Journal of Monetary Economics 59 (2012) 111–128

Contents lists available at SciVerse ScienceDirect

Journal of Monetary Economics

journal homepage: www.elsevier.com/locate/jme

Taxing women: A macroeconomic analysis

Nezih Guner[a,*], Remzi Kaygusuz[b], Gustavo Ventura[c]

[a] ICREA-MOVE, Universitat Autonoma de Barcelona, and Barcelona GSE, Spain
[b] Faculty of Arts and Social Sciences, Sabanci University, Turkey
[c] Department of Economics, Arizona State University, USA

ARTICLE INFO

Available online 29 October 2011

ABSTRACT

Based on well-known evidence on labor supply elasticities, several authors have concluded that women should be taxed at lower rates than men. We evaluate the quantitative implications and merits of this proposition. Relative to the current system of taxation, setting a proportional tax rate on married females equal to 4% (8%) increases output and married female labor force participation by about 3.9% (3.4%) and 6.9% (4.0%), respectively. Gender-based taxes improve welfare and are preferred by a majority of households. Nevertheless, welfare gains are higher when the U.S. tax system is replaced by a proportional, gender-neutral income tax.

1. Introduction

Two observations are central to this paper. First, it is well known that the labor supply elasticities of women are larger than those of men, especially when the extensive margin is considered.[1] Second, the current U.S. tax system is biased against women's work in the marketplace. Since the U.S. system taxes the income of households and not the income of individuals, for a married woman who considers entering the labor force, her marginal tax rate depends on her husband's income. Given the current levels of marginal tax rates, this is arguably a substantial impediment to labor force participation.

These observations have motivated work in the theory of optimal taxation. From standard public-finance principles, the higher labor supply elasticities of women suggest that they should be taxed at lower rates than men. Boskin and Sheshinski (1983) were possibly the first to establish this insight. They focused on the optimal linear-income taxation of two-earner households with exogenously given differences in labor supply elasticities between men and women.[2] More recently, Alesina et al. (2011) put forward more forcefully the idea of differential taxation of men and women within a model in which gender differences in labor supply elasticities emerge endogenously. Under parametric restrictions, they conclude that married women should be taxed at lower rates than married men.[3]

* Correspondence to: MOVE (Markets, Organizations and Votes in Economics), Campus de Belleterra-UAB Edifici B (s/n), 08193 Cedanyola del Valles, Barcelona, Spain. Tel.: +34 93 581 3068.

E-mail addresses: nezih.guner@movebercelona.eu (N. Guner), rkaygusuz@sabanciuniv.edu (R. Kaygusuz), gustavo.ventura@asu.edu (G. Ventura).

[1] See Blundell and MaCurdy (1999) and Keane (2010) for surveys of estimates. With growing labor force participation of females, the labor supply elasticity of men and women recently became more similar (see Blau and Kahn, 2007; Heim, 2007). There still exist, however, substantial differences.

[2] In an earlier paper, Rosen (1977) hints at the same issue. Apps and Rees (1988) reach a similar conclusion within a model with home production. See Apps and Rees (2010) for an excellent summary and discussion of these results.

[3] Kleven et al. (2009), following Mirlees (1971), study the optimal taxation of couples in a model economy where the planner does not observe the ability of primary earner or the cost of participation for the secondary earner. As a result, the government faces a multidimensional screening problem. They show that if the participation of the secondary earner is a signal of the couple being better off, the secondary earner faces a tax and this tax is declining in the primary earner's earnings.

0304-3932/$ - see front matter © 2011 Published by Elsevier B.V.
doi:10.1016/j.jmoneco.2011.10.004

Although the above results are attractive for their policy implications, work in this area has been almost exclusively theoretical, and a quantitative evaluation of the relative merits of differential taxation by gender is still missing. It is an open question what are the expected, quantitative effects associated to changing the current structure of taxation in this direction. In this paper, we fill this void. We ask: What are the aggregate effects of taxing married females at lower rates? What are the welfare implications of these lower tax rates? To answer these questions, we use a model able to capture a number of key cross-sectional observations for the problems at hand. We build a life-cycle model populated by heterogeneous single and married agents. Individuals differ in terms of their labor endowments, which differ both initially and how they evolve over the life cycle. In particular, the labor market productivities of females are endogenous and depend on their labor market histories: not working is *costly* for females since if they do not work their human capital depreciates. Married households decide if both or only one member should work, in the presence or absence of (costly) children and the structure of the tax system. In this context, changes in the structure of taxation lead to changes in participation rates and aggregate labor supply, and can have large welfare consequences.

We calibrate our model to the U.S. economy under the current tax system, taking into account the observed heterogeneity in skill endowments, marital segregation by skill, labor-force participation rates as well as the presence of children and their cost. As we explain in detail in Guner et al. (in press), the parameterized environment is capable of jointly reproducing a host of labor supply observations. The model is consistent with the wage-gender gap and its evolution over the life cycle, female labor force participation by educational attainment, and the pattern of participation rates by women with and without children as they age. This makes the model environment an ideal vehicle to evaluate the consequences of differential taxation by gender.

Within the model disciplined by data, we then proceed to study the effects of a tax system that imposes different *proportional taxes* on the labor earnings of married females. Following Alesina et al. (2011), we will refer to these as *gender-based* taxes, albeit their particular implementation will be connected to marital status as we explain below. The gender-based taxes that we consider nest as special cases the equal tax rates on men and women. Hence, a virtue of our analysis is that it allows us to separate the effects of differential taxation of married females, from the effects associated to the elimination or reduction of tax progressivity.

We consider two implementations of gender-based taxes. First, we consider replacing the U.S. tax system by proportional tax rates on labor earnings of married females that are lower than for the rest (married males, singles). We refer to this case as the *broad-base* case, as the reduction in tax rates on married females is financed by all other agents. In our second scenario, we first calculate a revenue-neutral proportional tax applied to all agents independent of their gender. We then assign this tax rate to singles, and reduce the tax rates on the labor earnings of married females increasing only the tax rates on married males. We refer to this case as the *narrow-base* case, as only tax rates on married males are used to achieve revenue neutrality.

We find that a shift to proportional tax rates has substantial effects. Replacing the current tax structure by a proportional income tax at a 10.2% rate increases aggregate hours worked by 3.2% and aggregate output by 3.2% across steady states. As marginal tax rates are reduced for majority of households, married females increase their labor market participation by 2.8%. Taking into account changes in labor supply along the extensive as well as the intensive margin, the overall contribution of married females to changes in hours is substantial and amounts to 48.9%.

The effects of proportional taxes outlined above are amplified when married females are taxed at lower rates. If taxes on married females are lowered to 4% (8%) in our narrow-base case, output increases by 4.0% (3.5%) and aggregate hours increase by 4.2% (3.6%) across steady states. These findings are driven by the much stronger responses of married females; they increase their participation by 6.9% (4.2%), and contribute 65.8% (56.1%) to the overall changes in hours. This is all not surprising, as tax rates are reduced on the group that reacts the most to tax changes. Similar results hold under our broad-base case.

To assess welfare effects from our experiments, we compute transitions between steady states under the assumption of a small-open economy. We find that gender-based taxes lead to a welfare improvement to a majority of households alive at the date when the structure of taxes change. Nevertheless, we find that proportional income tax at a uniform rate dominates gender-based taxes in terms of aggregate welfare gains. While a proportional income tax on all delivers aggregate welfare gains of about 1.1% in consumption terms, a differential tax rate of 4% (8%) on married females implies gains of about 0.4% (0.7%). As we explain in Section 7.1, this result is driven by the effects associated to taxing married men at higher rates as in revenue-neutral tax reforms lower taxes on married females have to be financed by higher taxes on married males. While households where married women have a higher initial labor endowment tend to gain from the shift to gender-based taxes, most married households in our model are those where males have *higher* labor productivity. This is due to the observed marital sorting by skill, and initial wage gaps. Hence, the higher tax rates on males that accompany the lower rates on females have a net detrimental consequence on the welfare of most married households, and thus on aggregate welfare. These conclusions hold in a variety of robustness checks.

Our paper is organized as follows. Section 2 presents a simple example that highlights the effects of differential tax rates on females on labor supply and participation decisions. Sections 3 and 4 present the model economy. Sections 3 discusses calibration.[4] In Section 6 we explain in detail the nature of the quantitative experiments that we conduct. Section 7 contains the

[4] The details of the calibration are delegated to an online appendix.

main findings of the paper. Section 8 analyzes the sensitivity of our results via a number of robustness checks. Finally, Section 9 concludes.

