Household Taxation and Intra-household Redistributions of Consumption in a Limited Commitment Household model*

Luca Rondina†

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Abstract

This paper investigates the effects of a change in the taxation system from joint to separate taxation on households' labour supply, patterns of human capital formation, and intra-household allocations of consumption between primary and secondary earners. Household behaviour is described by an inter-temporal version of the collective household model, where household members' relative bargaining power determines intra-household allocations of consumption. Household members have limited commitment over future allocations, and their bargaining power evolves endogenously in response to changes in the gains from marriage. The tax reform is shown to cause an internal redistribution of consumption from primary to secondary earners in households where the bargaining power of secondary earners is low. Following a switch from joint to separate taxation, secondary earners' labour supply and stock of human capital are increased, which raises their value of divorce against the value of staying in the marriage. This translates into a higher bargaining power in the couple, and thus a higher share of secondary earners' consumption in the household.

JEL Codes: D15, E62, H31, I38, J22, J24.

Keywords: Household taxation, Human capital, Collective household, Limited commitment, Pareto weight.

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†University of Surrey, 388 Stag Hill, Guildford GU2 7XH. E-mail: luca.rondina@surrey.ac.uk. Web: LRondina.com

1 Introduction

How governments should tax labour income is an important question that is often raised by academics and policy makers alike. The design of taxation systems affects households' labour supply, consumption and savings decisions, and other economic outcomes with various implications for government budgeting decisions, as well as households welfare. Most of the economic literature focuses on key aspects such as the level of tax rates or the progressivity of the tax schedule, whereas relatively fewer studies are concerned with who should be the unit of taxation, either households or individuals. Some countries consider households as the relevant unit of taxation, while other countries choose individuals to be the unit of taxation. If households are the unit of taxation, a system known as *joint taxation* or *joint filing*, household members file their labour earnings jointly. If individuals are the unit of taxation, a system known as *separate taxation* or *single filing*, household members file their labour earnings as separate individuals.[1]

This distinction is central to determine the effective income tax rates that primary and secondary earners face when making labour supply decisions. In countries which adopt a joint taxation system, e.g. United States or Germany, the average tax rate on secondary earners' income is higher than the tax rate they would face if they were single or they filed income independently.[2] This difference in tax rates across countries has been shown to be important in explaining the cross-country variation of primary and secondary earners' labour supply, with secondary earners working relatively more hours in countries where spouses file income separately (Bick and Fuchs-Schündeln, 2017, 2018). The intuition behind this result is simple; since secondary earners are facing a relatively higher tax rate on additional earnings when income is filed jointly, the optimal decision is to limit their labour supply and invest their time in other activities such as caring for children and home production. The policy implication is also straightforward; switching from joint to single filing would create the right incentives for secondary earners to increase their labour force participation, with positive effects on households income, consumption, and aggregate labour supply (Guner et al., 2012a).

A change in the taxation system from joint to separate taxation is likely to have an impact on other important outcomes that have been partially ignored by the literature, namely the stock of human capital of primary and secondary earners, their bargaining power within the household, and the intra-household allocation of consumption. If secondary earners successfully increase their labour force participation, their experience in the labour market and labour productivity increases through learning-by-doing, which ultimately translates into higher

[1] The sharp division of taxation systems into joint and single filing is a simplification of actual taxation systems. Some countries, e.g. Italy, adopt separate taxation but allow tax credits to be transferable across spouses. Other countries, e.g. United States, adopt joint taxation but give households the option to file income separately. In this paper, I assume a clear distinction between joint and separate taxation systems, and I characterise both systems independently. This allows me to investigate how the intrinsic properties of either taxation system impact the variables of interest.

[2] The opposite is true for primary earners; when income is filed jointly, the tax rate on primary earners' income is lower than the tax rate they would face under single filing.

wages and improved career prospects. As secondary earners' contribution to households resources increases, it is reasonable to expect their bargaining power in the couple and weight in household decisions to increase as well.

In order to measure these effects, the choice of model is crucial. Standard unitary household models used in the literature fail to account for changes in the bargaining power and intra-household allocations as they abstract from the internal decision making process, often seen as irrelevant or unimportant (Apps and Rees, 1988, 1999). The implicit assumption is that households' decisions on internal allocations of consumption and leisure are orthogonal to external factors, and thus unaffected by the tax reform. On the contrary, collective household models (Chiappori, 1988, 1992) explicitly model household members' bargaining power in the internal decision making process and allow changes in external factors to influence households' decisions. As a result, the collective household model is better suited to identify changes in the bargaining power of household members and intra-household allocations.

This paper documents the effects of switching from joint to separate taxation on labour supply, human capital, and intra-household allocations of consumption in an economy where household behaviour is modelled as in the collective household model. More precisely, the model is an intertemporal version of the collective household model where household members have limited commitment to future allocations of consumption and leisure (Mazzocco, 2007). Household members' bargaining power evolves endogenously and is characterised by the size of the Pareto weight on individual utility, with a higher Pareto weight being associated to a higher bargaining power. The choice of model is motivated by two important features. First, the explicit modelling of household members' individual preferences allows me to study how the tax reform influences the internal decision process, and thus how consumption and leisure is allocated between members. Second, the intertemporal dimension is necessary to explain how labour supply decisions translate into human capital formation of primary and secondary earners. The interplay between these two features is key to uncover some mechanisms that would otherwise be absent in a standard model.

In particular, human capital accumulation is the key channel through which the tax reform affects intra-household allocations. When the taxation system changes from joint to single filing, the unit of taxation becomes the individual and the marginal tax rate on secondary earners' income is reduced. Lower marginal tax rates create an incentive for secondary earners to increase their labour supply, which ultimately translates into a higher stock of human capital through learning-by-doing. Higher human capital increases secondary earners' value of the outside option (divorce) which makes the participation constraint of the limited commitment marriage contract more likely to bind, thus the Pareto weight on secondary earners' utility to increase. Higher bargaining power translates into a larger share of private consumption in the household.

The paper is organised as follows. Section 2 reviews the related literature. Section 3 compares joint and separate taxation systems and comments on the potential implications for

households' labour supply and income in a simple framework. Section 4 introduces the model. Section 5 reports the quantitative results. Section 6 discusses the sensitivity of the results to key assumptions in the model. Section 7 concludes.

2 Related literature

The relationship between the tax treatment of households and labour supply has received increased attention in the literature. Guner et al. (2012a) quantitatively document how household labour supply responds to changes in the tax system. Using an overlapping generations life-cycle model calibrated to U.S. data, they show how a switch from joint to single filing has a positive effect on aggregate labour supply with the bulk of the adjustment in hours coming from the increased labour force participation of married women.[3] Bick and Fuchs-Schündeln (2017, 2018) use data from Unites States and 17 European countries to document how cross-country differences in the tax treatment of married couples correspond to cross-country differences in the labour supply of married men and women. Similarly to Guner et al. (2012a), they show that the household tax treatment (joint or single filing), along with the progressivity of the tax schedule, is crucial to explain the hours gap between married men and women. Chade and Ventura (2002, 2005) develop a marriage-market model with endogenous marital choices and labour supply decisions to investigate several tax reforms aimed at removing marriage tax bonuses or penalties, including a change from joint to individual taxation. They find that the tax reform has significant positive effects on the labour supply of married females, while the effect on marriage formation and dissolution is uncertain and quantitatively small.

On the normative side, Karabarbounis (2016) studies the optimal tax system in an economy where households file jointly or separately depending on the number of working members in the household. Kleven et al. (2009) show that the optimal taxation of couples is dependent on secondary earners' relative labour productivity in the market and in home production, and that the optimal marginal tax rate on secondary earners' income should be declining in primary earners' income. Gayle and Shephard (2019) argue that a taxation system where households file income jointly along with a progressive tax can create substantial marriage bonuses or penalties; therefore, they develop an equilibrium collective marriage market and consider an optimal design problem where the planner is allowed to adjust the tax jointness of the tax schedule of married couples. Their analysis seems to confirm the result of Kleven et al. (2009) that the optimal tax system is characterised by a certain degree of negative jointness, hence the tax rate on secondary earners' income should be lower when primary earners' income is higher.

[3] In Guner et al. (2012a), the increase in married women's labour supply and the associated increase in aggregate labour supply are mainly driven by the extensive margin. In comparison, this paper shows that in a model with an intensive margin, the increase in secondary earners' labour supply and the effect on aggregate labour supply are more muted.

While the literature recognises the disincentives created by a joint taxation system on secondary earners' labour force participation and highlights the potential benefits of switching to individual taxation, only relatively few studies consider the effects of a tax reform aimed at removing such disincentives on household members' bargaining power, intra-household allocations, and individual well-being.[4] Nevertheless, the interplay between households' internal decision making process and the taxation system has been shown to matter, with one affecting the other in important ways. Alesina et al. (2011) and Bastani (2013) explore gender-based taxation in a framework that allows for explicit bargaining of intra-household allocations between household members. Obermeier (2019) studies the impact of tax progressivity on the inequality of consumption, leisure, and individual well-being within and across households. Oikonomou and Siegel (2015) show how labour income taxes, along with capital taxes, directly influence the intra-household risk sharing possibilities of married couples, and thus the intra-household allocations of consumption and leisure.

This paper is closely related to Gayle and Shephard (2019) and Bronson and Mazzocco (2019). Gayle and Shephard (2019) show how the degree of tax jointness, i.e. how one spouse's marginal tax rate depends on the other spouse's income, can influence the equilibrium bargaining power of spouses that results from marriage market clearing. Their analysis can correctly identify the labour supply responses of primary and secondary earners to changes in the household tax treatment, but it abstracts from inter-temporal aspects such as the accumulation of human capital and evolution of labour productivity, which are considered in this paper and shown to be important. Bronson and Mazzocco (2019) investigate the effect of a switch from joint to individual taxation on labour supply, home production, and consumption using a framework similar to the one used in this paper. However, they abstract from general equilibrium effects on market wages and prices that might arise from potential movements in aggregate labour supply.

3 Joint versus separate taxation: definitions and comparison

In this section I compare joint taxation to separate taxation and discuss how these alternative taxation systems can influence households' labour supply, households' tax liabilities, and households' income.

Joint and separate taxation differ in how primary and secondary earners' income are treated for the purpose of calculating households' tax liabilities. Under joint taxation the unit of taxation is the household. Household members pool their income and report their labour earnings as a single unit. For example, consider a household with two members: a primary earner with labour income y^1 and a secondary earner with labour income y^2. Total

[4] Most of the tax reforms discussed in the literature aim to remove the disincentive effects on secondary earners' labour supply by reducing the marginal tax rate on secondary earners' income. Examples of such reforms include gender-based taxation (Alesina et al., 2011; Guner et al., 2012b; Bastani, 2013), proportional (flat) taxation (Guner et al., 2012a), and secondary earners' tax deductions.

tax liabilities T^{joint} for the household are given by

$$T^{joint}\left(y^1, y^2\right) = 2\mathcal{T}\left(\frac{y^1 + y^2}{2}\right),$$

where $\mathcal{T}$ is a tax function which allows for progressive taxation, and the tax base is an average of primary and secondary earners' income.[5]

Under separate taxation the unit of taxation is the individual. Each household member separately reports their labour income, and tax liabilities are computed based on each individual's income. Total tax liabilities T^{sep} for the household are the sum of individual tax liabilities

$$T^{sep}\left(y^1, y^2\right) = \mathcal{T}(y^1) + \mathcal{T}(y^2).$$

In what follows I compare joint and separate taxation and illustrate how these alternative systems can influence household labour supply and income. Throughout the analysis, I assume that the tax function $\mathcal{T}$ satisfies certain properties such as convexity, monotonicity, and differentiability. Details are left to the Appendix, where the reader can find a formal definition of the tax function and its properties.

3.1 Marginal tax rates and household labour supply

Marginal tax rates on individual household members' income depend on the tax system in place and the progressivity of the tax function $\mathcal{T}$. Under joint taxation, the marginal tax rates on primary and secondary earners' incomes are given by

$$\frac{\partial T^{joint}\left(y^1, y^2\right)}{\partial y^1} = \frac{\partial T^{joint}\left(y^1, y^2\right)}{\partial y^2} = \mathcal{T}'\left(\frac{y^1 + y^2}{2}\right),$$

while under separate taxation the marginal tax rates are respectively

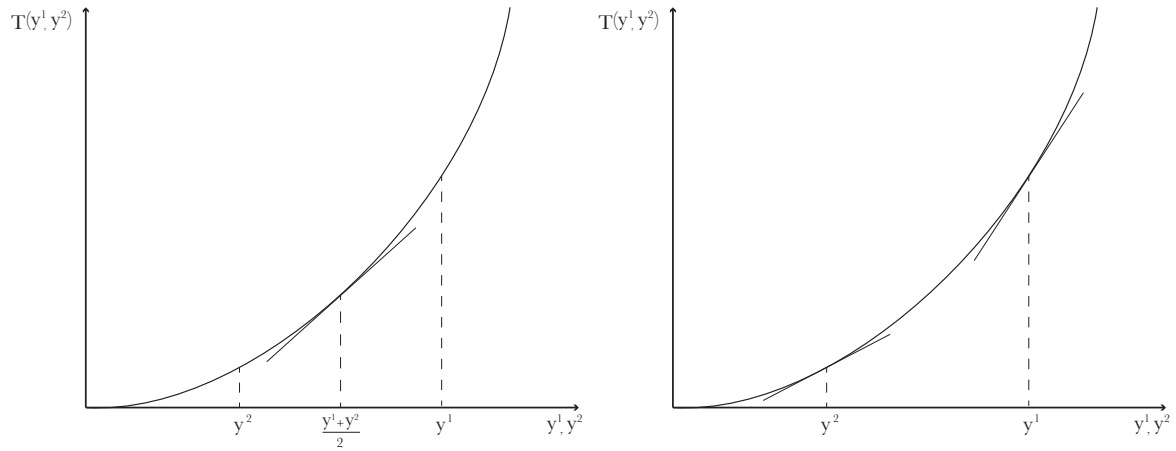
$$\frac{\partial T^{sep}\left(y^1, y^2\right)}{\partial y^1} = \mathcal{T}'\left(y^1\right), \qquad \frac{\partial T^{sep}\left(y^1, y^2\right)}{\partial y^2} = \mathcal{T}'\left(y^2\right),$$

where $\mathcal{T}'(\cdot)$ denotes the first derivative of the tax function $\mathcal{T}(\cdot)$.

Notice that under joint filing, the tax base is a function of both primary and secondary earner's income. As Figure 1 shows, any marginal increase in income by either primary or secondary earners affects the tax base equally, and increases household tax liabilities at the same rate. This implies that secondary earners' marginal income is taxed at the same rate as primary earners' marginal income.

[5] In this paper, tax liabilities under joint taxation are computed according to the income splitting method where part of primary earners' income is attributed to secondary earners' income and viceversa. Another method is income aggregation; primary and secondary earners' income are summed and the relevant tax rate is given by the tax bracket associated with the sum of incomes. For the purpose of this paper both methods are equivalent, however income splitting is preferred as it allows for an easier and direct comparison of joint and separate taxation systems.

Figure 1: Taxation system and marginal tax rates



(a) Joint taxation **(b)** Separate taxation

Notes: This figure shows a progressive tax function along with marginal tax rates on primary and secondary earners' income under joint and separate taxation. Marginal tax rates are given by the tangent lines to the tax function corresponding the relevant tax base. Panel (a) shows the marginal tax rates under joint taxation. Panel (b) shows the marginal tax rates under separate taxation.

Alternatively, under separate taxation any marginal increase in income by either household member affects their individual tax liabilities only. That is, primary and secondary earners' marginal tax rates are determined by their own income. As a result, the marginal increase in household tax liabilities depends on which household member's income is increasing; as long as the tax schedule is progressive, the marginal increase in household tax liabilities following an increase in secondary earners' income is always less than the marginal increase following an increase in primary earners' income. Simply put, the marginal tax rate on secondary earners' income is lower than the marginal tax rate on primary earners' income.

Moreover, the marginal tax rate on primary and secondary earners' income under joint taxation always lies in between the corresponding marginal tax rates under separate taxation.

Proposition 1. *Let* $\left(y^1, y^2\right) \in \mathbb{R}^2_+$ *be any pair of primary and secondary earners' income, with* $y^1 \geq y^2$*. Then*

$$\frac{\partial T^{sep}\left(y^1, y^2\right)}{\partial y^2} \leq \frac{\partial T^{joint}\left(y^1, y^2\right)}{\partial y^2} = \frac{\partial T^{joint}\left(y^1, y^2\right)}{\partial y^1} \leq \frac{\partial T^{sep}\left(y^1, y^2\right)}{\partial y^1}.$$

Proof. It follows from the monotonicity of the first derivative of the tax function. See the Appendix for more details. □

Different marginal tax rates across taxation systems imply that labour supply choices of household members will depend on the taxation system in place. Under joint taxation, secondary earners that want to increase their labour supply will face a marginal tax rate on additional income that is higher than the marginal tax rate under separate taxation. Therefore, under joint taxation there is a disincentive for secondary earners to supply additional

hours. A change in the tax system from joint to single filing would lower the marginal tax rate on secondary earners' income and induce them to increase their labour supply.

Differences in hours worked under joint and separate taxation can be explained by a simple static model of household labour supply. Consider, as an example, a household composed of two members, a primary earner and a secondary earner. Each household member, $m \in \{1, 2\}$, supplies hours to the labour market at wage rate w^m. By assumption, the primary earner in the household has a wage rate w^1 which is higher than the wage rate of the secondary earner w^2. Household members pool their labour income and pay taxes according to the tax system in place. Total tax liabilities are denoted by $T\left(y^1, y^2\right)$. Formally, the household solves the following maximisation problem:

$$\begin{aligned} \max_{\{q,h^1,h^2\}} \quad & \ln q - \frac{\left(h^1\right)^2}{2} - \frac{\left(h^2\right)^2}{2} \\ \text{s.t.} \quad & q + T\left(y^1, y^2\right) = y^1 + y^2 \\ & y^1 = w^1 h^1 \\ & y^2 = w^2 h^2 \end{aligned}$$

where h^1 is the labour supply of the primary earner, h^2 is the labour supply of the secondary earner, and q is household consumption.

