Cho and Rogerson (1988), Cho and Cooley (1994), Mulligan (2001) and Chang and Kim (2006), among others, are examples of the papers in this group.

Using a simple structural model, Blau (1997) investigates the effects of the spousal benefit provision on labor force participation of married women.[4] In order to overcome estimation problems, he assumes away households' saving decisions and labor supply decisions along hours margin, the progressive calculation of benefits and general equilibrium implications of eliminating the provision. The current paper is a first attempt to integrate these features to study the aggregate and cross-sectional implications of the spousal benefit provision.

Rest of the paper is organized as follows. Section 2 details specifics of the model. Section 3 describes the way I calibrate the benchmark economy. Section 4 has a detailed description of the reforms that I study together with my findings. Section 5 concludes.

3.2 A Life-Cycle Model with Two-Earner Households

In this section I describe the model.

Demographics

The economy is populated by overlapping generations that consists of a continuum of males and a continuum of females. In every period, a new generation of individuals is born. There is no population growth. Agents in this economy live at most J periods.

[4]See also Gustman and Steinmeier (2004) and Blau (1998) and Blau(1998).

They begin life as workers and after the mandatory retirement age j_R they retire. After retirement agents face mortality risk. In particular, at start of age j they die with probability ρ_j. Each agent enters economic life as married or single. I assume that a constant fraction ϕ of the newborns are married and the rest is single. Marital status of agents do not change over their life spans. I assume that husbands and wives age together. Hence, they retire and die at same age.

Productive Heterogeneity

Each individual is endowed with one unit of time and supply labor services for j_R periods. Working-age agents differ by their market productivity levels. Market productivity of an agent, $e_i(z, j)$, depends on the agent's skill (education) type z, age j, and gender i. Skill type z takes n possible values, with $z \in Z = \{z_1, z_2, ..., z_n\}$. I assume that each agent is born with a particular skill type and this skill type does not change. I allow, however, market productivity levels differ by gender and age for each skill type. In addition, there is no uncertainty about a worker's future earnings.

For married households, let z denote skill type of the wife and $\tilde{z}$ denote skill type of the husband. I denote by $M(z, \tilde{z})$ the distribution of married households by skill types of spouses, and by $S_i(z)$ the distribution of single households of gender i, with $i \in \{m, f\}$, by skill type. I assume that these distributions are same at all ages.

Preferences

In this economy agents value consumption and leisure. The momentary utility function for a single person of gender $i \in \{f, m\}$ is given by

$$U_{si}(c, l) = \ln(c) - \theta_i \frac{l^{1+\frac{1}{\gamma}}}{1 + \frac{1}{\gamma}}, \tag{3.1}$$

where c is consumption, l is labor, and parameter γ is the Frisch elasticity of labor supply.

For a married household, momentary utility function is given by

$$U(c, l_m, l_f, q) = 2\ln(c) - \theta_m \frac{l_m^{1+\frac{1}{\gamma}}}{1+\frac{1}{\gamma}} - \theta_f \frac{l_f^{1+\frac{1}{\gamma}}}{1+\frac{1}{\gamma}} - \chi(l_f)q. \tag{3.2}$$

Here c is again consumption and l_i, $i \in \{m, f\}$, is labor supply. The parameter q stands for per period utility cost of joint-work and $\chi(l_f)$ is an indicator function such that

$$\chi(l_f) = \begin{cases} 1, \text{ if } l_f > 0 \\ 0, \text{ otherwise} \end{cases}. \tag{3.3}$$

I assume that husbands always work, but wives may stay out of the labor force. Following Cho and Rogerson (1988) I assume that if a wife participates in the labor market then her household incurs a utility cost of $q \in R_+$.[5] The household draws its utility cost from a distribution $\Phi(q|z, \tilde{z})$ upon birth. I assume that q is constant over the household's life-cycle.

Income

For a working-age married household total household income is sum of labor earnings and interest income. Working-age agents participate in a competitive labor market. Let w denote the wage rate per efficiency unit of labor. Households are born with no assets and are not allowed to borrow. They can save in the form of risk-free capital and earn a competitive rental rate r. Upon death, asset holdings of the households are not rebated back to the agents in the economy. I focus on a steady state equilibrium in which w and r are constant over time.

For a married household of age j, if wife works l_f hours and husband works l_m hours, then their labor earnings are $e_f(z, j)l_f w$ and $e_m(\tilde{z}, j)l_m w$, respectively. Moreover, if the household's assets are a , then the total household income is $e_f(z, j)l_f w$

[5] The utility cost can be interpreted as utility loss due to inconvinience for scheduling and/or less family time with children.

$+e_m(\tilde{z}, j)l_m w + ra$. Similarly, income of a single agent of gender i and age j is the sum of labor earnings, $e_i(z, j)l_i w$, and interest income ra.

There is a pay-as-you-go social security system that pays social security benefits to retirees. Therefore, for retired households total household income is sum of benefit payments from the social security system and interest income. The benefit that an agent is entitled to depends on her/his past mean labor earnings. For a retiree of gender $i \in \{f, m\}$ the benefit that she/he can claim is given by $B(\bar{e}_i)$, where $\bar{e}_i$ is her/his past mean labor earnings. Functional form for $B(\bar{e}_i)$ is

$$B(\bar{e}_i) = \begin{cases} \xi_1 \bar{e}_i & \text{if } \bar{e}_i \leq \kappa_1 \\ \xi_1 \kappa_1 + \xi_2(\bar{e}_i - \kappa_1) & \text{if } \kappa_2 \geq \bar{e}_i \geq \kappa_1 \\ \xi_1 \kappa_1 + \xi_2(\kappa_2 - \kappa_1) + \xi_3(\bar{e}_i - \kappa_2) & \text{if } \bar{e}_i \geq \kappa_2 \end{cases} \tag{3.4}$$

where ξ_1, ξ_2 and ξ_3 are all between 0 and 1. Hence, up to a past earnings level of κ_1 the person is entitled to $\xi_1 \bar{e}_i$, and ξ_1 is simply the replacement rate. If the past earnings is greater than κ_1 but less than κ_2, then she/he is entitled to $\xi_1\kappa_1 + \xi_2(\bar{e}_i - \kappa_1)$, and finally if the past earnings is greater than κ_2, then she/he is entitled to $\xi_1\kappa_1 + \xi_2(\kappa_2 - \kappa_1) + \xi_3(\bar{e}_i - \kappa_2)$. This particular functional form is the one used by the the current social security system.[6] In accordance with the current law, I assume that $\xi_1 > \xi_2 > \xi_3$. Therefore, the benefit function is progressive. Given that the social security system finances itself, such a system redistributes resources from workers with high past earnings to the ones with low past earnings.

For a j-year old worker the law of motion for $\bar{e}_i$ is given by

$$\bar{e}_i' = E(e_i(z, j)l_i w, \bar{e}_i) = \frac{(j-1)\bar{e}_i + \min\{e_i(z, j)l_i w, E_{\max}\}}{j}. \tag{3.5}$$

In this formulation $E_{\max}$ is the maximum level of earnings that is applied to benefit formula.

[6] See http://www.ssa.gov/policy/docs/statcomps/supplement/2000/apnd.pdf for details.

A single retired household collects social security benefits according to (3.4). On the other hand, a married household is treated differently. If one of the members' benefit payment is less than half of the other's, then the member with lower benefits can claim half of her/his spouse's benefits instead of his/her own. Hence, each married agent compares his/her benefits with half of his/her spouse's benefits and decide whether to claim spousal benefits. Therefore, the social security payments that the married household receives is given as

$$H(\bar{e}_f, \bar{e}_m) = \max \ \{B(\bar{e}_m) + B(\bar{e}_f), B(\bar{e}_m) + \frac{1}{2}B(\bar{e}_m), B(\bar{e}_f) + \frac{1}{2}B(\bar{e}_f)\}. \qquad (3.6)$$

Taxation

Households pay income tax, social security tax and capital income tax. Income tax that a household pays depends on the household's taxable income and marital status. The taxable income is sum of labor earnings and interest income. I assume that benefit payments are exempt from income taxes. Income tax schedules for married households is given by $T^M(.)$, whereas $T^S(.)$ denotes the income tax schedule for single households.