1.1. Current U.S. taxes

It is well known that the current U.S. tax system is biased against women's work.[5] As we mentioned earlier, this bias originates from the fact that the U.S. tax system taxes the income of *households*, not the income of individuals. As a result, for a woman who considers entering the labor force, her marginal tax rate depends on her husbands' income. In addition, given the progressivity built in the system, the tax rate on her first dollar of income increases with the household's income (inframarginal income).

In related work (Guner et al., 2011), we examine in detail the relationship between taxes effectively paid by households and their income in a large cross-sectional data from the U.S. Internal Revenue Service for the year 2000. Using this data, we estimate effective average tax rates. In Fig. 1, we present the average tax rates and corresponding marginal rates, for a married couple with two children in the year 2000.[6] To illustrate the bias against women's work, imagine a married couple in which only the husband works and earns about the mean household income in the U.S. (about $58,375 in the 2000 IRS data). The average and marginal tax rates of this household are about 7.9% and 15.5%, respectively. Hence, the marginal tax rate that the household faces is 15.5% for woman's first hour of work. Together with payroll taxes and the additional child care expenses that the family might face, the combined reduction on the additional income that the female generates can be substantial, leading to disincentives for labor market participation. For higher income households, as Fig. 1 indicates, the disincentives can be much stronger. For a household at twice the level of mean income, the marginal tax rate is about 20.8%, whereas for a household at five times mean income, the marginal tax rate amounts to about 27.8%. Fig. 1 also shows average and marginal tax rates for a single household (head of household) with two children. These households face higher taxes than married ones. Still a married female would be less distorted in terms of her labor supply decisions if she was taxed as an individual at the singles' rates. Consider again a female whose husband earns about the mean household income. Suppose her earnings are about 0.6 times her husband's earnings. If she was taxed as an individual facing the tax schedule of singles, her marginal tax rate would be 13%, whereas if she files jointly with her husband her marginal rate would be 19.2%.

Table 1 presents more detailed information about marginal tax rates faced by married households. The table shows marginal tax rates at different levels of household's income, that changes according to different hypothetical earnings for married female (secondary earner). Using our estimates, this is done for when she is about to enter the labor force, at low earnings (one- half mean income), or at higher earnings (mean income).

As we note in Guner et al. (2011), the aforementioned marginal tax rates are lower bounds on the marginal rates faced by married households. This follows from the fact that the marginal tax rates reported are calculated from average tax rates, and taken into account all the *inframarginal* deductions that households have access to. Effective marginal tax rates are good approximations at low levels of income. At high levels of income, reported marginal tax rates are non-trivially higher than effective marginal rates.[7]

More broadly, international evidence suggests that differences in taxation might indeed matter for cross-country differences in female labor force participation. Bick and Fuchs-Schuendeln (2011) provide a detailed account of how household incomes are taxed in different OECD countries (both in terms of the unit of taxation and the tax burden on the secondary earners). They study a model of household labor supply and show that differences in taxes can account for a large part of cross-country differences in married female labor supply. Fig. 2, which is based on their analysis, shows the relation between tax burden on secondary earner and married female labor supply, where the tax burden is measured as the ratio of the tax liabilities of a two-earner household to a one-earner one. It is clear that higher taxes on secondary earners are associated with lower female labor force participation. It is also worth noting that low labor force participation of countries like the U.S., Germany, France and Portugal are countries that tax jointly household income.[8]

2. Taxing married women differently

In this section, we present a simple static, decision-problem example that illustrates how differential taxation of married females affects labor supply decisions in two earner households, at the intensive and extensive margins.

A one-earner household: Consider a married couple. The household decides whether only one or both members should work and if so, how much. Let x and z denote the labor market productivities (wage rates) of males and females,

[5] See McCaffery (1999) for a comprehensive description.

[6] See Section 5 for details.

[7] For instance, the average recorded marginal rate at five times mean income is about 34.0%, more than 6% points above the marginal rate computed from our effective tax function.

[8] The U.S. and Germany are joint taxation countries where the unit of taxation is household and tax liabilities are calculated based on total household income. France and Portugal are family taxation countries, where tax liabilities are calculated roughly by dividing total household income by the number of family members. See Kesselman (2008) for a classification of different countries according to how they tax household income.

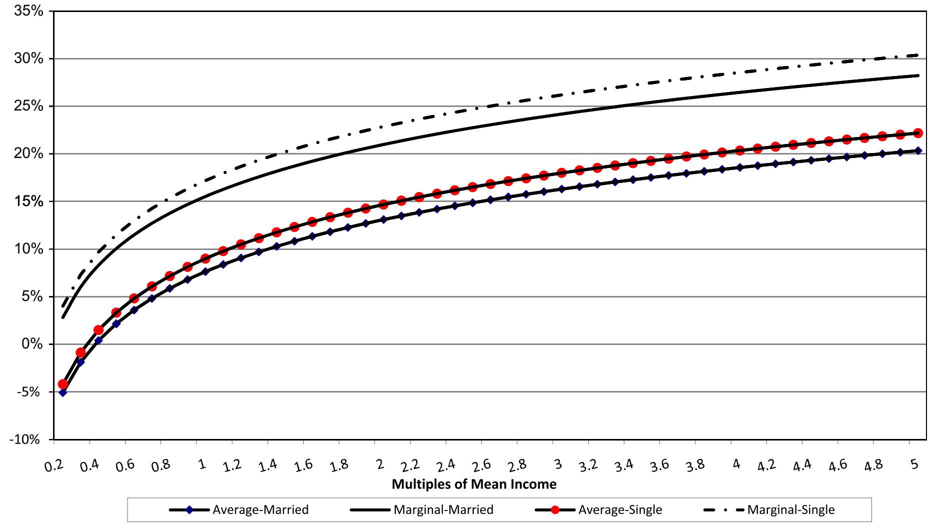

Fig. 1. Average and marginal tax rates, two children. *Note*: The figures shows average and marginal tax rates for married and single households with two children. For singles, filing category *head of household* is used. Figures are based on estimates of effective tax functions—see text for details.

Table 1
Marginal tax rates: married household with two children.

Household income	Wife's earnings (additional income)	Marginal tax rate (%)
Panel A: Initial income = 0.5 × mean income		
0.5 × mean income	0	10.2
Mean income	0.5 × mean income	15.5
2 × mean income	Mean income	20.8
Panel B: Initial income = 3.0 × mean income		
3 × mean income	0	23.9
3.5 × mean income	0.5 × Mean income	25.1
4.5 × mean income	Mean income	27.0

Note: Entries show the marginal tax rates for a married household with two dependent children, at different income levels driven by additional wife's earnings.

respectively. Let τ_H be a proportional tax on the labor income of the male, and let τ_L be a proportional tax on the labor income of the female.

Consider first the problem if only one member (husband) works. The household problem is given by

$$\max_{l_{m,1}} \left\{ 2\left[\underbrace{\log((1-\tau_H) z l_{m,1})}_{=\log(c)} \right] - W(l_{m,1}) \right\},$$

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

Household utility when only one member works is given by

$$V_1(\tau_H) = 2[\log((1-\tau_H) z l^*_{m,1})] - W(l^*_{m,1}),$$

where a '*' denotes an optimal choice.