First order optimality conditions imply that the ratio of labour supply is given by

$$\frac{h^2}{h^1} = \frac{w^2\left(1 - T_2\right)}{w^1\left(1 - T_1\right)}$$

where $T_m \equiv \partial T / \partial y^m$ denotes the marginal tax rate on member m's labour income under the tax system in place. As previously mentioned, the marginal tax rates under joint and separate taxation differ, which means that the labour supply of primary and secondary earners can be directly influenced by the tax system. Denote by h^m_{joint} the labour supply under joint taxation and h^m_{sep} the labour supply under separate taxation. Also, let T_m^{joint} and T_m^{sep} be the marginal tax rates under joint and separate taxation respectively. Proposition 1 ensures that the following inequality holds:

$$\frac{h^2_{sep}}{h^1_{sep}} = \frac{w^2\left(1 - T_2^{sep}\right)}{w^1\left(1 - T_1^{sep}\right)} \geq \frac{w^2\left(1 - T_2^{joint}\right)}{w^1\left(1 - T_1^{joint}\right)} = \frac{h^2_{joint}}{h^1_{joint}}$$

Because of the different marginal tax rates, under separate taxation the after-tax wage of secondary earners is higher, and the after-tax wage of primary earners is lower, compared to the corresponding after-tax wage under joint taxation. As a consequence, the relative labour supply of secondary earners is higher when household members report their labour earnings individually rather than jointly. If the taxation system were to suddenly change from joint to separate taxation, household would find it optimal to substitute primary earners' hours with

secondary earners' hours.

3.2 Household tax liabilities and income

The existing taxation system determines the size of total household tax liabilities, and thus the amount of income available for consumption given primary and secondary earners' labour income.

Proposition 2. *Let* $\left(y^1, y^2\right) \in \mathbb{R}^2_+$ *be any pair of primary and secondary earners' income, with* $y^1 \geq y^2$*. Then*

$$T^{joint}\left(y^1, y^2\right) \leq T^{sep}\left(y^1, y^2\right) .$$

Proof. It follows directly from the convexity of the tax function. See the Appendix for more details. □

Proposition 2 shows that households can benefit from tax savings when labour income is filed jointly rather than separately. This is usually known as a joint tax bonus: assuming that primary and secondary earners' income under joint and separate taxation is identical, household tax liabilities under joint taxation are always less than or equal to tax liabilities under separate taxation. As Figure 2a shows, when the tax schedule is progressive, the point on the tax function that identifies tax liabilities under joint taxation, T^{joint}, always lies below the corresponding point under separate taxation, T^{sep}, for any given combination of y^1 and y^2. The distance between these two points represents the joint tax bonus. Proposition 2 has also implications for the income available for consumption.

Corollary 1. *Let* $\left(y^1, y^2\right) \in \mathbb{R}^2_+$ *be any pair of primary and secondary earners' income, with* $y^1 \geq y^2$*. Then*

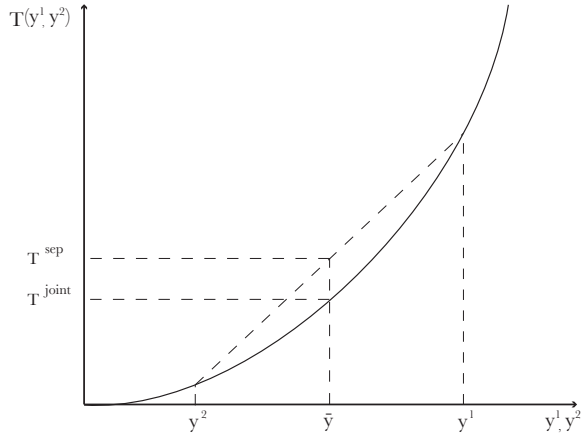
$$y^1 + y^2 - T^{joint}\left(y^1, y^2\right) \geq y^1 + y^2 - T^{sep}\left(y^1, y^2\right) .$$

Proof. If follows immediately from Proposition 2. □

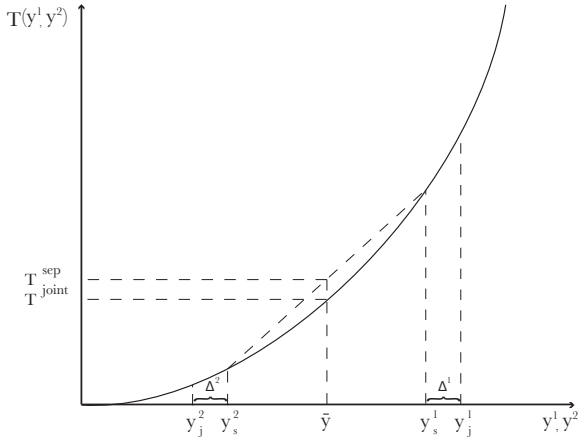
Since under joint filing tax liabilities are lower, it follows that household income left after paying taxes is higher. Therefore, assuming that primary and secondary earners' income under joint and separate taxation is identical, household income available for consumption under joint taxation is always greater than or equal to income available for consumption under separate taxation.

Proposition 2 and Corollary 1 are useful results that allow us to compare joint and separate taxation, but ignore the potential labour supply adjustments that a change in the taxation system is likely to trigger. As discussed in Section 3.1, differences in the marginal tax rates on primary and secondary earners' income across taxation systems create an incentive for households to adjust the labour supply of primary and secondary earners. Consider a hypothetical tax reform consisting of a switch from joint to single filing: households react to the change in marginal tax rates by reducing primary earners' hours to the labour market and increasing

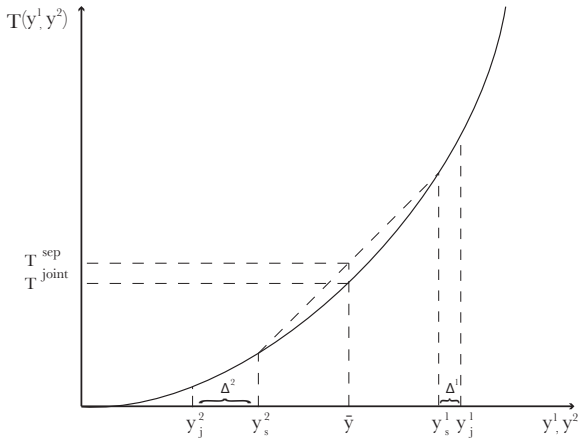
Figure 2: Tax liabilities and income changes



(a) Joint tax bonus



(b) Same income variation, $\Delta^2 = \Delta^1$



(c) Different income variation, $\Delta^2 > \Delta^1$

Notes: This figure compares the size of households' tax liabilities under joint and separate taxation. Panel (a) shows the relative size of tax liabilities under joint and separate taxation for any given combination of primary and secondary earners' income. Panels (b) and (c) show compare tax liabilities under joint and separate taxation, assuming that income changes when switching from joint to separate taxation. Panel (b) assumes that primary and secondary earners' income variations are equal in size but in opposite directions. Panel (c) assumes that secondary earners' income increase is larger than primary earners' income decrease.

secondary earners' labour supply. As a result, primary earners' labour income decreases and secondary earners' income increases; the net effect on households' income, tax liabilities, and income available for consumption is not clear and ultimately depends on the relative size of the income changes.

For instance, consider the case where the increase in secondary earners' labour income is equal to the decrease in primary earners' income. In such a scenario, household income available for consumption would fall even though household income before taxes remains constant. This is because tax liabilities increase when households are filing under the new taxation system.

Figure 2b illustrates this case. Since secondary earners' increase in income, Δ^2, is identical to primary earners' decrease in income, Δ^1, household income before taxes does not change. If households were to file jointly, there would not be any change in income after taxes because the tax base would be constant, hence tax liabilities would also be constant. However, under separate taxation tax liabilities are higher, which implies that household income left for consumption is lower. Proposition 3 formalises this result.

Proposition 3. *Let* $\left(y_j^1, y_j^2\right) \in \mathbb{R}_+^2$ *be any pair of primary and secondary earners' income. Let* $\left(y_s^1, y_s^2\right) \in \mathbb{R}_+^2$ *be another pair of primary and secondary earners' income such that*

$$y_s^1 = y_j^1 - \Delta^1, \qquad y_s^2 = y_j^2 + \Delta^2$$

with Δ^1 *and* Δ^2 *both positive. If* $\Delta^1 = \Delta^2$*, then*

$$y_j^1 + y_j^2 - T^{joint}\left(y_j^1, y_j^2\right) \geq y_s^1 + y_s^2 - T^{sep}\left(y_s^1, y_s^2\right) .$$

Proof. See the Appendix. □

Proposition 3 tells us that as long as households' income before taxes does not change after the tax reform, the switch to separate taxation would be detrimental as households' income available for consumption would fall. However, assuming that the income changes of primary and secondary earners exactly offset each other is quite restrictive. Since primary and secondary earners have different labour supply elasticities, one would expect the labour supply adjustments and the size of the income changes to be different. For instance, one might expect secondary earners to respond more strongly than primary earners to the changes in the marginal tax rates, which would imply that secondary earners' increase in income is larger than primary earners' decrease in income.

Figure 2c illustrates this case. Following the tax reform, the increase in secondary earners' income is larger than the decrease in primary earners' income; thus household income before taxes increases. However, part of the increase in income is counterbalanced by an increase in tax liabilities under separate taxation, so the net effect on household income available for consumption remains unclear. Only if the increase in secondary earners' income is large

enough, would household income after taxes increase.

Whether household income available for consumption increases after a switch to separate taxation is ultimately a quantitative question, which depends on a number of factors including the relative labour supply of primary and secondary earners before the tax reform, their contribution to household income, their labour supply elasticity, and other household decisions such as the degree of intra-household specialisation in home production. Furthermore, a comparative static analysis is likely to neglect some important inter-temporal aspects of the tax reform, such as the gradual change in the labour force participation of primary and secondary earners, and the associated change in the patterns of human capital accumulation. Finally, a simple framework such as the one used in this section ignores households' internal decision making process which must be taken into account if we are interested in intra-household allocations of resources and household members' individual well-being.

In the remainder of the paper, a richer model of household behaviour is introduced and simulated to evaluate the effects of a switch from joint to separate taxation on primary and secondary earners' labour supply, human capital accumulation, and households' internal allocation of consumption.

4 Model

The economy has three types of agents: households, firms, and a government. Households supply hours to the labour market and firms aggregate labour inputs into production. Each period, the wage rate is determined in equilibrium to clear the labour market. The government collects labour income taxes according to either a joint or separate taxation system. Households are aware of the existing taxation system and honour their tax liabilities accordingly.

4.1 Households

Households are composed of two members, a primary earner and a secondary earner, each with individual characteristics and preferences over consumption and time allocations.

Household members enjoy consumption of a private good q_t and a public good Q_t. A private good is purchased using available income and is allocated to primary and secondary earners according to a sharing rule that reflects their respective bargaining power. Income available for consumption is obtained by pooling primary and secondary labour income and subtracting the tax liabilities computed according to the current taxation system. A public good is produced internally in the household using time devoted to home production by both members, denoted by d_t^1 and d_t^2. Unlike private goods, public goods are non–rival so both members enjoy the same amount of public good consumption. Public goods are meant to represent the outcome of all activities and time investments that take place in the household or are specific to a married couple. A key aspect is that utility from such activities is shared

and cannot be attributed exclusively to either household member.[6]

Primary and secondary earners participate in the labour force and earn an income that is proportional to their hours worked, labour productivity, and a market wage. When measuring labour supply and potential earnings of primary and secondary earners, it is useful to think in terms of efficiency units, defined by hours worked times individual productivity. Individual labour productivity is proxied by the stock of human capital, denoted by θ_t^1 for primary earners and θ_t^2 for secondary earners. As a result, given a market wage per efficiency units w_t, primary and secondary earners labour income is $w_t\theta_t^1 h_t^1$ and $w_t\theta_t^2 h_t^2$ respectively.

The individual stock of human capital evolves endogenously in this model, with primary and secondary earners' labour supply decisions affecting it. More time spent in the labour force adds skills and experience in the workplace thus increasing the stock of human capital through learning-by-doing. Less time spent in the labour force makes the stock of human capital depreciate. As a result, the stock of human capital of household member $m \in \{1, 2\}$ evolves according to

$$\theta_{t+1}^m = (1 - \delta_\theta^m)\,\theta_t^m + h_t^m + \delta_\theta^m \bar{\theta}^m$$

where δ_θ^m is a constant depreciation rate and $\bar{\theta}^m$ is an intrinsic stock of human capital.

Households behave according to an inter-temporal version of the collective household model. Intra-household allocations are the outcome of an internal decision process where households choose present and future variables to reflect the relative bargaining power of household members. Formally, each household is maximising a weighted sum of primary and secondary earners' individual utility. The values of the Pareto weights attached to household members' utility are interpreted as their bargaining power in the couple and directly affect intra-household allocations. For instance, a higher Pareto weight on secondary earners' utility implies a higher share of consumption, thus a higher individual utility for secondary earners.

The inter-temporal nature of the problem gives rise to commitment issues within the household. At the time of household formation, a plan that maximises household utility is set given the Pareto weights on primary and secondary earners' utility; this plan ensures that every member's value of staying in the household is higher than the value of an outside option. However, changes in external factors in subsequent periods might influence the household in a way that makes the value of the outside option higher than the value of staying in the household for either the primary or secondary earner. Whenever this happens, commitment to the original plan is suboptimal.

In this model, I assume that household members can only partially commit to future allocations as in Mazzocco (2007). Therefore, a time-consistent optimal plan has to ensure that at any point in time the value of staying in the household for either member is at least as great as the value of their best outside option; in other words, households can only choose plans that satisfy a set of participation constraints for both household members. The limited

[6]Typical examples of such activities and time investments are housework and child care, with associated public goods being house cleanliness and quality of children.

commitment assumption is key to explain variations in the bargaining power. Under perfect commitment, the relative bargaining power is set at the time of household formation and there are no future renegotiations between household members. Under limited commitment, any future change in external factors that makes one of the participation constraints binding will trigger a renegotiation of intra-household allocations. The bargaining power of the household member whose participation constraint is binding will increase to ensure that staying in the household is optimal; this translates into a larger Pareto weight on individual utility and a larger share of household resources.

Human capital accumulation and partial commitment to future allocations are crucial to generate endogenous variations in the bargaining power of household members. Changes in the stock of human capital of either primary or secondary earners directly affect the value of their best outside option, given by the value of divorce in this model. Each period, household members compare the benefits of staying in the household against divorcing and can decide to leave the household if it makes them better off. In equilibrium, divorce threats never materialise and the marriage remains intact: as long as the marriage can create a positive surplus to be reallocated between household members, there always exists a renegotiation of consumption and time allocation that makes both household members better off in the marriage.

The value of the best outside option for primary and secondary earners is defined as follows. In case of divorce, ex-spouses continue to single life and do not remarry.[7] While divorced, ex-spouses still contribute to the production and enjoy consumption of a public good, which is meant to capture all activities that survive the dissolution of marriage, such as child care. When deciding how many hours to invest in home production, each ex–spouse takes the ex–partner investment in home production as given.

Ex–spouses participate in the labour force, earn income, and pay taxes according to the tax schedule for single households. As the stock of human capital is not directly affected by divorce events, ex–spouses continue in the labour force with the same labour productivity as before. In addition to labour income, divorcees that were secondary earners in the household receive spousal maintenance from their ex–partner. Spousal maintenance takes the form of a constant transfer tr from ex–primary earners to ex–secondary earners.[8]

[7] While not entirely realistic, a no remarriage assumption keeps the model tractable without sacrificing the results of this paper. Given the inter-temporal nature of the model, the possibility of remarriage means that current and future utility prospects depend on a larger set of state variables including the agent's stock of human capital, expected future marriage surpluses, and expected bargaining power in the future marriage. On the other hand, a no remarriage assumption ensures that the value of divorce can be entirely summarised by the stock of human capital. The difference between these two cases would approximately be a constant shift in the value of divorce and would not dramatically change how the value of marriage and divorce variate after the tax reform, which is key for changes in bargaining power in the marriage.

[8] In most countries, spousal maintenance is awarded to ex–spouses with a lower earning capacity after the dissolution of a marriage. Moreover, these payments are computed independently of child support payments.

Formally, the value of the outside option for primary earners in period t is defined by

$$\begin{aligned} V_D^1(\theta_t^1) \equiv \max_{\{x_\tau^1\}_{\tau=t}^{\infty}} \quad & \sum_{\tau=t}^{\infty} \beta^{\tau-t} u^1(Q_\tau, q_\tau^1, h_\tau^1, d_\tau^1) \\ \text{s.t.} \quad & q_\tau^1 + T^{single}(w_\tau \theta_\tau^1 h_\tau^1) = w_\tau \theta_\tau^1 h_\tau^1 - tr \\ & \theta_{\tau+1}^1 = (1-\delta_\theta^1)\theta_\tau^1 + h_\tau^1 + \delta_\theta^1 \overline{\theta}^1 \\ & Q_\tau = \overline{A}_Q (d_\tau^1)^{\delta_1} (d_\tau^2)^{\delta_2} \end{aligned}$$

and the value of the outside option for secondary earners by

$$\begin{aligned} V_D^2(\theta_t^2) \equiv \max_{\{x_\tau^2\}_{\tau=t}^{\infty}} \quad & \sum_{\tau=t}^{\infty} \beta^{\tau-t} u^2(Q_\tau, q_\tau^2, h_\tau^2, d_\tau^2) \\ \text{s.t.} \quad & q_\tau^2 + T^{single}(w_\tau \theta_\tau^2 h_\tau^2) = w_\tau \theta_\tau^2 h_\tau^2 + tr \\ & \theta_{\tau+1}^2 = (1-\delta_\theta^2)\theta_\tau^2 + h_\tau^2 + \delta_\theta^2 \overline{\theta}^2 \\ & Q_\tau = \overline{A}_Q (d_\tau^1)^{\delta_1} (d_\tau^2)^{\delta_2} \end{aligned}$$

where $x^m \equiv (Q, q^m, h^m, d^m, \theta^m)$ is the set of choice variables for household member $m \in \{1, 2\}$ and $T^{single}(\cdot)$ is the tax schedule for single households.