Taxable income for social security purposes consists only of labor earnings up to a certain level $E_{\max}$. For earnings below this cap, a worker faces a proportional social security tax rate τ^p. I denote the total social security tax payments schedule by $T^p(.)$.

In this economy interest income is subject to double taxation. Besides income taxes, households pays an additional capital income tax for their interest earnings. I denote this additional proportional tax by τ^k.

Technology

There is a single representative firm in the economy which hires capital and labor. Let K denote the aggregate capital and L denote the aggregate labor in efficiency units. The production technology of the firm is given by

$$Y = K^{\alpha} L^{1-\alpha}, \qquad (3.7)$$

where $\alpha \in (0,1)$ is the output share of capital. The capital depreciates at a constant rate $\delta \in (0,1)$. The representative firm hires capital and labor to maximize its profits and as a result w and r are given by marginal products.

3.2.1 Households' Decision Problem

As stated previously, married households differ by their ages j, skills of the members, z and $\tilde{z}$, and cost of joint work q. At the start of each period, the households observe their current asset holdings a and past mean earnings of the male and the female $\bar{e}_m$ and $\bar{e}_f$. I group these state variables as $x = (a, \bar{e}_m, \bar{e}_f)$.

Single households differ by their gender (f or m), their ages (j) and their skills (z). Again prior to any decision making, a single household observes current asset holdings (a) and past mean earnings ($\bar{e}_m$ or $\bar{e}_f$). I group these as $x_{si} = (a, \bar{e}_i)$, $i \in \{m, f\}$. All types of households at age 1 have zero units of asset holdings.

Single Households

Consider the problem of a j-year old single person of gender $i \in \{m, f\}$. Given (z, j, x_{si}), she/he decides on current consumption (c_{si}), labor supply (l_{si}), and next period asset holdings (a'_{si}). I write this problem as

$$V_{si}(z,j,x_{si}) = \max_{a'_{si} \geq 0,\ l_i} U_{si}(c_{si}, l_{si}) + \beta(1 - I(j)\rho_{j+1})V_{si}(z, j+1, x'_{si}), \tag{3.8}$$

subject to

$$c_{si} + a'_{si} = e_i(z,j)wl_{si} - T^p(e_i(z,j)wl_{si}) - T^S(e_i(z,j)wl_{si} + ra) + (1+r)a - \tau^k ra + I(j)B(\bar{e}_i), \tag{3.9}$$

$$x'_{si} = (a'_{si}, E(e_i(z,j)wl_{si}, \bar{e}_i)), \tag{3.10}$$

$$I(j) = \begin{cases} 0 \text{ if} & j \leq j_R \\ 1 \text{ if} & j_R < j \leq J \end{cases}, \tag{3.11}$$

$$l_{si} = 0 \text{ if } j_R < j \leq J,\ l_{si} \in [0,1] \text{ if } j \leq j_R, \tag{3.12}$$

where β is the discount factor. Note that since I focus on steady states, w and r are constant. I assume that agents cannot borrow, i.e., $a'_{si} \geq 0$. Equation (3.9) states the budget constraint for the household. Consumption and savings of the household must be equal to the disposable resources of the household at age j. Note that after age j_R, agents are not allowed to work, but they collect social security income. Finally, Equation 3.10 specifies how the state of next period, x'_{si}, is determined.

Married Households

Consider the problem of a j-year old married household. The household observes the relevant variables, $(z, \tilde{z}, q, j, x)$. Consequently, the household decides on current consumption (c), labor supply of the husband (l_m), labor supply of the wife (l_f), and next period asset holdings ($a\prime$). The household's joint maximization problem can be written as

$$V(z, \tilde{z}, q, j, x) = \max\{ \max_{a' \geq 0,\, l_f,\, l_m} U(c, l_m, l_f, q) + \beta(1 - I(j)\rho_{j+1})V(z, \tilde{z}, q', j+1, x')$$

$$, \max_{a' \geq 0,\, l_m} U(c, l_m, 0, q) + \beta(1 - I(j)\rho_{j+1})V(z, \tilde{z}, q', j+1, x')\}$$

subject to

$$c + a' = e_m(\tilde{z}, j)wl_m + e_f(z, j)wl_f - T^p(e_m(\tilde{z}, j)wl_m) - T^p(e_f(z, j)wl_f) \tag{3.13}$$

$$- T^M(e_m(\tilde{z}, j)wl_m + e_f(z, j)wl_f + ra) + (1 + r)a - \tau^k ra$$

$$+ I(j)H(\bar{e}_f, \bar{e}_m),$$

$$x' = (a', E(e_m(\tilde{z}, j)wl_m, \bar{e}_m), E(e_f(z, j)wl_f, \bar{e}_f)), \tag{3.14}$$

$$I(j) = \begin{cases} 0 \text{ if } j \leq j_R \\ 1 \text{ if } j_R < j \leq J \end{cases}, \tag{3.15}$$

$$l_m = 0 \text{ if } j_R < j \leq J,\ l_m \in [0,1] \text{ if } j \leq j_R, \tag{3.16}$$

$$l_f = 0 \text{ if } j_R < j \leq J,\ l_f \in [0,1] \text{ if } j \leq j_R. \tag{3.17}$$

Next period state of the household, x', is given by equation (3.14).

3.2.2 Equilibrium

I am now ready to define a steady state equilibrium for this economy. Given the basic demographic variables, J, j_R, ρ_j, and ϕ, earning profiles, $e_i(z,j)$ $i \in \{m,f\}$, the distribution of households $M(z,\tilde{z})$, $S_m(z)$ and $S_f(z)$, the benefit function $B(\bar{e})$, the function that gives benefit collections of married households $H(\bar{e}_f,\bar{e}_m)$, the income tax functions, $T^M(.)$ and $T^S(.)$, capital income tax rate τ^k, and government spending G, a steady state equilibrium consists of a set of decision rules $c(z,\tilde{z},q,j)$, $l_i(z,\tilde{z},q,j)$, $a(z,\tilde{z},q,j)$, $c_{si}(z,j)$, $l_{si}(z,j)$, and $a_{si}(z,j)$, aggregate capital stock K, aggregate labor supply L, rental rates for labor and capital w and r, and the social security tax τ^p such that:

1. The set of decision rules $c(z,\tilde{z},q,j)$, $l_i(z,\tilde{z},q,j)$, $a(z,\tilde{z},q,j)$, $c_{si}(z,j)$, $l_{si}(z,j)$, and $a_{si}(z,j)$ solve the dynamic problems of married and single households.