A two-earner household: When both members work, the household incurs a utility cost q, drawn from a distribution with cumulative distribution function $\zeta(q)$. Then the problem is given by

$$\max_{l_{m,2}, l_{f,2}} \left\{ 2\left[\underbrace{\log((1-\tau_H) z l_{m,2} + (1-\tau_L) x l_{f,2})}_{=\log(c)} \right] - W(l_{m,2}) - W(l_{f,2}) - q \right\},$$

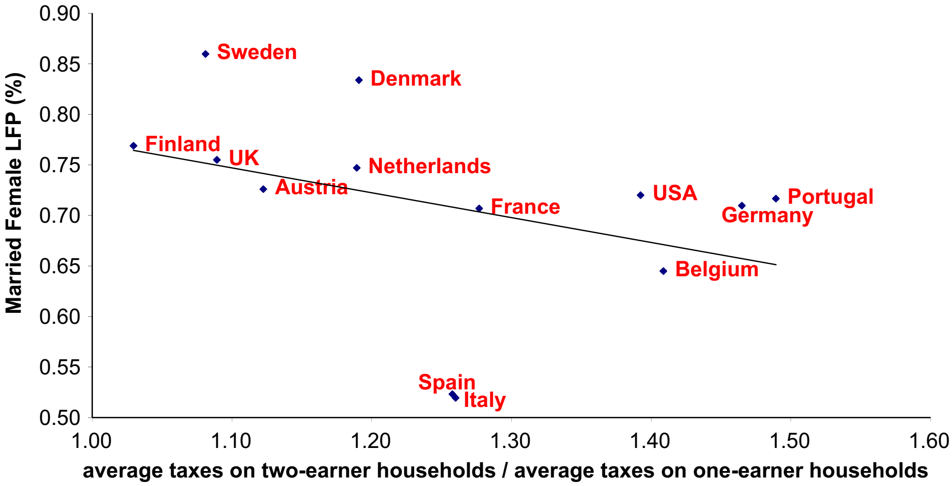

Fig. 2. Taxes on additional workers and married female LFP, 2001–2008 (married females with two children, ages 25–54). *Note*: The figure shows the married female labor force participation for ages 25–54 against tax burden on secondary earners. Tax burden is calculated as the ratio of total tax liabilities for a household with two children in which husband has mean wage income and wife has 67% of mean wage income to the tax liabilities of the same couple when only the husband works. The tax liabilities are defined as all taxes paid by the household plus employee social security contributions less cash benefits relative to the household gross income. The solid line shows a linear trend. Source: Bick and Fuchs-Schuendeln (2011).

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

$$V_2(\tau_H,\tau_L)-q=2[\log((1-\tau_H)zl^*_{m,2}+(1-\tau_L)xl^*_{f,2})]-W(l^*_{m,2})-W(l^*_{f,2})-q.$$

Letting the function $W(\cdot)$ adopt the functional form that we will use later, $\varphi l^{1+1/\gamma}$, it is easy to find that relative labor supplies depend on relative productivities, the relative tax wedge and the Frisch elasticity γ, and is given by

$$\frac{l^*_{f,2}}{l^*_{m,2}}=\left(\frac{x}{z}\right)^{\gamma}\left(\frac{1-\tau_L}{1-\tau_H}\right)^{\gamma}$$

It follows that a higher relative productivity of the female, or a lower relative tax distortion on her, increases her labor supply relative to her partner.

The extensive margin in labor supply: A married household is indifferent between having one and two earners for a sufficiently high value of the utility cost. Hence, there exists a q^* that satisfies $q^*=V_2(\tau_H,\tau_L)-V_1(\tau_H)$. For households with a q higher than the corresponding threshold value, it is optimal to have only one earner, while for those with a q lower than the threshold it is optimal to be a two-earner household.

From the above expressions, it is clear that the thresholds will change as either τ_H or τ_L change. In order to determine how exactly they will change with taxes, we appeal to the envelope theorem. It follows that

$$\frac{\partial q^*}{\partial \tau_L}=\frac{\partial V_2(\tau_H,\tau_L)}{\partial \tau_L}=-2\frac{xl^*_{f,2}}{(1-\tau_H)zl^*_{m,2}+(1-\tau_L)xl^*_{f,2}}<0 \tag{1}$$

and

$$\frac{\partial q^*}{\partial \tau_H}=\frac{\partial V_2(\tau_H,\tau_L)}{\partial \tau_H}-\frac{\partial V_1(\tau_H)}{\partial \tau_H}=-2\frac{zl^*_{m,2}}{(1-\tau_H)zl^*_{m,2}+(1-\tau_L)xl^*_{f,2}}+2\frac{zl^*_{m,1}}{(1-\tau_H)zl^*_{m,1}}>0. \tag{2}$$

Note that (2) holds if $l^*_{m,1}>l^*_{m,2}$ and

$$(1-\tau_H)zl^*_{m,1}<(1-\tau_H)zl^*_{m,2}+(1-\tau_L)xl^*_{f,2}.$$

Both conditions are quite intuitive and satisfied in the current setup.[9] Hence, q^* and as a result, the labor force participation of married females, will be higher when taxes on married females are lower. Similarly, q^* and the labor force

[9] For the first condition, note that income effects from female labor supply imply that males work less when they are in a two-earner household, i.e. $l^*_{m,2}<l^*_{m,1}$. For the second condition, note that since the first-order condition for husband's hours implies that marginal disutility from work has to be equal to the marginal utility from consumption times the after-tax wage rate, household consumption with two earners must be higher than with one earner.

participation of married females, will be higher when taxes on married males are higher. Changes in either tax rates affect the threshold values for the utility cost, and change labor force participation.

Welfare Note that for given labor productivities, we can write welfare as

$$V = \int_0^{q^*} (V_2(\tau_H,\tau_L)-q)\, d\zeta(q) + \int_{q^*} V_1(\tau_H)\, d\zeta(q) = \zeta(q^*)V_2(\tau_H,\tau_L)+(1-\zeta(q^*))V_1(\tau_H) - \int_0^{q^*} q\, d\zeta(q). \tag{3}$$

From this expression, some intuition regarding the welfare changes driven by changes in tax rates follow. First, for fixed participation decisions, an increase in τ_H reduces the welfare of one and two-earners households. Similarly, a reduction in τ_L increases the welfare of two-earner households. Hence, for fixed participation decisions, a reduction in τ_L accompanied by an increase in τ_H to balance the budget *may* increase welfare if τ_H does not have to be increased too much. This would be the case if the labor supply elasticity of married females is high enough, and participation rates are high. With variable participation decisions, there are further reasons for a reduction in τ_L accompanied by an increase in τ_H to increase welfare. This would occur as with an increase in participation, the required increase in τ_H to finance a given reduction in τ_L will be smaller.

Note also that the wage gap between the spouses can play a central role in welfare changes. If z is much higher than x, say, a reduction in τ_L accompanied by an increase in τ_H may reduce welfare: one-earner households will be worse off, and inframarginal two-earner households may be worse off as well.

3. Model

Our model economy follows the model we use in Guner et al. (in press). Consider a stationary overlapping generations economy populated by a continuum of males (m) and a continuum of females (f). We denoted by $j \in \{1,2,\ldots,J\}$ the age of each individual. Individuals differ in terms of their marital status. They are born as either single or married, and their marital status does not change over time. Population grows at rate n.

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

Agents start life as workers and at age J_R, they retire and collect pension benefits until they die at age J. Spouses are assumed to be of the same age, and as a result, experience identical life-cycle dynamics.

Each period, working households (married or single) make labor supply, consumption and savings decisions. If a female with children, married or single, works, then the household has to pay child care costs. Children also imply a fixed time cost for females. Not working for a female is *costly*; if she does not work, she experiences losses of labor efficiency units for next period. On the other hand, if the *female* member of a married household supplies positive amounts of market work, then the two-earner household incurs a utility cost.

3.1. Heterogeneity and demographics

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

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

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

$$h' = G(x,h,l,j) = \exp[\ln h + \alpha_j^x \chi(l) - \delta(1-\chi(l))] \tag{4}$$

all $h \in H$. In this formulation α_j^x represents age and type specific growth factors associated to female labor supply while δ is the depreciation rate associated to non-participation.[10] As we explain in online Appendix B, α_j^x values are calibrated so that if a female of a particular type works every period, her productivity profile grows exactly as a male of the same productivity. As a result, except for a constant gender gap, there are no productivity differences between a female who works every period and a male. Hence, as we elaborate later in detail, a key decision for a married household is whether the female stays at home and thus the household avoids childcare and utility costs, and let her human capital depreciate at rate δ. Given our emphasis on children and how they affect labor supply decisions and the relative importance of women's role in child care, we assume, for simplicity, that males do not face the same trade-off and their productivity levels are given exogenously.

[10] Our formulation of the human capital accumulation process follows Attanasio et al. (2008).

Let $M_j(x,z)$ denote the fraction of marriages between an age-j, type-x female and an age-j type-z male, and let $\omega_j(z)$ and $\phi_j(x)$ be the fraction of single type-z males and the fraction of single type-x females, respectively. For each z and $j \geq 1$, the following accounting identity must hold

$$\Omega_j(z) = \sum_{x \in X} M_j(x,z) + \omega_j(z). \tag{5}$$

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

$$\Phi_j(x) = \sum_{z \in Z} M_j(x,z) + \phi_j(x). \tag{6}$$

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

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

3.2. Children

Children are assigned exogenously to married couples and single females at the start of life, depending on the intrinsic type of parents. Each married couple and single female can be of three types: *early* child bearers, *late* child bearers, and those *without* any children. Early and late child bearers have *two* children for three periods. Early child bearers have these children in ages $j = 1,2,3$ while late child bearers have children attached to them in ages $j = 2,3,4$.

