

Comparison between unitary and collective models of household labor supply with taxation

Denis Beninger^z and François Laisney^y

12 January 2001

Abstract

Several recent papers (in particular Fortin and Lacroix, 1997, and Browning and Chiappori, 1998) have shown the relevance of collective models for the empirical investigation of household labour supply and consumption. This paper compares collective and unitary models on the basis of simulated data with income taxation. We distinguish the two cases of individual and joint taxation. For the unitary model we obtain starkly different estimates of preference parameters depending on the type of taxation. We also obtain important discrepancies between predicted adjustments to labour supply following a switch between these two tax regimes. Finally we discuss the resulting distortions affecting the welfare analysis of reforms on the basis of unitary estimates when the data come from a collective model.

These results suggest that increased efforts should be devoted to the estimation of collective models with taxation.

^zZentrum für Europäische Wirtschaftsforschung (ZEW), L7 1, D-68161 Mannheim, GERMANY.

^yBETA-THEME, Université Louis Pasteur, 61 avenue de la Forêt-Noire, F-67085 Strasbourg cedex, FRANCE, and ZEW.

1 Introduction

Collective models, introduced by Chiappori (1988, 1992) and Apps and Rees (1988), allow the representation of individual behaviour inside the household. By contrast, unitary models, actually the most widely used, consider household behaviour as resulting from the decisions of a single individual, occulting the fact that households are most of the time composed of several members. This precludes analysis of intra-familial redistribution of household resources. Unitary models treat the family as a "black box", i.e. the income distribution inside the family cannot be reconstructed (Lechene, 1993). Another difficulty with the unitary models concerns aggregation of preferences (see Arrow, 1951) and of individual demands (see Deaton and Muellbauer, 1980). Although Samuelson's "consensus" idea (1956) and Becker's "altruistic" model (1991) generate consensual behaviour for as regards resource allocation within the family, the underlying assumptions have been criticized as highly restrictive (see e.g. BenPorath, 1982, and Bergstrom, 1989); indeed allocations within the household may well be conflictual (see Sen, 1984).

Chiappori (1988, 1992) shows that the definition of collective rationality imposes a set of restrictions on the labour supply functions, and that these suffice to identify the individual preferences and the income sharing rule (up to an additive constant). These conditions consist in a set of restrictions on the partial differentials of the labour supply functions (see Chiappori, 1988 and 1992, and Bourguignon, Browning, Chiappori and Lechene 1993).

Moreover, external parameters which appear neither in the individual preferences nor in the household budget constraint (EEPs: Extra-Environmental Parameters) may have a significant impact on the income sharing rule and thus on the intra-familial choices (see Chiappori, Fortin and Lacroix, 1997). Apps and Rees (1997) and Chiappori (1997) extend the model to domestic production. Chiuri (1999) proposes a model with children. Browning and Chiappori (1998) have also introduced representations in which families consist of more than two persons. Empirically relevant discrete decisions, such as non participation of one of the household's members, introduce further difficulties. Even in that case, complete identification (up to an additive constant) has been shown for collective models with a linear budget constraint (Blundell, Chiappori, Magnac and Meghir, 1998) and with a convex budget set (Donni, 2000 and Beninger, 2000).

Yet vast research efforts remain necessary for the implementation of collective models in all situations where unitary models are used in practice, in particular in the presence of non-convex budget sets, and for modeling intertemporal allocations. The aim of the present study is to draw attention to the potential returns of such a research program: by simulating data from

the collective model we circumvent the difficulties that are still connected with its estimation, but we are in a position to take into account the many distortions created by the use of a unitary model in such a situation.

In the second section, we briefly present both household representation models. The econometric specification of the estimated unitary model (the model of van Soest, 1995) is discussed in Section 3. In Section 4 we explain how the simulated data are generated, and these data are described in Section 5. The econometric results are discussed in Section 6, with four subsections presenting the estimates, their use in predicting labour supplies, and the positive and normative analysis of tax reforms, respectively.

2 The representation of household behaviour

2.1 Unitary models

Unitary models suppose that the household maximises a unique utility function, independent of prices and incomes. They also suppose the pooling of family incomes. Thus, for these models, the implicit choices are deduced from the maximisation of a utility function under budget and time constraints:

$$\begin{aligned} \max_{c_f, l_f, c_m, l_m} & U(c_f, l_f; c_m, l_m) & (1) \\ \text{u.c.} & c_f + c_m \cdot g(l_f, l_m; w_f, w_m; y) \\ & 0 \leq T_i - l_i \leq H \quad \forall i = f, m \end{aligned}$$

where c_i , l_i , w_i , y , H and T represent respectively i 's ($i = f; m - f$ for the wife, m for the husband) consumption, leisure demand and wage, the couple's non-working incomes, the maximum work time and the disposable time in a week. Function $g(\cdot)$ is assumed to be convex. The utility function $U(\cdot)$ has all classical characteristics and properties.

