Essays on Female Labor Supply

A DISSERTATION
SUBMITTED TO THE FACULTY OF THE GRADUATE SCHOOL
OF THE UNIVERSITY OF MINNESOTA
BY

Marina Mendes Tavares

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
Doctor of Philosophy

Fatih Guvenen and Christopher Phelan

October, 2011

Acknowledgements

I would like to thank you my advisor, Fatih Guvenen, for his guidance, support, and encouragement. I am very grateful for having Guvenen as my main advisor, under his guidance, I felt confident in reaching my goals. In addition, Guvenen also supported emotionally when I needed encouragement to move on and to face new challenges; without his support this thesis would not be possible.

I would also like to thank you my advisor, Christopher Phelan, for his support and assistance. Phelan's precise guidance helped me to overcome difficulties in key moments during these five years. In addition, I would also like to thank my colleagues at the Public Workshop for all their comments and suggestions .

I would also like to thank professors Alessandra Fogli and Jose-Victor Rios-Rull for their comments and feed-backs. In particular, Alessandra for our long conversations and for her guidance in key moments helping me navigate through the job market. In addition, I am also very grateful to my colleagues at Labor Workshop for all their comments and support.

I would also like to take this opportunity to re-thank my advisors and mentors at IMPA Luciano Irineu de Castro Filho and Aloisio Araujo. Without Luciano's guidance and encouragement at the early stages of my academic career I would never gone that far.

I would also like to acknowledge that the staff at the University's Department of Economics, especially Kara Kersteter and Caty Bach, provided support with administrative tasks, allowing me to focus my attention on my academics. In addition, the staff at The Federal Reserve Bank of Minneapolis also provided excellent assistance. Moreover, I benefited tremendously from the exciting research environment at The Federal Reserver Bank of Minneapolis.

I also thank the Center for German & European Studies, and in particular to Mrs. Hella Mears for the financial support during the summer of 2010.

Lastly, I would like to thank my family. My husband, Rene Schwengber, for all his support, encouragement and patience during these five years. My parents for their immeasurable support in so many ways thrghout my life, and my sister for all her friendship and encouragement. I would also to thank my grandmothers for all their love.

Dedication

This thesis is dedicated to my parents Celso Wagne Tavares and Ana Lucia Pinto Mendes da Silva.

Abstract

Income tax systems are very different across OECD countries. In this thesis, I study the impact of differences in the progressivity of the tax schedule and in the unit of taxation on female labor supply. More precisely, in the first essay I quantify the impact of income tax reforms on female labor supply in the United States, and in the second essay I quantify to what extent differences in income taxation between the United States and Europe explain differences in female labor supply.

Contents

List of Tables

List of Figures

Chapter 1

Introduction

This thesis is divided in two essays, both essays study the impact of income taxation on female labor supply. The first essay analysis the impact of income tax reforms on female labor supply in the United States, and the second essay quantifies to what extent differences in income taxation between the United States and Europe account for differences in female labor supply between the United States and Europe.

Income tax systems are very different among OECD countries; the difference is not only on the level of progressivity, but also on the unit of taxation. In general, countries can either have the family or the individual as the unit of taxation. By choosing the family as the unit of taxation it is guaranteed that families with the same total income will pay the same income tax. In contrast, by choosing the individual it is guaranteed that independently of one's marital status, individuals with the same total income will be taxed equally. The main consequence of having the family as the unit of taxation is that changes in marital status affect individuals marginal income tax. More precisely, after marriage, primary earners face a lower marginal income tax, while secondary earners face a higher marginal income tax. Since females are the majority of secondary earners, they are more likely to face a higher marginal income tax after marriage, which reduces their incentive to work.

In Chapter 2, I study the impact of income tax reformers in the United States. In this essay, I analyze the impact of income tax policies on household labor supply through two key life-cycle choices: education and marriage/divorce. To this end, I construct a quantitative life-cycle model to study the effects of changes in the degree of

tax progressivity and in the unit of taxation on household labor supply. The model is calibrated to match key statistics in the United States economy, then using the calibrated model I quantify the impact of several tax reforms on labor supply. I find that when the unit of taxation is changed from the family to the individual, the burden on the secondary earner is reduced. This increases women's education and labor supply, but has a negligible effect on men. Further, I find that small reductions in the progressivity of the tax schedule increase college enrollment and labor supply. To drive these results the marriage/divorce decision is important because it amplifies the effect of tax reforms on labor supply and education. This essay demonstrate that one underestimates the impact of income tax reforms on labor supply when life-cycle choices are ignored.

In Chapter 3, I quantify to what extent differences in income taxation between the United States and Europe can account for differences in hours worked between American and European females. To this end, I construct a simple model of household labor supply and I calibrate the model to match key statistics in the United States economy. Then, I replace the income tax of the United States by the income tax of selected European countries, and I quantify how much differences in labor supply between Americans and Europeans can be explained by differences in income tax. I find that differences in labor income tax explain one third of differences in females hours worked and one quarter of differences in females labor force participation between the United States and Europe.

Chapter 2

Taxes, Education, Marriage, and Labor Supply

2.1 Introduction

This essay studies two features of the United States income tax system: the degree of tax progressivity and the choice of the family as the unit of taxation. A tax system with these two characteristics is not *marriage neutral*, meaning that changes in marital status affect individuals federal income tax obligation. In particular, primary earners face a lower marginal tax rate after marriage, while secondary earners face a higher marginal tax rate. These changes in taxation encourage specialization within households. More precisely, after marriage primary earners have more incentives to work in the market, while secondary earners have fewer incentives to work in the market and more incentives to work at home.

A second aspect of the U.S. tax system is that the unit of taxation is the family. This structure was adopted in 1948, when 90% of families were traditional one-earner families,[1] consisting of a breadwinner husband and a stay-at-home wife. Specialization within the household was the norm, and the change in the unit of taxation reinforced it. Today, the majority of families have two earners, and 72% of secondary earners are women (as of 2003). This state is the result of important changes beginning in 1950's:

[1] For more information on 1948 tax reform, see the work of (McCaffery, 1999)

female labor force participation has more than doubled, they make up the majority of college students and study towards a more career-oriented degree.[2] Despite these large changes, the current income tax system is still very similar to the original 1950's implementation. Secondary earners are still penalized with an increased marginal tax rate after marriage; consequently, married women still have an incentive to reduce their labor supply or even to leave the labor force.

With females' responses in mind, this essay investigates the impact of changing the unit of taxation and the progressivity of the tax schedule on household labor supply. To fully account for these effects, I include two key life-cycle choices: college education and marriage/divorce. This essay main contribution is to quantify the impact of tax reforms on labor supply, while considering the impact on educational choice and household formation. A model with such endogenous choices is not only more realistic, but also offers a more precise evaluation of the *long-run* impact of tax reforms on household labor supply.

Both of these features clearly can affect the decision of potential workers to invest in college education. They can do so through two main channels: the average return on and the riskiness of the investiment. College is costly both in terms of tuition and forgone earnings. However, the investment also grants access to better wages and to a higher probability of marrying a college-educated spouse. These benefits are skewed by taxes that decrease the average income tax of primary earners, while increasing the tax liability to secondary earners. Because the majority of secondary earners are women, separating their tax liability from their spouse increases their return on college education, while it reduces the return for men. Furthermore, the progressivity of the tax code reduces the risk of investing in college, because it reduces the variance of after-tax wages. Female earners have less income variation than males, so reducing progressivity affects men to a greater extent than women, which leads to a relative increase in females's education. These changes in education have a sizable effect on labor supply, because college educated men and women supply more labor on average than women and men who don't have a college degree.

The U.S. income tax system distorts marital decisions by its asymmetric treatment of families and individuals. For a broad range of incomes, one-earner families receive

[2] For an overview on female transformation, the work of (Goldin, 2006)

a tax benefit, while high income two-earner families pay a tax penalty. Eliminating these tax distortions can impact marriage and divorce rates and assortative matching patterns, both of which are quantitatively important when assessing the effect of taxes on labor supply. Marriage and divorce rates affect labor supply, because, on average, married men work more than single men and married women work less than single women. The effect of assortative matching is the result of an increase in marriage among college-educated individuals, which leads to an increase in the individual return on investing in a college degree.

In order to analyze the impact of tax reforms on household labor supply, I construct a quantitative life-cycle model. When young, agents decide once whether to enroll in college. After college, agents are heterogeneous in wealth and wages. Then, they meet other singles and decide whether to marry. In each period, married agents face a divorce decision and everyone decides on their labor supply, which depends on marital status, wages, and wealth. In addition, I allow labor supply to vary along both intensive and extensive margins. The model is calibrated to match key statistics of the U.S. economy in 2003, and then I substitute the U.S. current tax schedule with four experimental tax schedules. These new tax schedules alter the degree of the tax progressivity and the unit of taxation.

In my first tax reform, *separate filing*, I change the unit of taxation by treating everyone according to the U.S. tax schedule of single individuals. Sweden, Canada and the U.K. are examples of countries that also consider the individual as the unit of taxation. The main implication of this tax reform is that now secondary earners' marginal tax rate does not increase after marriage. Consequently, this tax reform affects women more than men, because women are the majority of secondary earners. Particularly, females' hours increase by 4.1%, while males' increase by 1.3%. Regarding education, 2.3% more women enroll in college, while male college education increases by 1%.

In my second tax reform, *splitting of total income*,[3] I apply the single individual's tax schedule to the average family income. This tax schedule preserves the family as the unit of taxation, but minimizes changes in marginal tax rates due to marriage. This tax reform is similar to the French and German income tax system (though it can be criticized, because it generates a considerable tax benefit for married couples whose

[3] The split of total income is the 1948 original implementation of the family as the unit of taxation.

incomes are very disparate). In the U.S., the first two tax brackets by 2003 schedules are unaffected by this reform, because the joint filing is equivalent to the splitting of total income tax reform in these two brackets. Consequently, just a small fraction of the population is affected by this reform. Individuals change their education level in the same direction but to a lesser degree than with separate filing; female college education increases by 0.5% and male college education increases by 0.1%. Females' hours increase by 3.7% and males' hours increase by 5.11%.