We assume that if a female with children (married or single) works, then the household has to pay for child care costs. Child care costs depend on the age of the child (s). For a household with children of age $s \in \{1,2,3\}$, the household needs to purchase $d(s)$ units of (child care) labor services for their two children. Since the competitive price of child care services is the wage rate w, the total cost of child care services for two children equals $wd(s)$. Each young, $s = 1$, child also implies a time cost for the mother, whether she is working or not.

3.3. Preferences and technology

The momentary utility function for a single female is given by

$$U_f^S(c,l,k_y) = \log(c) - \varphi(l + k_y \varkappa)^{1+1/\gamma},$$

where c is consumption, l is time devoted to market work, φ is a parameter controlling the disutility of work, $\varkappa$ is fixed time cost having two age-1 (young) children for a female, and γ is the intertemporal elasticity of labor supply. Here $k_y \in \{0,1\}$ stands for the absence or presence of age-1 (young) children in the household. Since a single male does not have any children, his utility function is simply given by

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

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

$$U_f^M(c,l_f,q,k_y) = \log(c) - \varphi(l_f + k_y \varkappa)^{1+1/\gamma} - \tfrac{1}{2}\chi\{l_f\}q,$$

while the one for a married male reads as

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

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

At the start of their lives married households draw a $q \in Q$, where $Q \subset R_{++}$ is a finite set. For a given household, the initial draw of a utility cost depends on the intrinsic type of the husband. Let $\zeta(q|z)$ denote the probability that the cost of joint work is q, with $\sum_{q \in Q} \zeta(q|z) = 1$. This cost captures the *residual* heterogeneity in labor force participation and allows us to match married female labor force participation (which is critical for the question at hand). The basic idea is that households differ in how well they coordinate multiple household activities if both members are working, or they simply have differences in their taste for children or home production.[11]

There is an aggregate firm that operates a constant return to scale technology. The firm rents capital and labor services from households at the rate R and w, respectively. Using K units of capital and L_g units of labor, firms produce

[11] The idea of using such a utility cost to generate movements in the extensive margin goes back to Cho and Rogerson (1988).

$F(K,L_g)=K^{\alpha}L_g^{1-\alpha}$ units of consumption (investment) goods. We assume that capital depreciates at rate δ_k. Households save in the form of a risk-free asset that pays the competitive rate of return $r=R-\delta_k$.

3.4. Incomes, taxation and social security

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

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

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

There is also a (flat) payroll tax that taxes individual labor incomes, represented by τ_p, to fund social security transfers. Besides the income and payroll taxes, each household pays an additional flat capital income tax for the returns from his/her asset holdings, denoted by τ_k.

4. Decisions and equilibrium

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

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

$$V_m^S(a,z,j)=\max_{a',l}\{U_m^S(c,l)+\beta V_m^S(a',z,j+1)\} \tag{7}$$

subject to

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

and

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

The problem of a single female household: A single female's decisions also depends on her current human capital h and her child bearing status b. Hence, given her current state, (a,x,h,b,j), the problem of a single female is

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

subject to

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

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

Furthermore, if $b=j$, then $k_y=1$.

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

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

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

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

In addition,

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

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

Note how the cost of children depends on the age of children. If $b=1$, the household has children at ages 1, 2 and 3, then $wd(j+1-b)$ denote cost for ages 1, 2 and 3 with $j=\{1,2,3\}$. If $b=2$, the household has children at ages 2, 3 and 4, then $wd(j+1-b)$ denotes the cost for children of ages 1, 2 and 3 with $j=\{2,3,4\}$. A female only incurs the time cost of children if her kids are 1 year old, and this happens if $b=j=1$ or $b=j=2$.

The problem of married households: Married couples decide how much to consume, how much to save, how much to work, and whether the female member of the household should work. Their problem is given by

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

subject to

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

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

Furthermore, if $b=j$, then $k_y=1$.

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

$$c+a' = a(1+r(1-\tau_k))+w(\varpi_m(z,j)l_m+hl_f)(1-\tau_p)-T^M(w\varpi_m(z,j)l_m+whl_f+ra,0).$$

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

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

In addition,

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

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

4.1. Stationary equilibrium

The aggregate state of this economy consists of distribution of households over their types, asset and human capital levels. Let $\psi_j^M(a,h,x,z,q,b)$ be the number (measure) of age j married households with assets a, female human capital h, when the female is of type x, the male is of type z, the household faces a utility cost q of joint work, and is of child bearing type b. Define $\psi_{f,j}^S(a,h,x,b)$ and $\psi_{m,j}^S(a,z)$ in a similar fashion. Variables x,z, b and q take values from finite sets. Household assets, a, and female human capital levels, h, are continuous decisions. Let sets $A=[0,\overline{a}]$ and $H=[0,\overline{h}]$ be the possible assets and female human capital levels.

The number of married households of type (x,z), $M(x,z)$, satisfies for $j \geq 1$

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

Similarly, the fraction of single females and males is consistent with the corresponding measures $\psi_{f,j}^S$ and $\psi_{m,j}^S$, i.e. for $j \geq 1$

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

and

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

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

$$K = \sum_j \mu_j \left[\sum_{x,z,q,b}\int_H\int_A a\psi_j^M(a,h,x,z,q,b)\, dh\, da + \sum_z \int_A a\psi_{m,j}^S(a,z)\, da + \sum_{x,b}\int_H\int_A a\psi_{f,j}^S(a,h,x,b)\, dh\, da\right] \tag{8}$$

and

$$L=\sum_j \mu_j \left[\sum_{x,z,q,b}\int_H\int_A (hl_f^M(a,h,x,z,q,b,j)+\varpi_m(z,j)l_m^M(a,h,x,z,q,b,j))\psi_j^M(a,h,x,z,q,b)\,dh\,da \right.$$
$$\left. +\sum_z\int_A \varpi_m(z,j)l_m^S(a,z,j)\psi_m^S(a,z)\,da+\sum_{x,b}\int_H\int_A hl_f^S(a,h,x,b,j)\psi_{f,j}^S(a,x,b)\,dh\,da\right]. \quad (9)$$

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

$$L_g=L-\left[\sum_{x,z,q}\sum_{b=1,2}\sum_{j=b,b+2}\mu_j\int_H\int_A \chi\{l_f^M\}\,d(j+1-b)\psi_j^M(a,h,x,z,q,b)\,dh\,da+\sum_x\sum_{b=1,2}\sum_{j=b,b+2}\mu_j\int_H\int_A \chi\{l_f^S\}\,d(j+1-b)\psi_{f,j}^S(a,h,x,b)\,dh\,da\right], \quad (10)$$

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

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

5. Parameter values

To assign parameter values, we use aggregate and cross-sectional data from different sources. The model period is 5 years. Except for the choice of income tax functions (see below), details regarding the choice of parameters are contained in online Appendix B.

To construct income tax functions for married and single individuals, we use our estimates contained in Guner et al. (2011) of *effective tax rates* as a function of reported income, marital status and children. The underlying data is tax-return, micro-data from Internal Revenue Service for the year 2000 (Statistics of Income Public Use Tax File). For married households, the estimated tax functions correspond to the legal category *married filing jointly*. For singles without children, tax functions correspond to the legal category of *single* households; for singles with children, tax functions correspond to the legal category *head of household*.[12] To estimate the tax functions for a household with children, married or not, the sample is restricted to households in which there are two dependent children for tax purposes.

In Guner et al. (2011) we posit

$$t(\tilde{y})=\eta_1+\eta_2\log(\tilde{y}),$$

where t is the average tax rate, and the variable $\tilde{y}$ stands for multiples of mean household income in the data. That is, a value of $\tilde{y}$ equal to 2.0 implies an average tax rate corresponding to an actual level of income that is twice the magnitude of mean household income in the data. Given these estimates, we impose these tax functions in our model using the model counterpart of $\tilde{y}$ and mean income. That is, total tax liabilities amount to $t(\tilde{y})\times\tilde{y}\times$ *mean household income*.