Notice that the value of divorce in any period t is a function of the stock of human capital θ_t^m, which entirely summarises the labour market conditions of member m at the time of divorce. As I argue in the next section, a change in the taxation system that improves labour market conditions for secondary earners will increase the value of their outside option and make the participation constraint more likely to bind. Whenever the participation constraint binds, a renegotiation of intra-household allocations that benefits secondary earners occurs.

Finally, denote by μ^1 the Pareto weight on primary earners' utility, μ^2 the Pareto weight on secondary earners' utility, and $x \equiv \left(Q, q^1, q^2, h^1, h^2, d^1, d^2, \theta^1, \theta^2\right)$ the set of choice variables for the household. Households choose intra-household allocations to solve the following problem

$$\begin{aligned} \max_{\{x_t\}_{t=1}^{\infty}} \quad & \sum_{t=1}^{\infty} \beta^{t-1} \left\{ \mu^1 u^1 \left(Q_t, q_t^1, h_t^1, d_t^1\right) + \mu^2 u^2 \left(Q_t, q_t^2, h_t^2, d_t^2\right) \right\} \\ \text{s.t.} \quad & q_t^1 + q_t^2 + T\left(w_t \theta_t^1 h_t^1, w_t \theta_t^2 h_t^2\right) = w_t \theta_t^1 h_t^1 + w_t \theta_t^2 h_t^2 \\ & \theta_{t+1}^1 = \left(1-\delta_\theta^1\right)\theta_t^1 + h_t^1 + \delta_\theta^1 \bar{\theta}^1 \\ & \theta_{t+1}^2 = \left(1-\delta_\theta^2\right)\theta_t^2 + h_t^2 + \delta_\theta^2 \bar{\theta}^2 \\ & Q_t = A_Q \left(d_t^1\right)^{\delta_1} \left(d_t^2\right)^{\delta_2} \\ & \sum_{\tau=0}^{\infty} \beta^\tau u^1 \left(Q_{t+\tau}, q_{t+\tau}^1, h_{t+\tau}^1, d_{t+\tau}^1\right) \geq V_D^1\left(\theta_t^1\right) \\ & \sum_{\tau=0}^{\infty} \beta^\tau u^2 \left(Q_{t+\tau}, q_{t+\tau}^2, h_{t+\tau}^2, d_{t+\tau}^2\right) \geq V_D^2\left(\theta_t^2\right) \end{aligned}$$

where the last two inequalities in the set of constraints represent the participation constraints, which ensure that in any period both household members are better off in the marriage. $T(\cdot,\cdot)$ is the tax schedule for households, which maps primary and secondary earners' labour earnings into household tax liabilities according to the existing tax system, either joint or separate taxation.

4.2 Firms and labour market

Firms combine labour inputs of primary and secondary earners into production according to the following production technology

$$Y_t = A_Y (H_t)^{\alpha}$$

where H_t is total labour input and A_Y is total factor productivity.

Total labour input H_t is measured in efficiency units. Since primary and secondary earners time and experience in the labour force differs, so does their output contribution per hour worked. Each worker's effective contribution to production is given by their hours worked augmented by their individual productivity. Assuming that the individual stock of human capital θ_t is a proxy for individual productivity, each worker's efficiency units of labour are given by $\theta_t h_t$.

The labour market structure is standard. Firms demand labour and workers supply hours at the prevailing market wage. Aggregate labour supply is the sum of primary and secondary earners' contribution to the labour market, that is

$$H_t^S = \frac{1}{2}\theta_t^1 h_t^1 + \frac{1}{2}\theta_t^2 h_t^2 .$$

Aggregate labour demand is given by firms' optimality condition

$$\alpha A_Y \left(H_t^D\right)^{\alpha-1} = w_t$$

where the wage per efficiency unit w_t is endogenously determined by market clearing,

$$H_t = H_t^S = H_t^D .$$

4.3 Parameters and functional forms

Household members' preferences over consumption and leisure are described by the following utility function

$$u^m (Q, q^m, h^m, d^m) = \gamma^m \log Q + \frac{(q^m)^{1-\sigma^m} - 1}{1-\sigma^m} - \phi^m \frac{(h^m + d^m)^{1+1/\eta^m}}{1+1/\eta^m}$$

which is additively separable in consumption of both goods and time devoted to either labour or home production. Parameters are household member-specific and described as follows: γ^m controls the preference for public good consumption over private good consumption, σ^m is the relative risk aversion, ϕ^m controls the disutility from hours worked, and η^m is the Frisch elasticity of labour supply.

Home production is described by a Cobb-Douglas technology that combines time inputs from primary and secondary earners to produce a public good

$$Q(d^1, d^2) = A_Q \left(d^1\right)^{\delta_1} \left(d^2\right)^{\delta_2}$$

where δ^1 and δ^2 control the marginal productivity of primary and secondary earners in home production.

Parameter values are reported in Table 1. All primary and secondary earner-specific parameters are symmetric except for the Frisch elasticity of labour supply. According to Peterman (2015), primary earners' elasticity of labour supply is lower than secondary earners' elasticity of labour supply; therefore, I set primary earners' elasticity to be half of that of secondary earners. According to Blundell et al. (2016), a value of 0.5 for secondary earners' labour supply elasticity is within the estimates obtained with a labour supply model that takes human capital accumulation into account. This asymmetry in labour supply elasticities is sufficient to generate a steady state where primary earners supply more hours to the labour market and have a higher stock of human capital than secondary earners.

Primary and secondary earners' productivity in home production is identical, $\delta^1 = \delta^2$, and home production displays constant returns to scale. A_Q controls the overall home production productivity in the marriage, whereas $\overline{A}_Q$ controls productivity in the case of divorce. Everything else being held constant, it is reasonable to expect a married couple to be more productive than a divorced or separated couple. For instance, one could think that coordination problems might arise when a couple is divorced which would make the production of public goods less efficient. Therefore, I normalise A_Q to one and set $\overline{A}_Q = 0.85$.

The Pareto weight on primary earners' utility is normalised to one, whereas the initial Pareto weight on secondary earners' utility is set to 0.92. Therefore, secondary earners start with a lower relative bargaining power than primary earners. More details on the initial distribution of bargaining power and its implications for the evolution of primary and secondary earners' private consumption are given in Section 6.1.

The model introduced in the previous section allows for spousal maintenance payments in the case of divorce. Spousal maintenance (alimony) payments are transfers ruled by a court or agreed between ex-spouses that benefit divorcees with a lower earning capacity. Spousal maintenance is regulated by family laws concerning marriage dissolution and divorce settlements. In most countries—e.g. US, UK, Germany, and Italy—there is not a fixed formula to decide the amount and duration of payments, thus family judges make a decision based on a number of factors that consider ex-spouses' earning capacity and investments in

Table 1: Model parameters

Description	Parameter	Value
Primary earner		
Preference for public good	γ^1	1
Relative risk aversion	σ^1	1
Labour disutility	ϕ^1	4
Frisch elasticity of labour supply	η^1	0.25
Depreciation rate of human capital	δ_θ^1	0.2
Intrinsic human capital	$\bar{\theta}^1$	5
Home production productivity	δ_1	0.5
Initial Pareto weight	μ^1	1
Secondary earner		
Preference for public good	γ^2	1
Relative risk aversion	σ^2	1
Labour disutility	ϕ^2	4
Frisch elasticity of labour supply	η^2	0.5
Depreciation rate of human capital	δ_θ^2	0.2
Intrinsic human capital	$\bar{\theta}^2$	5
Home production productivity	δ_2	0.5
Initial Pareto weight	μ^2	0.92
Households		
Discount factor	β	0.96
Home production productivity (marriage)	A_Q	1
Home production productivity (divorce)	$\overline{A}_Q$	0.85
Spousal maintenance	tr	0.55
Firms		
Total factor productivity	A_Y	2.23
Labour share	α	$2/3$

Notes: Model parameterisation and calibration. Please refer to main text.

the household.[9] As a result, the correct size of spousal maintenance payments can be hard to pin down; here I choose tr to be 0.55, which corresponds to 15 percent of ex-primary earners disposable income in the outside option steady state.

Firms' total factor productivity is calibrated to target a wage per efficiency units equal to one in the steady state under joint taxation. This wage normalisation allows me to easily interpret the labour market effects of the change in the tax system from joint to separate taxation.

When comparing household labour supply under joint and separate taxation systems, a progressive tax schedule is necessary to generate different marginal tax rates on primary and secondary earners' income. Therefore, the tax function $\mathcal{T}$ that maps primary and secondary earners' labour income into household tax liabilities should be flexible enough to reproduce some degree of progressivity. Under joint taxation, the relevant tax base is computed according to the income splitting method, thus household tax liabilities are given by

$$T^{joint}\left(y^1, y^2\right) = 2\mathcal{T}\left(\frac{y^1 + y^2}{2}\right)$$

where y^1 and y^2 are primary and secondary earners' labour income. Under separate taxation, household tax liabilities are the sum of primary and secondary earners' individual tax liabilities, that is

$$T^{sep}\left(y^1, y^2\right) = \mathcal{T}\left(y^1\right) + \mathcal{T}\left(y^2\right) .$$

In the outside option problem, the tax schedule for single households is given by the tax function $\mathcal{T}$ itself, that is $T^{single}\left(y\right) = \mathcal{T}\left(y\right)$.

Table 2 reports different tax function specifications used in this paper. Functional forms and parameters values are taken from Guner et al. (2014) who estimate tax functions and the associated degree of progressivity using U.S. micro-data. The quantitative analysis in the next section uses the power specification as a baseline. Nevertheless, results are robust to other specifications.

5 Joint versus separate taxation: steady states and transition

In this section, I document the effects of a switch from joint to separate taxation on labour supply, human capital formation, and intra-household allocations of consumption. The economy is assumed to be at its steady state in the period before the tax reform and the change in the taxation system is unanticipated by households. At the time of the tax reform, households

[9] Several factors are considered. First, the current and expected future income and earning capacity of divorcees. Secondly, the contribution which each divorcee has made or is expected to make to the welfare of the family, including looking after the family home and children. Thirdly, investments made during the marriage that have generated needs on the part of the financially weaker party, such as sacrificing careers prospects to dedicate time to children or other household-specific investments. Lastly, the marital standard of living before the dissolution of marriage.

Table 2: Tax function specifications

Functional form	Parameter	Value
Power specification		
$\mathcal{T}(y) = y(\delta + \gamma y^{\epsilon})$	δ	-0.089
	γ	0.186
	ϵ	0.236
HSV specification		
$\mathcal{T}(y) = y(1 - \lambda y^{-\tau})$	λ	0.902
	τ	0.036
Log specification		
$\mathcal{T}(y) = y(\alpha + \beta \log y)$	α	0.099
	β	0.035

Notes: Tax functions used to compute household tax liabilities as a function of primary and secondary earners' income. In the joint filing case, household tax burden is given by $2\mathcal{T}(y)$ where $y = \left(y^1 + y^2\right)/2$. In the single filing case, household tax burden is given by $\mathcal{T}\left(y^1\right) + \mathcal{T}\left(y^2\right)$. Functional forms and parameter values are taken from Guner et al. (2014).

receive news that primary and secondary earners have to file their income individually, and thus they revise their labour supply and consumption plans accordingly. As shown in Section 3, a change in the taxation system from joint to single filing modifies the marginal tax rates on primary and secondary earners' income. In a simple static model, household members adjust their labour supply to reflect the more (or less) favourable tax rate with secondary earners increasing labour supply and primary earners decreasing theirs. In a dynamic model, the same labour supply adjustments have a direct impact on the human capital accumulation of primary and secondary earners, and thus on the value of marriage and divorce.

Higher labour supply and improved labour market conditions for secondary earners imply a higher share of their income over household total income. However, a larger contribution to household resources does not automatically translate into higher well-being for secondary earners as intra-household allocations of consumption depend on their bargaining power. In households where secondary earners' relative bargaining power is low, most of the benefits will be reaped by primary earners since their share in consumption of private good is higher. Therefore, secondary earners' decrease in leisure is less than compensated for by an increase in private consumption, which ultimately results into a lower individual utility in the household. Conversely, better labour market conditions for secondary earners directly improve the value of their outside option since in the case of divorce they will be able convert higher labour income into more consumption.

The aim of this section is to show that variations in the value of marriage and divorce caused by the tax reform can trigger an internal redistribution of private consumption from primary to secondary earners in households where the bargaining power of secondary earner

Table 3: Labour income and taxes

Description	Variable	Joint taxation	Separate taxation
Labour income			
Primary earner income	y^1	4.4149	4.0057
Secondary earner income	y^2	2.1544	2.6271
Secondary earner share (%)	y^2/y	32.80	39.61
Household income	y	6.5693	6.6328
Household income after taxes	y^{net}	5.5362	5.5756
Taxes			
Primary earner marginal tax rate (%)	T_1	21.54	23.00
Secondary earner marginal tax rate (%)	T_2	21.54	19.98
Household tax liabilities	T	1.0331	1.0572

Notes: Steady state of endogenous variables under joint and separate taxation.

is low. If the increase in secondary earners' human capital is such that the value of divorce exceeds the value of marriage, the participation constraint of the household problem is binding. As a result, the Pareto weight on secondary earners' individual utility increases to guarantee that the participation constraint is not violated; that is, the household revises allocations of consumption to ensure that the value of staying in the marriage for secondary earners is at least as great as the value of divorce.

The limited commitment assumption is crucial to explain variations in the bargaining power of secondary earners. To emphasise the role of limited commitment, the quantitative analysis in this section reports the main results along with the full commitment case. Firstly, the steady state of endogenous variables is computed under joint and separate taxation. Then, the transition from the steady state under joint taxation to the steady state under separate taxation is shown and commented. The Pareto weight on primary earners' utility μ^1 is normalised to 1, and the initial Pareto weight on secondary earners' utility μ^2 is set to 0.92.

5.1 Taxes, labour supply, and human capital

Table 3 reports the steady state values of labour income, marginal tax rates, and household tax liabilities under joint and separate taxation. Compared to joint taxation, under separate taxation primary earners' labour income is lower and secondary earners' labour income is higher. The steady state value of primary earners' labour income decreases from 4.41 to 4.01 when the economy reaches its new steady state under separate taxation. Conversely, the steady state value of secondary earners' labour income increases from 2.15 to 2.63.

Households' labour income, defined as the sum of primary and secondary earners' labour income, increases after the tax reform. This is because the decrease in primary earners' income is more than counterbalanced by the increase in secondary earners' income. Moreover, the tax

Table 4: Time allocations and human capital

Description	Variable	Joint taxation	Separate taxation
Labour supply			
Primary earner labour supply	h^1	0.5644	0.5271
Secondary earner labour supply	h^2	0.3252	0.3820
Home production			
Primary earner time to home production	d^1	0.3473	0.3706
Secondary earner time to home production	d^2	0.4426	0.4123
Human capital			
Primary earner human capital	θ^1	7.8221	7.6357
Secondary earner human capital	θ^2	6.6258	6.9101

Notes: Steady state of endogenous variables under joint and separate taxation.

reform modifies the internal distribution of income in the household. Under joint taxation, secondary earners' share of labour income over household income is 32.8 percent, while under separate taxation it is almost 40 percent.

As a result of the increase in households' income, the steady state value of households' tax liabilities under separate taxation is higher than its steady state value under joint taxation. Nevertheless, households' income after taxes increases from 5.54 to 5.58 which means that households have access to more consumption of private goods under separate taxation.

Marginal tax rates on household members' labour income are a direct function of the tax system in place. Under joint taxation, the relevant tax base is either household's income or a measure that takes into account both household members' income, e.g. an average of primary and secondary earners' income. Hence, marginal tax rates on primary and secondary earners' income are identical, regardless of the internal distribution of income. Under separate taxation, each household member reports her own income individually. The progressivity of the tax schedule, along with a gap in primary and secondary earners' income, creates two different marginal tax rates.

When the taxation system switches from joint to separate taxation, the marginal tax rate on primary earners' labour income increases and the marginal tax rate on secondary earners' labour income is reduced. In the steady state under joint taxation, the marginal tax rate on both primary and secondary earners' income is 21.54 percent. In the steady state under separate taxation, the marginal tax rate on primary earners' income is 23 percent and the marginal tax rate on secondary earners' income is 20 percent. A higher marginal tax rate implies that primary earners' after–tax wage is lower under the new taxation system. Conversely, a lower marginal tax rate implies that secondary earners' after–tax wage is higher.

Changes in the marginal tax rates and after–tax wages drive the labour supply adjustment

and reallocation of time devoted to home production within households. Table 4 reports the steady state values of labour supply, time devoted to home production, and human capital for primary and secondary earners under joint and separate taxation. Due to the change in relative wages, primary and secondary earners adjust their labour supply and time to home production in opposite directions. Primary earners reduce their labour supply and increase their time devoted to home production, whereas secondary earners increase their labour supply and reduce their time devoted to home production. Comparing the steady states under joint and separate taxation, primary earners' labour supply decreases from 0.56 to 0.53, and time spent in home production increases from 0.35 to 0.37. Secondary earners' labour supply increases from 0.33 to 0.38, and time spent in home production decreases from 0.44 to 0.41.