In my third tax reform, *flat tax*, I eliminate the progressivity of the tax code, consequently all individuals pay the same income tax rate. This is the only reform that is both marriage neutral and treats families equally, meaning families with the same total income pay the same amount of taxes. However, because the flat tax eliminates the progressivity of the tax schedule, it increases the risk of investing in college education. Men, facing a higher risk in investing in college education than women, reduce their college enrollment by 0.3%, while female college enrollment increases by 5.6%. Overall males' hours increase by 9.7% and females' hours increase by 11.1%.

In my last tax reform, *the two-brackets tax reform*, I simplify the tax code to two income tax brackets. The marginal tax rates and the size of the brackets are chosen to maximize total welfare. This reform is based on (Hall and Rabushka, 1996), which proposed a flat tax to replace the current U.S. income tax system with a tax exemption for low earners. The idea of this tax reform is to simplify the tax schedule without dramatically increasing the tax rate on low income individuals. It thereby maintains some of the insurance that the currently income tax system provides to low income individuals. As a consequence, in this tax reform both males' and females' education increase; females college education increases by 9.9% and male college education increases by 3.7%. Females' hours increase by 17.3% and males' hours by 12.8%.

My work here is closely related to that of (Chade and Ventura, 2002), who study the impact of income tax reforms in the U.S. tax system on household labor supply and marriage formation. Also in a similar vein, (Guner et al., 2008) analyzes the effect of tax reforms on household labor supply, focusing on married females' extensive margin. In this paper, the authors preserve the current U.S. demographics distribution meaning that it does not consider long-run effects on household formation. In the empirical literature, (Kaygusuz, 2010) analyzes the impact of the Tax Reform Act of 1981 and

the Tax Reform Act of 1986 on female labor supply. (Kaygusuz, 2010) finds that changes in the tax structure introduces by theses laws can explain 20% of the increase in married female labor force participation between 1980 and 1990. Reinforcing this finding, (Eissa, 1995) concludes that the labor supply from high-income married women increased in response to the Tax Reform Act of 1986.

This essay is organized as follows. In Section 2.2, I describe the model. In Section 3.4, I discuss the calibrated model and its quantitative properties. My main findings are presented in Section 2.5, where I evaluate and explain the effects of the four tax reforms. Section 3.6 concludes this essay.

2.2 The Economic Environment

The economy is populated by a continuum of males and females, each sex with unit mass. Individuals live for T periods. This paper focuses on a stationary equilibrium; therefore, it is sufficient to keep track of the agents' age, denoted by t. Agents are born single and ready to decide whether to enroll in college. When born agents are heterogeneous in their psychic cost θ_i, which captures the non-monetary cost of enrolling in college. In addition to the psychic cost, agents that decide to enroll in college have to pay a monetary cost κ that is homogeneous across agents. Agents are born with no wealth; consequently, college students borrow to pay for their college expenses. There are two direct returns on attending college: (i) Drawing a lifetime wage from the college-educated distribution $F_g^c(\cdot)$, which is gender-specific g; and (ii) having a benefit in the matching process. During college, agents, that decide not enroll in college, draw a lifetime wage from the non-college-educated distribution $F_g^{nc}(\cdot)$ and work. After agents turn 2 years old, and they enter the marriage market.

Matching in the marriage market is restricted to single agents of the same cohort. Furthermore, the first marriage market, which happens after college, is special; in addition to the age restriction, matching is within the same education group. Every period, matched agents learn their potential spouse's wage and their wealth, and the couple's match quality b, then they decide whether to marry. The match quality b is identically and independently distributed. After the couple marriage, the match quality evolves by following a first-order autoregressive process. At the beginning of each period married

agents learn their current match quality, and they face a unilateral divorce decision. At the end of each period, with the exception of college students at age 1, agents make their labor supply choice. For simplicity, there is no remarriage, and the only borrowing and lending in the economy is for college enrollment.

2.2.1 College Decision

Again, there are two costs to enroll in college: a uniform monetary cost κ and an agent-specific psychic cost θ_i. The psychic cost is independently and identically distributed with cumulative distribution $\Theta(\cdot)$. The benefits of attending college are two: (i) Drawing a lifetime wage from the college-educated distribution $F_g^c(\cdot)$; and (ii) matching only singles with a college education, after the graduation. All college students study full-time, therefore, they do not work. Since agents are born with zero wealth, college students borrow to pay their college expenses and to consume during this period. There is no default on college loans. The sequence of college payments a_t is determined by problem (2.4) in the following section.

Agents who decide to not enroll college draw a lifetime wage from the non-college-educated distribution $F_g^{nc}(\cdot)$ and they work while the college students study. After college age, agents are characterized by a vector $x_g = \{w, d, m, t\}$, where g indicates the agent's gender, w is the agent's lifetime wage, d is the agent's wealth, m is the agent's marital status and t is the agent's age. Agents that do not enroll in college have zero wealth d.

Let θ_g^* be the psychic cost at which an agent of gender g is indifferent about attending college or not. In this case, θ_g^* is defined by

$$\theta_g^* = E_c V_g(w, d, s) - E_{nc} V_g(w, 0, s),$$

where the expectation is taken with respect to the college-educated c and non-college-educated nc wage distribution and s indicates that the agent is single. The college decision is characterized by a threshold. Agents of gender g with a psychic cost less than θ_g^*, enroll in college and agents with a psychic cost greater than θ_g^* not enroll. The following indicator function $I^E(\cdot)$ characterizes the education choice:

$$I^E(g,\theta_i) = \begin{cases} 1 & \text{if } \theta_i \leq \theta_g^* \\ 0 & \text{if } \theta_i > \theta_g^*. \end{cases} \quad \%labeleq : mar \tag{2.1}$$

2.2.2 Match Quality

Matched agents draw a match quality b that is independent of wages, wealth, and age. The match quality is normally distributed $N(\mu_b, \sigma_b^2)$, with mean μ_b and variance σ_b^2. Let the cumulative distribution of the match quality be represented by $S(\cdot)$. Match quality follows a first order autoregressive process AR(1):

$$b = \varrho + \rho b_{-1} + \epsilon, \quad \text{with} \quad \epsilon \sim N(0, \sigma_{div}^2),$$

where ϱ is a constant, ρ is the coefficient of autocorrelation and ϵ is the error term, which is normally distributed with mean zero and variance σ_{div}^2. Let the match quality conditional distribution be represented by $M(b|b_{-1})$.

2.2.3 Marriage Decision

At the beginning of the marriage market, single agents of the opposite sex are matched. They learn their potential spouse wage and wealth. Then they draw a match quality b. A matched couple is characterized by a pair of vectors $\{x_m, x_f, b\}$, where x_m summarizes the male characteristics, x_f summarizes the female characteristics and b is the couple's current match quality. Let $W_m(x_m, x_f, b)$ be the value to the potential husband of marrying a women with characteristics x_f when the couples's match quality is b. Respectively, let $W_f(x_m, x_f, b)$ be the value to the potential wife. Let $V(x_g)$ be the value of being single for agent $\{x_g\}$. The matched couple $\{x_m, x_f, b\}$ will marry if the conditions in Table 2.1 are satisfied.

Table 2.1: Marriage Decision

Husband accepts	$W_m(x_m, x_f, b)$	$\geq$	$V(x_m)$
Wife accepts	$W_f(x_m, x_f, b)$	$\geq$	$V(x_f)$

Because the value of being married for both woman and man $W_g(x_m, x_f, \cdot)$ is increasing in the match quality b, the marriage decision is characterized by a threshold $b(x_m, x_f)$. This threshold is the maximum between the match quality at which the potential husband is indifferent about marriage and the one at which the potential wife is indifferent. Therefore, for any match quality b above the threshold, agents marry, and for any match quality below it, they do not. The marriage decision is characterized by the indicator function below:

$$I^M(x_m, x_f, b) = \begin{cases} 1 & \text{if } b \geq b(x_m, x_f) \\ 0 & \text{if } b < b(x_m, x_f). \end{cases} \tag{2.2}$$

2.2.4 Divorce Decision

Divorce is unilateral. At the beginning of each period, married agents learn their current match quality b, and they decide to stay married or to divorce. Let $H(x_g)$ be the value of being divorced for an agent $\{x_g\}$. A married couple $\{x_m, x_f, b\}$ divorce if at least one of the inequalities in table 2.2 holds:

Table 2.2: Divorce Decision

Husband divorces	$W_m(x_m, x_f, b)$	$<$	$H(x_m)$
Wife divorces	$W_f(x_m, x_f, b)$	$<$	$H(x_f)$

Because the value of being married $W_g(x_m, x_f, \cdot)$ is increasing in the match quality b, the divorce decision is also characterized by a threshold $d(x_m, x_f)$, at which at least one of the spouses wants to divorce. The divorce decision is characterized by the indicator function below:

$$I^D(x_m, x_f, b) = \begin{cases} 0 & \text{if } b \geq d(x_m, x_f) \\ 1 & \text{if } b < d(x_m, x_f). \end{cases} \tag{2.3}$$

2.2.5 Household Labor Supply Problem

At the end of each age, with the exception of college students, agents make their labor supply choice. Each individual is endowed with one unit of time that can be allocated to market work l_1, home production l_2, and leisure $(1 - l_1 - l_2)$. Following (Becker, 1965), I assume that there is a home production function that uses market goods c_M and home production time l_2 to produce a final consumption good c_T. The home production function is of the constant of elasticity of substitution type and the parameter η determines the elasticity of substitution between market goods and home time in the home production and the parameter ψ is the share of market goods and $1 - \psi$ is the share of home production time. The productivity of labor in the home production θ_g is gender-specific.

Market goods c_M are purchased with labor l_1. Wages are fixed and do not vary over time; they are lifetime wages. Agents pay income taxes $T(\cdot)$ and each tax reform implies a different tax function. Agetns maximize their total consumption and leisure, the parameter α measures the weight in the utility function that is given to consumption and $1 - \alpha$ is the weight to leisure. The parameter σ determines the elasticity of labor supply. Agents discount their future total consumption and leisure, with a discount factor β.