Estimates for η_1 and η_2 are contained in Table 2 for different tax functions we use in our quantitative analysis. Fig. 1 displays estimated average and marginal tax rates for different multiples of household income for married and single households with two children. Our estimates imply that a married household at around mean income faces an average tax rate of about 7.9% and marginal tax rate of 15.5%. As a comparison, a single household at the half of mean income faces average and marginal tax rates that are 3.3% and 11.5%, respectively. At twice the mean income level, the average and marginal rates for a married household amount to 13.2% and 20.8%, respectively, while a single household at the mean income level has an average tax rate of 9% and a marginal tax rate of 17.2%.

Table 3 summarizes our parameter choices. Table 4 shows the performance of the benchmark model in terms of the targets we impose. The table also shows how well the benchmark calibration reproduces the labor force participation of married females. The model has no problem in reproducing jointly these observations as the table demonstrates.

6. The quantitative experiments

We study the effects of moving from the current U.S. tax system to a tax system where different proportional tax rates on labor earnings coexist, τ_L an τ_H. All households pay a common additional proportional tax rate on capital income, τ_k^*. In all cases considered, the experiments are revenue neutral. The social security system remains intact so each worker still pay the same proportional payroll tax τ_p as in the benchmark economy.

We first implement a revenue-neutral proportional income tax reform and compute the common proportional income tax τ such that $\tau_L=\tau_H=\tau$. Once the common proportional income tax rate τ is calculated, we set $\tau_L<\tau$ and find $\tau_H>\tau$ that achieves revenue neutrality. Naturally, our formulation incorporates a trade off: if lower tax rates τ_L are chosen, a higher tax rate τ_H becomes necessary to achieve budget balance. We consider two cases of differential taxation of married females, depending on

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

Table 2
Tax function estimates.

Estimates	Married (no children)	Married (two children)	Single (no children)	Single (two children)
η_1	0.1028	0.0789	0.1392	0.090
η_2	0.0582	0.0763	0.0481	0.0819
St. errors				
η_1	0.0002	0.0003	0.0003	0.0011
η_2	0.0002	0.0003	0.0003	0.0020

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

Table 3
Parameter values.

Parameter	Value	Comments
Population growth rate (n)	1.1	U.S. data—see online Appendix B
Discount factor (β)	0.972	Calibrated—matches K/Y
Intertemporal elasticity (labor supply) (γ)	0.4	Literature estimates
Disutility of market work (φ)	8.03	Calibrated—matches hours per worker
Time cost of children ($\varkappa$)	0.132	Calibrated—matches LFP of married females with young children
Child care costs for young children (d_1)	0.064	Calibrated—matches child care expenditure for young (0–4) children
Child care costs for young children (d_2)	0.049	Calibrated—matches child care expenditure for old (5–14) children
Dep. of human capital, females (δ)	0.02	Literature estimates—see online Appendix B
Growth of human capital, females (α_j^x)	–	Calibrated—see online Appendix B
Capital share (α)	0.343	Calibrated—see online Appendix B
Depreciation rate (δ_k)	0.055	Calibrated—see online Appendix B
Payroll tax rate (τ_p)	0.086	U.S. data—see online Appendix B
Social security income ($p_m^S(z_1)$) (lowest type single male, as a % of average household income)	18.1%	Calibrated—balances social security budget
Capital income tax rate (τ_k)	0.097	Calibrated—matches corporate tax collections
Distribution of utility costs $\zeta(.\|z)$ (gamma distribution)	–	Calibrated—matches LFP by education conditional on husband's type

Note: Entries show parameter values together with a brief explanation on how they are selected—see online Appendix B for details.

Table 4
Model and data.

Statistic	Data	Model
Capital output ratio	2.93	2.92
Labor hours per-worker	0.40	0.40
Labor force participation of married females with young children (%)	62.6	62.1
Participation rate of married females (%), 25–54		
Less than high school	61.8	61.7
Some college	74.0	73.5
College	74.9	75.0
More than college	81.9	80.8
Total	72.2	71.9
With children	68.3	67.1
Without children	85.9	81.4

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

the tax base used to balance the budget. Let E_m and E_f be the labor income of males and females, respectively. In our *narrow-base* case, under differential tax rates for married females, we assume that the after-tax labor income of a single male is simply $E_m(1-\tau)$, while for single females it is given by $E_f(1-\tau)$. For married males and females, respectively, the after-tax labor income is given by $E_m(1-\tau_H)$ and $E_f(1-\tau_L)$. Hence, the narrow case taxes married females at a lower rate and achieves revenue-neutrality by applying higher taxes *only* on married males. The narrow-base case follows the proposal of Alesina et al. (2011) and highlights the basic trade-off associated to lowering taxing on married women and increasing taxes on married men.

In our *broad-base* case, married females face τ_L and everyone else (married or single) face τ_H. Hence, the after-tax labor income of a single male is simply $E_m(1-\tau_H)$, while for single females it is given by $E_f(1-\tau_H)$. For married males and females, respectively, the after-tax labor income is given by $E_m(1-\tau_H)$ and $E_f(1-\tau_L)$. Since lower taxes on married females are financed by a larger tax base, τ_H that achieved revenue neutrality will be lower in the broad-base case, and this might matter for the aggregate effects of gender based taxes.

In both cases, the capital income tax rate equals $\tau_k^* = \tau_k + \tau$. That is, capital income of all households is taxed at the rate original rate τ_k plus the marginal rate τ from proportional taxation. It follows that when we make τ_L and τ_H different from each other, the tax rates on capital are *unchanged*. Therefore, our results capture the consequences of taxing different people differently in terms of their labor earnings, without changes in the tax rate on capital income.

All our experiments are conducted under the assumption of a small-open economy: the rate of return to capital and the wage rate are unchanged across steady states. To achieve revenue neutrality, we balance the budget period by period via adjusting τ for the proportional income tax experiment, or τ_H for gender-based taxation experiments.

7. Findings

We report first in this section steady-state comparisons of economies in relation to the benchmark. As the effects on aggregate outcomes (such as female labor force participation, aggregate hours and output) change monotonically with lower taxes on females, we only report results for two values of τ_L. Table 5 shows key aggregate findings for the case of a proportional income tax ($\tau = \tau_H = \tau_L$), and for two levels of tax rates for females ($\tau_L = 8\%$) and ($\tau_L = 4\%$), under broad and narrow tax-base cases.

We start by discussing the results from a shift to a proportional income tax. In this case, by construction, marginal and average tax rates on capital and labor income become equal for all households, eliminating in this way the non-linearities of the current system discussed earlier. In the new steady state, the uniform tax rate that balances the budget equals 10.2%. As Table 5 demonstrates, the introduction of a proportional income tax leads to substantial effects on output and factor inputs. Total labor supply (hours adjusted by efficiency units) increases by 3.0%. Aggregate capital increases by 3.6%. As a result of these changes, aggregate output increases substantially by about 3.2% across steady states.

Table 5 also shows more disaggregated responses in labor supply to a proportional tax, that take place at the intensive margin for both males and females, as well as at the *extensive* margin for married females. Recall that in the benchmark economy, the tax structure generates non-trivial disincentives to savings and work since average and marginal tax rates increase with incomes. In addition, married females who decide to enter the labor force are taxed at their partner's current marginal tax rate. With the elimination of these disincentives, the changes in hours worked by married females are much larger than the aggregate change in hours. The introduction of a flat-rate income tax implies that the labor force participation of married females increases by about 2.8%, while hours per-worker rise by about 2.9% for females, and about 2.6% for males. Taking stock of intensive and the extensive margins, total hours for married females increases by about 5.8%.

Differential taxation of married females amplifies the effects discussed above. As τ_L becomes lower than τ_H, married households find optimal to shift hours worked from males to females and thus, participation rates increase. The level of τ_H that achieves revenue neutrality ranges from 10.95% (for $\tau_L = 8\%$ with broad tax base) to 13.45% (for $\tau_L = 4\%$ with narrow tax base). The change in labor force participation sharply increases as τ_L is reduced: this change goes from 2.8% under a proportional tax to about 6.5% and 6.9% under a tax rate on married females of 4%. These effects are reflected in the

Table 5
Aggregate effects (%).