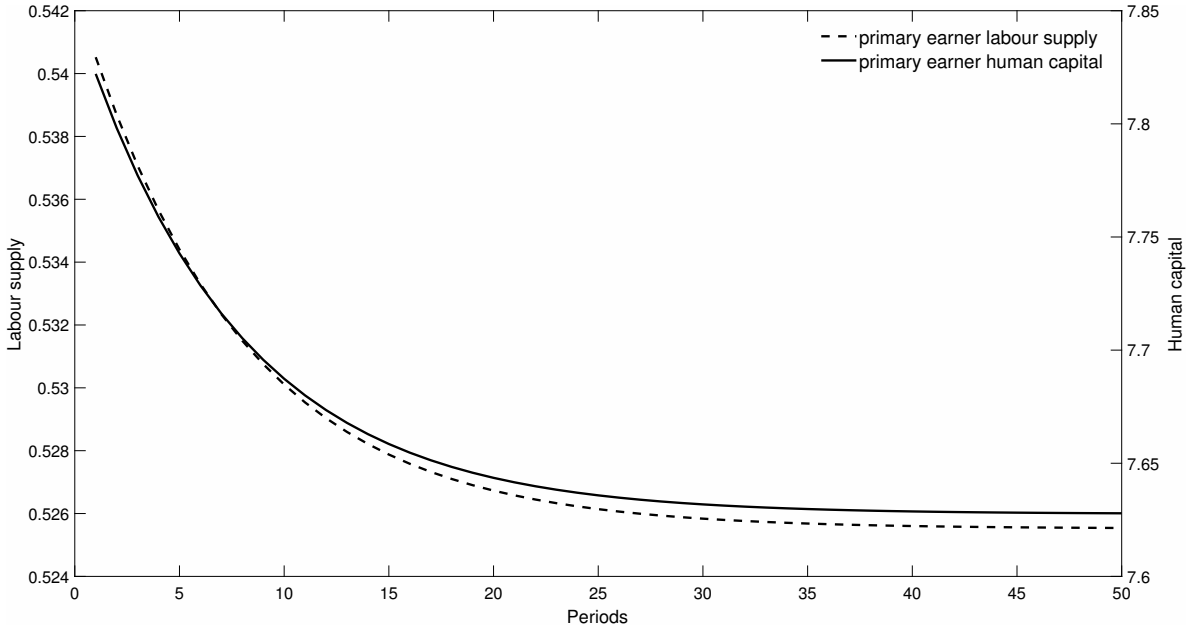
Labour supply adjustments induced by the tax reform change the patterns of human capital formation for primary and secondary earners. Following the switch from joint to separate taxation, the steady state of primary earners' stock of human capital decreases from 7.82 to 7.64, while the steady state of secondary earners' stock of human capital increases from 6.63 to 6.91. The transition to the new stock of human capital is not immediate. As Figure 3 and Figure 4 suggest, labour supply and human capital of primary and secondary earners slowly adjust to reach their new steady state values. Immediately after the tax reform, changes in the marginal tax rates create an incentive for secondary earners to supply more hours and primary earners to reduce their labour supply. As secondary earners increase their effort in the workplace, they accumulate additional skills which ultimately raise their nominal wage. This effect creates a positive feedback loop where increased wages boost labour supply, and increased labour supply contributes to human capital accumulation. A similar but opposite argument applies to primary earners; as primary earners gradually reduce their labour supply, their stock of human capital deteriorates.

At the same time, primary and secondary earners adjust their time devoted to home production. As Figure 5 shows, secondary earners' investment in home production is gradually reduced as they put more effort in the labour market. Secondary earners' dis-investment is counterbalanced by an increase in time spent in home production by primary earners. Overall, the net effect is that households' internal production of public goods is virtually unchanged.

5.2 Bargaining power and consumption

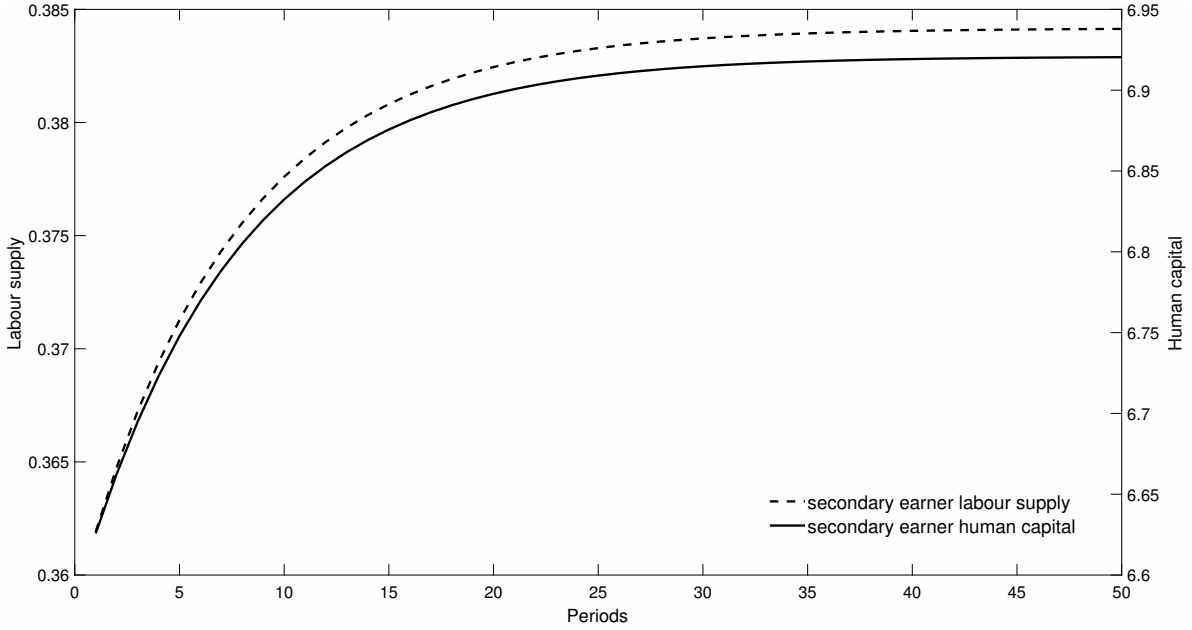
Intra-household allocations of private good consumption depend on the relative bargaining power of primary and secondary earners in the household. In the model, household members' bargaining power is determined endogenously by the relative size of the Pareto weights on primary and secondary earners' individual utilities. In each period, primary and secondary earners' value of staying in the household (marriage) is compared to the value of their outside option (divorce), and the Pareto weights change or remain constant based on this information. Given the relative movements in the stock of human capital of primary and secondary earners after the tax reform, the value of their outside option changes accordingly which could create

Figure 3: Primary earners' labour supply and human capital transition



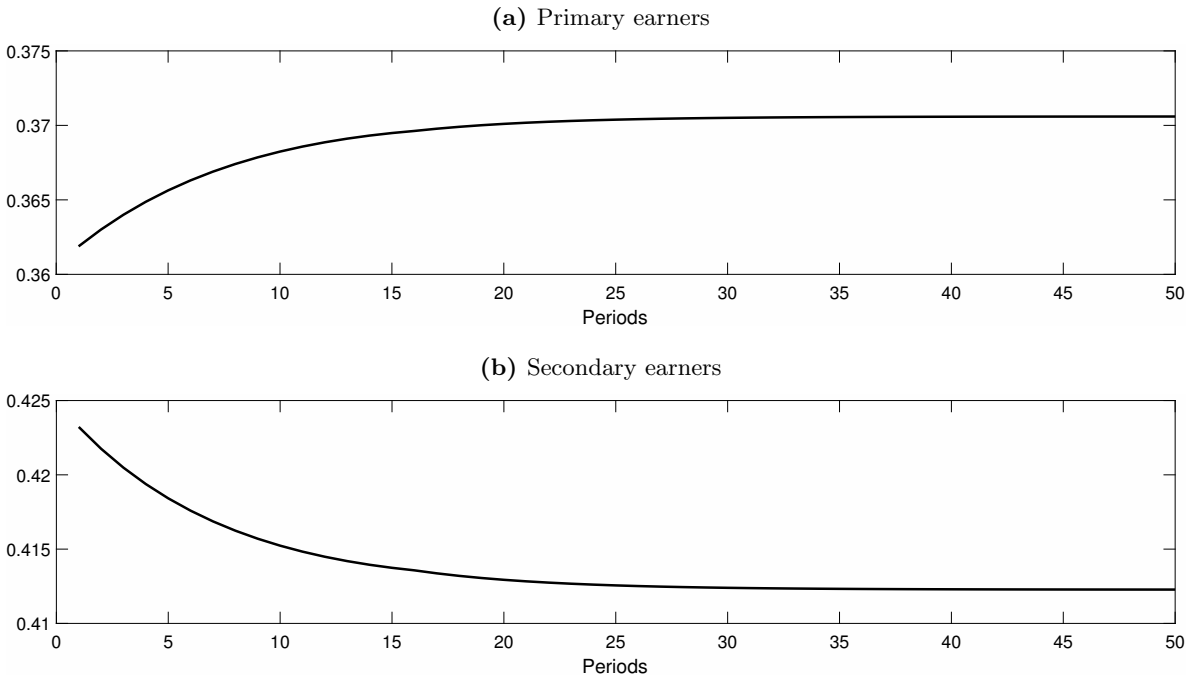
Notes: This figure shows the evolution of labour supply and stock of human capital of primary earners immediately after the tax reform. Labour supply is indicated by a dashed line with associated values on the left axis. Human capital is indicated by a solid line with associated values on the right axis.

Figure 4: Secondary earners' labour supply and human capital transition



Notes: This figure shows the evolution of labour supply and stock of human capital of secondary earners immediately after the tax reform. Labour supply is indicated by a dashed line with associated values on the left axis. Human capital is indicated by a solid line with associated values on the right axis.

Figure 5: Time devoted to home production transition



Notes: This figure shows the evolution of time devoted to home production immediately after the tax reform. Panel (a) shows primary earners' time to home production. Panel (b) shows secondary earners' time to home production.

endogenous variations in the Pareto weights. In what follows, I show that secondary earners' Pareto weight changes after the tax reform, and its implications for intra-household allocations of private good consumption. First, I document the steady state of household consumption under joint and separate taxation. Then, I explain how the model is able to generate an internal reallocation of private good consumption between household members.

Table 5 reports the steady state of household members' private and public good consumption under joint and separate taxation. To highlight the role of bargaining, steady state values are reported for two alternative scenarios: full commitment and limited commitment. Under full commitment, the Pareto weights on household members' utility are fixed at their initial level. Under limited commitment, the Pareto weights are allowed to change endogenously in order to ensure that the participation constraints are satisfied.

Under both scenarios, the consumption of private good increases for both primary and secondary earners when the tax system changes from joint to separate taxation. Since the tax reform increases households' net income, households members have access to more consumption of private good in the steady state under separate taxation compared to joint taxation. However, the intra-household distribution of consumption differs depending on the scenario considered.

Under full commitment, the tax reform has no effect on the relative bargaining power of household members. Therefore, secondary earners' share of private consumption over total

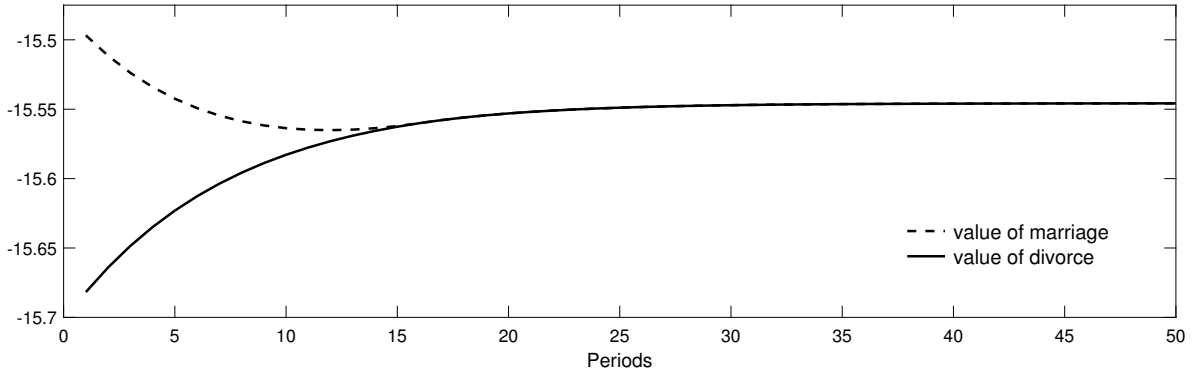
Table 5: Consumption

Description	Variable	Joint taxation	Separate taxation (constant μ)	Separate taxation (endogenous μ)
Private good				
Primary earner private good consumption	q^1	2.8834	2.905	2.8959
Secondary earner private good consumption	q^2	2.6527	2.6726	2.6797
Primary earner consumption share (%)	q^1/q	52.08	52.08	51.94
Secondary earner consumption share (%)	q^2/q	47.92	47.92	48.06
Household private consumption	q	5.5362	5.5777	5.5756
Public good				
Public good consumption	Q	0.3921	0.3910	0.3909

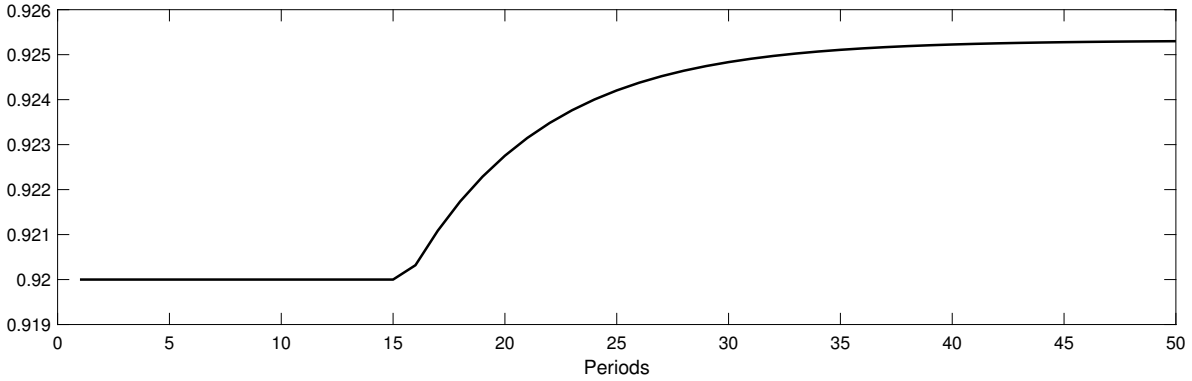
Notes: Steady state of endogenous variables under joint and separate taxation. The Pareto weight on primary earners' utility is normalised to 1 in both full commitment and limited commitment models. In the full commitment model, the Pareto weight on secondary earners' utility is set to 0.92 and kept constant before and after the tax reform. In the limited commitment model, the initial Pareto weight is set to 0.92 but is allowed to vary endogenously. If after the tax reform secondary earners' participation constraint is binding, the Pareto weight is adjusted to ensure that the value of marriage is at least as great as the value of divorce.

Figure 6: Secondary earners' values and bargaining power

(a) Secondary earners' value of marriage $\left(V_M^2\right)$ and divorce $\left(V_D^2\right)$



(b) Secondary earners' Pareto weight $\left(\mu^2\right)$

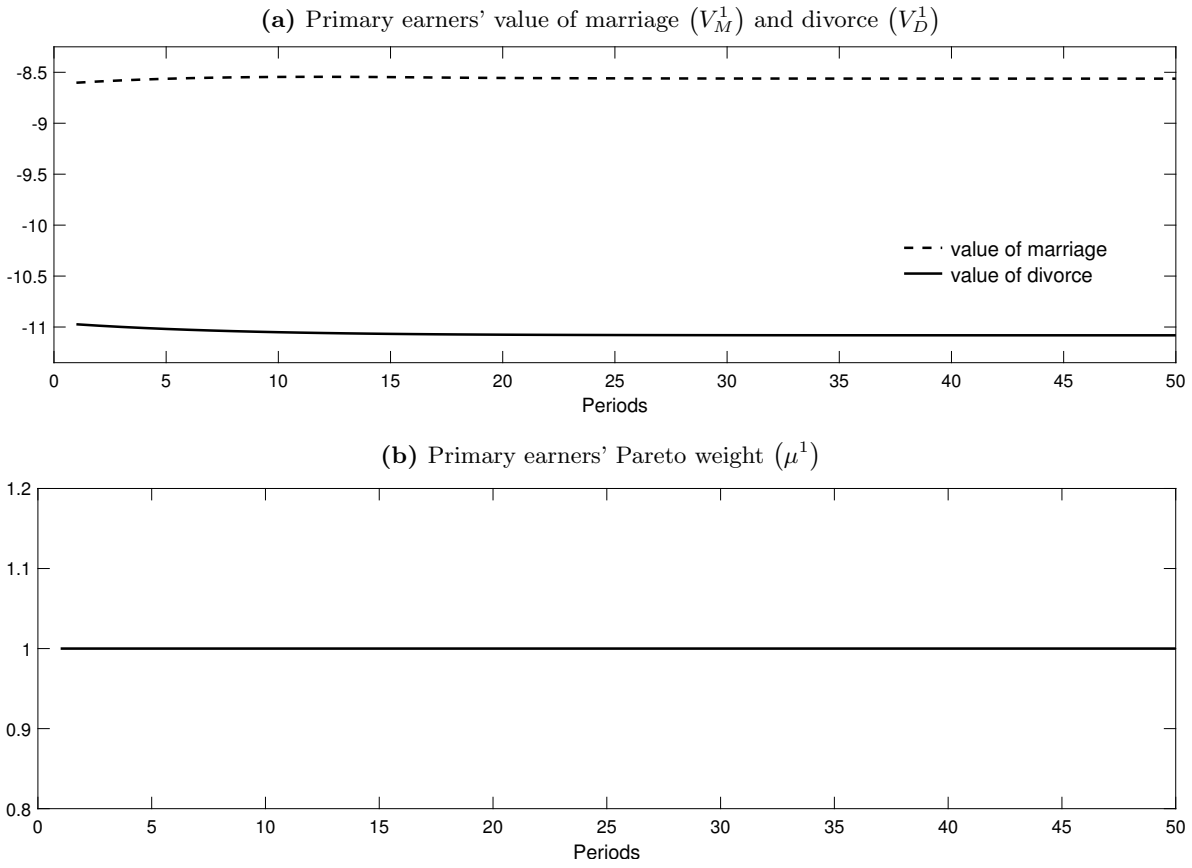


Notes: This figure shows the evolution of secondary earners' value and bargaining power after the tax reform. Panel (a) compares the value of staying in the household (marriage) to the value of the best outside option (divorce) for secondary earners. Panel (b) shows the variation in the Pareto weight on secondary earners' utility.

private consumption is constant despite the increase in their share of income over household income. Under limited commitment, the Pareto weight on secondary earners' utility increases to 0.9253 in the steady state under separate taxation, whereas the Pareto weight on primary earners' utility remains constant. The increase in secondary earners' bargaining power causes a redistribution of private good consumption from primary to secondary earners; that is, secondary earners' share of private good consumption over total private good consumption increases from 47.92 to 48.06 percentage points.