Now it is possible to define the student debt problem. College students borrow to pay their college expenses and tuition cost during college. They have access to college loans, in which they pay a fixed interest rate r and they commit to a fixed sequence of payment for the rest of their life. The payment scheme is characterized by the solution of the following maximization problem

$$\max_{\{c_{T,t},c_{M,t},l_{1,t},l_{2,t},a_t\}_{t=1}^{T}} \quad E\sum_{t=1}^{T}\beta^t \quad \alpha\log(c_{T,t}) + (1-\alpha)\frac{(1-l_{1,t}-l_{2,t})^{1-\sigma}}{1-\sigma}$$

s.t.

$$\begin{aligned} & c_{M,t} + a_1 \leq \kappa \\ & c_{M,t} + a_{t+1} \leq wl_1 - T(w,l_{1,t}) + (1+r)a_t \\ & c_{T,t} = (\psi c_M^{\eta} + (1-\psi)(\theta_g l_2)^{\eta})^{\frac{1}{\eta}} \\ & l_1 + l_2 \leq 1 \\ & l_1 \geq 0, \quad l_2 \geq 0 \quad , a_{T+1} = 0, \end{aligned} \tag{2.4}$$

where the expectation is taken with respect to the wage distribution of college-educated agents. The wage distribution depends only on education and gender, individuals of the same gender that decide to enroll in college face the same wage distribution, and consequently the same maximization problem. Because there is a unique solution for the college debt problem, agents of the same gender have the same optimal sequence of debt payments and it is sufficient to keep track of the agents gender and age to characterize fully the sequence of payment. Let $d(g,t) = a_{t+1} - (1+t)a_t$ be the net payment made by an agent of gender g at age t.

Single and Divorced Households Singles and divorced agents solve the same maximization problem. After college, all agents learn their life-time wage, when single and divorced they solve the following household maximization problem. The sequence of payment is determined before agents know their future wages. After college, single and divorced households solve the following maximization problem:

$$\max_{c_M, c_{HP}, l_1, l_2} \quad \alpha \log(c_T) + (1-\alpha)\frac{(1-l_1-l_2)^{1-\sigma}}{1-\sigma}$$

s.t.

$$\begin{aligned} & c_M \leq w l_1 - T(w l_1) - d(g,t) 1_{\{e=college\}} \\ & c_T = (\psi c_M^{\eta} + (1-\psi)(\theta_g l_2)^{\eta})^{\frac{1}{\eta}} \\ & l_1 + l_2 \leq 1 \\ & l_1 \geq 0, \quad l_2 \geq 0, \end{aligned}$$

where $T(\cdot)$ is a tax function that changes according to the tax experiment. The indicator function for college debt is equal to 1 for agents who have enrolled in college and 0 otherwise.

Married Households A married couple, as an single individual, choose how many hours each spouse work at the market, l_m^1 and l_f^1, where m indicates the husband hours and f the wife, and how many hours each spouse work at home, l_m^2 and l_f^2, and last how many hours each spouse enjoy of leisure. The utility function of an married couple combined a traditional and a modern view of marriage. The traditional part is the specialization within the household, which is captured by the perfect substitution between the wife and the husband time in the home production. The modern part is the couple's leisure, which is a combination of the husband's leisure and the wife's leisure. The parameter ζ measures the elasticity of substitution between the wife's and the husband's leisure in the family utility function. In addition, married couples enjoy a return of scale ϕ in consumption and leisure. The couple's income is taxed $T(\cdot)$ and the taxes function depends on the tax reform. The match quality b enters additively in the couples' utility function and can be either positive or negative. The household problem for a married couple $\{x_m, x_f, b\}$ with current match quality b is given by:

$$\max_{c_T,c_M,l_m^1,l_f^1,l_m^2,l_f^2} \quad \alpha \log\left(\frac{c_T}{2^\phi}\right) + \frac{(1-\alpha)}{1-\sigma}\left(\frac{(1-l_m^1-l_f^1)^\zeta + (1-l_m^2-l_f^2)^\zeta}{2^\phi}\right)^{\frac{1-\sigma}{\zeta}} + b$$

s.t.

$$c_M \leq w_m l_m^1 + w_f l_f^1 - T(w_m l_m^1, w_f l_f^1) - d(m,t)1_{\{e=college\}} - d(f,t)1_{\{e=college\}}$$
$$c_T = (\psi c_M^\eta + (1-\psi)(\theta_m l_m^2 + (1-\theta_m) l_f^2)^\eta)^{\frac{1}{\eta}}$$
$$l_m^1 + l_m^2 \leq 1$$
$$l_f^1 + l_f^2 \leq 1$$
$$l_m^1 \geq 0, \quad l_m^2 \geq 0, \quad l_f^1 \geq 0, \quad l_f^2 \geq 0$$

The indicator function is for each spouse and it is equal to 1 if the spouse enrolled in college and 0 otherwise.

2.2.6 Matching Process

After college single agents are matched at the beginning of each period. Matching is restricted to single agents of the same cohort. The first marriage market for each agent is limited to single agents of the same education group. After this special marriage market, single agents of the same cohort meet at the beginning of each period. Now, we can define the the matching process, let $\lambda_g(e,t)$ be the probability of meeting a single agent of gender g, with education e, and age t. Let $\eta_g(e,t)$ be the proportion of single agents of gender g, with education e, and age t. Then, we can compute the proportion of $(t+1)$-year-old single college-educated men by

$$\eta_m(c,t+1) = \eta_m(c,t) \quad \{\lambda_f(c,t)\int_{-\infty}^{b(x_m,x_f)} dS(b)dF_m^c(w)dF_f^c(w) \\ \lambda_f(nc,t)\int_{-\infty}^{b(x_m,x_f)} dS(b)dF_m^c(w)dF_f^{nc}(w)\}$$

where the proportions for the other gender and education groups are defined similarly. The law of motion of the matching probability $\lambda(g,e,t+1)$ is just a normalization of the proportion of singles in each education group.

$$\lambda_g(e, t+1) \quad = \quad \frac{\eta_g(e, t+1)}{\eta_g(e, t) + \eta_g(e', t)}$$

where e indicates the education group, for which the proportion is being calculate and e' indicates the other education group.

2.2.7 Equilibrium

Agents differ in the size of the psychic cost θ_i of attending college. The psychic cost is normally distributed, $N(\mu_{edu}, \sigma^2_{edu})$, with mean μ_{edu} and variance σ^2_{edu}. Let the cumulative distribution of the psychic cost be represented by $\Theta(\cdot)$. In equilibrium, agents perfectly foresee the fraction of agents of each gender who will enroll college. The following equation summarize the equilibrium condition:

$$\begin{aligned}
\theta^*_m &= E_c V_m(w, d, s)\left(\Theta(\theta^*_m), \Theta(\theta^*_f)\right) - E_{nc} V_m(w, 0, s)\left(\Theta(\theta^*_m), \Theta(\theta^*_f)\right) \\
\theta^*_f &= E_c V_f(w, d, s)\left(\Theta(\theta^*_m), \Theta(\theta^*_f)\right) - E_{nc} V_f(w, 0, s)\left(\Theta(\theta^*_m), \Theta(\theta^*_f)\right)
\end{aligned}$$

where $\{\theta^*_f, \theta^*_m\}$ is the fraction of females and males that enroll in college in equilibrium. The equilibrium equation guarantees that the forecast of the fraction of college-educated agents of each gender is the same as the actual fraction of college-educated agents that choose to enroll in college. Now I can define the equilibrium of the model.

Definition 1 *An equilibrium is a set of allocations for single and divorced households* $\{c^i_{T,t}, c^i_{M,t}, l^i_{1,t}, l^i_{2,t}, a^i_t\}_{t=1:n, i\in I_g, g\in\{m,f\}}$ *and a set of allocations for married households* $\{c^{ij}_{T,t}, c^{ij}_{M,t}, l^i_{1,t}, l^j_{1,t}, l^i_{2,t}, l^j_{2,t}, a^i_t, a^j_t\}_{t=1:n, i\in I_m, j\in I_f}$ *and a set of decision rules: (i) marriage decisions* $\{I^{Mij}_t\}_{t=2:n, i\in I_m, j\in I_f}$*; (ii) divorce decisions* $\{I^{Dij}_t\}_{t=3:n, i\in I_m, j\in I_f}$*; and (iii) education decisions* $\{I^{E_i}, I^{E_j}\}_{i\in I_m, j\in I_f}$*.*

1. *Debt Payment Optimality: Given a tax system* $\{T(\cdot)\}$*, college tuition cost* κ *and interest rates* r*, the college payment scheme* $\{a_t\}_{t=1,n}$ *is optimal*

2. *Allocation Optimality: Given wages* $\{w_i, w_j\}_{i\in I_m, j\in I_f}$*, a tax system* $\{T(\cdot)\}$ *and college payment scheme* $\{a_t\}_{t=1,n}$*, allocations solve the household problem. Government budget constraint is satisfied.*

3. *Marriage and Divorce Decision Optimality: Given* $\{\theta_f^*, \theta_m^*\}$ *and the agents' optimal allocations, the agents' marriage* $\{I_t^{Mij}\}_{t=2:n, i\in I_m, j\in I_f}$ *and divorce* $\{I_t^{Dij}\}_{t=3:n, i\in I_m, j\in I_f}$ *decisions are optimal.*

4. *Education Optimality: Given the agents' allocations and marriage and divorce decisions, agents' education decisions* $\{I^{E_i}, I^{E_j}\}_{i\in I_m, j\in I_f}$ *are optimal, and* $\{\theta_f^*, \theta_m^*\}$ *satisfies the education equilibrium condition.*

2.3 Data

The stationary equilibrium is calibrated to the U.S. data in the year of 2003. Agents live for nine periods, $T = 9$; each period corresponds to five years. All Agents are from 20 to 65 years old. All the data from the Current Population Survey is from the Integrated Public Use Microdata Series - Current Population Survey (IPUMS-CPS) and the year is 2003. The definition used to college-educated agents is individuals with at least 3 years of college attendance and to non-college-educated agents are individuals with less than 3 years of college attendance.