	Proportional income, $\tau_L = \tau_H$	Broad tax base		Narrow tax base	
		$\tau_L = 0.08$	$\tau_L = 0.04$	$\tau_L = 0.08$	$\tau_L = 0.04$
Married female LFP	2.8	4.1	6.5	4.2	6.9
Aggregate hours	3.2	3.6	4.1	3.6	4.2
Aggregate hours (married female)	5.8	7.2	9.8	7.4	10.2
Hours per worker (female)	2.9	3.2	3.2	2.9	2.9
Hours per worker (male)	2.6	2.6	2.4	2.6	2.4
Aggregate labor	3.0	3.4	3.8	3.4	3.9
Aggregate output	3.2	3.5	4.0	3.6	4.0
Tax rate (τ_H)	10.20	10.95	12.10	11.50	13.45
Δ in married female hours (% of total Δ in hours)	48.9	54.6	64.8	56.1	65.8
Δ in married female labor (% of total Δ in labor)	48.2	54.0	64.4	55.8	65.5

Note: Entries show effects across steady states on selected variables, as well as the contribution of married females to changes in hours (labor), driven by the changes in the tax system. The values for "Tax Rate" correspond to τ_H values that are necessary to achieve budget balance. See text for details.

resulting increases in output; while output increases by about 3.2% under a proportional income tax, the increases are *larger* as the tax rate on married females is reduced.

Two aspects of the findings so far are worth mentioning here. First, as Table 5 shows, the aggregate effects of gender-based taxes are largely independent of the tax base under consideration. The effects on participation rates and labor supply are slightly higher under the narrow-tax base, as the gap between tax rates on married females and married males is larger there, but the differences between the cases are rather small. Hence, for the effects on aggregates, whether taxes to balance the budget are raised on married males or everyone else is of second-order importance. Second, the bulk of aggregate gains in output and labor supply emerge under a proportional tax. Gender-based taxes add relatively little to output and aggregate labor supply: a simple proportional tax accounts for about 80% (77%) of the output (labor) gains under $\tau_L = 4\%$ (with the narrow tax base).

The importance of married females: How large is the contribution of married females to changes in hours and labor supply? The bottom panel of Table 5 sheds light on this question. We calculate the fraction of total hours and labor changes, accounted for by the responses of married females. About 48.9% (48.2%) of the total changes in hours (labor) are accounted for the responses of married females under a simple proportional tax. With $\tau_L = 8\%$, this fraction raises to 56.1% (55.8%), whereas for $\tau_L = 4\%$ it becomes 65.8% (65.5%). These results are striking, and lead to the conclusion that the majority of gains in hours worked upon tax changes are connected to the behavior of married females. Furthermore, as tax rates on married females are reduced, they account for a larger share of the changes associated to tax changes.

Who changes participation? We concentrate now on the identity of married females who change their behavior along the extensive margin, and the consequent effects on their human capital. Table 6 shows the participation changes for different skill levels and childbearing status, for the case of the proportional tax and narrow-tax base under $\tau_L = 8\%$ and $\tau_L = 4\%$.

The results clearly indicate that less-skilled married females and those with children respond more to the tax changes. Note, for instance, that at the lowest value for the tax rate on married females, 4%, married females with a high school degree or less increase their participation by about 11%. Meanwhile, married females with a college degree or more, increase participation by much less, 4.2%. Given this behavior, it should be expected that females with children would react more than those without children to tax changes: lower types are more likely to have children as well as to have them early. In addition, as we elaborated in Guner et al. (in press), income effects lead females with children to react more strongly to tax changes.

Multiple factors account for the asymmetry in participation responses by skill. First, notice that the labor force participation of high-type married females is quite large in the benchmark economy to begin with, leaving relatively little room to react to tax changes. Second, marginal tax rates on women drop even for low types, and drop drastically with the lower values of τ_L. Recall that in the benchmark economy, the marginal tax rate on a household with an income equal to one-half average income is about 10.2% while the marginal rate amounts to about 15.5% for those with a mean income level. The corresponding marginal rates are now 10.2%, 8% and 4%, and in the case of gender-based taxes, their effect is compounded by the correspondingly higher marginal rates on married males. Finally, since our benchmark is forced to account for the participation patterns in our parameterization, the shape of the distributions (cdf) of utility costs differ non-trivially according to husband's type. This leads to a typically larger slope in the cdf for married households with less-skilled females. It follows that change in participation decisions rules result in larger effects for the group of less-skilled females than for high-skilled ones.

7.1. Welfare analysis

We now discuss the welfare implications of the tax changes discussed so far. Given our findings on the similarities between the broad-base scenario and the narrow-base one, we focus our attention on the latter in conjunction with the case of a proportional income tax. We compute transitions between steady states and report multiple welfare findings for individuals

Table 6
Effects on labor force participation and human capital (%), narrow base case.

	Labor force participation			Human capital		
	$\tau_L = \tau_H$	$\tau_L = 0.08$	$\tau_L = 0.04$	$\tau_L = \tau_H$	$\tau_L = 0.08$	$\tau_L = 0.04$
Education						
High school	4.1	6.5	11.0	1.3	2.3	3.7
Some college	2.9	4.2	6.8	1.3	2.0	3.1
College	1.9	3.2	5.1	0.9	1.4	2.1
More than college	2.2	3.1	4.2	1.3	1.9	2.4
Child bearing status						
Childless	1.3	2.2	3.8	0.6	1.0	1.5
Early child bearer	4.1	5.9	9.5	1.9	2.7	4.0
Late child bearer	1.7	3.0	4.9	0.7	1.3	1.9

Note: Entries show effects across steady states on labor force participation and lifetime human capital driven by a tax changes. Gender-based taxes correspond to the narrow-base case.

Table 7
Welfare effects.

Age group	Proportional income, $\tau_H = \tau_L$	Narrow base, $\tau_L = 0.08$	Narrow base, $\tau_L = 0.04$
25–29	−0.4	−1.2	−1.9
30–34	0.5	−0.2	−0.7
35–39	1.5	0.9	0.6
40–44	2.4	1.9	1.6
45–49	2.6	2.2	2.1
50–54	2.3	2.1	2.0
55–59	1.8	1.7	1.7
All	1.1	0.7	0.4
Winners	57.0	57.1	57.3
Newborns (25–29) (steady state)	0.2	−0.3	−0.8

Note: Entries show the consumption compensation for households alive at the start of the transition and the fraction experiencing welfare gains driven by tax changes. The last row shows the consumption compensations for households born at the steady state. Gender-based taxes correspond to the narrow-base case.

alive at the date when the tax system is changed. To achieve budget neutrality, we find in each period either the proportional tax rate τ or the tax rate τ_H, that generate the same amount of tax collections as in the benchmark economy.

In order to quantify gains/losses relative to the benchmark economy, we compute the common, percentage change in consumption in the benchmark economy, that keeps households indifferent between the benchmark steady state and transition path driven by the alternative regime. We do this for all households, as well as for different groups of them, and discuss how their welfare is impacted upon tax changes.

Table 7 reports the consumption compensation for different age groups, the common compensation for all households alive at the start of the change in the tax regime, and the fraction of households who experience a welfare gain. Table 7 shows that about 57% of households benefit from the shift to proportional income taxation. The table also reveals that the aggregate welfare gain is substantial, which amounts to about 1.1% increase in consumption. It is important to note here that welfare gains display an inverted U-shape as a function of age; younger households lose from the shift to a proportional income tax whereas middle-age households gain, and gain substantially. The old households also gain but their gains are lower than those of middle-aged households. This reflects the fact that young and old households, who have lower incomes than middle-aged ones, pay relatively lower taxes under the current (progressive) U.S. tax system than under a proportional income tax.

As the tax rate on married females is reduced from the proportional tax level, the aggregate fraction of winners remains relatively constant. Moving from the current U.S. tax system to gender-based taxes generate aggregate welfare gains; they amount to 0.7% under a tax rate on married females of 8%, and about 0.4% under a tax rate of 4%.[13] As it was the case with proportional taxes, welfare gains display an inverted U-shape since younger households are negatively affected as a group whereas middle-age ones gain.

A central implication from these findings is that, even when there are non-trivial gains in taxing married women at proportionally lower rates than married males, the gains associated to moving to a simple proportional income tax are *larger*. This also holds in experiments (not reported) for the broad-base case. Since in the narrow-base case, tax rates on singles are not affected by the comparison (recall that by design these tax rates are fixed at the proportional tax levels), the findings suggest that there are effects on married households that operate differently as we move in the direction of gender-based taxes. We focus on these effects below.