The endogenous variation in the bargaining power of secondary earners is entirely determined by the relative changes in the value of marriage and divorce along the transition from the steady state under joint taxation to the steady state under separate taxation. When the taxation system changes from joint to single filing, secondary earners incrementally increase their labour supply, which makes their stock of human capital increase as a consequence of more experience in the labour force. The gradual increase in the labour supply and human capital of secondary earners causes movements in their value of marriage as well as their value of divorce. On the one hand, the value of marriage is decreasing as the increase in labour

Figure 7: Primary earners' values and bargaining power



Notes: This figure shows the evolution of primary earners' value and bargaining power after the tax reform. Panel (a) compares the value of staying in the household (marriage) to the value of the best outside option (divorce) for primary earners. Panel (b) shows the variation in the Pareto weight on primary earners' utility.

supply is not adequately compensated by an increase in private consumption. On the other hand, the value of divorce is increasing as a result of better labour market conditions for secondary earners, i.e. a higher human capital.

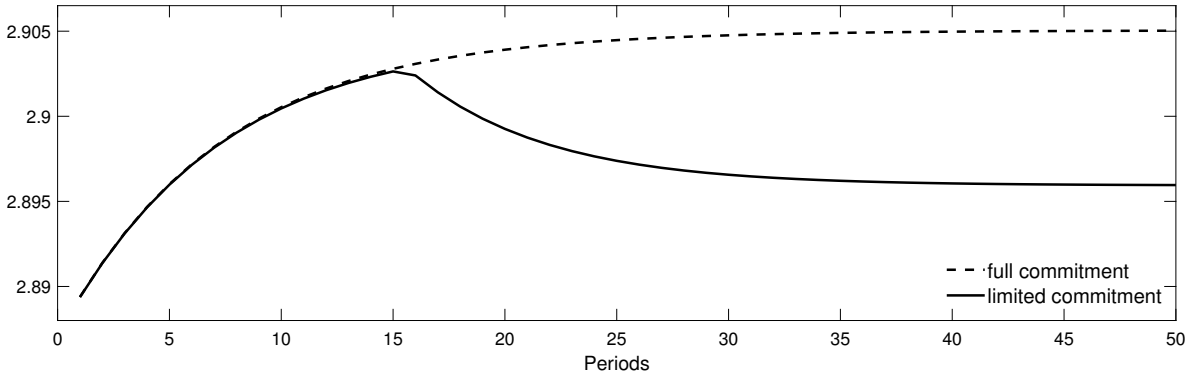
As Figure 6 shows, the continued reduction in the value of marriage along with the increase in the value of divorce makes the participation constraint of the household problem binding. Household members have to renegotiate intra-household allocations in order to ensure that the value of marriage is at least as great as the value of divorce, and thus the participation constraint is satisfied. This is achieved by gradually increasing the Pareto weight on secondary earners' utility. As the Pareto weight increases, secondary earners gain more bargaining power in the marriage, which ultimately translates into an increased share of secondary earners' private good consumption over household private good consumption.

Figure 7 shows the transition of primary earners' value of marriage and divorce, as well as the Pareto weight on primary earners' utility. After the tax reform, primary earners' value of marriage initially increases and subsequently falls to stabilise at its new steady state.[10] At

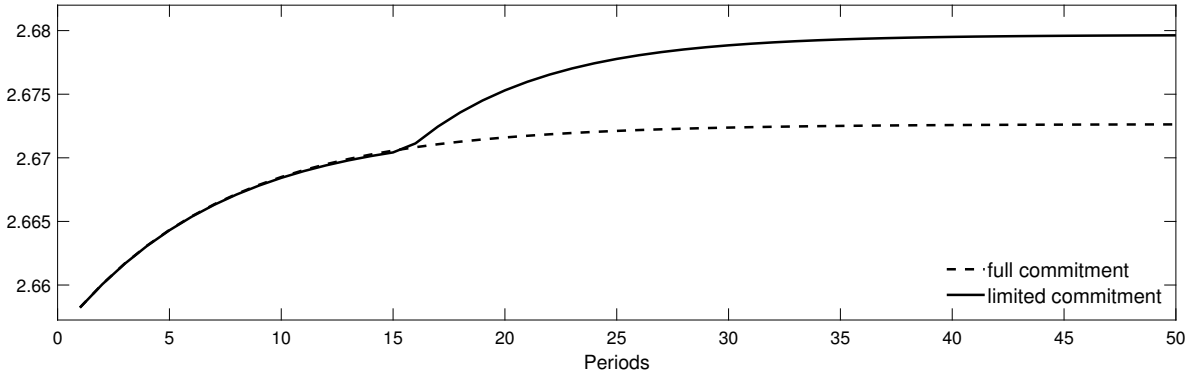
[10]The fall in primary earners' value of marriage is due to the reallocation of private good consumption from

Figure 8: Private good consumption dynamics

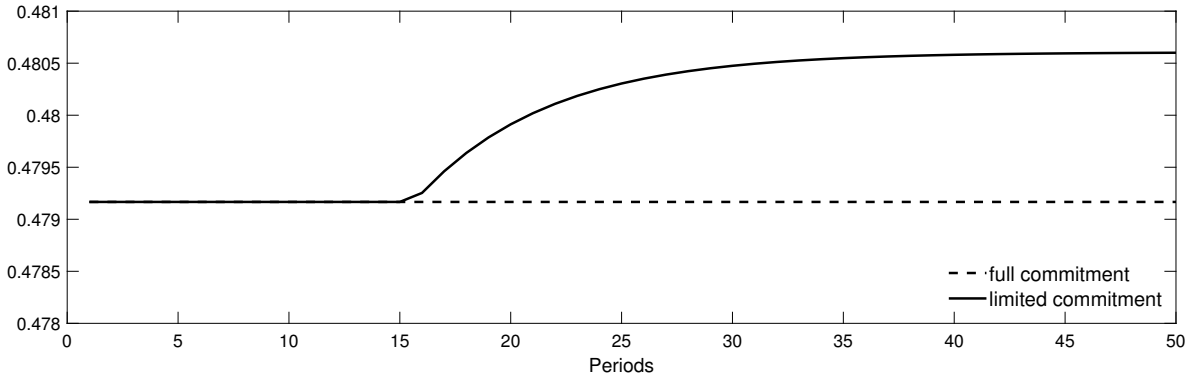
(a) Primary earners' private good consumption $\left(q^1\right)$



(b) Secondary earners' private good consumption $\left(q^2\right)$



(c) Secondary earners' share of private consumption $\left(q^2/q\right)$



Notes: This figure shows the evolution of private consumption after the tax reform under full commitment and limited commitment. Panel (a) shows primary earners' private good consumption. Panel (b) shows secondary earners' private good consumption. Panel (c) shows the share of secondary earners' private good consumption over household private good consumption.

the same time, the depreciation of primary earners' human capital is responsible for the fall in the value of divorce. Since the value of marriage is always larger than the value of divorce, the participation constraint for primary earners is always satisfied, and their Pareto weight remains constant along the transition.

The shift in relative bargaining power creates interesting dynamics of private good consumption. Figure 8 compares the transition of private good consumption under limited commitment to the transition under full commitment. After the tax reform, both primary and secondary earners' private consumption increase due to an increase in household labour income. Around sixteen periods after the switch to separate taxation, the sudden increase in secondary earners' bargaining power changes the trajectories of private good consumption. While primary earners' private good consumption starts to fall, secondary earners' private consumption increases at a faster rate. As a consequence, secondary earners enjoy a higher share of private good consumption in the household.

Figure 9 compares the dynamics of household's value and household members' value of marriage under limited commitment and full commitment. Household's value is computed as the sum of primary and secondary earners' value in the marriage. Under limited commitment, the Pareto weights are allowed to vary endogenously. Under full commitment, the Pareto weights are fixed at their initial values. Households members' value of marriage display a reverse pattern. While primary earners are better off in the full commitment scenario, secondary earners are better off in the limited commitment scenario. Under limited commitment, the transition to separate taxation is able to create a redistribution of private consumption from primary to secondary earners; hence, under limited commitment primary earners enjoy relatively less consumption, whereas secondary earners enjoy more.

After the tax reform, household's value remains roughly constant in both full commitment and limited commitment scenarios. Notice that compared to the full commitment case, under limited commitment household's value is higher, even though this difference seems to be small. Since secondary earners start from a lower level of consumption, their marginal utility from private consumption is higher than primary earners' marginal utility. Therefore, any redistribution of consumption from primary to secondary earners translates into a higher welfare at a household level.

6 Sensitivity analysis

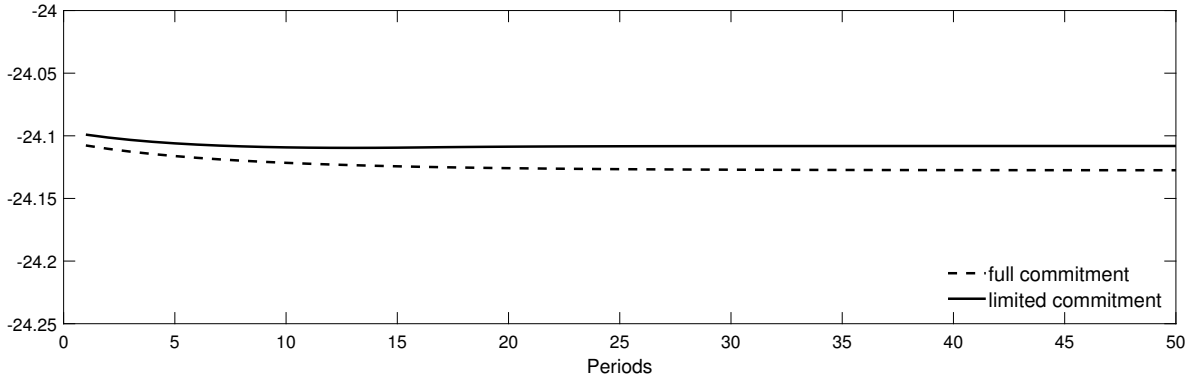
6.1 Initial bargaining power and gains from marriage

Household decisions on labour supply and intra-household allocations of consumption depend on the relative bargaining power of primary and secondary earners in the household. As shown in the previous section, any variation in the bargaining power depends on the endogenous variation of the gains from marriage of each household member, defined as the difference

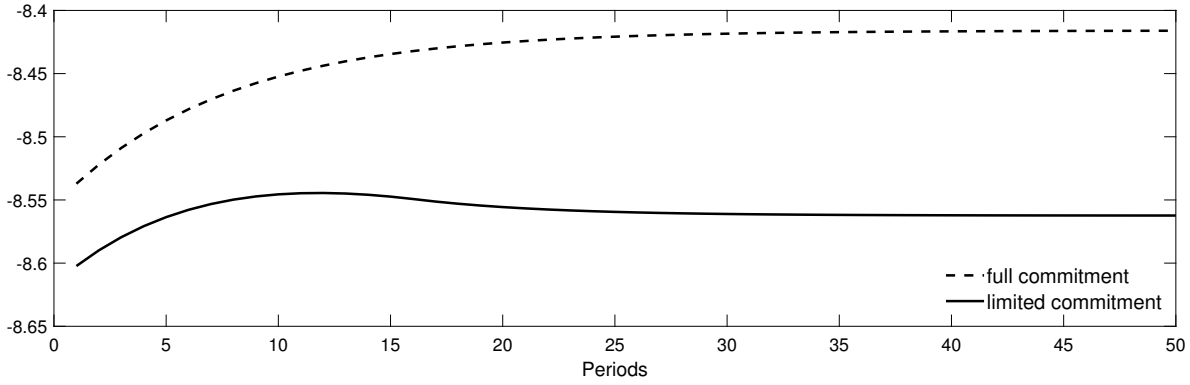
primary earners to secondary earners.

Figure 9: Household's value and household members' value of marriage

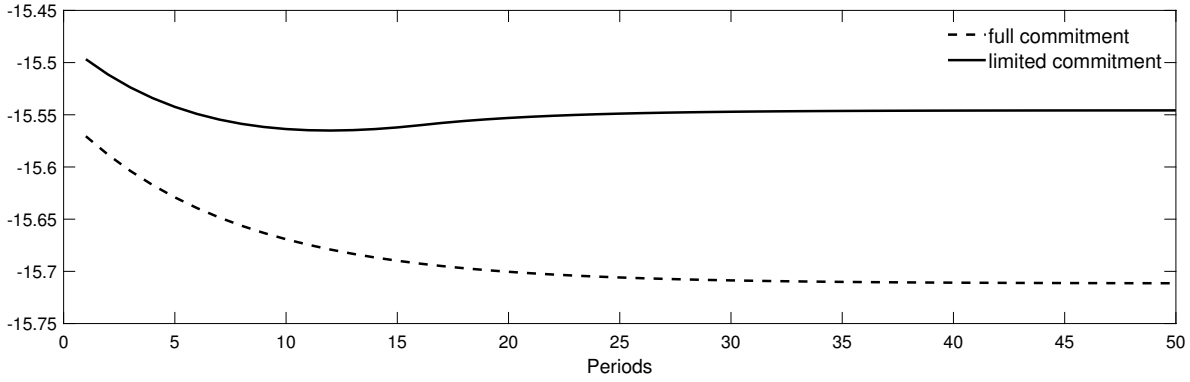
(a) Household's value



(b) Primary earners' value of marriage



(c) Secondary earners' value of marriage



Notes: This figure compares the evolution of household's value and household members' value of marriage under full commitment and limited commitment. Household's value is computed as the sum of household members' values. Panel (a) shows the value for the household. Panel (b) shows the value of marriage for primary earners. Panel (c) shows the value of marriage for secondary earners.

between the value of staying in the household and the value of the outside option. Therefore, the gains from marriage and the relative bargaining power of household members are key quantities in the model. On the one hand, the size of the gains from marriage determines whether primary and secondary earners' relative bargaining power endogenously responds to changes in external factors.[11] On the other hand, the initial bargaining power determines primary and secondary earners' initial share of the marriage surplus. Household members with higher (lower) bargaining power enjoy a larger (smaller) share of the marriage surplus. As a result, the initial bargaining power matters for the evolution of bargaining power after the tax reform.

In the previous section, I assumed a Pareto weight on secondary earners' utility equal to 0.92 and normalised the Pareto weight on primary earners' utility to one; then I showed that secondary earners' bargaining power increases along the transition from joint to separate taxation. In this section, I show how the evolution of primary and secondary earners' bargaining power and gains from marriage changes with the initial choice of Pareto weights.

Table 6 reports the steady state values of secondary earners' share of private good consumption and gains from marriage for different initial values of Pareto weights. As before, the Pareto weight on primary earners' utility is normalised to one, which means that primary and secondary earners' initial bargaining power is uniquely identified by choosing the Pareto weight on secondary earners' utility.[12] For each value of secondary earners' Pareto weight, Table 6 reports the steady state under joint (pre-reform) and separate taxation (post-reform).

As expected, lower values of the Pareto weight are associated with lower gains from marriage for secondary earners. Since the ratio of the Pareto weights controls the private good consumption sharing rule, lower values of secondary earners' Pareto weight imply a lower share of their private good consumption over households' private good consumption. As a result, secondary earners have access to a lower share of households' resources, and thus lower gains from marriage. Under joint taxation, any initial Pareto weight higher than 0.88 is such that the gains from marriage for secondary earners are positive. Conversely, any initial Pareto weight lower than or equal to 0.88 implies that secondary earners' gains from marriage are negative, and their participation constraint is not satisfied.

The tax reform influences secondary earners' gains from marriage and share of private consumption differently depending on the initial bargaining power. For all initial Pareto

[11] For instance, household members that enjoy large gains from marriage are less likely to see their bargaining power change as their participation constraint is less likely to bind. Conversely, household members that enjoy small gains from marriage are more likely to experience an increase in their bargaining power as their participation constraint is more likely to bind.

[12] The choice of secondary earners' initial Pareto weight is arbitrary. The model introduced in Section 4 assumes that households are already formed, and it lacks a marriage market where individuals meet and decide to marry; therefore, the *initial* bargaining power of married couples is not endogenously determined as a function of individuals' characteristics and is taken as given. This assumption allows me to investigate the behaviour of households whose Pareto weights are off the equilibrium outcome of the marriage market, and to focus on married couples whose relative bargaining power has evolved over time due to exogenous factors which are hard to model or to identify in the data.