College The psychic cost of attending college θ_i is assumed to have a normal distribution and is the same across gender. The mean μ_{edu} and the variance σ_{edu} of the psychic cost are calibrated to match the fractions of college-educated males (0.29) and college-educated females (0.28) in the 2003 IPUMS-CPS, using the definition above of college-educated and non-college educated agents. College tuition κ is from the College Board and based on four years public and private not for profit universities. The college tuition is an annual estimation of the tuition paid, which is the full tuition price minus the amount of financial aid received. The final monetary cost is \$4580 in 2003 dollars. The interest rate on college loans is assumed to be 4% annually. Studying time during college is calibrated to match 32.5 hours per week, which is from the American Time Use Survey.

Demographics The match quality distribution and its autoregressive process are

calibrated to match marriage rates by education group and the fraction of divorced agents. There are four education groups: (i) both spouses have a college education, (ii) only the wife has, (iii) only the husband has, and (iv) neither one has. The data is from the 2003 IPUMS-CPS and the match quality initial distribution is normal, with mean μ_b and variance σ_b. The first-order autoregressive process has a constant ϱ, the autocorrelation coefficient ρ and an error term with a mean of zero and a variance σ_{edu}. Table 3.8 summarizes the values found and the statistics targeted.

Preferences The time discount factor β is equal to 0.81, which corresponds to a discount factor of 0.96 annually. There are three utility function parameters to be calibrated: (i) the elasticity of labor supply σ, (ii) the elasticity of substitution ζ between wife leisure and husband leisure, and (iii) the household weight α on leisure and consumption. The preference parameters are calibrated to match the average hours worked per female, which is 27.94 and the average hours worked by males, which is 39.35. Both are average hours worked per person of each gender and they are from the 2003 IPUMS-CPS, with the population restricted from 25 to 65 years old. The other moment is the fraction of two-earner households among married households. This moments is very important to measure the impact of separate filing and the splitting of total income tax reforms on labor supply. It is also calculated from the 2003 IPUMS-CPS for the same age group.

Home Production The elasticity of substitution between market goods and home production time η is from the work of (McGrattan et al., 1997). The difference in home productivity θ and the weight on market goods and home time ψ on the home production are calibrated to match the average time on home production for males (9.1) and females (17.34) from the American Time Use Survey in 2003. The return of scale on consumption ϕ for married households is from the Organisation for Economic Co-operation and Development (OECD) and it is equal to 0.77.

Wages Wages are from the CPS in 2003 and are lifetime wages. They are hourly-wages[4] and restricted to those in the civilian labor force who make at least half of the minimum wage and to those who worked at least 10 hours per week. Hourly wages are assumed to have a log-normal distribution. There are four wage distributions, one for each education and gender group. Table 3.4 summarizes the mean and variance for

[4] Mean hourly wage $= \frac{\text{Income Wage}}{\text{Usual Hours Worked*Weeks Worked}}$.

each education and gender group.

Table 2.3: Wage Distribution

Category	Parameter Values	
Female College	$\mu_{f,c} = 23.43$	$\sigma_{f,c} = 20.98$
Male College	$\mu_{m,c} = 33.50$	$\sigma_{m,c} = 34.40$
Female Non-College	$\mu_{f,nc} = 13.83$	$\sigma_{f,nc} = 10.96$
Male Non-College	$\mu_{m,nc} = 18.24$	$\sigma_{m,nc} = 17.76$

Taxes The income tax schedule is estimated from OECD data and includes the federal income tax, the earned income tax credit (EITC), the state tax from Michigan, and the city tax from Detroit. Two tax schedules are estimated, one for singles individuals and one for married individuals. The average tax function ($t(\cdot)$) is estimated in terms of average income, AI, which in 2003 was $\$36,084$. The average income tax functions for singles (s) and for married (m) are:

$$t^S(income) = -1.3059 - 0.0050\left(\frac{income}{AI}\right) - \frac{0.0097}{1-0.9382}\left(\frac{income}{AI}\right)^{1-0.9382}$$
$$t^M(income) = -0.3920 - 0.0052\left(\frac{income}{AI}\right) - \frac{0.8944}{1-0.8293}\left(\frac{income}{AI}\right)^{1-0.8293}.$$

The social security tax function ($t_{ssc}(\cdot)$) is estimated separately. It is equal to a flat tax of 0.0765 for an income less than $\$87,000$ in 2003 dollars. Above this upper limit the social security tax function is estimated as:

$$t_{ssc}(income) = 0.0145 + \frac{5,349}{income}$$

The total tax function for singles is the sum of their average income tax and the social security rate rate times their income. For couples, the total tax function is the couple's income multiplied by their income tax, and for spouses who participate in the labor force, their individual social security contributions are added. The social security contribution is equal to the social security rate multiplied by the spouse's income.

Table 2.4 summarizes all the parameters calibrated in the model.

Table 2.4: Parameter Values

Category	Parameter Values	Source
Preferences	$\beta = 0.81$	Prior Information
	$\alpha = 0.48$, $\zeta = -1.36$	Calibrated
	$\sigma = 0.86$	Calibrated
Home Production	$\eta = 0.45$, $\phi = 0.77$	Prior Information
	$\psi = 0.38$, $\theta = 0.46$	Calibrated
College	$\kappa = 4,580$, $l_{edu} = 32.5$	Prior Information
	$\mu_{edu} = -2.79$, $\sigma_{edu} = 1.71$	Calibrated
Marital	$\mu_b = 1.13$, $\sigma_b = 1.82$	Calibrated
	$\varrho = 0.40$, $\rho = 0.64$	Calibrated
	$\sigma_{div} = 1.80$	Calibrated

2.4 The Benchmark Economy

Before proceeding to investigate the impact of income tax reforms on labor supply, I must investigate how well the benchmark model performs with the parameters selected and calibrated. Table 3.8 summarizes the performance of the model compared to the statistics targeted. The model does very well. The objective of the tax reform exercise is to quantify the effect of taxes not only on labor supply, but also on education, marriage, and divorce. To assess the effect of tax reform on labor supply correctly, I consider a potential two-earner household model in which the household maximizes the time devoted to working outside and inside the home -labor supply and home production- and leisure. By allowing the household to do home production the model generates changes in both the intensive and extensive margins. In the data, both average hours worked and home production for both males and females are targeted, and the model comes close to both targets.

In the calibration, neither labor force participation nor hours worked per education group were targeted, yet the benchmark model's steady states value match both moments very well. Hours worked and labor force participation by education group are very important to my analysis, since an increase in education does not only affect

Table 2.5: Benchmark Calibration Results

	Data	Model
College Females	0.28	0.28
College Males	0.29	0.30
College Husband, College Wife	0.15	0.16
College Husband, Non-College Wife	0.08	0.08
Non-College, Husband College Wife	0.06	0.08
Non-College, Husband Non-College Wife	0.39	0.39
Divorced	0.14	0.14
Average Hours Worked Females	27.96	27.86
Average Hours Worked Males	38.95	39.46
Average Home Production Females	17.40	17.54
Average Home Production Males	9.60	9.55
Proportion of Two-Earner Married Agents	0.62	0.63

productivity, but also in general generates an increase in hours worked. Table 2.6 compares hours worked and labor force participation of married individuals generated by the model to the value in the data for each gender and education group. All the data is from IPUMS-CPS for individuals from 25 to 65 years old.

Table 2.6: Benchmark Calibration Results: Labor Supply by Education

	Hours Worked		LFP (Married Individuals)	
	Data	Model	Data	Model
College Females	32.05	32.51	0.77	0.77
College Males	42.15	41.82	0.94	0.93
Non-College Females	26.27	25.57	0.69	0.69
Non-College Males	37.16	36.54	0.89	0.89

The education choice is crucial to the model, and as presented before, is carefully modeled. Investing in education is risky, because there is uncertainty on future wages. This uncertainty comes from the wage distribution that is estimated from the data. The fact that college-educated males have higher variance in their future wages will play an important role when the progressivity of the tax schedule is modified. There are two returns on attending college: wages and marriage. Marriage and divorce decisions

amplify the effect of taxes on education. In order to assess correctly the return on college from the marriage market, the marriage composition among education groups is targeted. By targeting the marriage composition, the model captures the fact in the data that individuals with a college education are more likely to marry a college-educated spouse than a non-college-educated spouse.

A key feature needed in order to quantify the effects of taxes on labor supply, education, and total welfare is the fraction of two-earner families. This feature is fundamental to all tax reforms, because the change in the unit of taxation from the family to the individual results in one-earner families no longer receiving tax benefits and two-earner families no longer paying a tax penalty. Consequently, by targeting the fraction of two-earner families and one-earner families, I have the correct composition of the current family types. This feature of the calibration allows me to estimate the impact of tax reforms on both short-run, when the demographics characteristics are fixed, and in the long-run, when agents are allowed to adjust both marriage/divorce and education decisions.

2.5 Results

After calibrating the model to the current U.S. income tax system. I impose, sequentially, four tax reforms on my model: (i) a splitting of total income, (ii) a separate filing, (iii) a flat tax, and (iv) a two-bracket tax code. The first two reforms maintain the progressivity of the tax code and the last three tax reforms are marriage-neutral. All tax reforms are revenue-neutral. To make the splitting of total income and separate filing reforms revenue neutral, I have all households potentially receiving a subsidy or paying a tax from the government that is proportional to their total income, from the estimation I find that in both cases households receive a subsidy.

The analysis is a steady-state comparison. I impose each tax reform on the benchmark model, and then I find the new steady-states, which is compared with that of the benchmark model. In addition, in the most interesting cases, I quantify the importance of each life-cycle choice to the tax reform. Consequently, I analyze the same tax reforms in a model with only education, with only marriage/divorce, [5] and with the

[5] In the exercise agents' marriage and divorce decisions are the same as those in the benchmark

demographics distribution fixed and only labor supply varying with taxes.

2.5.1 Splitting of Total Income

The reform of splitting income for tax purposes is based on the original 1948 U.S. income tax implementation. There is a unique tax schedule, which is the tax schedule for single individuals. Married individuals' tax rate is given by applying single individual tax schedule to the couple average income. In this tax system, there is no marriage tax penalty and individuals can only receive a tax benefit from getting married. As a consequence of the increase in the tax benefit from marriage, marriage increases by 0.5% and divorce per married couple decreases by -1.2%. An increase in marriage and a reduction in divorce generates an increase in male labor supply and a decrease in female labor supply, because as in the data a married man work more than a single man and a married woman work more than a single man. Overall, female college enrollment increases by 0.5% and male college enrollment increase by 0.1%. Female hours worked increases by 3.7% and male hours worked increase by 5.1%.