2. Factor markets are competitive, i.e.,

$$w = F_2(K,L) \text{ and } r = F_1(K,L) - \delta.$$

3. Capital and labor markets clear, i.e.,

$$K = \sum_{z,\tilde{z},q,j\leq j_R} \phi M(z,\tilde{z})\Phi(q|z,\tilde{z})a(z,\tilde{z},q,j) + \sum_{z,i,j\leq j_R} \frac{(1-\phi)}{2} S_i(z)a_{si}(z,j)$$
$$+ \sum_{z,\tilde{z},q,j>j_R} \left(\prod_{k=j_R+1}^{j}(1-\rho_k)\right) \phi M(z,\tilde{z})\Phi(q|z,\tilde{z})a(z,\tilde{z},q,j)$$
$$+ \sum_{z,i,j>j_R} \left(\prod_{k=j_R+1}^{j}(1-\rho_k)\right) \frac{(1-\phi)}{2} S_i(z)a_{si}(z,j).$$

and

$$L = \sum_{z,\tilde{z},q,i,j\leq j_R} \phi M(z,\tilde{z})\Phi(q|z,\tilde{z})e_i(z,j)l_i(z,\tilde{z},q,j) + \sum_{z,i,j\leq j_R} \frac{(1-\phi)}{2} S_i(z)e_i(z,j)l_{si}(z,j).$$

4. Social security budget balances, i.e.,

$$w\tau^p \sum_{z,\tilde{z},q,i,j\leq j_R} \phi M(z,\tilde{z})\Phi(q|z,\tilde{z})\min(e_i(z,j)l_i(z,\tilde{z},q,j),E_{\max})$$
$$+ w\tau^p \sum_{z,i,j\leq j_R} \frac{(1-\phi)}{2} S_i(z)\min(e_i(z,j)l_{si}(z,j),E_{\max})$$
$$= \sum_{z,\tilde{z},q,j>j_R} \left(\prod_{k=j_R+1}^{j}(1-\rho_k)\right) \phi M(z,\tilde{z})\Phi(q|z,\tilde{z})H(\bar{e}_f(z,\tilde{z},q,j),\bar{e}_m(z,\tilde{z},q,j))$$
$$+ \sum_{z,i,j>j_R} \left(\prod_{k=j_R+1}^{j}(1-\rho_k)\right) \frac{(1-\phi)}{2} S_i(z)B(\bar{e}_i(z,j)).$$

5. Government budget balances, i.e.,

$$G = \sum_{z,\tilde{z},q,j \le j_R} \phi M(z,\tilde{z})\Phi(q|z,\tilde{z})T^M(.) + \sum_{z,i,j \le j_R} \frac{(1-\phi)}{2} S_i(z)T^S(.)$$

$$+ \sum_{z,\tilde{z},q,j > j_R} \left(\prod_{k=j_R+1}^{j} (1-\rho_k) \right) \phi M(z,\tilde{z})\Phi(q|z,\tilde{z})T^M(.)$$

$$+ \sum_{z,i,j > j_R} \left(\prod_{k=j_R+1}^{j} (1-\rho_k) \right) \frac{(1-\phi)}{2} S_i(z)T^S(.) + \tau^k rK$$

3.3 Parameter Values

In this section I summarize my calibration strategy and discuss parameter values that I use to simulate the model economies.

Demographics

I calibrate my model economy to the U.S. economy in 2000. I use the U.S. Census data unless stated otherwise.[7] Length of a period is set to be 10 years. Age 1 in the model corresponds to all ages between 25 and 34. Agents live at most 6 periods ($J = 6$) and they retire after age 4 ($j_R = 4$). Since all agents die at the end of final period I set probability of death after this period to 1 ($\rho_7 = 1$). For simplicity I assume that probability of death at ages 5 and 6 are the same, i.e., $\rho = \rho_5 = \rho_6$. I set these probability values so that number of retired agents is 20 percent of the entire population ($\rho = 0.382$), as it is the case for the U.S. population 25 years and older. In the data 74 percent of people between ages 25 and 64 are married. Therefore, in my model I use 74 percent as the fraction of married individuals in the population ($\phi = 0.74$).

Skills and Endowments

I choose five skill types corresponding to educational attainments in the population. Table 3.1 summarizes my classification. I assume that there are 5 skill types. As a result, there are 25 different types of married households by skill types of the members.

[7] Source: Census data tabulated by IPUMS-USA, Minnesota Population Center, University of Minnesota (www.ipums.org).

In order to calculate the distribution of married and single households across skill types, I consider the population between ages 25 and 64. First, I divide the total population into two groups according to marital status. Next, I divide these groups according to skill types of the households. Using the number of observations for each subgroup, I construct the distributions of households by skill types, $M(z, \tilde{z})$, $S_m(z)$ and $S_f(z)$ in the model (see Tables 3.2 and 3.3). From Table 3.2, I observe the well known fact about assortative mating. Married households are concentrated along the diagonal of the table, i.e., spouses in most households have similar educational attainment levels.[8]

Next, I determine the market productivity levels for each skill type. I consider again individuals who are older than 25 and younger than 64. I divide the sample into 40 subgroups by age, gender and skill type of individuals, respectively. In order to construct market productivity profiles I first calculate mean hourly wages by dividing total wage and salary income by total hours worked.[9] Then, I normalize these mean wages with the mean hourly wage for the whole sample to find relative market productivity levels. Table 3.4 reports these productivity values.

Two features of this table are worth noting. First, as documented in Olivetti (2006), age-earning profiles for females are much flatter than the ones for males. Second, as Eckstein and Nagypál (2004) document there is a significant difference between earnings of people with post-college education and college graduates, and post-college premium is relatively significant. Given these facts and the fact that the fraction of people with post college degree is quite high, around 0.10, it is important to treat this group separately.

Production Technology

There are 2 parameters to be determined on the production side of the model. I set the capital share α to be 0.317. In the absence of population growth and growth in labor efficiency, I set the depreciation rate δ so that annual rate is 0.07 (see Table 3.5).

[8] The level of marital sorting by education has been quite high and constant from 1940 until 1980s, but increased since then. See Mare and Schwartz (2005) for changes in assortative mating by education from 1940 to 2003.

[9] Hours worked per week and number of weeks worked last year are the two variables that are available in the Census data. I use these to find total hours worked. I exclude self-employed people and people who are not working from the sample.

Table 3.1. Classification of Skill Types

Skill Type	Educational Attainment
<hs	less than high school degree
hs	high school diploma
sc	less than 4 years of college education
col	college degree
col+	post college education

Table 3.2. Distribution of Married Households by Skill Types

	Female					
Male	<hs	hs	sc	col	col+	Total
<hs	0.0676	0.0424	0.0232	0.0039	0.0018	0.1389
hs	0.0316	0.1350	0.0728	0.0184	0.0068	0.2646
sc	0.0174	0.0745	0.1351	0.0432	0.0155	0.2858
col	0.0039	0.0236	0.0576	0.0758	0.0261	0.1870
col+	0.0016	0.0089	0.0262	0.0442	0.0427	0.1236
Total	0.1222	0.2845	0.3150	0.1855	0.0928	1.0

Table 3.3. Distribution of Single Households by Skill Types

	Males	Females
<hs	0.1581	0.1754
hs	0.2696	0.2646
sc	0.2985	0.3185
col	0.1823	0.1488
col+	0.0915	0.0927

These values are consistent with a notion of capital that excludes residential capital consumer durables and government owned capital for the period 1960-2000. The corresponding notion of output is then GDP accounted for by the business sector. Altogether, this implies an annual capital to output ratio of about 2.325.[10]

Preference Parameters

There are four preference parameters: θ_m, θ_f, γ and β. I calibrate these parameters to match four data targets. I choose the values for θ_m and θ_f so that benchmark values of hours per worker by males and females match the ones observed in the data. In the data males spend about 0.451 of their available non-sleeping time in the market while the same number is 0.362 for females.[11] Values of θ_m and θ_f I use in the benchmark model are reported in Table 3.5.

Other preference variable γ is the Frisch elasticity of labor supply. I choose γ so that it is within the range of its estimates in the literature (see Table 3.5). For married women Blundell & MaCurdy (1999) reports a range from 0.5 to 1, for males MaCurdy (1981) finds a range from 0.10 to 0.40 and Altonji (1986) finds a range from 0 to 0.35.

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

Female Labor Force Participation

An important element of the model is the participation decision of females. The distribution of utility cost, $\Phi(q|z,\tilde{z})$, determines the labor force participation rate of females. Since this distribution depends on skill types of members of married households, I have to specify 25 distribution functions. I assume that all of these distributions are and denoted by

$$\Phi(q|z,\tilde{z}) = 1 - e^{-\frac{q}{\bar{q}(z,\tilde{z})}}.$$

[10] See Guner, Ventura and Yi (2006) for details.

[11] For these statistics the sample is the group of people who are between 25 and 64. First I find yearly total hours by each individual and then divide these by 5000 to find labor hours per unit of time. I assume that 5000 hours is the total amount of time available for work and leisure.