Table 6: Secondary earners' bargaining power and gains from marriage

	Initial Pareto weight (μ^2)						
Description	0.88	0.89	0.90	0.91	0.92	0.93	0.94
Pre–reform (joint taxation)							
Private good cons. share (%)	46.81	47.09	47.37	47.64	47.92	48.19	48.45
Gains from marriage	-0.279	0.194	0.661	1.123	1.580	2.032	2.482
Participation constr. binding	yes	no	no	no	no	no	no
Post–reform (separate taxation)							
Gains from marriage	0	0	0	0	0	0.178	0.522
Participation constr. binding	yes	yes	yes	yes	yes	no	no
Period binding	1	2	3	8	16		
Pareto weight	0.929	0.928	0.927	0.926	0.925	0.93	0.94
Private good cons. share (%)	48.16	48.14	48.11	48.09	48.06	48.19	48.45

Notes: Steady state of secondary earners' share of private good consumption and gains from marriage. The model is simulated for each different value of the initial Pareto weight on secondary earners' utility. The Pareto weight on primary earners' utility is normalised to one.

weights, the gains from marriage are smaller in the steady state under separate taxation.[13] This is because under the new tax system, secondary earners have a higher stock of human capital and enjoy better labour market conditions. As a result, the value of their outside option increases, making the prospect of staying in the household less appealing. However, an internal redistribution of private consumption only occurs if the initial Pareto weight is 0.92 or lower. If secondary earners' bargaining power is low enough, secondary earners' gains from marriage gradually decrease to an extent which makes the participation constraint binding. When this happens, household members renegotiate intra-household allocations of private consumption to ensure that secondary earners are at least as better off as in their outside option. As a result, secondary earners' share of private consumption increases in the steady state under separate taxation.

The timing of the internal renegotiation depends on the initial bargaining power as well. Secondary earners with a lower bargaining power enjoy a smaller share of marital surplus; therefore, their gains from marriage erode more quickly as their value of divorce increases. For instance, with an initial Pareto weight of 0.91 the participation constraint starts to bind eight periods after the tax reform, and with an initial Pareto weight of 0.89 the participation constraint starts to bind after two periods only.[14]

[13]The only exception being the case where $\mu^2 = 0.88$. In this case, the participation constraint is violated immediately and the gains from marriage are set to zero to enforce secondary earners' participation in the marriage.

[14]Figures showing the transition of secondary earners' value of marriage, value of divorce, and bargaining power can be found in the Appendix.

Table 7: Labour market and aggregate effects

Description	Variable	Joint taxation	Separate taxation	
			full model	partial eq.
Aggregate quantities				
Aggregate labour supply	H	3.2846	3.3324	3.3321
Wage per efficiency unit	w	1	0.9952	1
Labour supply and human capital				
Primary earner labour supply	h^1	0.5644	0.5271	0.5271
Primary earner human capital	θ^1	7.8221	7.6357	7.6355
Secondary earner labour supply	h^2	0.3252	0.3820	0.3820
Secondary earner human capital	θ^2	6.6258	6.9101	6.9099
Income and consumption				
Households income	y	6.5693	6.6328	6.6641
Taxes	T	1.0331	1.0572	1.0640
Household consumption	q	5.5362	5.5756	5.6001

Notes: Steady state of endogenous variables under joint and separate taxation. Values are reported for the full model and the restricted model (partial equilibrium). The full model is calibrated to ensure that the equilibrium wage per efficiency unit is equal to one in the steady state under joint taxation. Therefore, full and partial equilibrium model coincide under joint taxation.

6.2 Labour market and aggregate effects

This section focuses on the labour market effects generated by the tax reform. In particular, I investigate whether the change in taxation system is able to generate movements in aggregate quantities and equilibrium wages. To identify any aggregate effect, I compare the steady state of the full model to the steady state of a restricted version of the model without a labour market. In the restricted version of the model—which I refer to as partial equilibrium model—I assume that the wage per efficiency unit does not respond to aggregate labour supply variations and remains constant throughout the transition to the new steady state.[15] In the restricted model, I normalise the wage per efficiency unit to one. In the full model, I calibrate firms' total factor productivity to target a wage per efficiency unit equal to one in the steady state under joint taxation. As a result, both restricted and full model have an identical steady state under joint taxation.

Table 7 reports the steady state before and after the tax reform. As previously discussed, the switch to a separate taxation system creates a substitution effect where secondary earners increase their labour supply and primary earners reduce theirs. Similarly, secondary earners' human capital increases and primary earners' human capital is reduced. Overall, aggregate labour supply—measured in efficiency units—slightly increases in the steady state under sep-

[15]Formally, the partial equilibrium model is defined by households' optimality conditions only. Firms' optimality conditions and market clearing are omitted. The wage per efficiency unit is a constant parameter.

arate taxation, which pushes the equilibrium wage downwards. Nevertheless, the movement in the wage per efficiency unit is very small, and households' labour supply response to such change is barely noticeable if not absent. That is, primary and secondary earners' labour supply and human capital in the full model are almost identical to their counterparts in the partial equilibrium model. Some difference is present in households' income; due to a reduction in the wage per efficiency unit, households' income before and after taxes is slightly lower in the full model compared to the partial equilibrium model.

7 Conclusions

Joint and separate taxation systems differ in two key aspects. First, there exists a tax bonus for married couples when income is filed jointly; that is, the tax liabilities of married individuals under joint taxation are lower than their combined liabilities under separate taxation. Secondly, the marginal tax rate on primary and secondary earners' income differs across taxation systems, with secondary earners' marginal tax rate being higher under joint taxation. Recent literature has shown that these differences in household tax treatment matter for labour supply decisions of primary and secondary earners. Nevertheless, the implications for households' internal decision making process and allocation of consumption between primary and secondary earners have been for the most part unexplored.

This paper documents households' labour supply, patterns of human capital formation, and changes in intra-household allocations of consumption along the transition from joint to separate taxation. Household behaviour is described by an inter-temporal version of the collective household model, where the relative bargaining power of primary and secondary earners determines intra-household allocations of consumption and time. Household members can only partially commit to present and future allocations, which means that previously agreed allocations are occasionally renegotiated when the relative bargaining power of household members shifts.

The quantitative exercise in this paper shows that the tax reform causes an internal redistribution of consumption from primary to secondary earners in households where the bargaining power of secondary earners is low. The size of the redistribution depends on the initial bargaining power of household members; the lower the bargaining power of secondary earners, the higher the magnitude of the redistribution. When the tax system changes from joint to single filing, the marginal tax rate on secondary earners' income is reduced. A lower marginal tax rate creates an incentive for secondary earners to increase their labour force participation, with a positive effect on their human capital and value of divorce. Along the transition from joint to separate taxation, the gradual increase in the value of the outside option makes secondary earners' participation constraint binding, which causes their Pareto weight to increase. A higher bargaining power translates into a higher share of secondary earners' private good consumption in the household.

References

Alesina, A., Ichino, A., and Karabarbounis, L. (2011). Gender-based taxation and the division of family chores. *American Economic Journal: Economic Policy*, 3(2):1–40.

Apps, P. and Rees, R. (1999). On the taxation of trade within and between households. *Journal of Public Economics*, 73(2):241–263.

Apps, P. F. and Rees, R. (1988). Taxation and the household. *Journal of Public Economics*, 35(3):355–369.

Bastani, S. (2013). Gender-based and couple-based taxation. *International tax and public finance*, 20(4):653–686.

Bick, A. and Fuchs-Schündeln, N. (2017). Quantifying the disincentive effects of joint taxation on married women's labor supply. *American Economic Review*, 107(5):100–104.

Bick, A. and Fuchs-Schündeln, N. (2018). Taxation and labour supply of married couples across countries: A macroeconomic analysis. *The Review of Economic Studies*, 85(3):1543–1576.

Blundell, R., Costa Dias, M., Meghir, C., and Shaw, J. (2016). Female labor supply, human capital, and welfare reform. *Econometrica*, 84(5):1705–1753.

Bronson, M. A. and Mazzocco, M. (2019). Taxation and household decisions: an intertemporal analysis.

Chade, H. and Ventura, G. (2002). Taxes and marriage: a two-sided search analysis. *International Economic Review*, 43(3):955–985.

Chade, H. and Ventura, G. (2005). Income taxation and marital decisions. *Review of Economic Dynamics*, 8(3):565–599.

Chiappori, P.-A. (1988). Rational household labor supply. *Econometrica: Journal of the Econometric Society*, pages 63–90.

Chiappori, P.-A. (1992). Collective labor supply and welfare. *Journal of political Economy*, 100(3):437–467.

Gayle, G.-L. and Shephard, A. (2019). Optimal taxation, marriage, home production, and family labor supply. *Econometrica*, 87(1):291–326.

Guner, N., Kaygusuz, R., and Ventura, G. (2012a). Taxation and household labour supply. *The Review of Economic Studies*, 79(3):1113–1149.

Guner, N., Kaygusuz, R., and Ventura, G. (2012b). Taxing women: A macroeconomic analysis. *Journal of Monetary Economics*, 59(1):111–128.

Guner, N., Kaygusuz, R., and Ventura, G. (2014). Income taxation of U.S. households: Facts and parametric estimates. *Review of Economic Dynamics*, 17(4):559–581.

Karabarbounis, M. (2016). A road map for efficiently taxing heterogeneous agents. *American Economic Journal: Macroeconomics*, 8(2):182–214.

Kleven, H. J., Kreiner, C. T., and Saez, E. (2009). The optimal income taxation of couples. *Econometrica*, 77(2):537–560.

Marcet, A. and Marimon, R. (2019). Recursive contracts. *Econometrica (forthcoming)*.

Mazzocco, M. (2007). Household intertemporal behaviour: A collective characterization and a test of commitment. *The Review of Economic Studies*, 74(3):857–895.

Obermeier, T. (2019). The marriage market, inequality and the progressivity of the income tax. Technical report, University of Bonn and University of Mannheim, Germany.

Oikonomou, R. and Siegel, C. (2015). Capital taxes, labor taxes and the household. *Journal of Demographic Economics*, 81(3):217–260.

Peterman, W. B. (2015). Reconciling micro and macro estimates of the frisch labor supply elasticity. *Economic Inquiry*, 54(1):100–120.

Appendix

A Tax function definition and properties

Definition 1 (Tax function)**.** $\mathcal{T} : \mathbb{R}_+ \to \mathbb{R}$ is a tax function that maps labour income into taxes. The tax function $\mathcal{T}$ has the following properties:

($p1$) $\mathcal{T}$ is continuous and differentiable in every point of the domain.

($p2$) $\mathcal{T}$ is convex, that is

$$\mathcal{T}\left(\lambda y^1 + (1-\lambda)\, y^2\right) \leq \lambda \mathcal{T}\left(y^1\right) + (1-\lambda)\, \mathcal{T}\left(y^2\right)$$

for every $y^1, y^2 \in \mathbb{R}_+$ and $\lambda \in [0,1]$.

($p3$) $\mathcal{T}$ is monotonically increasing, that is

$$\mathcal{T}\left(y^1\right) \geq \mathcal{T}\left(y^2\right)$$

for every $y^1, y^2 \in \mathbb{R}_+$ that satisfy $y^1 \geq y^2$.

($p4$) Its first derivative $\mathcal{T}'$ is such that

$$0 \leq \mathcal{T}'\left(y\right) \leq 1$$

for every $y \in \mathbb{R}_+$.

($p5$) Its first derivative $\mathcal{T}'$ is monotonically increasing, that is

$$\mathcal{T}'\left(y^1\right) \geq \mathcal{T}'\left(y^2\right)$$

for every $y^1, y^2 \in \mathbb{R}_+$ that satisfy $y^1 \geq y^2$.

B Proofs

Proposition 1

Proof of Proposition 1. Since $y^2 \leq y^1$, we have that $y^2 \leq \frac{y^1+y^2}{2} \leq y^1$. Using the monotonicity of the first derivative of $\mathcal{T}$ (property p5), it follows that

$$\mathcal{T}'\left(y^2\right) \leq \mathcal{T}'\left(\frac{y^1+y^2}{2}\right) \leq \mathcal{T}'\left(y^1\right).$$

Proposition 1 is obtained by applying the definitions of marginal tax rates under joint and separate taxation. □

Proposition 2

Proof of Proposition 2. Let us define $\overline{y}$ as $\overline{y} \equiv \frac{y^1+y^2}{2}$. It is immediate to see that $\overline{y}$ is a convex combination of y^1 and y^2 with $\lambda = \frac{1}{2}$, that is

$$\overline{y} = \lambda y^1 + (1-\lambda)\, y^2 = \frac{1}{2}y^1 + \frac{1}{2}y^2 \,.$$

By the convexity of $\mathcal{T}$ (property p2), it follows that

$$\begin{aligned} \mathcal{T}\left(\overline{y}\right) &\leq \frac{1}{2}\mathcal{T}\left(y^1\right) + \frac{1}{2}\mathcal{T}\left(y^2\right) \\ 2\mathcal{T}\left(\overline{y}\right) &\leq \mathcal{T}\left(y^1\right) + \mathcal{T}\left(y^2\right) \end{aligned}$$

for all $y^1, y^2 \in \mathbb{R}_+$.

Proposition 2 is obtained by using the definition of household tax liabilities under joint and separate taxation respectively. □

Proposition 3

Proof of Proposition 3. Proposition 3 relies on the fact that tax liabilities under joint taxation depend on the sum of primary and secondary earners' income only. Since $\left(y_s^1, y_s^2\right)$ is such that

$$y_s^1 = y_j^1 - \Delta^1, \qquad y_s^2 = y_j^2 + \Delta^2$$

and $\Delta^1 = \Delta^2$, it follows that

$$y_s^1 + y_s^2 = y_j^1 - \Delta^1 + y_j^2 + \Delta^2 = y_j^1 + y_j^1 \tag{1}$$

hence

$$\frac{y_s^1 + y_s^2}{2} = \frac{y_j^1 + y_j^1}{2} \,.$$

Using the definition of tax liabilities under joint taxation, we can establish that

$$T^{joint}\left(y_s^1, y_s^2\right) = 2\mathcal{T}\left(\frac{y_s^1 + y_s^2}{2}\right) = 2\mathcal{T}\left(\frac{y_j^1 + y_j^2}{2}\right) = T^{joint}\left(y_j^1, y_j^2\right)$$

which combined with (1) gives

$$y_s^1 + y_s^2 - T^{joint}\left(y_s^1, y_s^2\right) = y_j^1 + y_j^1 - T^{joint}\left(y_j^1, y_j^2\right) \,. \tag{2}$$

Corollary 1 guarantees that for any pair $\left(y_s^1, y_s^2\right)$ we have that

$$y_s^1 + y_s^2 - T^{joint}\left(y_s^1, y_s^2\right) \geq y_s^1 + y_s^2 - T^{sep}\left(y_s^1, y_s^2\right) \,. \tag{3}$$

Combining equality (2) with inequality (3) completes the proof. □

C Household problem optimality conditions

In this section, I show the optimality conditions of the limited commitment household problem introduced in Section 4. Following Marcet and Marimon (2019), the Lagrangean of the problem can be rearranged by expressing the Pareto weights on household members' utility as a function of the Lagrange multipliers on past periods participation constraints. Formally, the Pareto weight on household member $m \in \{1, 2\}$ utility function evolves according to

$$\mu_t^m = \mu_{t-1}^m + \alpha_t^m$$

for every $t \geq 1$, where α_t^m is the Lagrange multiplier on the participation constraint of household member m in period t and $\mu_0^m \equiv \mu^m$ is the initial Pareto weight which is given as a parameter of the model. This formulation is useful as it allows us to measure the size of household members' bargaining power in period t, μ_t^m, without having to keep track of the whole history of Lagrange multipliers up to that period, $\{\alpha_\tau^m\}_{\tau=1}^t$. The Pareto weight μ_t^m therefore becomes a co-state variable of the dynamic problem.

The Lagrangean of the household problem is given by

$$\begin{aligned}
\mathcal{L} = \sum_{t=1}^{\infty} \beta^{t-1} \Bigg\{ & \mu_t^1 \left(\gamma^1 \log Q_t + \frac{\left(q_t^1\right)^{1-\sigma^1} - 1}{1-\sigma^1} - \phi^1 \frac{\left(h_t^1 + d_t^1\right)^{1+1/\eta^1}}{1+1/\eta^1} \right) \\
& + \mu_t^2 \left(\gamma^2 \log Q_t + \frac{\left(q_t^2\right)^{1-\sigma^2} - 1}{1-\sigma^2} - \phi^2 \frac{\left(h_t^2 + d_t^2\right)^{1+1/\eta^2}}{1+1/\eta^2} \right) \\
& - \lambda_t \left(q_t^1 + q_t^2 + T\left(w_t \theta_t^1 h_t^1, w_t \theta_t^2 h_t^2\right) - w_t \theta_t^1 h_t^1 - w_t \theta_t^2 h_t^2 \right) \\
& - \zeta_t \left(Q_t - A \left(d_t^1\right)^{\delta_1} \left(d_t^2\right)^{\delta_2} \right) \\
& - \nu_t^1 \left(\theta_{t+1}^1 - \left(1 - \delta_\theta^1\right) \theta_t^1 - h_t^1 - \delta_\theta^1 \bar{\theta}^1 \right) \\
& - \nu_t^2 \left(\theta_{t+1}^2 - \left(1 - \delta_\theta^2\right) \theta_t^2 - h_t^2 - \delta_\theta^2 \bar{\theta}^2 \right) \\
& - \alpha_t^1 V_D^1\left(\theta_t^1\right) \\
& - \alpha_t^2 V_D^2\left(\theta_t^2\right) \Bigg\}
\end{aligned}$$

where $V_D^1(\cdot)$ and $V_D^2(\cdot)$ are the value functions of the outside option problems of primary and secondary earners respectively.