Only a small fraction of the population is affected by this tax reform, because the current U.S. tax system allows it for middle- and low-income households. The main groups that are affected by this tax reform are the high-income, two-earner households and the very poor-households. The high-income, two-earner households used to pay a marriage penalty; with the tax reform, they can receive a marriage benefit. As a result, in two-earner families the wife's labor supply increases by 6.5% and the husband's labor supply increases by 5.0%. The poorest families have more access to the earned income tax credit after the tax reform. As a result, their labor supply increases considerably. The labor supply of poor males increases by 15.0% and that of poor females by 6.0%.

2.5.2 Separate Filing

The separate filing tax reform eliminates marriage as a factor in tax calculations. Therefore, changes in marital status do not affect individuals' income taxes. The main effects of this tax reform are to reduce the marginal tax rate on secondary earners and increase that on primary earners. Females are the majority of secondary earners, and secondary

model, but also they are myopic with respect to the proportion of college students.

earners' tax burden is an increasing function of primary earners' income. Because college-educated females are more likely to be married to high-income primary earners, they are the demographic group that benefits most from this tax reform. Female college education increases by 2.3%.

A separate filing reform benefits college-educated females in another way as well. After this tax reform, the income of the secondary earner becomes a larger fraction of after-tax total income. Consequently the value of marrying a high-income secondary earner increases. In Table 2.7, I compare the value of the separate filing tax reform with three special cases of the model, one without the marriage decision and one without the education decision and the last one where the only decision is labor supply. In this last case there is no change in the demographics composition. In the model without the marriage decision, female college attendance increases, but less than in the model with all three life-cycle choices. Female labor supply increases by 4.13% in the full model. In Table 2.7, we can see that changes in both decisions are important to explain the increase in female labor supply. In a model without any life-cycle choice, female labor supply increases by 2.41%, which is lower than in any other model. For males the situation is opposite, in the model without any change in the demographic composition male labor supply increases more than in the model with endogenous decisions.

Table 2.7: Separate Filing Reform

	Percentage Change From The Benchmark			
	Full Model	Only Marital	Only Education	Constant
Married	−0.33%	0.01%	−0.01%	0.0%
Divorced/Married	−0.59%	−0.72%	−0.46%	0.0%
College Females	2.26%	0.0%	1.88%	0.0%
College Males	1.03%	0.0%	0.42%	0.0%
Average Hours per Females	4.13%	4.02%	3.67%	2.41%
Average Hours per Males	1.30%	1.07%	1.38%	1.41%
Average Home Prod Females	−6.58%	−6.42%	−5.89%	−5.40%
Average Home Prod Males	−8.53%	−8.33%	−9.44%	9.50%
Total Welfare	0.71%	0.67%	0.67%	0.65%

In the separating filing tax reform, male labor supply increases by 1.3% and male education by 1.0%. The effects of the tax reform on male labor supply and female labor supply depend on the family type. In two-earner families, the separate filing reform

causes secondary earners to work more and primary earners to work less. Two-earner families substitute home goods for market goods and leisure. After the tax reform, one-earner families do the opposite, they substitute market goods for home goods. Because the majority of families are two-earner families, overall there is a reduction in the time used in home production.

2.5.3 Flat Tax

The flat tax reform eliminates the progressivity of the tax code, which increases the risk of acquiring a college education. College-educated males expect a higher variance in their future wages than do college-educated females; as a result they face more risk in investing in college education after the tax reform. Male college education decreases by 0.3%, while female college education increases by 5.6%. In this environment, the progressivity of the tax code and marriage are the only mechanisms that reduces the risk of acquiring education.

Table 2.8: Flat Tax Reform

	Percentage Change From The Benchmark			
	Full Model	Only Marital	Only Education	Constant
Married	−0.63%	−0.19%	−0.53%	0.00%
Divorced/Married	0.30%	−0.33%	0.01%	0.00%
College Females	5.57%	0.00%	5.35%	0.00%
College Males	−0.29%	0.00%	−1.13%	0.00%
Average Hours per Female	11.07%	10.74%	10.85%	9.01%
Average Hours per Males	9.69%	9.07%	8.86%	9.56%
Average Home Prod Females	−6.10%	−5.62%	−5.89%	−5.72%
Average Home Prod Males	−11.24%	−11.14%	−10.54%	−9.64%
Total Welfare	0.49%	0.40%	0.42%	0.40%

The flat tax reform eliminates any marriage tax benefit and penalty, which can make marriage more or less attractive. Before this reform more couples receive a marriage benefit than a marriage penalty, so overall the flat tax reform decreases marriage and increases divorce. With this reform individuals become more selective in choosing their future spouse; as a result, marriage among the college-educated agents increases by 2%, which amplifies the effect of taxes on education. After the flat tax reform, females not only experience an increase in the value of attending college, but an increase in the value

of marrying a college-educated spouse. The impact of taxes on the marriage decision creates an amplification effect on education. Table 2.8 compares the value of the tax reform for four cases of the model: one with all endogenous decisions, one with only education decision, one with only marriage and divorce decisions, and the last one with only labor supply, in which the demographics distribution is fixed. Female labor supply increases by 11.07% and both the reduction in marriage and the increase in education are important to explain that increase.

Males labor supply also increases with this tax reform, most of the increase in male labor supply is driven by poor males who face a much higher tax rate after marriage. Table 2.9 indicates the change in labor supply by income group. These groups are the richest quarter, poorest quarter, and the half in between, or the middle class. This table shows that the poorest males are responsible for the sizable fraction of the increase in male labor supply under a flat tax.

Meanwhile, most of the increase in female labor supply with the flat tax reform is from middle-class females. The increase in female education generates an increase in female income; as a consequence in the middle class, many females who were secondary earners become primary earners in one-earner and two-earner families. This helps explain the 13.6% increase in the middle-class female labor supply that results with this reform.

Table 2.9: Flat Tax Reform Income Distribution

	Benchmark		Flat Tax	
	Market Hours Worked	Home Hours Worked	Market Hours Worked	Home Hours Worked
Rich Females	46.19	3.97	49.40	3.40
Rich Males	51.20	1.03	54.56	0.74
Middle Females	27.70	17.04	31.57	14.05
Middle Males	42.59	6.20	46.37	6.00
Poor Females	10.05	30.62	10.94	32.30
Poor Males	16.00	26.67	19.83	22.45

2.5.4 Two Brackets

In this tax reform, I simplify the tax code to two income tax brackets. The marginal tax rates and the size of the brackets are chosen to maximize total welfare. In this tax

reform, although the top bracket has a higher marginal tax rate than with the flat tax, both male and female education increase more than with that reform. This is because the progressivity of the two-brackets tax reform reduces the risk of acquiring a college education. Females' college education increases by 9.9% and males' college education increases by 3.67%.

Two-brackets tax reform generates the biggest increase in labor supply, for both males and females. Female labor supply increases by 17.32% and male labor supply by 12.82%. Because in the two brackets tax reform, the marginal tax rate on the rich is higher, this income group labor supply is lower than in the flat tax. However, for all the other income groups the labor supply is higher. In the two brackets tax code, middle-class females are the group most affected by this tax reform in both the intensive and the extensive margins. Female labor force participation increases by 11.05%. Differently from the flat tax where most of the increase in male labor supply comes from the poor, in this tax reform, middle-class males are responsible for an important fraction of the increase in male labor supply, as Table 2.10 indicates.

Table 2.10: Two Brackets Tax Code Income Distribution

	Benchmark		Flat Tax	
	Market Hours Worked	Home Hours Worked	Market Hours Worked	Home Hours Worked
Rich Females	46.19	3.97	47.72	3.76
Rich Males	51.20	1.03	54.01	0.85
Middle Females	27.70	17.04	35.11	12.15
Middle Males	42.59	6.20	48.15	5.00
Poor Females	10.05	30.62	11.85	30.20
Poor Males	16.00	26.67	21.53	23.27

2.6 Conclusion

The inclusion of the three life-cycle choices in the analysis of tax reforms is fundamental to correctly assessing their impact on labor supply. The education choice brings a new perspective to the importance of the degree of progressivity in the tax code, which affects the risk of investing in college education. This relationship emerges when we compare the outcome of the flat tax with the outcome the two-brackets tax reform. In the flat

tax, only female college education increases, while in the two-brackets tax reform both male and female college education increases. This result demonstrates the importance of some degree of progressivity as insurance for investment in college education.

The separate filing and the splitting of total income tax reforms do not alter the degree of progresssivity of the tax code, but they modify the marginal tax rate on secondary earners and primary earners. These two tax reforms indicate that the gains from a reduction in the secondary earner marginal tax rates is sizable. In both tax reforms not only female labor supply increases, but also female education, which is fundamental to measure the gains in total welfare from the tax reform for current and future generations.[6] In addition, when comparing the separate filing tax reform with the splitting of total income, we can conclude that a more dramatical reduction in the marginal tax rate of the secondary earner, which occurs in the separate filing tax reform, can lead to bigger gains in total welfare.

[6] It is a well know fact in the literature that mothers education has an important impact on children performance, (Carneiro et al., 2007)

Chapter 3

A Cross-country Comparison of Female Labor Supply

3.1 Introduction

Macroeconomists have long been interested in understanding changes in average hours worked in the last century, as documented by (Ohanian et al., 2008). In the last fifty years, average hours worked have changed dramatically across countries. During the 1950's, Europeans worked on average more hours than Americans. Nowadays, however, the opposite is true; Americans work on average more hours than Europeans. In his pioneering paper, (Prescott, 2004) showed that differences in labor income taxation between countries can explain most of the differences in average hours worked since the 1970's. Although macroeconomists have made an important progress in understanding the impact of taxation on labor supply behavior, one important aspect has been largely ignored - differences in gender.

The current macroeconomics literature[1] has focused on the representative agent model ignoring any particular aspect of gender differences. This is surprising, given that differences in hours worked across European countries and the United States are much bigger for women. As an example, while on average an American man works 25 per cent more than a German man, an American woman works 60 per cent more than

[1] (Rogerson, 2006) has a nice review of the literature.

a German woman.[2] Consequently, in order to fully understand differences in hours worked across countries, it is key to incorporate female labor supply decision.