Married households: Gender-based taxes, with a narrow tax base, effectively reduce taxes on married females and increase taxes on married males. As a result, the aggregate welfare gains and losses that we report in Table 7 mainly reflect gains and losses for married households. In order to highlight the welfare effects on them, we present results in Table 8 for different types of married households born at the date when the tax changes are implemented, organized by the skills of each of the spouses and their childbearing status. In each cell the first entry show the results for the case of a proportional income tax, while the numbers in parenthesis are for $\tau_L = 4\%$.

For the proportional income tax case, the results reveal large differences in welfare gains and losses. Households with spouses with high labor productivity gain, whereas those with relatively low initial productivity lose. The differences in welfare changes between types can be substantial; whereas childless couples in which both members have post-college education gain about 5.4%, their counterparts with high school education or less lose by about 1.7%. The presence of children does not affect this conclusion at the qualitative level, but clearly affects the magnitude of resulting welfare gains/losses. As households with children are less likely to be two-earner households, they are less likely to benefit from lower taxes on females and more likely to suffer from the higher taxes on males. As a result, the presence of children mitigate

[13] Under $\tau_L = 8\%$, the tax rate on married males amounts to 13.8% in the first period of the transition, declining monotonically to about 11.6% after 10 model periods. Under $\tau_L = 4\%$, the tax rate on married males is about 15.9% in the first period, declining to about 13.5% after 10 model periods.

Table 8
Welfare effects: newborn married households (%). Proportional income tax and gender-based taxes (in parenthesis).

Male	High school	Some college	College	College +
Panel A: No children female				
High school	−1.7 (−3.1)	−1.1 (−1.9)	−0.4 (−0.2)	1.0 (2.4)
Some college	−0.2 (−2.3)	0.1 (−1.4)	0.7 (0.1)	2.2 (2.4)
College	2.4 (−1.0)	2.7 (−0.3)	3.0 (0.6)	4.0 (2.7)
College +	4.2 (0.0)	4.3 (0.4)	4.7 (1.2)	5.4 (3.0)
Panel B: Children early female				
High school	−4.6 (−6.9)	−4.3 (−5.9)	−3.4 (−3.9)	−1.4 (−0.4)
Some college	−2.6 (−5.3)	−2.3 (−4.4)	−1.6 (−3.0)	−0.4 (−0.3)
College	0.2 (−3.8)	0.7 (−2.8)	1.1 (−1.9)	2.0 (0.3)
College +	2.6 (−2.1)	2.7 (−1.7)	3.0 (−1.1)	3.6 (0.6)
Panel C: Children late female				
High school	−2.8 (−4.9)	−2.6 (−4.1)	−2.2 (−2.7)	−0.8 (1.1)
Some college	−1.3 (−4.0)	−1.2 (−3.2)	−0.8 (−2.0)	0.4 (1.0)
College	1.5 (−2.2)	1.5 (−1.8)	1.9 (−0.9)	2.8 (1.3)
College +	3.7 (−0.8)	3.7 (−0.8)	3.9 (0.2)	4.5 (1.6)

Note: Entries show the consumption compensation for newborn married households at the start of the transition driven by a tax change, according to the type of the spouses and childbearing status. In each cell, the first number is for a uniform proportional tax. The results for gender-based system, under a narrow base, with $\tau_L = 4\%$ are shown in parenthesis.

welfare gains and enhance welfare losses. Not surprisingly, households with children early in their life cycle tend to have lower gains and larger losses relative to households where children appear late.

How will different types of married households be affected by a shift from a gender-neutral proportional tax to gender-based taxes? Intuitively, there are three different types of married households to consider. First, there are households where even at lower rates, wives do not participate in the labor market. Second, there are households where both members work before and after a move to gender-based taxes. In these households, whether they gain or not relative to a gender-neutral proportional tax depends mainly on the wage-gender gap between the spouses. If the husband is earning substantially more than the wife, they stand to lose from a move to differential taxation, as the household has to pay higher taxes in exchange. On the other hand, if the wife has higher wages than the husband, the household will gain. Finally, there is the third group where female will enter the labor force after a move to gender-based taxes. How would these three groups fare under a such a policy shift? The first group (non-working wives) will be better off with gender-neutral proportional income taxes as this will imply lower taxes on husbands. The second (working wives) group is also likely to prefer gender-neutral taxes as for *most* of these households, females face lower wages than males. Finally, it is an open question if the third group (wives who start working), will prefer gender-neutral or gender-based taxes. This will depend on changes in the tax liability of females versus males associated with the shift to gender-based taxes.

Consider now the results for gender-based taxes. To fix ideas, consider first those households in which both spouses have the same types (along the diagonal). For these cases, welfare gains (losses) are uniformly *lower (higher)* under $\tau_L = 4\%$ relative to the case of the proportional income tax.[14] In particular, among households with low-type husbands and wives, gender-based taxation generates large welfare losses as these households consist mainly of working husband and non-working wives and they are clearly hurt by higher taxes on husbands. As we start moving in the direction of higher labor endowments for females or lower labor endowments for males, welfare losses are reduced and welfare gains start emerging or increase relative to the proportional income tax case. Indeed, independent of their child bearing status, only for households in which the wife has more than college education and the husband has some college education or less, the welfare numbers are better under $\tau_L = 4\%$ than under proportional taxes. As we argued above, these households gain more in relation to a uniform proportional tax as taxes on the relatively more productive spouse are reduced, while in all other cases the opposite is true. Altogether, it follows that a crucial reason for the lower welfare gains under gender-based taxes is the wage differences between spouses. For households in which spouses have the same type (about half of married households in our economy), there is an initial wage-gender gap that continues over the life cycle. For households in which females are lower types than males, wage differences are further amplified by differences in skills. As a result, for majority of households in our economy, husbands have higher wages than their wives. Therefore, the higher tax rates on males have a large impact on welfare that dominates the effects resulting from lower tax rates on females.

Summing up, the message of our results is clear. Differential taxation of married males and females at proportional rates improves welfare in aggregate terms relative to the benchmark economy, and a majority of households are better off. Nevertheless, due to sorting and the presence of wage-gender gaps, the resulting gains are smaller than those emerging under a proportional income tax.

[14] We obtain similar results with $\tau_L = 8\%$.

Table 9
Robustness (%).

	Child care		High elasticity		Alternative scenario
	Prop. income, $\tau_H = \tau_L$	Gender based, $\tau_L = 0.05$	Prop. income, $\tau_H = \tau_L$	Gender based, $\tau_L = 0.04$	
LFP	9.3	12.4	2.1	5.6	6.9
Agg. hours	3.9	4.7	4.7	5.3	4.2
Agg. hours (MF)	11.3	14.6	7.6	11.9	10.2
Hour per worker-f	1.9	1.9	5.4	5.7	2.9
Hours per worker-m	1.2	1.2	4.8	4.4	2.4
Output	3.9	4.3	3.7	4.1	4.0
Tax rate (τ_H)	11.6	14.8	9.8	12.4	13.5
Welfare					
All	0.1	−0.3	1.7	1.5	−0.5
Newborns (25–29)	−0.2	−1.3	0.5	−0.2	−1.1
% winners	38.3	46.2	75.0	81.8	72.9
Newborns (25–29) (steady state)	0.7	0.0	1.4	0.8	−1.0

Note: Entries display the steady-state and welfare consequences on key variables of three experiments, under a narrow tax base. "Tax Rate" indicates the rate under proportional taxes, or τ_H under gender-based taxes. The panel "Child Care" shows the effects of providing transfers to married households with children to fully cover childcare costs. The panel "High Elasticity" shows the effects under a Frisch elasticity equal to 1.0. The last panel shows the effects when gender-based taxes are introduced into a steady-state with proportional taxes.

8. Robustness

We now investigate the extent to which our findings regarding gender-based taxes are sensitive to particular features of the environment. We consider three experiments, under a narrow tax base, with a summary of quantitative findings in Table 9. In the first case, we consider the effects of a transfer system where the government fully subsidizes childcare costs. In the second case, we conduct the benchmark experiments under a higher intertemporal elasticity ($\gamma = 1$). In the third set of experiments, we change the nature of the reform experiments: we evaluate the introduction of gender-based taxes departing from a steady state with proportional, gender-neutral tax rates.

Child care transfers: Given the progressive nature of taxes in the benchmark economy, their replacement by proportional taxes leads to welfare losses for poorer households. These losses are magnified for poorer households with children, as Table 8 demonstrates. To assess whether these distributional effects matter for the evaluation of gender-based taxes, we introduce a transfer system along with the tax reforms, where the government fully covers pecuniary child care costs whenever present. We do this under a proportional tax and a gender-based tax.