The associated system of optimality conditions is

$$\mu^1 \left(q_t^1\right)^{-\sigma^1} = \lambda_t \tag{4}$$

$$\mu^2 \left(q_t^2\right)^{-\sigma^2} = \lambda_t \tag{5}$$

$$\left(\mu^1\gamma^1 + \mu^2\gamma^2\right)\frac{\delta_1}{d_t^1} = \mu^1\phi^1\left(h_t^1 + d_t^1\right)^{1/\eta^1} \tag{6}$$

$$\left(\mu^1\gamma^1 + \mu^2\gamma^2\right)\frac{\delta_2}{d_t^2} = \mu^2\phi^2\left(h_t^2 + d_t^2\right)^{1/\eta^2} \tag{7}$$

$$\lambda_t\theta_t^1 w_t\left[1 - T_1\left(w_t\theta_t^1 h_t^1, w_t\theta_t^2 h_t^2\right)\right] + \nu_t^1 = \mu^1\phi^1\left(h_t^1 + d_t^1\right)^{1/\eta^1} \tag{8}$$

$$\lambda_t\theta_t^2 w_t\left[1 - T_2\left(w_t\theta_t^1 h_t^1, w_t\theta_t^2 h_t^2\right)\right] + \nu_t^2 = \mu^2\phi^2\left(h_t^2 + d_t^2\right)^{1/\eta^2} \tag{9}$$

$$\beta\left\{\lambda_{t+1}w_{t+1}h_{t+1}^1\left[1 - T_1\left(w_{t+1}\theta_{t+1}^1 h_{t+1}^1, w_{t+1}\theta_{t+1}^2 h_{t+1}^2\right)\right] + \left(1 - \delta_\theta^1\right)\nu_{t+1}^1 - \alpha_{t+1}^1 {}^{\partial V_D^1/\partial\theta_{t+1}^1}\right\} = \nu_t^1 \tag{10}$$

$$\beta\left\{\lambda_{t+1}w_{t+1}h_{t+1}^2\left[1 - T_2\left(w_{t+1}\theta_{t+1}^1 h_{t+1}^1, w_{t+1}\theta_{t+1}^2 h_{t+1}^2\right)\right] + \left(1 - \delta_\theta^2\right)\nu_{t+1}^2 - \alpha_{t+1}^2 {}^{\partial V_D^2/\partial\theta_{t+1}^2}\right\} = \nu_t^2 \tag{11}$$

$$\theta_{t+1}^1 = \left(1 - \delta_\theta^1\right)\theta_t^1 + h_t^1 + \delta_\theta^1\bar{\theta}^1 \tag{12}$$

$$\theta_{t+1}^2 = \left(1 - \delta_\theta^2\right)\theta_t^2 + h_t^2 + \delta_\theta^2\bar{\theta}^2 \tag{13}$$

$$q_t^1 + q_t^2 + T\left(w_t\theta_t^1 h_t^1, w_t\theta_t^2 h_t^2\right) = w_t\theta_t^1 h_t^1 + w_t\theta_t^2 h_t^2 \tag{14}$$

$$Q_t = A\left(d_t^1\right)^{\delta_1}\left(d_t^2\right)^{\delta_2} \tag{15}$$

$$H_t^S = \frac{1}{2}\theta_t^1 h_t^1 + \frac{1}{2}\theta_t^2 h_t^2 \tag{16}$$

$$\alpha A_Y\left(H_t^D\right)^{\alpha-1} = w_t \tag{17}$$

$$H_t^S = H_t^D \tag{18}$$

along with the Kuhn–Tucker conditions on primary earner's participation constraint

$$\alpha_t^1 \geq 0 \tag{19}$$

$$\sum_{\tau=0}^{\infty}\beta^\tau u^1\left(Q_{t+\tau}, q_{t+\tau}^1, h_{t+\tau}^1, d_{t+\tau}^1\right) \geq V_D^1\left(\theta_t^1\right) \tag{20}$$

$$\alpha_t^1\left(\sum_{\tau=0}^{\infty}\beta^\tau u^1\left(Q_{t+\tau}, q_{t+\tau}^1, h_{t+\tau}^1, d_{t+\tau}^1\right) - V_D^1\left(\theta_t^1\right)\right) = 0 \tag{21}$$

and secondary earner's participation constraint

$$\alpha_t^2 \geq 0 \tag{22}$$

$$\sum_{\tau=0}^{\infty} \beta^\tau u^2 \left(Q_{t+\tau}, q_{t+\tau}^2, h_{t+\tau}^2, d_{t+\tau}^2\right) \geq V_D^2 \left(\theta_t^2\right) \tag{23}$$

$$\alpha_t^2 \left(\sum_{\tau=0}^{\infty} \beta^\tau u^2 \left(Q_{t+\tau}, q_{t+\tau}^2, h_{t+\tau}^2, d_{t+\tau}^2\right) - V_D^2 \left(\theta_t^2\right) \right) = 0. \tag{24}$$

The relationship between Lagrange multipliers, Pareto weights, and intra-household renegotiations is entirely described by the Kuhn-Tucker conditions and the Pareto weights' law of motion. Whenever the participation constraint of household member m is slack, the complementary slackness condition 21 or 24 implies that the Lagrange multiplier α_t^m must be zero and the Pareto weight is constant, that is

$$\alpha_t^m = 0 \quad \Longrightarrow \quad \mu_t^m = \mu_{t-1}^m .$$

Conversely, if the participation constraint is binding the Lagrange multiplier is strictly positive and the Pareto weight increases to ensure that the participation constraint is satisfied as an equality, that is

$$\alpha_t^m > 0 \quad \Longrightarrow \quad \mu_t^m > \mu_{t-1}^m$$

and μ_t^m is determined endogenously to satisfy

$$\sum_{\tau=0}^{\infty} \beta^\tau u^m \left(Q_{t+\tau}, q_{t+\tau}^m, h_{t+\tau}^m, d_{t+\tau}^m\right) = V_D^m \left(\theta_t^m\right) .$$

D Value of the outside option

The value function of divorce for primary and secondary earners appears in a number of optimality conditions; namely in equations (10) and (11) as well as in the Kuhn-Tucker conditions (19)–(21) and (22)–(24).

When solving the model, both value functions $V_D^1(\cdot)$ and $V_D^2(\cdot)$ as well as their first derivatives have to be known in advance in order to check whether the participation constraints are binding along the transition from the old steady state to the new steady state. Therefore, the outside option problem must be solved and value functions obtained before solving the main problem.

The outside option problem for household member $m \in \{1, 2\}$ can be rearranged into a

recursive form as follows

$$
\begin{aligned}
V_D^m\left(\theta^m\right) \equiv \max_{\{Q,q^m,h^m,d^m,\theta^{m'}\}} \quad & \left\{u^m(Q,q^m,h^m,d^m)+\beta V_D^m\left(\theta^{m'}\right)\right\} \\
\text{s.t.} \quad & q^m + T(w\theta^m h^m) = w\theta^m h^m \pm tr \\
& \theta^{m'} = (1-\delta_\theta^m)\theta^m + h^m + \delta_\theta^m \overline{\theta}^m \\
& Q = \overline{A}_Q (d^1)^{\delta_1} (d^2)^{\delta_2}
\end{aligned}
$$

where $\theta^{m'}$ denotes next period stock of human capital and the hours devoted to home production of the other household member are taken as given and assumed to be at their steady state value.

The above recursive problem is solved independently from the main household problem and the value function is obtained by value function iteration. In order to increase the precision outside the grid points, I interpolate the value function using Chebyshev polynomials.

The first derivative of the value function is obtained by applying the following Envelope condition

$$
V_D^{m'}\left(\theta^{m'}(\theta^m)\right) = \frac{\nu(\theta^m)}{\beta}
$$

at each grid point $\theta^m \in \Theta$ and interpolating the obtained values afterwards. $\nu(\cdot)$ and $\theta^{m'}(\cdot)$ denote the policy functions where ν is the Lagrange multiplier on the human capital accumulation constraint.

E Model solution

This section reports details on how to compute the transition from the steady state under joint taxation to the steady state under separate taxation. Given the absence of exogenous shocks in the model, the transition can be obtained as the solution to a boundary value problem where the initial condition is given by the steady state of state variables under joint taxation and the final condition is given by the steady state under separate taxation. That is, the transition is simply a sequence of allocations that satisfy the optimality conditions of the household problem in every period.

Formally, the transition is defined as follows. First, notice that the Kuhn–Tucker conditions (19)–(21) and (22)–(24) can be redefined as

$$
\min\left\{\mu_t^1 - \mu_{t-1}^1, \sum_{\tau=0}^{\infty} \beta^\tau u^1\left(Q_{t+\tau}, q_{t+\tau}^1, h_{t+\tau}^1, d_{t+\tau}^1\right) - V_D^1\left(\theta_t^1\right)\right\} = 0 \tag{25}
$$

$$
\min\left\{\mu_t^2 - \mu_{t-1}^2, \sum_{\tau=0}^{\infty} \beta^\tau u^2\left(Q_{t+\tau}, q_{t+\tau}^2, h_{t+\tau}^2, d_{t+\tau}^2\right) - V_D^2\left(\theta_t^2\right)\right\} = 0 \tag{26}
$$

where the min operator ensures that both non-negativity and complementary slackness con-

ditions are satisfied.

Second, the system of household optimality conditions can be rearranged into a $f\left(x_t, x_{t+1}; \mu_t, \mu_{t+1}\right) = 0$ form where $x_t \equiv \left(Q_t, q_t^1, q_t^2, h_t^1, h_t^2, d_t^1, d_t^2, \theta_t^1, \theta_t^2\right)$ is the vector of endogenous variables and $\mu_t \equiv \left(\mu_t^1, \mu_t^2\right)$ is the vector of Pareto weights at period t. The function f is defined by

$$f(x_t, x_{t+1}; \mu_t, \mu_{t+1}) \equiv \begin{pmatrix} g(x_t, x_{t+1}; \mu_t, \mu_{t+1}) \\ h(x_t, x_{t+1}; \mu_t, \mu_{t+1}) \end{pmatrix}$$

where $g\left(\cdot\right)$ represents the equalities (4)–(15) and $h\left(\cdot\right)$ represents the Kuhn–Tucker conditions (25) and (26), that is

$$h(x_t, x_{t+1}; \mu_t, \mu_{t+1}) \equiv \begin{pmatrix} \min\left\{\mu_t^1 - \mu_{t-1}^1, \sum_{\tau=0}^{\infty} \beta^\tau u^1\left(Q_{t+\tau}, q_{t+\tau}^1, h_{t+\tau}^1, d_{t+\tau}^1\right) - V_D^1\left(\theta_t^1\right)\right\} \\ \min\left\{\mu_t^2 - \mu_{t-1}^2, \sum_{\tau=0}^{\infty} \beta^\tau u^2\left(Q_{t+\tau}, q_{t+\tau}^2, h_{t+\tau}^2, d_{t+\tau}^2\right) - V_D^2\left(\theta_t^2\right)\right\} \end{pmatrix}.$$

Third, denote by $\mathbf{x} \equiv \left\{x_t, \mu_t\right\}_{t=1}^T$ the sequence of allocations and Pareto weights from period $t = 1$ to period $t = T$ and by

$$\mathbf{F}\left(\mathbf{x}\right) \equiv \begin{cases} f(x_1, x_2; \mu_1, \mu_2) \\ \vdots \\ f(x_t, x_{t+1}; \mu_t, \mu_{t+1}) \\ \vdots \\ f(x_T, x_{T+1}; \mu_T, \mu_{T+1}) \end{cases} \tag{27}$$

the collection of optimality conditions. Notice that the initial condition on state variables $\left(\theta_0^1, \theta_0^2\right)$ and co–state variables $\left(\mu_0^1, \mu_0^2\right)$ is given by their steady state values under joint taxation. Moreover, T should be large enough to allow the model to reach the steady state condition $x_T = x_{T+1}$ and $\mu_T = \mu_{T+1}$.

Finally, the transition from the steady state under joint taxation to the steady state under separate taxation is given by the sequence of allocations and Pareto weights that solves the system of equations 27 defined above. That is, the transition is the vector $\mathbf{x}^*$ such that

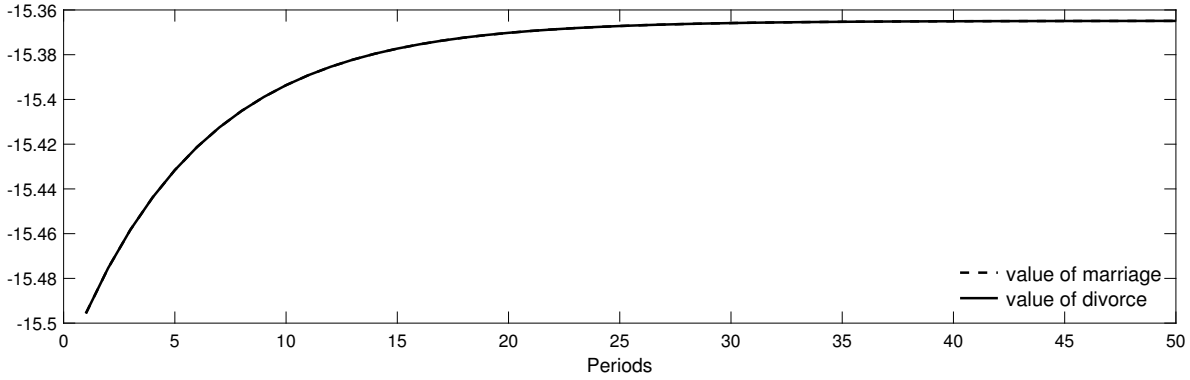
$$\mathbf{F}\left(\mathbf{x}^*\right) = \mathbf{0}.$$

F Initial bargaining power and gains from marriage transition

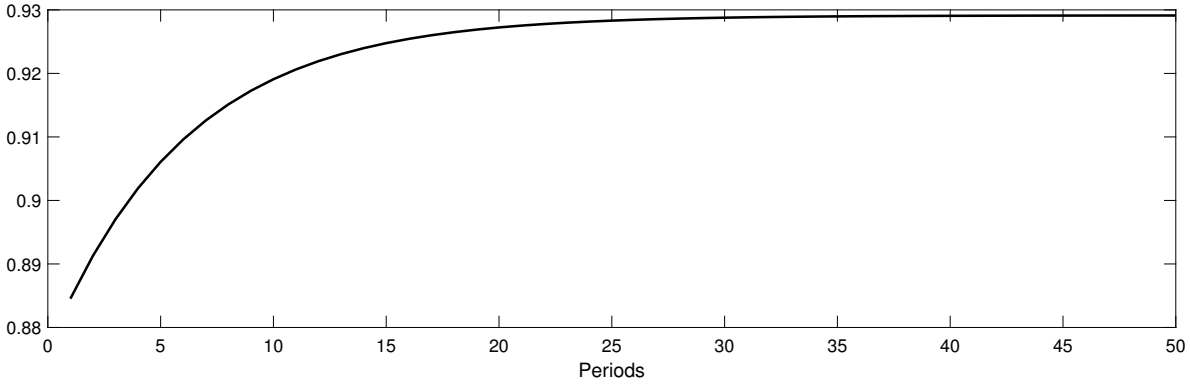
This section contains figures illustrating the evolution of secondary earners' value of marriage and divorce and bargaining power after the tax reform. Each figure is associated to a different initial Pareto weight on secondary earners' utility.

Figure 10: Secondary earners' values and bargaining power. Initial Pareto weight $\mu^2 = 0.88$

(a) Secondary earners' value of marriage $\left(V_M^2\right)$ and divorce $\left(V_D^2\right)$



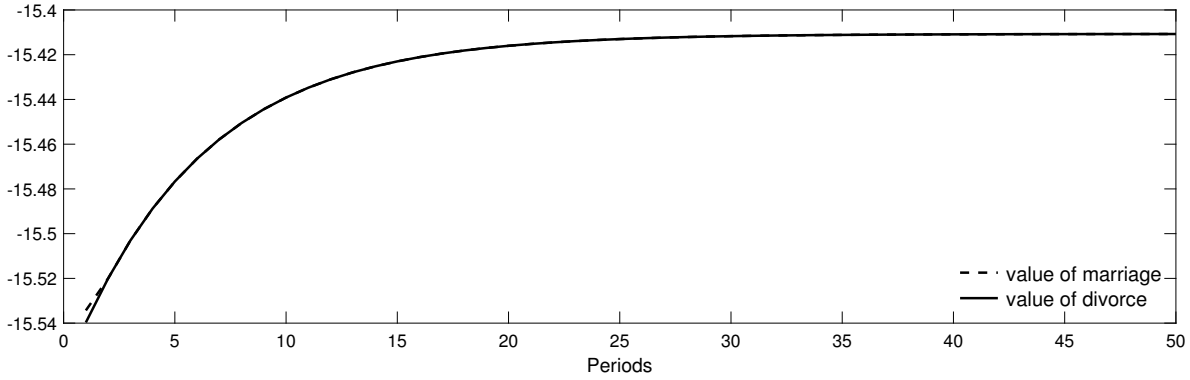
(b) Secondary earners' Pareto weight $\left(\mu^2\right)$



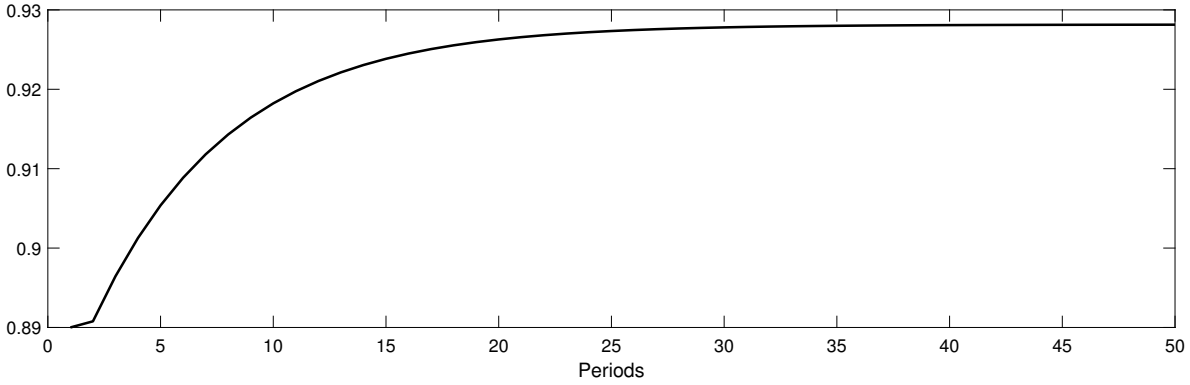
Notes: This figure shows the evolution of secondary earners' value and bargaining power after the tax reform. Panel (a) compares the value of staying in the household (marriage) to the value of the best outside option (divorce) for secondary earners. Panel (b) shows the variation in the Pareto weight on secondary earners' utility.