Table 3.4. Productivity Values by Types, by Gender

	Males					Females				
	Skill					Skill				
Age	<hs	hs	sc	col	col+	<hs	hs	sc	col	col+
1	0.662	0.747	0.833	1.132	1.340	0.559	0.611	0.703	0.946	1.119
2	0.765	0.887	1.056	1.579	1.887	0.603	0.672	0.816	1.166	1.433
3	0.833	0.982	1.168	1.689	2.033	0.640	0.722	0.867	1.145	1.418
4	0.914	1.070	1.296	1.867	2.226	0.695	0.744	0.893	1.188	1.441

Table 3.5. Parameter Values

γ	0.5
β	0.818 ($\beta^{0.1} \cong 0.98$)
θ_m	13
θ_f	16.9
α	0.317
δ	0.516
ρ	0.382
ϕ	0.74
κ_1	0.112 of mean income
κ_2	0.673 of mean income
$E_{\max}$	1.33 of mean income
ξ_1	0.90
ξ_2	0.32
ξ_3	0.15
τ^p	0.11
τ^k	0.161

This distribution is specified by its single parameter $\bar{q}(z, \tilde{z})$, which is the mean. For any type $(z, \tilde{z})$ married households, $\bar{q}(z, \tilde{z})$ determines the labor force participation rate of married females. This allows me to choose this parameter to match the labor force participation rate for the corresponding group in the data. The sample I consider is a group of married females older than 25 and younger than 64. First, I group these married females according to skill types of the members of the households that they belong to. Next, for each group I find employment to population ratio. Table 3.6 shows the participation rates of married females by types of households for 2000 US economy. By setting 25 mean utility costs I match participation rates by types of married households. Table 3.6 also reports the participation rates for the benchmark economy and Table 3.7 shows the values of mean utility cost values, $\bar{q}(z, \tilde{z})$, used in the benchmark economy.

Table 3.6. Labor Force Participation of Married Women, (%)

	Data					Benchmark				
	Female					Female				
Male	<hs	hs	sc	col	col+	<hs	hs	sc	col	col+
<hs	38.15	57.65	67.05	73.76	68.15	38.28	57.40	66.74	73.06	67.44
hs	44.25	61.60	72.06	77.77	80.12	44.00	61.63	71.70	77.90	79.80
sc	45.32	61.45	69.56	77.70	83.10	45.17	60.98	69.58	77.55	82.87
col	44.22	57.71	63.21	68.85	79.87	44.45	57.45	62.87	68.82	79.49
col+	40.86	50.68	57.02	60.64	75.28	41.16	50.28	57.34	60.35	76.27

Table 3.7. Mean Utility Cost Values

	Female				
Male	<hs	hs	sc	col	col+
<hs	1.19	0.73	0.67	0.77	1.01
hs	0.81	0.55	0.5	0.56	0.64
sc	0.65	0.47	0.45	0.5	0.49
col	0.42	0.32	0.35	0.45	0.39
col+	0.35	0.3	0.31	0.44	0.36

Social Security System

One feature of the equilibrium in the environment is that social security budget balances at all times. The current social security law determines both social security tax rate and benefit levels. However, I cannot use both of them in my model, since social security budget would not balance for obvious reasons. Therefore, I have to take either tax side or benefit side from the law. Since I consider reforms that change the way benefits are calculated, I take the benefit function from the law and let the social security tax rate adjust so that budget balances.

Benefit function has 5 parameters to be determined. According to the 2000 social security rules, ξ_1 is 0.90, ξ_2 is 0.32 and ξ_3 is 0.15. Besides, bend points in the benefit function in the current law, κ_1 and κ_2, are \$531 and \$3202.[12] These are applied to average indexed monthly earnings. In order to be consistent with the law, I multiply these bend points (\$531 and \$3202) with 12 to arrive at a yearly figure and then normalize them with mean household income for 2000.[13] For benchmark calculations, I multiply these normalized numbers with mean household income in the benchmark model to determine the bend points. The values of κ_1 and κ_2 that I use in the benchmark model are reported in Table 3.5.

Maximum taxable labor earnings for social security purposes in 2000 is \$76,200. In order to be consistent with previous calibration strategy I normalize this cap with mean household income for 2000. Again, I use mean household income that comes out of the model and determine income cap $E_{\max}$ in the model (see Table 3.5).

Income Tax and Capital Income Tax

In the U.S. tax law statutory tax rates are applied to taxable incomes of households. I don't use these tax rates in the models that I consider, instead I estimate effective tax functions for married and single households for their reported income. I follow the procedure described in Kaygusuz (2006). I use income tax data for 2000 tabulated by Internal Revenue Service.[14] Total income tax paid, total income, total

[12] See http://www.ssa.gov/policy/docs/statcomps/supplement/2000/apnd.pdf for details.

[13] Mean household income for 2000 is \$57,135 (from Census).

[14] Source: Statistics of income division, *Individual Income Tax Returns* bulletin for 2000. Publication number :1304.

number of returns and total number of taxable returns are available for certain income brackets. Using this data I find the average tax rate within each income bracket with following formula

$$average\ tax\ rate = \frac{\{\frac{\text{total income tax paid}}{\text{number of taxable returns}}\}}{\{\frac{\text{total income}}{\text{number of returns}}\}}. \tag{3.18}$$

I also normalize average incomes with mean household income for each bracket. Then, I estimate the relation between these normalized income levels and average tax rates. This procedure is similar to the one in Gouveia and Strauss (1994). In particular, I estimate the following tax functions for married and single households:

$$T^M(income) = [0.1023 + 0.0733 \log(income)]income,$$

and

$$T^S(income) = [0.1547 + 0.0497 \log(income)]income.$$

I use these income tax functions in all of the model economies. Marginal tax rates derived from these tax functions are shown in Figure 3.1.

Finally, I estimate the capital income tax rate to proxy the corporate income tax. Between 1987 and 2000, corporate income tax revenue was approximately 1.92 percent of GDP. Given my assumption about the production technology, I should have a 16.1 percent capital income tax to replicate this share. Hence, I set τ^k as 0.161.

3.4 Reforms

In this section I specify the tax reforms that I study in this paper. I focus on two aspects the current social system. First aspect is the spousal benefit. In the current system, a spouse with lower benefits can claim half of his/her spouse's benefits instead of his/her own. It is obvious that this rule discourages women from labor market participation as non-participating married women can claim spousal benefits. Indeed, when the spousal benefit provision was added to social security law in 1939, one of the explicit aims was to encourage traditional bread winner-home maker households.[15] Another feature of this provision is that since the spousal benefit grow with primary earners benefits, it provides more benefits to rich single-earner households. In particular, households with two similar but low earnings are in a clear disadvantage compared to households with one high earnings member.[16]

A second aspect of the current system that I consider is the shape of the benefit formula. As I explain in Section 2, the benefit function is a piecewise-linear concave function. As a result, it redistributes resources from retired workers with high labor earnings to the ones with low labor earnings. Due to gender gap and differences in skills, females in most married households have lower earnings than their husbands. However, due to the progressive nature of the benefit calculation, differences in benefit entitlements are smaller than differences in earnings. As the calculation gets less progressive, the gap between entitlements approaches to the gap between earnings. Therefore, as the system gets less progressive more married households qualify for the spousal benefit.

In order to gain insight about how the current system works for different types of households, I study long-run implications of three hypothetical reforms. In Reform 1, I simply remove the spousal benefit option given to married households regarding benefit collection. In Reform 2, I replace progressive calculation of benefits with a flat replacement function. Finally, in Reform 3 I remove the spousal benefit and replace the progressive benefit function with a flat replacement function at the same time.[17] Note that none of these hypothetical reforms change the pay-as-you-go feature of the social security system.

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[15] See Carlson (2005) for development of 1939 amendments to social security system. One person testifying before Congress reported: "The mother's services are worth more in the home than they are in the outside labor market and ... she should be enabled to stay home and care for the children."