Female labor supply decision differs significantly from male. Although female labor force participation has increased dramatically over the last 50 years. Female labor force participation is still significantly lower than male. In the OECD countries female labor force participation is around 60 per cent, while for men it is around 80 per cent. Consequently, female labor supply decision is still not only on how many hours to work, but also on whether to work. In addition, the existent literature has focused on differences in the progressivity of the tax schedule across countries, neglecting one important aspect - differences in the treatment of families. Countries differ significantly on how they treat one versus two earner families. Since females are the majority of secondary earners, they are still penalized with higher marginal income tax after marriage in many countries. This increase in marginal income tax can lead females to reduce hours worked or even to drop the labor force.

This essay quantifies how much differences in labor income taxation across countries explains differences in female hours worked. With this objective, I consider a household model, where agents allocate their time to market work, to home production, and to leisure. The economy is populated by single and married agents that are heterogeneous in gender and wages. Given wages, and labor income tax, the economy is calibrated to match time allocation patterns in the United States. Then, I substitute the labor income tax of the United States for the labor income tax of different European countries, and I quantify how much of differences in hours worked is due to differences in labor income tax.

The explanatory power of differences in labor income tax in explaining differences in hours worked varies across countries. For Germany and France, that like the United States, have the family as the unit of taxation, differences in income taxation and social security contribution are able to explain 35 per cent of differences in hours worked between American women and French women, and they are also able to explain 16 per cent of the difference between French and American men. For Germany differences in labor income taxes explain 45 per cent of differences in hours worked between both men and

[2] Author own calculation using Multinational Time Use Survey

women. For the group of countries that have the individual as the unit of taxation, differences in labor income tax can explain most of differences in hours worked for women, but it is not able to explain differences in hours worked for men. United Kingdom is the exception, where differences in taxation are not able to explain differences in hours worked both for men and women.

My work here is closely related to (Prescott, 2004), (Rogerson, 2006) and others that explore differences in taxation to explain differences in hours worked between the United States and Europe. It is also related to (Alesina et al., 2005) that finds that differences in unions and labor market regulation can explain differences in hours worked.

This essay is organized as follows. In Section 3.2, I describe the economic environment, and in Section 3.3 I describe the main data set used in this essay. In Section 3.4 I discuss the calibrated model and the quantitative properties of the benchmark economy. The main findings of the essay are presented in Section 3.5, where I quantify the impact of labor income taxation on female labor supply across countries. Section 3.6 concludes the essay.

3.2 The Economic Environment

The economy is populated by a continuum of males and a continuum of females. The total mass of each gender is normalized to one. Agents are born with a wage w_g, that depends on gender. In addition, agents are born with a fixed marital status. Let $S(w_g)$ denotes the fraction of single and divorced agents with wage w_g, and let $M(w_h, w_f)$ be the fraction of married agents, in which the husband has a wage w_h and the wife has a wage w_f. Each agent is endowed with one unit of time that can be allocate to market work l_1, home production l_2, and leisure. Following (Becker, 1965), I assume that there is a home production function that uses market goods c_M and time l_2 to produce a final consumption good c_{HP}. Agents differ in their home production productivity θ_g, that is gender specific. Market goods c_M are purchased with labor l_1 for a wage w_g. Income is taxed $T(\cdot)$ and this tax function is estimated to each country.

Single and Divorced Households Singles and divorced agents maximize their consumption of the final good c_{HP} and leisure $1 - l_1 - l_2$ subject to their budget constraint. The single and divorced agent maximization problem is given by:

$$\max_{c_M, c_{HP}, l_1, l_2} \quad \alpha \log(c_{HP}) + (1-\alpha)\frac{(1-l_1-l_2)^{1-\sigma}}{1-\sigma}$$

s.t

$$c_{HP} = (\psi c_M^{\eta} + (1-\psi)(\theta_g l_2)^{\eta})^{\frac{1}{\eta}}$$
$$c_M \leq w l_1 - T(w l_1)$$
$$l_1 + l_2 \leq 1$$
$$l_1 \geq 0, l_2 \geq 0$$

Married Households Married agents maximize consumption of the final good c_{HP} and the combined husband leisure‘ and wife leisure‘. The parameter ζ measures the elasticity of substitution between the wife and the husband leisure in the couple utility function. In addition, a married couple consume a final consumption good using market good and time. The time of the husband and the wife at home production is combined using CES aggregator, in which the parameter χ captures the elasticity of substitution between the husband and the wife time at home. Married couples also enjoy a return of scale ϕ in consumption and leisure, and they face an income tax $T(\cdot,\cdot)$ that depends on the earning of the wife and the earnings of the husband. This tax function is estimated to each country.

$$\max_{c_{HP}, c_M, l_m^1, l_f^1, l_m^2, l_f^2} \quad \alpha \log\left(\frac{c_{HP}}{2^{\phi}}\right) + \frac{(1-\alpha)}{1-\sigma}\left((1-l_m^1-l_f^1)^{\zeta} + (1-l_m^2-l_f^2)^{\zeta}\right)^{\frac{1-\sigma}{\zeta}}$$

s.t

$$c_{HP} = (\psi c_M^{\eta} + (1-\psi)(\theta_m (l_m^2)^{\chi} + (1-\theta_m)(l_f^2)^{\chi})^{\frac{\eta}{\chi}})^{\frac{1}{\eta}}$$
$$c_M \leq w_m l_m^1 + w_f l_f^1 - T(w_m l_m^1, w_f l_f^1)$$
$$l_m^1 + l_m^2 \leq 1$$
$$l_f^1 + l_f^2 \leq 1$$
$$l_m^1 \geq 0, l_m^2 \geq 0, l_f^1 \geq 0, l_f^2 \geq 0$$

Equilibrium The equilibrium is very simple, households maximize utility subject to the relevant budget constraint.

3.3 Data

The equilibrium is calibrated to match patterns of time allocation in the United States in 2003. With this objective the United States demographic distribution and wages are estimated from the data. Then, given wages, and labor income tax, the economy is calibrated to match time allocation patterns. After the calibration, the United States income tax and social security contribution is replaced by the income tax and social security contribution of the selected country.

Hours Data on time allocation is obtained from the Multinational Time Use Study (MTUS). MTUS main objective is to create a harmonized time use data that is comparable across countries. The data is collected from daily time use diaries in each country. In this essay the latest version available of the MTUS is used for the selected countries: France (1998), Germany (2001), Italy (2002), The Netherlands (2000), Norway (2000), The United Kingdom (2000), The United States (2003). For each country the sample is restricted to males and females aged 20-65.

The time allocation at the MTUS is divided in 41 daily activities represented in table 3.1. I divide this 41 categories in three groups: market work, home production, and leisure. Market work consists of mainly activities for which individuals are paid to perform. Home production are activities that it is easier to find a substitute in the market, as an example you can cook your own food or you can buy it in a restaurant. The last category is leisure, which is the complement of market work and home production, in general activities in these category follow the third-part rule, meaning you can not pay an individual to perform it in your place.

Preferences There are three utility function parameters to be calibrated: (i) the elasticity of labor supply σ, (ii) the elasticity of substitution between the leisure of the wife and the leisure of the husband ζ, and (iii) the household weight α on leisure and consumption. The preference parameters are calibrated to match the average hours worked per female, which is 24.20 in the United States, and the average hours worked per male, which is 36.03 in the United States, both from the MTUS. The other moment calibrated is the fraction of two-earner households among married households. This moments is very important to measure the impact of tax on one-earner versus two-earner households, and it is calculated from the 2003 Integrated Public Use Microdata

Table 3.1: MTUS Activities

Activity Code	Activity	Activity Code	Activity
AV1	Paid Work	AV21	Walking
AV2	Paid Work at home	AV22	Religious activity
AV3	Paid Work, second job	AV23	Civic activities
AV4	School, classes	AV24	Cinema or Theater
AV5	Travel to/from work	AV25	Dancers or Parties
AV6	Cook, wash up	AV26	Social clubs
AV7	Housework	AV27	Pubs
AV8	Odd jobs	AV28	Restaurants
AV9	Gardening	AV29	Visit friend at their home
AV10	Shopping	AV30	Listen to radio
AV11	Childcare	AV31	Watch television or video
AV12	Domestic Travel	AV32	Listen to records, tapes, cds
AV13	Dress/personal care	AV33	Study, homework
AV14	Consume personal services	AV34	Read books
AV15	Meals and snacks	AV35	Read papers, magazines
AV16	Sleep	AV36	Relax
AV17	Free time travel	AV37	Conversation
AV18	Excursions	AV38	Entertain friends at home
AV19	Active sports participation	AV39	Knit,sew
AV20	Passive sports participation	AV40	Other leisure
AV41	Unclassified time		

Series - Current Population Survey (IPUMS-CPS) for the same age group.

Home Production The elasticity of substitution between market goods and home production time η is from the work of (McGrattan et al., 1997). The difference in home productivity across gender θ and the weight on market goods and home time ψ on the home production are calibrated to match the average time on home production for males (13.18) and females (21.09) from the MTUS. The return of scale on consumption ϕ for married households is from the Organization for Economic Co-operation and Development (OECD) and it is equal to 0.77.

Demographics The demographic distribution in the United States in the year of 2003 is calculated from the IPUMS-CPS . The population is divided in 8 demographic groups. First, each gender is divided in two educational groups, one for college educated agents, which in the data corresponds to individuals with at least 3 years of college education, and one for high school educated agents, which in the data correspond to individuals with less than 3 years of college education. Then, individuals are divided

Table 3.2: Main Activities

Activity	MTUS Category
Market Work	AV1-3
Home Work	AV5-11
Leisure	All other activities

by marital status. Table 3.3 summarizes the demographics distribution.

Table 3.3: Demographic's Distribution

	Proportion
Single and Divorced Agents	
College-Educated Females	0.07
College-Educated Males	0.06
High-School-Educated Females	0.25
High-School-Educated Males	0.26
Married Agents	
College-Educated Husband, College-Educated Wife	0.15
College-Educated Husband, High School-Educated Wife	0.06
High-School-Educated Husband, College-Educated Wife	0.05
High-School-Educated Husband, High-School-Educated Wife	0.39

Wages Wages are from the IPUMS-CPS in 2003. They are hourly-wages[3] and restricted to those in the civilian labor force, who make at least half of the minimum wage, and to those who worked at least 10 hours per week. Hourly wages are assumed to have a log-normal distribution. There are four wage distributions, one for each education and gender group. Table 3.4 summarizes the main statistics of the wage distribution.