Figure 11: Secondary earners' values and bargaining power. Initial Pareto weight $\mu^2 = 0.89$

(a) Secondary earners' value of marriage $\left(V_M^2\right)$ and divorce $\left(V_D^2\right)$



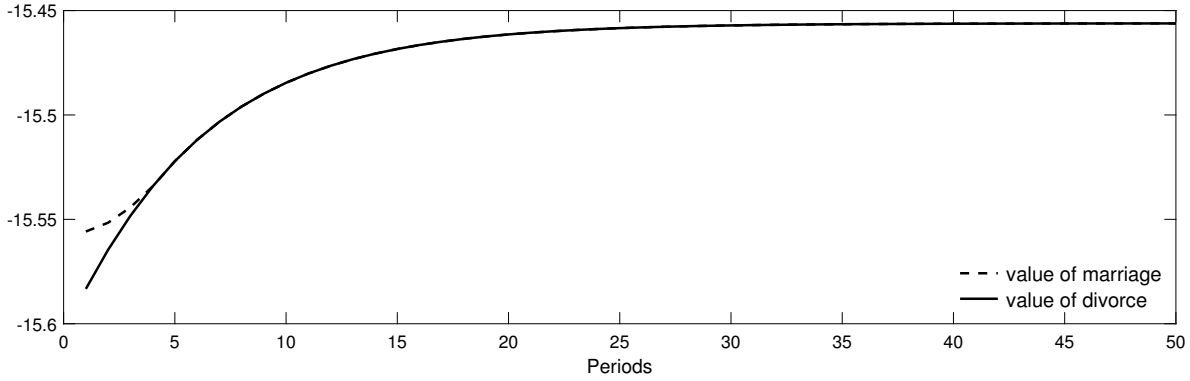
(b) Secondary earners' Pareto weight $\left(\mu^2\right)$



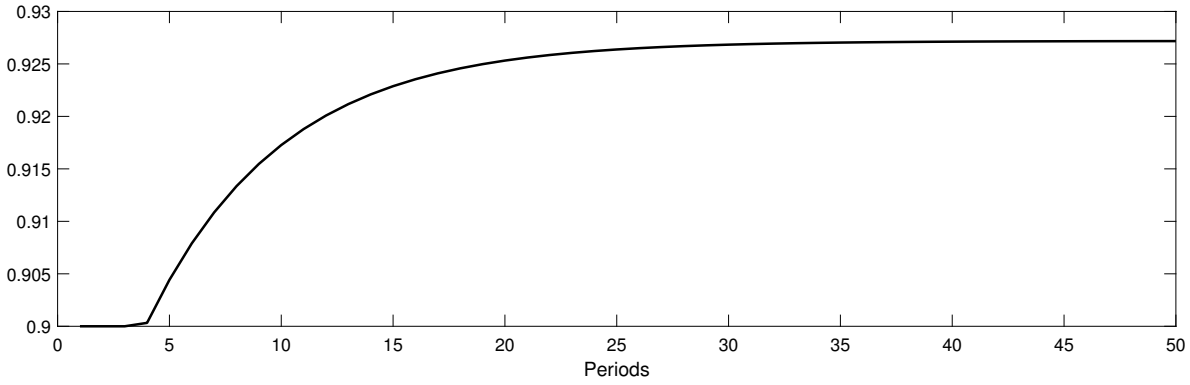
Notes: This figure shows the evolution of secondary earners' value and bargaining power after the tax reform. Panel (a) compares the value of staying in the household (marriage) to the value of the best outside option (divorce) for secondary earners. Panel (b) shows the variation in the Pareto weight on secondary earners' utility.

Figure 12: Secondary earners' values and bargaining power. Initial Pareto weight $\mu^2 = 0.90$

(a) Secondary earners' value of marriage $\left(V_M^2\right)$ and divorce $\left(V_D^2\right)$



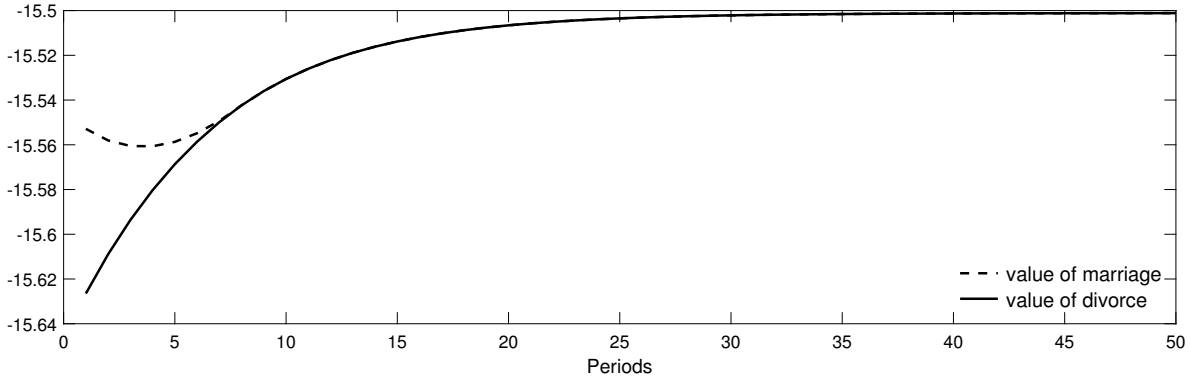
(b) Secondary earners' Pareto weight $\left(\mu^2\right)$



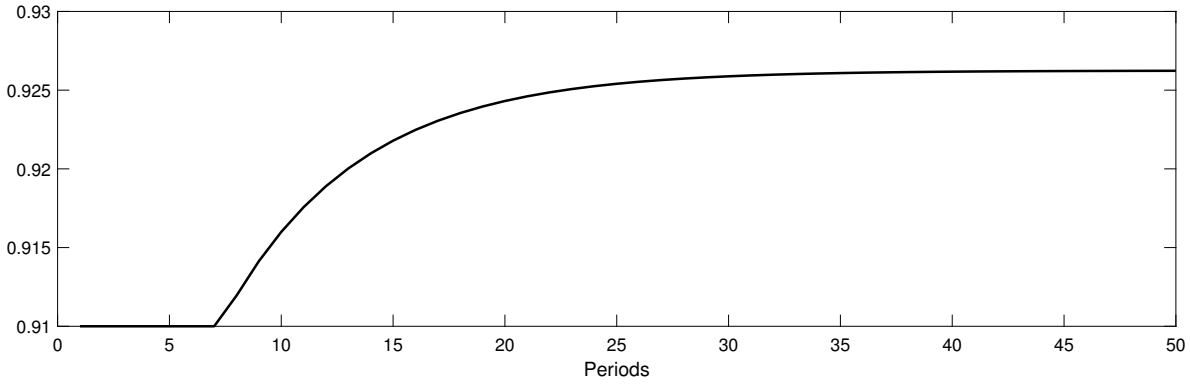
Notes: This figure shows the evolution of secondary earners' value and bargaining power after the tax reform. Panel (a) compares the value of staying in the household (marriage) to the value of the best outside option (divorce) for secondary earners. Panel (b) shows the variation in the Pareto weight on secondary earners' utility.

Figure 13: Secondary earners' values and bargaining power. Initial Pareto weight $\mu^2 = 0.91$

(a) Secondary earners' value of marriage $\left(V_M^2\right)$ and divorce $\left(V_D^2\right)$



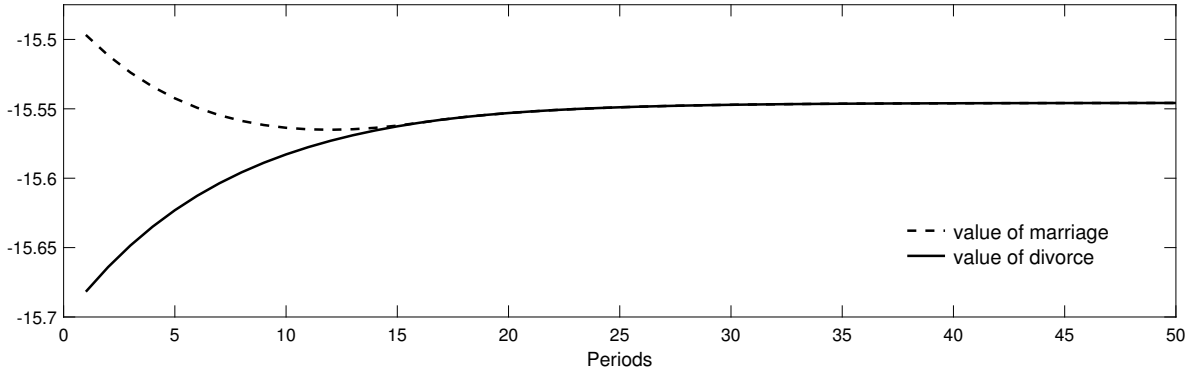
(b) Secondary earners' Pareto weight $\left(\mu^2\right)$



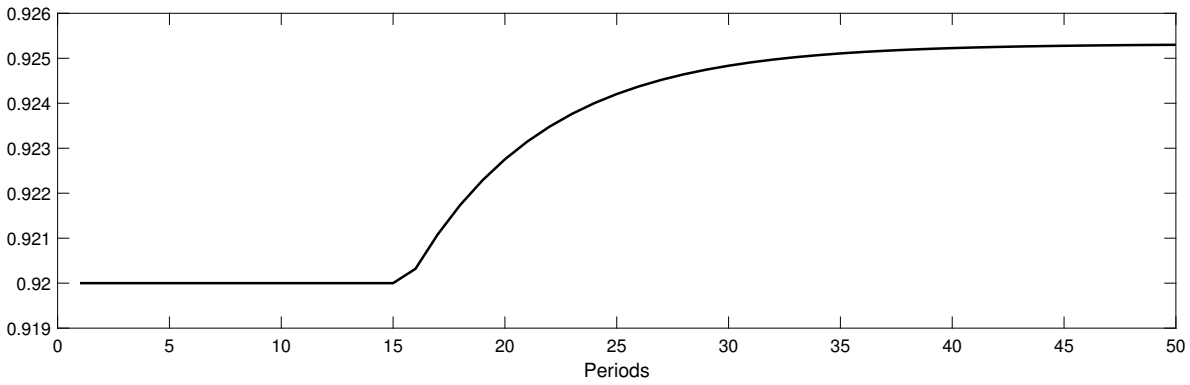
Notes: This figure shows the evolution of secondary earners' value and bargaining power after the tax reform. Panel (a) compares the value of staying in the household (marriage) to the value of the best outside option (divorce) for secondary earners. Panel (b) shows the variation in the Pareto weight on secondary earners' utility.

Figure 14: Secondary earners' values and bargaining power. Initial Pareto weight $\mu^2 = 0.92$

(a) Secondary earners' value of marriage $\left(V_M^2\right)$ and divorce $\left(V_D^2\right)$



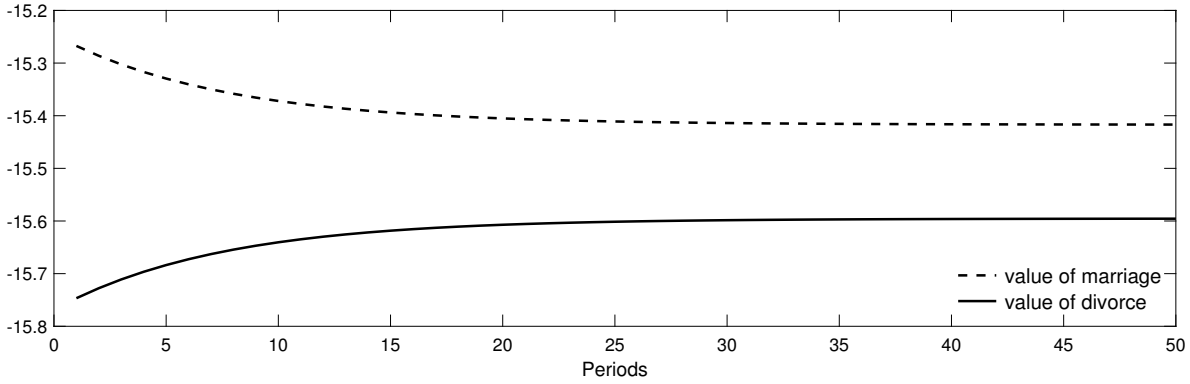
(b) Secondary earners' Pareto weight $\left(\mu^2\right)$



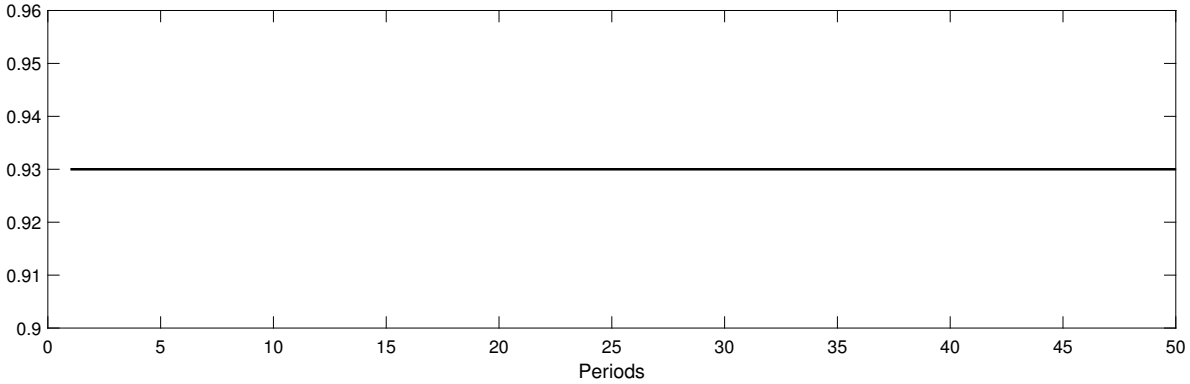
Notes: This figure shows the evolution of secondary earners' value and bargaining power after the tax reform. Panel (a) compares the value of staying in the household (marriage) to the value of the best outside option (divorce) for secondary earners. Panel (b) shows the variation in the Pareto weight on secondary earners' utility.

Figure 15: Secondary earners' values and bargaining power. Initial Pareto weight $\mu^2 = 0.93$

(a) Secondary earners' value of marriage $\left(V_M^2\right)$ and divorce $\left(V_D^2\right)$



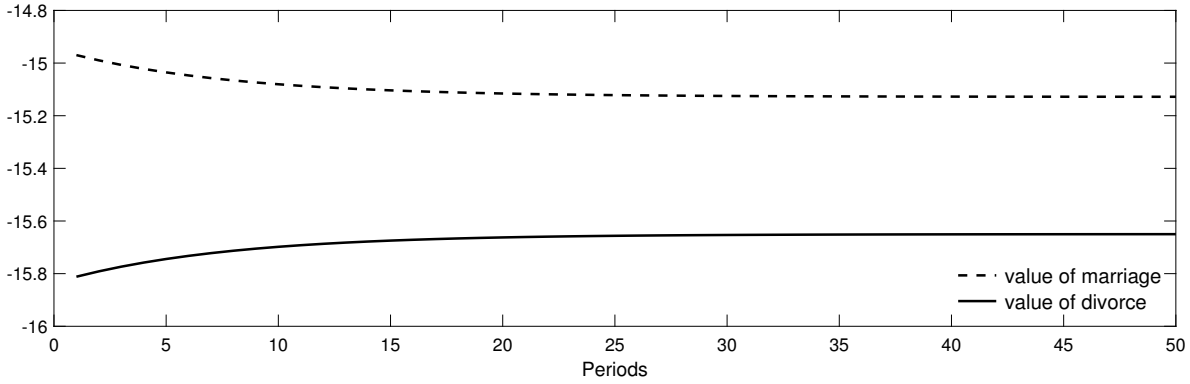
(b) Secondary earners' Pareto weight $\left(\mu^2\right)$



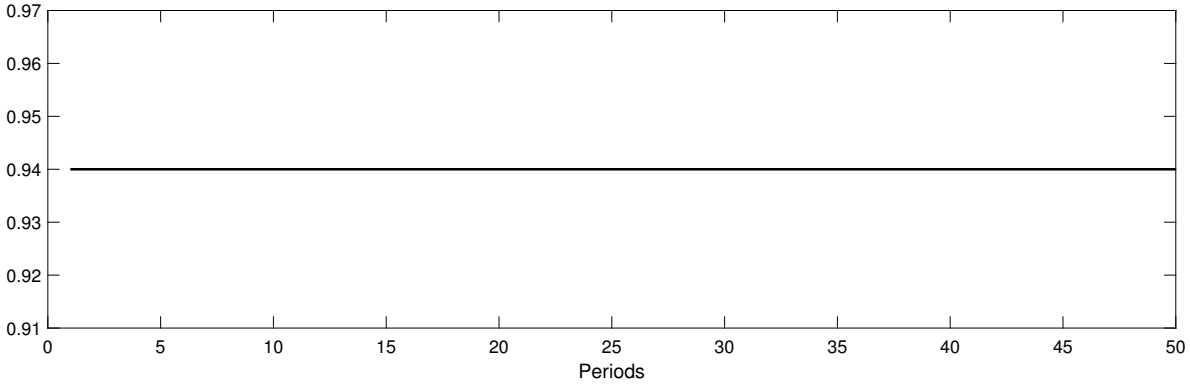
Notes: This figure shows the evolution of secondary earners' value and bargaining power after the tax reform. Panel (a) compares the value of staying in the household (marriage) to the value of the best outside option (divorce) for secondary earners. Panel (b) shows the variation in the Pareto weight on secondary earners' utility.

Figure 16: Secondary earners' values and bargaining power. Initial Pareto weight $\mu^2 = 0.94$

(a) Secondary earners' value of marriage $\left(V_M^2\right)$ and divorce $\left(V_D^2\right)$



(b) Secondary earners' Pareto weight $\left(\mu^2\right)$



Notes: This figure shows the evolution of secondary earners' value and bargaining power after the tax reform. Panel (a) compares the value of staying in the household (marriage) to the value of the best outside option (divorce) for secondary earners. Panel (b) shows the variation in the Pareto weight on secondary earners' utility.