The following features of the results are worth noting. First, the child care transfer increases the importance of the extensive margin, and leads to larger responses in participation rates. Table 9 indicates that under proportional taxes *and* child care transfers, female labor force participation increases by 9.3% across steady states, which is more than three times the corresponding increase in the previous experiments. These effects are naturally magnified under gender-based taxes, with an increase of about 12.4%. Hence, child care subsidies as a form of implicit subsidies to work by married women can have substantial consequences.

Second, in terms of welfare, the results still indicate that gender-based taxes are dominated by a proportional tax. At the onset of transition, the magnitude of welfare gains under child care transfers is substantially lower than in the original set of experiments. This reflects the fact that taxes at $t = t_0$ are higher for childless, middle age and older households who receive *no* benefits from the transfer policy. In contrast, newborn households are much better off in the new steady states with a proportional or gender-bases taxes when the transfer is present than in the new steady states without transfers.

Higher intertemporal elasticity: To what extent our findings depend on the assumption of a relatively low value for the intertemporal elasticity of labor supply? To answer this question, we calibrate our economy again under the higher value of $\gamma = 1$, and report results for the set of experiments conducted earlier.

As Table 9 shows, there are much larger effects on labor supply across steady states under $\gamma = 1$ than in the benchmark value of this parameter. These effects, however, mostly emerge from the responses along the intensive margin. This is expected, as a large elasticity naturally leads to larger changes in hours worked among those who work. And since *both* men and women respond strongly, the consequences of replacing progressive taxes on output are much larger than under the benchmark elasticity value.

In terms of welfare gains, welfare gains measured at the start of the transition are, not surprisingly, larger than with the lower elasticity value. Nevertheless, the qualitative nature of our earlier results remains: albeit gender-based taxes can lead to large welfare gains, they deliver lower welfare gains than a simple proportional tax.[15]

[15] It is important to note, however, that the welfare effects of a proportional tax and gender-based taxes look more similar with a higher value of γ. A higher γ reduces the asymmetries between men and women, by increasing the importance of intensive margin and by reducing the effect of fixed-time cost of young children on female labor supply decision.

Alternative initial conditions: Do our findings depend on the distribution of agents in the initial steady state? Since this distribution depends on the tax system in place when gender-based taxes are introduced, we investigate the consequences of introducing these in a steady state with a proportional income tax rather instead of progressive taxes.[16]

The last column of Table 9 shows the consequences of introducing gender-based taxes with $\tau_L = 4\%$. Note that by construction, the values in the upper panel coincide with those for the narrow case for $\tau_L = 4\%$. Welfare gains measured as of $t = t_0$ are *negative*, and amount to about -0.5%. Similar results hold for other tax rates; that is, a uniform proportional tax dominates gender-based tax rates in welfare terms. Thus, the nature of our initial welfare results hold, regardless of whether we start from a steady state with progressive taxes or one with proportional tax rates.

9. Concluding remarks

A central result from this paper is that, on a measure of aggregate welfare, a shift to gender-based taxes delivers welfare gains, and that a majority of households would support such a change. Nevertheless, these gender-based taxes are dominated by the replacement of the current structure of taxes by a uniform, proportional tax system on all households. Put differently, we found mixed support for gender-based proportional taxes in our model economy.

It is worth emphasizing at this point that a central concern in the current paper is the detailed consideration of the female labor supply decision, in order to capture the heterogeneity observed in the data. In doing so, we admittedly have abstracted from some factors that may lead to the optimality of differential taxation by gender, as considered by Alesina et al. (2011). Our results highlight one reason why lower taxes on married females might not improve welfare relative to a simple proportional tax: lower taxes on females have to be financed by higher taxes on married males and taxing high earners in married couples at higher rates can be costly.

Since our welfare results stand in contrast with results on the optimality of gender-based taxes, we conclude by relating our model with the model in the aforementioned paper. In both papers, the elasticity of female labor supply is *endogenous*; in Alesina et al. (2011) it is driven by comparative advantage in home production and career investments, whereas in our model is affected by the participation decision of married females. There are income effects in labor supply in our model, while in their paper, home and market consumption goods enter linearly in preferences. Their model is effectively a static setup, amenable for theoretical analysis, while ours incorporates life-cycle behavior and capital accumulation.

A central difference between Alesina et al. (2011) and our paper relates to marriage and the modeling of household decisions. All individuals are married in equilibrium in Alesina et al. (2011), while we explicitly consider married and single people. In particular, we assume that (i) marital status and marital sorting is exogenous to the model, and unlike Alesina et al. (2011), (ii) there is no bargaining affecting household decisions as there is nothing to disagree on. Endogenous marriage coupled with bargaining over the gains from marriage would clearly affect the identity of winners and losers from the shift to gender-based taxes and therefore, the scope and magnitude of welfare gains. Gender-based taxes can also affect incentives to acquire education, which in our model is exogenously given to individuals at the start of the life cycle. Future research should determine whether these features are important enough to overcome our welfare findings.

Acknowledgments

We thank editors Thomas Cooley and Yongsung Chang, our discussant Richard Rogerson, and participants at the 77th Meeting of the Carnegie-Rochester Conference on Public Policy at New York University for their detailed comments and suggestions. We also thank Loukas Karabarbounis, Tim Kehoe, Virginia Sanchez-Marcos and seminar and conference participants at Universitat Autonoma de Barcelona, State University Higher School of Economics (Moscow) and the 2011 Society for Economic Dynamics Annual Meetings in Gent. Guner acknowledges support from European Research Council (ERC) Grant 263600. The usual disclaimer applies.

Appendix A. Supplementary data

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.jmoneco.2011.10.004.

References

Alesina, A., Ichino, A., Karabarbounis, L., 2011. Gender based taxation and the division of family chores. American Economic Journal: Economic Policy 3, 1–40.
Apps, P., Rees, R., 1988. Taxation and the household. Journal of Public Economics 35 (3), 355–369.
Apps, P., Rees, R. Taxation of couples. In: Cigno, A., Pestieau, P., Rees, R. (Eds.), Taxation and the Family, MIT Press, forthcoming.
Attanasio, O., Low, H., Marcos, V.S., 2008. Explaining changes in female labor supply in a life-cycle model. American Economic Review 98 (4), 1517–1542.
Bick, A., Fuchs-Schuendeln, N., 2011. Taxation and labor supply of married females: a cross-country analysis. Working paper.
Blau, F., Kahn, L., 2007. Changes in the labor supply behavior of married women: 1980–2000. Journal of Labor Economics 25, 393–438.
Blundell, R., MaCurdy, T., 1999. Labor supply: a review of alternative approaches. In: Ashenfelter, O.A., Card, D. (Eds.), Handbook of Labor Economics, North Holland, Amsterdam, pp. 1599–1695.

[16] We thank Richard Rogerson for suggesting this robustness experiment.

Boskin, M., Sheshinski, E., 1983. Optimal tax treatment of the family: married couples. Journal of Public Economics 20 (3), 281–297.
Cho, J., Rogerson, R., 1988. Family labor supply and aggregate fluctuations. Journal of Monetary Economics 21 (2), 233–245.
Guner, N., Kaygusuz, R., Ventura, G. Taxation and household labor supply. Review of Economic Studies, in press.
Guner, N., Kaygusuz, R., Ventura, G., 2011. Income taxation of U.S. Households: basic facts. IZA Discussion Paper No: 5549.
Heim, B.T., 2007. The incredible shrinking elasticities: married female labor supply, 1978–2002. Journal of Human Resources 42, 881–891.
Keane, M.P., 2010. Taxes and female labor supply: a survey. Working Paper No. 160, University of Technology Sydney.
Kesselman, J.R., 2008. Income splitting and joint taxation of couples what's fair? The Institute for Research on Public Policy. Choices 14 (1).
Kleven, H., Kreiner, C.T., Saez, E., 2009. The optimal taxation of couples. Econometrica 77, 537–560.
McCaffery, E.J., 1999. Taxing Women. The University of Chicago Press, Chicago.
Mirlees, J.A., 1971. An exploration in the theory of optimal income taxation. The Review of Economic Studies 38, 175–208.
Rosen, H.S., 1977. Is it time to abandon joint filing? National Tax Journal 30 (4), 423–428.