[16] See Nicolaou and Stanfield (2000).

[17] All of these reforms will possibly change labor supply and saving behavior of households. As a result sum of revenues from income tax and capital income tax might change. To keep the tax revenue from these sources unchanged, I introduce a flat tax on income.

With Reform 1 a married household's social security benefits are given by

$$H(\bar{e}_f, \bar{e}_m) = B(\bar{e}_m) + B(\bar{e}_f).$$

Hence, the total benefit that a married household receives becomes sum of the benefits that each member of the household is entitled to. In order to balance social security budget I adjust social security tax rate (τ^p).

This reform should affect the married households who take advantage of spousal benefit option. The total benefits of these households will decrease and they will respond in a way to compensate for their losses. Such households consist of all single-earner households and some of two-earner ones. Recall that the two-earner households also can take advantage of the option if one of the earners' past earnings is considerably lower than the other one. Table 3.8 shows the fraction of married households who claim spousal benefits according to types for the benchmark economy. This table gives us an idea about which types of households will be affected most after the reform.

In Reform 2 I change the way the benefits are calculated while spousal benefit rule is kept intact. The benefit formula in the benchmark economy is given by

$$B(\bar{e}_i) = \begin{cases} 0.90\bar{e}_i & \text{if } \bar{e}_i \leq 0.0261 \\ 0.90(0.0261) + 0.32(\bar{e}_i - 0.0261) & \text{if } 0.1565 \geq \bar{e}_i \geq 0.0261 \\ 0.90(0.0261) + 0.32(0.131) + 0.15(\bar{e}_i - 0.1565) & \text{if } \bar{e}_i \geq 0.1565 \end{cases} \cdot$$

Figure 3.2 shows this function. I replace this function with a linear function so that I remove progressivity of the benefit function. The new function, also shown in Figure 3.2, that I use in Reform 2 is

$$B(\bar{e}_i) = \vartheta \bar{e}_i.$$

In this experiment I keep the social security tax rate in the benchmark economy unchanged and choose ϑ so that social security budget balances.

As one can see from the figure, Reform 2 should penalize workers with low labor earnings and make workers with high labor earnings better off. Benefit collections of the retired workers with high labor earnings should increase and benefit collections of the retired workers with low labor earnings should decrease. In the benchmark economy most of the agents with low earnings are females whereas most of the agents with high earnings are males. As a result, for some married households ratio of wife's benefit entitlement to husband's benefit entitlement decreases. Hence, we should expect to see more married households claiming spousal benefits.

The third reform removes the progressivity of the benefit function together with the spousal benefit. I keep the social security tax rate unchanged and choose the parameter of the new benefit function, ϑ, so that the social security budget balances. Similar to Reform 1, the households claiming the spousal benefits should experience losses in social security benefits. In addition, as in Reform 2 benefit collections of the retired workers with high labor earnings should increase and benefit collections of the retired workers with low labor earnings should decrease. Contrary to Reform 2, there won't be any married households claiming spousal benefits. Outcomes of Reform 2 and 3 should show us how the progressive nature of the benefit function in the current system interacts with the spousal benefit. Moreover, we should see the importance of modelling the participation decisions for married females when studying implications of a widely discussed feature of the social security, i.e. the progressivity of benefit calculation.

3.4.1 Reform 1: Eliminating the Spousal Benefit

Aggregate effects of Reform 1 are shown in Table 3.9. The results show that current social security rules encourage married women to stay out of the labor force. When I remove the spousal benefit, labor force participation rate of married women increases by 4.54 percent (about 2.9 percentage points). At the same time, aggregate capital stock increases by 2.29 percent, aggregate labor in efficiency units increases by 0.99 percent and aggregate output increases by 1.25 percent. There are no significant changes in hours per working males and females. Note that the social security tax rate declines from 11 percent to 10.3 percent.

Table 3.8. Fraction of Married Households Who Claim Spousal Benefits, Benchmark

	Female				
Male	<hs	hs	sc	col	col+
<hs	0.61	0.39	0.26	0.09	0.11
hs	0.64	0.49	0.24	0.14	0.05
sc	0.69	0.54	0.37	0.14	0.08
col	1.00	1.00	0.53	0.36	0.13
col+	1.00	1.00	1.00	0.47	0.29

Table 3.9. Aggregate Effects, Reform 1

	Data	Benchmark	Reform 1	% change
Aggregate Hours	-	100.00	100.99	0.99
Hours per Worker (males)	0.451	0.453	0.4526	-0.09
Hours per Worker (females)	0.36	0.3559	0.3557	-0.06
LFP of married women	63.71	63.62	66.51	4.54
Y	-	100.00	101.25	1.25
K	-	100.00	102.29	2.29
L	-	100.00	100.77	0.77
w	-	100.00	100.48	0.48
Spousal Benefits (%) (recipients among married h.h.)	-	43.97	0	-
τ^p	-	0.11	0.103	-

Note: Table 3.9 reports the values of the aggregate variables in the data, in the benchmark economy and after Reform 1. Last column shows percentage changes after the reform. Reform 1 eliminates the spousal benefits paid to married households.

Now I report more detailed results in Table 3.10. Panel A shows the percentage change in benefit collections by married households. All household types shown in this table lose benefit collections, however, the losses vary systematically. As the female's skill type decreases and as the male's skill type increases, the loss in benefit collections of the household increases. In particular, households with husbands with at least a college degree and wives with at most a high school degree experience the most significant losses. This finding is well in line with what Table 3.8 suggests. Note that there are losers from all types of households. This is not unexpected, since among all types of married households there are single-earner families who lose after the reform, although the fraction of these are low among higher skilled households.

Panel B reports the percentage change in labor force participation of married women by skill types of married households. The responses of households follow the general pattern in Panel A. This table shows the way the spousal benefit discourages married women from market participation. After the loss of the spousal benefit, opportunity cost of staying at home increases for the females. Hence, some of them start working. The opportunity cost is higher for females who are married to high skilled men because the spousal benefit increases with skill of the spouse. Therefore we observe a larger response as the woman is less skilled relative to the husband. Note that the increase in labor supply of these females does not contribute much to the aggregate output (see Table 3.9) since they mostly have low market productivity.

Next, I report how the asset holdings of married households at the time of retirement change after the reform. Like female LFP, savings is another margin in which households who are affected negatively by this reform can try to improve their incomes after retirement. Indeed, as shown in Panel C households increase their savings in order to compensate for their losses in their retirement incomes. This, together with a lower social security tax rate, is an important contributor to the increase in the aggregate capital stock after this reform. Once again, the group of households who respond to the reform most in terms of labor supply increase their asset holdings more than the other households.

Finally, Panel D reports the percentage change in welfare of households from initial steady state to final steady state after the reform. The numbers in this table show

Table 3.10. Cross Sectional Effects, Married Households, Reform 1

Panel A

% Change in Social Security Benefits

	Female				
Male	<hs	hs	sc	col	col+
<hs	-17.01	-9.44	-4.18	-2.16	-2.89
hs	-15.96	-8.53	-3.69	-1.65	-1.14
sc	-16.04	-12.24	-5.43	-1.94	-0.54
col	-19.10	-13.08	-9.60	-5.66	-1.27
col+	-20.60	-17.88	-12.30	-8.68	-3.58

Panel B

% Change in LFP

	Female				
Male	<hs	hs	sc	col	col+
<hs	5.21	4.16	2.58	0.48	3.58
hs	7.79	4.39	2.52	2.10	0.84
sc	7.93	6.10	4.16	1.66	1.78
col	10.44	9.86	8.20	3.54	3.76
col+	12.57	10.76	10.66	5.52	2.55

Panel C

% Change in Assets After Retirement

	Female				
Male	<hs	hs	sc	col	col+
<hs	17.16	9.33	4.10	-0.78	4.87
hs	16.06	8.89	5.27	2.30	1.87
sc	14.26	9.42	4.99	2.74	11.08
col	18.07	11.39	8.22	3.93	-1.48
col+	16.40	14.13	10.78	6.99	1.59