Income Tax The income tax schedule is estimated from the publication (OECD, 2005) from the Organization for Economic Co-operation and Development (OECD) and follows the methodology developed by (Guvenen et al., 2009). In this publication, the OECD provides information on income tax paid by workers and social security contributions levied on employees in OECD countries. Based on this information, I estimated an income tax schedules to each country, that also contains state and local

[3] Mean hourly wage $= \frac{\text{Income Wage}}{\text{Usual Hours Worked*Weeks Worked}}$.

Table 3.4: Wage Distribution

Category	Parameter Values	
Female College	$\mu_{f,c} = 2.94$	$\sigma_{f,c} = 0.33$
Male College	$\mu_{m,c} = 3.25$	$\sigma_{m,c} = 0.46$
Female Non-College	$\mu_{f,nc} = 2.45$	$\sigma_{f,nc} = 0.27$
Male Non-College	$\mu_{m,nc} = 2.72$	$\sigma_{m,nc} = 0.36$

tax. The social security contribution is also considered, but separately.

As mentioned before countries not only differ in the progressivity of the tax schedule, but also on the unit of taxation. Consequently, in many cases more than one income tax schedule is estimated to each country. For the countries where the unit of taxation is the family; United States, Germany, and France, two tax schedules are estimated one for single individuals and one for married individuals. In addition, for France and Germany a third tax schedule is estimated to married individuals, in which only one spouse participates in the labor force. This third tax schedule is estimated to consider some important tax benefits that exist to one-earner families in these two countries.

For the set of countries in which the unit of taxation is the individual, the same problem arises. In many cases, tax benefits to one-earner families are sizable and an extra tax schedule is estimated for this reason. For Norway, two tax schedules are estimated one for singles or married individuals filling separately, and one for married individuals filling jointly. For Netherlands, only one tax schedule is estimated. For Italy and UK, because of specific tax benefits for dependent spouses, two tax schedules are estimated to each country, one for single and married individuals, in which both spouses participate in the labor force, and one for married individuals, in which only one spouse participates in the labor force.

All tax schedule are estimated using the following functional form:

$$t(income) = a_0 + a_1 \left(\frac{income}{AI} \right) - \frac{a_2}{1-\phi} \left(\frac{income}{AI} \right)^{1-\phi}$$

where AI stands for the average income for each country, which is from (OECD, 2005), and income is the income of the individual or in case of married agents filling

jointly is the total income of the married couple. Table 3.5 presents all the parameters estimated for each country along its R^2 values and figure **??** illustrates the income taxation of single individuals for each country.

Table 3.5: Income Tax Estimation

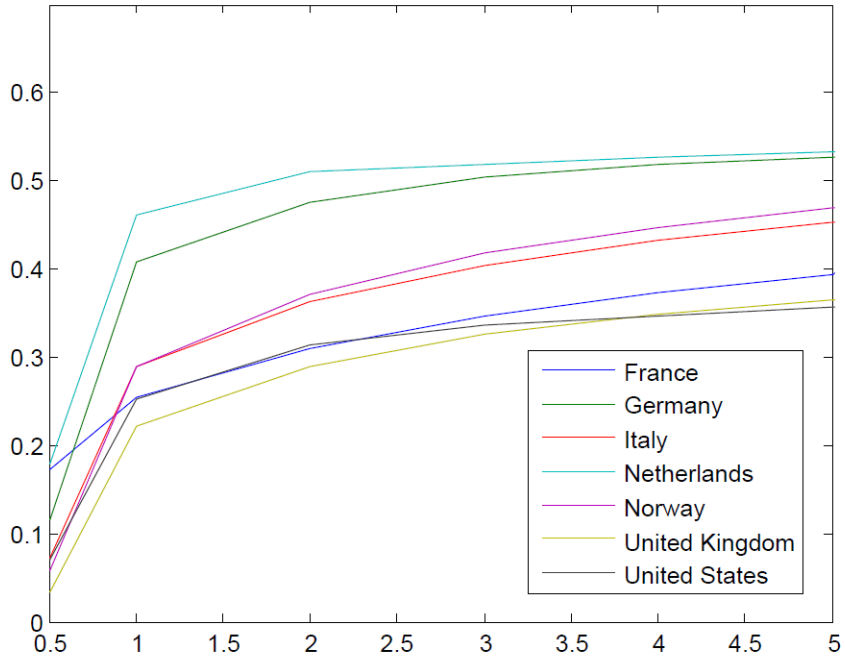
Country	Type	a_0	a_1	a_2	ϕ	R^2
France	Single Individuals	-0.0709	-0.0125	0.0952	0.5553	0.9936
	Married Individuals					
	Both Working In The Market	0.0392	0.0720	-0.0301	-0.2560	0.9949
	Only One Working In The Market	0.0436	0.0424	-0.0003	-0.8804	0.9908
Germany	Single Individuals	-1.7312	-0.0195	0.1751	0.9108	0.9932
	Married Individuals					
	Both In Working In The Market	-0.1187	-0.1052	0.2280	0.3052	0.9912
	Only One Working In the Market	-0.1290	-0.0858	0.2133	0.3475	0.9916
Italy	Single and Married Individuals Both Working In The Market	-1.2392	-0.0132	0.1283	0.9098	0.9921
	Married Individuals Only One Working In The Market	-0.9432	-0.0014	-0.1354	0.8781	0.9870
Netherlands	All Individuals	-0.0744	0.4540	-0.3450	-0.1099	0.9820
Norway	Single and Married Individuals Filling Separately	-0.9031	-0.0133	0.1319	0.8830	0.9934
	Married Individuals Filling Jointly	-0.2289	-0.0365	0.1643	0.5999	0.9935
United Kingdom	Single and Married Individuals Both Working In The Market	-0.5906	-0.0014	0.1253	0.8335	0.9916
	Married individuals Only One Wroking In The Market	-0.4417	-0.0189	0.1334	0.7774	0.9876
United States	Single Individuals	-1.3059	-0.0050	0.0097	-0.9382	0.9936
	Married Individuals	-0.3920	-0.0052	0.8944	-0.8263	0.9899

Social Security Contribution The social security contribution is estimated from the publication (OECD, 2005). Based on this information, I estimated the social security contribution for employees in each country using the following functional form:

$$t(income) = a_0 + a_1 \left(\frac{income}{AI} \right) - a_2 \left(\frac{income}{AI} \right)^{1-\phi}$$

where AI is the average income for each country and income is the worker income. Table 3.6 presents all the parameters estimated for each country along its R^2 values.

Figure 3.1: Approximation of Average Income Tax Schedule for Single Individuals



3.4 The Benchmark Economy

The model is calibrated to match the United States time allocation patterns in 2003. Given the American demographic and wage distribution, five parameters $\sigma, \zeta, \psi, \theta$ and α are calibrated to match average market work hours and home production hours for males and females. Last the fraction of married agents, in which both spouses are in the labor force is also target. Table 3.7 summarizes all parameters targeted in the model.

The parameter σ is equal 0.63, which generates a frish elasticity for males equal to 0.46 in the range of recent estimation of (Domeij and Floden, 2006). The elasticity of substitution between the leisure of husband and the leisure of wife ζ is equal to -0.41, which indicates that they are complements. This result is consistent with the evidence from (Burda et al., 2008), which shows that married households over time and across countries tend to spend the same amount of time on all-work hours (sum of market hours and home production hours). The parameter θ is equal to 0.50 and indicates that women and men have the same productivity at home. Last the parameter χ is equal to

Table 3.6: Social Security Contribution

Country	a_0	a_1	a_2	ϕ	R^2
France	0.1415	-0.0079	0.000	-4.2163	0.9813
Germany	0.2571	18.8405	-18.9045	0.0009	0.9736
Italy	0.1019	0.0000	0.0000	0.8322	0.9937
Netherlands	-0.2968	-21.1289	21.6571	0.0232	0.9826
	-0.2194	-22.6890	22.6433	0.0005	0.9530
Norway	0.0000	0.0780	0.0000	0.0000	0.9999
United Kingdom	-0.0402	0.0027	0.1904	1.7313	0.9951
United States	0.0332	0.1027	-0.0054	1.2323	0.9912

In order to match the Social Security in Netherland two social security functions are estimated. The first one for income less than 44506 euros, and the second one for income greater than 44506 euros.

Table 3.7: Parameter Values

Category	Parameter Values	Source
Preferences	$\alpha = 0.41$, $\zeta = -0.14$	Calibrated
	$\sigma = 0.63$	Calibrated
Home Production	$\eta = 0.45$	Prior Information
	$\psi = 0.37$, $\chi = 0.40$	Calibrated

0.40, which indicates that husband and wife time at home are substitutes.

In this section I analyzed the performance of the calibrated model. Table 3.8 summarizes the performance of the model and the statistics targeted. The objective of the exercise is to quantify how much of differences in income taxation and social security contribution can explain differences in hours worked between the United States and the selected European Countries. In order to be able to quantify the impact of taxes on not only, male labor supply, but also on female labor supply, both hours worked of males and females are targeted; the model performs quite well in these dimensions. Also to have a more precise response of the impact of taxes on female labor supply, hours spend on home production are targeted for both males and females. The model also perform quite well in this dimension, only overestimating the amount of hours spend on home production by men.

The last moment which is the fraction of two-earner households is also important,

Table 3.8: Benchmark Calibration Results

	Data	Model
Average Hours Worked Females	24.20	25.35
Average Hours Worked Males	36.03	36.45
Average Home Production Females	27.30	26.51
Average Home Production Males	16.58	18.10
Proportion of Two-Earner Married Agents	0.62	0.63

because as mentioned before countries not only differ in the level of progressivity, but on the unit of taxation. Consequently a change in the unit of taxation from the family to the individual results in one-earner families no longer receiving tax benefits and two-earner families no longer paying a tax penalties. By targeting the fraction of two-earner households, the model correctly predicted the impact of changes in income taxation in these two types of families.