Panel D

% Change In Welfare

	Female				
Male	<hs	hs	sc	col	col+
<hs	-0.81	0.41	1.14	1.53	1.25
hs	-0.39	0.62	1.34	1.64	1.67
sc	-0.18	0.64	1.17	1.68	1.86
col	-0.31	0.45	0.86	1.33	1.87
col+	-0.29	0.02	0.54	1.06	1.78

Note: Panels in Table 3.10 report cross sectional implications of eliminating the spousal benefits. All numbers shown in these panels are percentage changes relative to the benchmark economy. See Table 3.1 for definitions of <hs, hs, sc, col and col+.

the percentage increase/decrease in consumption that is needed to make a household living in the benchmark economy as well off as in the economy after the reform.[18] As this table shows there are losers and winners after the reform. The households who were taking the advantage of the spousal benefit the most are the biggest losers, while all households with skilled (college or more) wives gain. The reason why there are winners is that there is a decline in the social security tax rate and a rise in the wage rate. Welfare gains are larger for the groups of households in which the female labor force participation is higher (see Table 3.6).

Single households are also affected by the changes in the wage rate and social security tax rate. Table 3.11 reports the percentage change in hours per worker and welfare for single males and single females. There are virtually no changes in hours per worker for single males or females. However, there are significant changes in welfare for all single households. Due to lower taxes and higher wages, the singles experience a welfare gain in excess of 1%. Even though males and females experience similar gains in welfare, changes for males are slightly higher.

3.4.2 Reform 2: Removing the Progressivity of the Benefit Calculation

Reform 2 replaces the progressive benefit calculation formula with

$$B(\bar{e}_i) = 0.38\bar{e}_i,$$

where $\vartheta = 0.38$ balances the social security budget. An immediate implication of this reform is that workers with past mean earnings lower than some threshold level lose from retirement income, whereas the others get more retirement income. Hence, retirement income is redistributed back from workers with low earnings to workers with high earnings. Note that this reform does not change spousal benefit rule.

[18] The welfare analysis carried out in this paper does not take transition across steady states into account. Hence, these values are imperfect measures of the actual changes in welfare. However, aggregate capital does not change much. Therefore, these numbers are close approximates of the numbers if I had also considered the transition across steady states.

I first report the aggregate implications of the reform. Table 3.12 shows the percentage changes in the aggregate variables. Aggregate output of the economy decreases by 0.41 percent, aggregate capital decreases by 0.84, whereas the aggregate labor in efficiency units decreases by 0.23 percent. The labor force participation rate of married women decreases by 1.78 percent. In addition, hours per worker for males and females slightly increase. Decline in aggregate output and decline in participation of married women are two striking statistics from this table.

Why does LFP of married women decline after this reform? Panel A in Table 3.13 shows the percentage change in benefit collections of married households by skill types. The key observation is that the male's skill level is critical. For households with husbands who have a college degree or more, the benefit collections increase significantly. For almost all other types of married households benefit collections decrease. The decrease experienced by (<hs,<hs) married households and the increase experienced by (col+,col+) households are expected. The former type of households have two low earning members whereas the latter have two high earning members. What is striking in this table is the increase experienced in benefits by households with low skilled (<hs, hs or sc) wives and high skilled husbands (col or col+). For such households, benefit entitlements of females decrease because they have low earnings and benefit entitlements of males increase because they have high earnings. Recall that in the benchmark economy most of these households collect spousal benefits (see Table 3.8). Hence, after the reform the spousal benefits increases for these households simply because spousal benefits are determined by the husbands' benefits. As a result, total benefits of these households increase at the rate of the husbands' benefits.

Next, in Panel B, I report the percentage change in labor force participation of married women by types of married households. Females who are married to college graduate or post college graduate males drop out of the labor force. Among the rest, some enter the labor force and some exit the labor force. What drives the women out of the labor force is the increase in benefit collections of their husbands. Fraction of married households claiming spousal benefits increases by 40.72 percent (see Table 3.12). By comparing Tables 3.8 and 3.14 one can observe the types of households who begin to collect spousal benefits after the reform. As the benefit collections of the males

Table 3.11. Cross Sectional Effects, Single Households, Reform 1

	Panel A % Change In Hours/Worker		Panel B % Change In Welfare	
	Male	Female	Male	Female
<hs	0.09	0.00	1.11	1.03
hs	0.09	0.21	1.12	1.02
sc	0.37	0.21	1.19	1.07
col	-0.09	0.10	1.20	1.10
col+	0.00	0.42	1.23	1.11

Note: Panels in Table 3.10 report cross sectional implications of eliminating the spousal benefits. All numbers shown in these panels are percentage changes relative to the benchmark economy. See Table 3.1 for definitions of <hs, hs, sc, col and col+.

Table 3.12. Aggregate Effects, Reform 2

	Benchmark	Reform 2	% change
Aggregate Hours	100.00	99.77	-0.23
Hours per Worker (males)	0.453	0.4537	0.15
Hours per Worker (females)	0.3559	0.3568	0.25
LFP of married women	63.62	62.49	-1.78
Y	100.00	99.59	-0.41
K	100.00	99.16	-0.84
L	100.00	99.78	-0.22
w	100.00	99.80	-0.20
Spousal Benefits (%) (recipients among married h.h.)	43.97	61.88	40.72
τ^p	0.11	0.11	-

Note: Table 3.12.reports values of the aggregate variables before and after Reform 2. Last column reports percentage changes of these variables. Note that Reform 2 replaces the progressive benefit function with a linear benefit function.

Table 3.13. Cross Sectional Effects, Married Households, Reform 2

Panel A
% Change in Social Security Benefits

	Female				
Male	<hs	hs	sc	col	col+
<hs	-13.81	-15.80	-15.15	-14.60	-9.27
hs	-8.59	-12.61	-14.16	-12.53	-7.25
sc	-1.16	-1.35	-5.83	-7.97	-1.93
col	27.74	25.71	24.56	13.73	11.27
col+	33.40	33.40	33.40	27.95	20.51

Panel B
% Change in LFP

	Female				
Male	<hs	hs	sc	col	col+
<hs	-2.06	-1.35	0.90	0.75	4.07
hs	-3.34	-2.06	-0.14	0.48	-0.16
sc	-2.42	-3.57	-1.66	-0.34	1.99
col	-2.42	-1.86	-3.40	-2.60	0.18
col+	-1.07	-0.77	-0.81	-4.05	-3.61

Panel C
% Change in Assets After Retirement

	Female				
Male	<hs	hs	sc	col	col+
<hs	12.86	15.12	14.06	11.85	6.13
hs	13.95	14.19	15.39	10.56	6.01
sc	16.81	9.76	13.18	12.64	15.69
col	-23.75	-21.24	-16.03	-13.85	-10.70
col+	-24.48	-23.85	-23.13	-18.97	-16.67

Panel D
% Change In Welfare

	Female				
Male	<hs	hs	sc	col	col+
<hs	-1.95	-2.04	-1.97	-1.83	-1.31
hs	-1.32	-1.61	-1.69	-1.54	-0.91
sc	0.08	-0.38	-0.80	-0.98	-0.67
col	3.34	2.98	2.77	1.63	1.19
col+	3.64	3.60	3.53	2.99	2.25

Note: Panels in Table 3.13 report cross sectional implications of replacing the progressive benefit function with a linear one. All numbers shown in these panels are percentage changes relative to benchmark economy. See Table 3.1 for definitions of <hs, hs, sc, col and col+.

increase, more women claim half of the benefit collections of their spouses instead of working themselves. Not surprisingly, the decline in labor force participation increases as the females' skill decreases.

Next, I report the percentage change in asset holdings of the married households right after retirement. Panel C reports these numbers for different types of married households. The households who lose retirement income after the reform try to compensate for their losses by saving more whereas the ones that gain retirement income reduce their savings.

Finally, Panel D reports the welfare implications of Reform 2 by types. Once again, male's skill type is the vital determinant of the changes in welfare. The losses range from 2.04 percent to 0.38 percent whereas the gains range from 3.64 percent to 0.08 percent. The biggest winners are the households who have high skilled males and collect spousal benefits in the benchmark economy. Although the progressivity is expected to work more in favor of top earning households (col+,col+), due to spousal benefit rule the households who were single-earners or become single-earners enjoy the biggest gains.

Table 3.15 reports the changes in hours per worker, changes in welfare and changes in retirement benefits for single households. As in the case of Reform 1, there are no big changes in hours per worker for single households. Single males with a college degree or a higher education decrease their hours whereas all other single households increase their hours. Panel B of Table 3.15 reveals that only single males with a college degree or a higher education experience welfare gains. All other single households experience welfare losses. Once again the pattern of the changes in retirement benefits is the main reason why we observe such an outcome. Panel C shows that winners recieve higher retirment benefits and losers recieve lower retirement benefits relative to the benchmark economy.

In summary, removing the progressivity of the benefit function in the current social security system has significant implications. As expected high income households gain from this reform. However, some mid-income earning married households gain from the reform disproportionately. In particular households who gain most from these reports are the ones with a high skilled husband and low skilled wife. In these households wives leave the labor force and claim spousal benefits since with a flat benefit rule, they

Table 3.14. Fraction of Married Households Who Claim Spousal Benefits, Reform 2 Economy

	Female				
Male	<hs	hs	sc	col	col+
<hs	0.73	0.58	0.38	0.18	0.25
hs	1.00	0.54	0.36	0.15	0.11
sc	1.00	1.00	0.50	0.29	0.08
col	1.00	1.00	1.00	0.48	0.26
col+	1.00	1.00	1.00	1.00	0.44

Table 3.15. Cross Sectional Effects, Single Households, Reform 2

	Panel A % Change In Hours/Worker		Panel B % Change In Welfare		Panel C % Change In Social Security Benefits	
	Male	Female	Male	Female	Male	Female
<hs	0.19	0.21	-1.03	-1.62	-15.45	-24.08
hs	0.28	0.31	-0.80	-1.34	-12.44	-19.97
sc	0.28	0.10	-0.41	-1.08	-5.80	-16.58
col	-0.47	0.21	0.71	-0.61	14.16	-9.23
col+	-0.65	0.00	1.29	-0.03	26.12	0.04

Note: Panels in Table 3.13 report cross sectional implications of replacing the progressive benefit function with a linear one. All numbers shown in these panels are percentage changes relative to benchmark economy. See Table 3.1 for definitions of <hs, hs, sc, col and col+.

become much more attractive. Interestingly, these are exactly the households Reform 1 affecting most negatively in terms of labor. Therefore, next I consider a combination of these two reforms.

3.4.3 Reform 3: Eliminating the Spousal Benefit and Removing the Progressivity of the Benefit Calculation

In the new economy (after reform) the benefit function is a linear one and there is no spousal benefit payments. I take the social security tax rate from benchmark economy ($\tau^p = 0.11$). The benefit function is now given by

$$B(\bar{e}_i) = 0.42\bar{e}_i,$$

where once more $\vartheta = 0.42$ balances the social security budget. Note that social security system in this economy is more generous than Reform 2 since spousal benefits are now eliminated.

Table 3.16 shows the percentage changes of the aggregate variables. Labor force participation of married women increases by 3.49 percent. The hours of male workers and the hours of female workers slightly decrease. At the same time aggregate capital increases by 0.77 percent. As a result, the aggregate output increases by 0.55 percent.

I begin with discussing the impact of the reform on benefit collections of married households (Panel A, Table 3.17). Households with low earning members lose benefits and the ones with high earning members gain benefits. There are some important differences between implications of this reform and Reform 2. Low types of households lose even more and high types of households win more. Moreover, a comparison between Tables 3.13 and 3.17 shows that the effects on households with high skilled husbands (col or col+) and low skilled wives (<hs, hs or sc) are now much less significant. In contrast to Reform 2, wives in these households are not allowed to enjoy half of their spouses' benefits. Even though the replacement is larger, the very low types (<hs,<hs) lose more because a big fraction of them collect spousal benefits in Reform 2 economy (see Table3.14). On the other hand, the high type households who do not claim spousal

benefits in Reform 2 economy receive even higher benefits because the replacement rate of benefit function is bigger.

Panel B reports the percentage change in labor force participation of married females by types of households. Contrary to Reform 2 labor force participation of women increases for all types. Clearly, spousal benefit rule makes a big difference in terms of labor supply for most women married to high skilled men (col or col+). On the other hand, changes for some household types are not as big as in Reform 1. This is not surprising, since the participation responses of women are directly related to changes in benefit collections (see Tables 3.10 and 3.17).

Next, Panel C reports the percentage change in asset holdings of married households right after retirement. As expected changes are in line with changes in benefit collections. To compensate for losses in benefits, low type households increase their assets as much as 26.66 percent. On the other hand, high type households decrease their assets as much as 15.85 percent. One finding to note here is relative to Reform 2 more households increase their savings and less households decrease their savings. Hence, the aggregate capital stock increases contrary to the decrease after Reform 2. These reforms shows us the importance of participation decision of married females when studying implications of progressive structure of the social security.

Finally, I report the welfare implications of Reform 3. Panel D shows that there are significant changes in the welfare of the married households. This table demonstrates the degree of progressivity built in to the social security system by the two rules I change. Low income households lose as much as 3.41 percent in welfare whereas high income households gain as much as 2.58 percent. Contrary to Reform 2, the biggest winners are not the traditional single-earner families. The biggest winners are high skilled two-earner households.

On the other hand, some single households are affected significantly after Reform 3 (Table 3.18). Even though their labor suppy behavior does not change drastically, they experience significant changes in welfare that stem from changes in retirement benefit collections. Panel B shows that single males with some less than four years of college education or a higher education experience welfare gains. The winners among single females are the ones that have college education or more. Note that since the social security system is more generous in the absence of spousal benefit provision, Reform 3 economy is more preferable by single households compared to Reform 2 economy.

3.5 Conclusions

This paper builds a general equilibrium life-cycle model in which there are two-earner and single-earner households, and members in two-earner households make labor force participation decisions. I use this framework to study two features of the current social security system: the spousal benefit provision and the progressive calculation of social security benefits. The results show that labor force participation of married women is critically affected by these rules. In the benchmark economy, households composed of relatively high-earner men and relatively low-earner women are the ones who use spousal benefits most extensively. Therefore, the elimination of spousal benefits results in higher labor force participation of married women in these households, and adversely affects (in terms of welfare) these households.

The results also show that the implications of changing the progressive structure of the current benefit formula depend critically on its interaction with the spousal benefits. When I replace the current formula with a proportional one but keep the spousal benefits, labor force participation of women, aggregate capital, and aggregate output decline. This is due to significant increase in earnings of high skilled men and women who are married to these men simply drop out of the labor force. The married households who claim spousal benefits are the biggest winners with this reform. When I replace the current formula with a proportional one and remove spousal benefits, the results are very different. Labor force participation of married women, aggregate capital, and aggregate output increase. In this world, the biggest winners are the households with two high-wage members. These results suggest that modelling two-person households, who can make participation decisions for their secondary earners, can be critical for a proper evaluation of widely considered reforms that try to alter the progressive nature of the current social security system.