3.5 Cross Country Comparison

In this section, I perform the main exercise of the paper, I replace the income tax and the social security contribution of the United States for the income tax and social security contribution of each selected European country; and then I quantify how much differences in income tax and social security contribution can explain differences in hours worked and home production between these European countries and the United States.

3.5.1 Females

The success of differences in income tax and social security contribution in explaining differences in hours worked varies across countries. Differences in labor income tax explains almost all the difference in females hours worked in Germany, but they don't explain any of the difference in female hours worked in the United Kingdom. This last result is not so surprising, since both the United States and the United Kingdom have the least progressive tax schedule; In addition, the unit the taxation in the United Kingdom is the individual, differently from the United States, which is the family. When

the unit of taxation is the individual, secondary-earners face on average a lower marginal income tax, which explains why females work more when they face the British labor income tax. Table 3.9 summarizes the main finding for females hours worked.

Table 3.9: Females Hours Worked Data and Model

Country	Data	Model	Percentage Explained
France	19.22	24.19	0.30
Germany	16.25	16.30	0.99
Italy	15.40	22.56	0.34
Netherland	17.40	24.13	0.24
Norway	20.04	24.10	0.35
United Kingdom	19.08	27.16	-0.15

France, Germany and the United States have a progressive income tax and the family as the unit of taxation. A tax system with these two characteristics is not *marriage neutral*, meaning that changes in marital status affect individuals federal income tax obligation. In particular, primary earners face a lower marginal income tax rate after marriage, while secondary earners face a higher marginal income tax. Since both Germany and France have a more progressive tax schedule than the United Sates, the increase in the marginal income tax is even higher in these two counties. Consequently, females work fewer hours in Germany and France. In addition, since the German income tax schedule is more progressive than the French, female hours worked are even lower in Germany. For France, differences in labor income tax explain 30 per cent of the difference in females hours worked, while for Germany they explain 99 per cent.

Another important statistics generated by the model is the difference in female labor force participation. Differences in income tax and social security contribution can also explain differences in female labor force participation in these countries. From the OECD data[4] female labor force participation in France is around 72 per cent, and in the model it is around 74 per cent. For Germany female labor force participation is around 70 per cent, and the model predicted a female labor force participation of 68 per cent.

Italy, Netherlands, Norway and the United Kingdom have also a progressive income

[4] OECD sample restricted of females aged 20-65.

tax system, however the unit of taxation in these countries is the individual, not the family as in the United States, Germany, and France. Consequently, the second-earner marginal income tax does not depend on the first-earner earnings, this has a positive impact on married females hours worked. However, although the unit of taxation is the individual in these countries, in Italy, Netherlands, and United Kingdom generous tax benefits are given to families with one-earner, which reduces married women incentive' to participate in the labor force. As a result from all European countries Netherland, which is the only country that do not offer tax-benefits to one-earner families, has the highest labor force participation.

With respect to hours worked, differences in income tax and social security contribution explain 35 per cent of the differences in female labor supply in Norway, 34 per cent in Italy, and 24 per cent in Netherland. However, for the United Kingdom the model generates female hours worked very similar to Americans, which is not consistent with the data; on average an American women works 6 hours more than a British women per week. The income tax and social contribution in both countries are quite similar, however the main difference is in the unit of taxation, which in the United Kingdom is the individual, and in the United States is the family. Consequently on average a secondary earner face a lower marginal income tax in the United Kingdom than in the United States tax. As a result, in the model British women work more than Americans.

3.5.2 Males

For males differences in income tax and social security contribution do not explain so well differences in hours worked. For three countries, Italy, Netherlands, and the United Kingdom, the model predicts hours worked lower than they actually are. This generates a bigger difference in hours worked in the model than in the data. One possible explanation is that the actual hours worked on the data from the MTUS are actually overestimated. It is a well-known fact that for some countries the MTUS data underestimates holidays, sick days, and vacations, which is an important source of the difference in hours worked between United States and Europe. In this case, the actual hours worked for males is lower than the one presented in the table 3.10, and consequently the model is being consistent with the "actual" data. Table 3.10 summarizes the main finding for males hours worked.

Table 3.10: Males

Country	Data	Model	Percentage Explained
France	30.52	35.11	0.22
Germany	29.05	29.10	0.99
Italy	33.55	31.30	1.77
Netherland	33.09	30.57	1.75
Norway	32.58	33.18	0.84
United Kingdom	32.42	36.44	0.00

As it was mentioned before, France, Germany and the United States have the family as the unit of taxation and a progressive tax system. Like females, because the German income tax is more progressive than the French, on average a German man works less hours than a French man. Differences in income tax and social security contribution explain 22 per cent of differences in hours worked between Americans and French, and it explains 99 per cent of the differences between Americans and Germans.

For the group of countries in which the unit of taxation is the individual, so the head of the household does not receive a tax benefit from filling jointly, in two cases, Italy and Netherlands the model actually generated less hours worked than the ones observed in the MTUS data. It also important to observe that these two countries generate a larger difference in hours worked for women between the model and the data. This feature indicates that the model predicted a more "equal" division of market work between spouses than the one observed in the data.

For Norway, differences in income tax and social security contribution explain 84 per cent of differences in hours worked between an American man and a Norwegian man. In the case of the United Kingdom, like British women, the model predicts on average more hours worked than the data, moreover, it predicts that on average a British man works more hours than a American man, which is not consistent with the data

3.6 Conclusion

In this paper, I quantify the impact of differences in income taxation and social security contribution across countries on household labor supply. The main contribution of this paper is to study the impact of labor income taxes on female labor supply, considering

not only differences in the progressivity of the tax schedule, but also differences in the treatment of families. More precisely, this paper consider differences in the unit of taxation and how they impact female labor supply. The main finding is that differences in labor income taxation are much more important in explaining differences in hours worked for women than it is for men. Overall labor income tax is able to explain one third of differences in female hours worked between the United States and the selected European countries and it is able to explain on quarter of differences in male hours worked.

References

Alberto Alesina, Edward L. Glaeser, and Bruce Sacerdote. Work and leisure in the u.s. and europe: Why so different? Working Paper 11278, National Bureau of Economic Research, April 2005.

G.S. Becker. A Theory of the Allocation of Time. *The economic journal*, 75(299): 493–517, 1965. ISSN 0013-0133.

Richard. Blundell and T. MaCurdy. Labor supply: A Review of Alternative Approaches. *HANDBOOKS OF LABOR ECONOMICS*, 3(PART 1):1559–1696, 1999.

M.C. Burda, D.S. Hamermesh, and P. Weil. *The Distribution of Total Work in the EU and USA*. Oxford University Press, 2008.

P. Carneiro, C. Meghir, M. Parey, and Centre for Economic Policy Research (Great Britain). *Maternal education, home environments and the development of children and adolescents*. Centre for Economic Policy Research, 2007.

H. Chade and G. Ventura. Taxes and Marriage: A Two-Sided Search Analysis. *International Economic Review*, 43(3):955–985, 2002.

P.A. Chiappori, M. Iyigun, and Y. Weiss. Investment in schooling and the marriage market. *The American Economic Review*, 99(5):1689–1713, 2009. ISSN 0002-8282.

David Domeij and Martin Floden. The labor-supply elasticity and borrowing constraints: Why estimates are biased. *Review of Economic Dynamics*, 9(2):242–262, April 2006.

Nada Eissa. Taxation and labor supply of married women: The tax reform act of 1986 as a natural experiment. NBER Working Papers 5023, National Bureau of Economic Research, Inc, 1995.

R. Fernandez, N. Guner, and J. Knowles. Love and Money: A Theoretical and Empirical Analysis of Household Sorting and Inequality*. *Quarterly Journal of Economics*, 120 (1):273–344, 2005.

C. Goldin. The quiet revolution that transformed women's employment, education, and family. *The American Economic Review*, 96(2):1–21, 2006. ISSN 0002-8282.

J. Greenwood and N. Guner. Marriage and divorce since World War II: analyzing the role of technological progress on the formation of households. *NBER Working paper*, 2004.

Nezih Guner, Remzi Kaygusuz, and Gustavo Ventura. Taxation, Aggregates and the Household. *SSRN eLibrary*, 2008.

Fatih Guvenen, Burhanettin Kuruscu, and Serdar Ozkan. Taxation of Human Capital and Cross-country Trends in Wage Inequality. *Working Paper*, 2009.

Robert E. Hall and Alvin Rabushka. *The flat tax*. Hoover Press publication, 1996.

J.J. Heckman, L.J. Lochner, and P.E. Todd. Earnings Functions, Rates of Return and Treatment Effects: The Mincer Equation and Beyond1. *Handbook of the Economics of Education*, 1:307–458, 2006. ISSN 1574-0692.

Larry E. Jones, Rodolfo E. Manuelli, and Ellen R. McGrattan. Why are married women working so much? *Reserach Department Staff Report*, 317(317), 2003.

Remzi Kaygusuz. Taxes and female labor supply. *Review of Economic Dynamics*, 13 (4):725–741, October 2010.

E.J. McCaffery. *Taxing women*. University of Chicago Press, 1999. ISBN 0226555585.

Ellen R McGrattan, Richard Rogerson, and Randall Wright. An equilibrium model of the business cycle with household production and fiscal policy. *International Economic Review*, 38(2):267–90, May 1997.

OECD. *Taxing Wages 2002-2003*. OECD Publishing, 2005.

L. Ohanian, A. Raffo, and R. Rogerson. Long-term changes in labor supply and taxes: Evidence from OECD countries, 1956–2004. *Journal of Monetary Economics*, 55(8): 1353–1362, 2008.

E.C. Prescott. Why do Americans work so much more than Europeans? *Federal Reserve Bank of Minneapolis Quarterly Review*, 26(1):2–13, 2004.

R. Rogerson. Understanding differences in hours worked. *Review of Economic Dynamics*, 9(3):365–409, 2006.

R.D. Rogerson. *The Impact of Labor Taxes on Labor Supply: An International Perspective*. G - Reference, Information and Interdisciplinary Subjects Series. American Enterprise Institute for Public Policy Research, 2010. ISBN 9780844743554.