The current model can be extended in several dimensions. In this paper I make the simplifying assumptions that a husband and a wife retire and die concurrently and there are no transitions between marital groups. As a result, there are no survivors' benefits and benefits to divorced individuals, which is an extension of the spousal benefit provision in current legislation. The model can be easily extended to include these features. Furthermore, the current framework can be used to study the effects of replacing the current pay-as-you-go social security system with a fully-funded system. In particular, such an exercise will allow to investigate the importance of the demographic composition of society and the participation decisions of secondary earners in evaluating reforms that replace the current pay-as-you-go system. I leave these questions for future work.[19]

[19] In a recent paper Guner, Kaygusuz and Ventura (2006), using a model economy that shares several features with the current paper, try to undertake such an exercise to study the aggregate and cross-sectional implications of fundamental income tax reforms for the U.S. economy.

Table 3.16. Aggregate Effects, Reform 3

	Benchmark	Reform 3	% change
Aggregate Hours	100.00	100.68	0.68
Hours per Worker– Males	0.453	0.4524	-0.13
Hours per Worker– Females	0.3559	0.3554	-0.14
LFP of married women	63.62	65.84	3.49
Y	100.00	100.55	0.55
K	100.00	100.77	0.77
L	100.00	100.45	0.45
w	100.00	100.10	0.10
Spousal Benefits (%) (recipients among married h.h.)	43.97	0	-
τ^p	0.11	0.11	-

Note: Table 3.16 reports values of the aggregate variables before and after Reform 3. Last column reports the percentage changes. Note that Reform 3 replaces the progressive benefit function with a linear one and eliminates the spousal benefit.

Fig. 3.1. Marginal Tax Rates

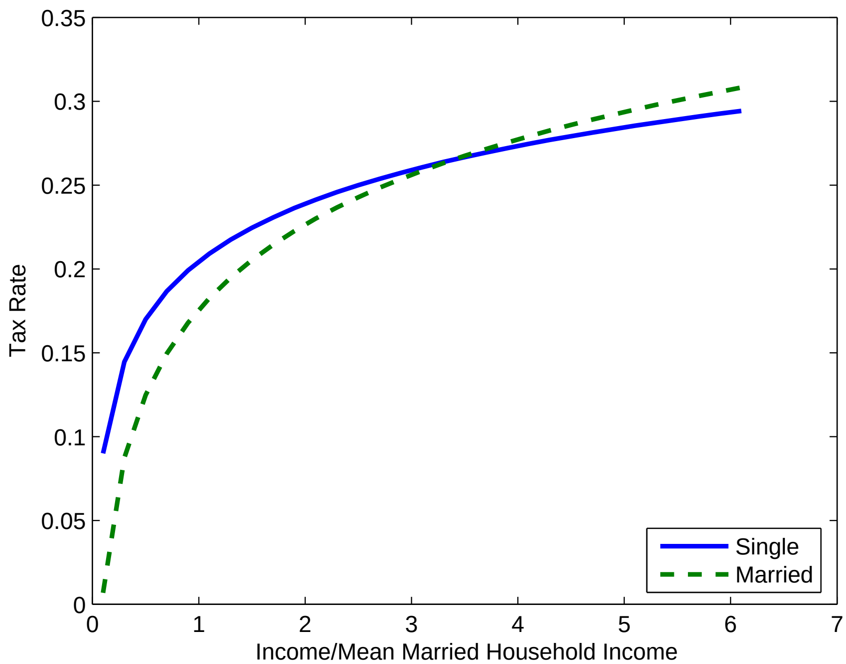


Table 3.17. Cross Sectional Effects, Married Households, Reform 3

Panel A

% Change in Social Security Benefits

	Female				
Male	<hs	hs	sc	col	col+
<hs	-24.11	-17.45	-12.75	-8.90	-3.25
hs	-18.85	-15.47	-10.16	-5.39	1.77
sc	-10.96	-9.19	-5.68	-2.59	6.36
col	2.99	6.90	10.09	12.30	17.95
col+	6.30	10.28	14.70	18.56	23.90

Panel B

% Change in LFP

	Female				
Male	<hs	hs	sc	col	col+
<hs	4.94	2.93	3.89	0.91	4.45
hs	5.47	3.97	3.34	1.89	2.48
sc	7.46	3.57	2.20	1.39	2.42
col	6.47	8.07	5.39	1.72	3.56
col+	9.32	8.27	8.82	5.12	0.86

Panel C

% Change in Assets After Retirement

	Female				
Male	<hs	hs	sc	col	col+
<hs	26.66	22.29	12.71	5.42	5.37
hs	24.90	18.25	11.69	8.37	0.63
sc	15.88	9.96	6.17	3.23	16.84
col	-5.74	-7.13	-3.36	-9.98	-14.11
col+	-4.33	-4.66	-7.69	-13.11	-15.85

Panel D

% Change In Welfare

	Female				
Male	<hs	hs	sc	col	col+
<hs	-3.41	-2.47	-1.83	-1.19	-0.90
hs	-2.82	-2.14	-1.48	-0.82	-0.14
sc	-1.75	-1.31	-0.80	-0.38	0.25
col	0.39	0.79	1.12	1.41	1.90
col+	0.76	0.95	1.41	1.93	2.58

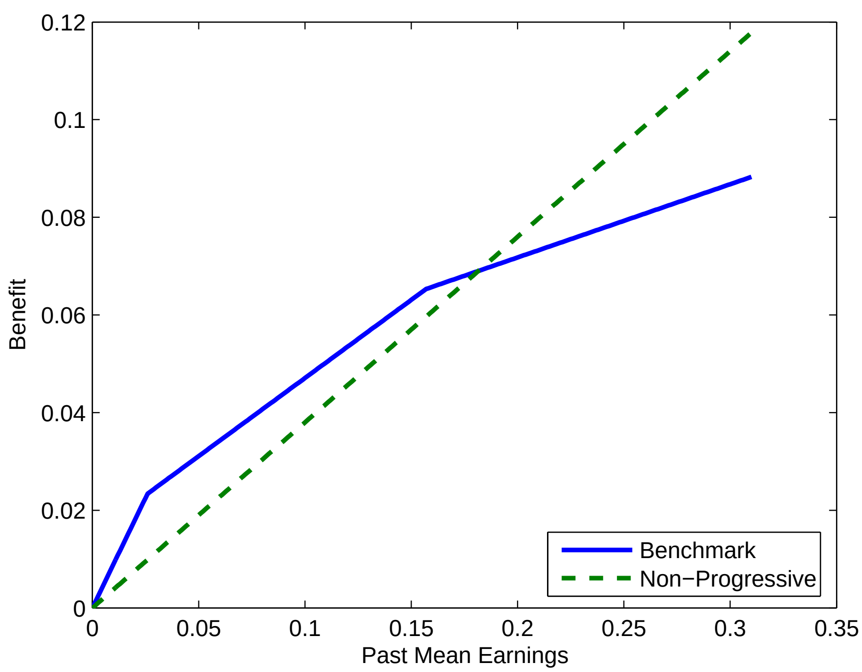
Note: Panels in Table 3.17 report cross sectional implications of replacing the progressive benefit function with a linear one together with eliminating the spousal benefits. All numbers shown in these panels are percentage changes relative to the benchmark economy. See Table 3.1 for definitions of <hs, hs, sc, col and col+.

Table 3.18. Cross Sectional Effects, Single Households, Reform 3

	Panel A % Change In Hours/Worker		Panel B % Change In Welfare		Panel C % Change In Social Security Benefits	
	Male	Female	Male	Female	Male	Female
<hs	0.17	0.21	-0.37	-1.02	-6.36	-15.92
hs	0.20	0.10	-0.14	-0.71	-3.02	-11.36
sc	0.28	0.21	0.32	-0.45	4.33	-7.60
col	-0.56	0.10	1.49	0.07	26.44	0.53
col+	-0.47	-0.10	2.10	0.67	39.68	10.80

Note: Panels in Table 3.17 report cross sectional implications of replacing the progressive benefit function with a linear one together with eliminating the spousal benefits. All numbers shown in these panels are percentage changes relative to the benchmark economy. See Table 3.1 for definitions of <hs, hs, sc, col and col+.

Fig. 3.2. Benefit Formulas



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