With the unitary models, only inter-household income inequalities can be compared. Yet the question of intra-familial redistribution of incomes can be crucial in determining household choices (see Lundberg, Pollak and Wales, 1996) and answers are important if the institutions want to conduct efficient and fair economic and social policies (see Haddad and Kanbur, 1990). Collective models propose such answers.

2.2 Collective models

In these models, consumption choices are derived by supposing only Pareto-optimality of the decisions. This single a priori assumption defines the col-

lective rationality of households. As Becker, Chiappori (1988) distinguishes two cases, according to whether agent's preferences are egoistic or altruistic. If the agents have egoistic preferences, their behaviour can be represented sequentially, using an explicit income sharing rule. In the other case, a sequential representation of household behaviour is no longer possible, but this behaviour still results from the sharing of consumption between the agents (Chiappori, 1988).

The extension of collective models to taking account of non linear budget constraints has been introduced by Donni (2000): under some restrictions, the individual consumptions behaviour and the unearned income sharing rule can still be identified up to an additive constant (see Beninger 2000).

Collective models following the hypothesis of collective rationality in the case of egoistic preferences are represented as follows:

$$\begin{aligned} \max_{c_f; l_f; c_m; l_m} & U^f(c_f; l_f) + \lambda(\cdot) U^m(c_m; l_m) & (2) \\ \text{u.c.} & c_f + c_m \cdot \lambda(l_f; l_m; w_f; w_m; y) \\ & 0 \leq T_i - l_i \leq H \quad \forall i = f; m \end{aligned}$$

or according the sequential representation (see Chiappori, 1992 and Apps and Rees, 1988, for the linear case, and Donni, 2000, for the general case):

$$\begin{aligned} \max_{c_i; l_i} & U^i(c_i; l_i) & (3) \\ \text{u.c.} & c_i \cdot w_i (T_i - l_i) + y_i \\ & 0 \leq T_i - l_i \leq H \quad \forall i = f; m \end{aligned}$$

where $\lambda(\cdot) = \lambda(w_f; w_m; y)$ represents the relative weight of the husband; w_i is i 's implicit wage at the optimum:

$$w_i = g_{l_i} \frac{\partial U^i}{\partial l_i} \Big|_{c_i^*} \Big|_{l_i^*} \Big|_{w_f; w_m; y} \quad (4)$$

with $g_x = \frac{\partial g}{\partial x}$. If y denotes the household's implicit unearned income, we have:

$$y = g \Big|_{c_i^*} \Big|_{l_i^*} \Big|_{w_f; w_m; y} \sum_{i=f;m} w_i (T_i - l_i^*) \quad (5)$$

There exists an implicit income sharing rule $\lambda(w_f; w_m; y)$ such as the sequential representation is equivalent to the centralised form of the model. Of course, the function $\lambda(\cdot)$ depends on the effective income sharing rule. Define y_i as i 's effective unearned income. The effective income sharing rule $\lambda(\cdot)$ (known only by the couple, and not by the tax authorities) is given by:

$$\lambda(\cdot) = \lambda(w_f; w_m; y) \neq \frac{y_f}{y} \quad (6)$$

3 The econometric model

For the unitary model, we use the van Soest's representation (1995). The household utility function is assumed log-quadratic:

$$\hat{U}(v) = v^0 A v + b^0 v, \quad (7)$$

where $v = (\log c; \log l_f; \log l_m) = (l_c; l_f; l_m)$, $\hat{U}(\cdot)$ represents the household's utility function, $A = (f_{ij}^0) - i, j = c; f; m$ is a 3×3 symmetric matrix and $b = (f_i^0) - i = c; f; m$, where $c; f; m$ are associated respectively to $l_c; l_f$ and l_m . Moreover, we can add to the model some heterogeneity factors representing characteristics of the individual agents or the household. Some characteristics have a significant impact on the household choices (cf. e.g. Flood, Hansen and Wahlberg, 1999). This inclusion of observable heterogeneity in the model will be done as follows:

$$f_i = \sum_{j=1}^K \beta_{ij} x_j \quad \forall i = c; f; m, \quad (8)$$

where x_{r_i} is the vector of heterogeneity factors, including potentially a constant term. In this study, we will introduce only one type of heterogeneity, connected with the existence of three types of individuals as regards the preference for consumption (see Section 4.2.4); this will take the form of two series of three dummies, one for the wife, and one for the husband.

Denoting H the maximum number of weekly hours worked, the model postulates the existence of $n_i = \frac{H}{n_i - 1}$ possible choices for weekly working hours for each agent. Thus each couple has $n^2 = N$ possible combinations. If $\hat{U}_j = \hat{U}(c^j; l_f^j; l_m^j)$ denotes the utility generated by combination j of the set of combinations $\{c^j; l_f^j; l_m^j\}_{j=1}^N$, adding an error term ϵ_j to the utility derived from combination j , we have:

$$\hat{U}_j = \hat{U}(c^j; l_f^j; l_m^j) + \epsilon_j \quad \forall j = 1; \dots; N: \quad (9)$$

The distribution of ϵ_j is defined by:

$$\Pr[\epsilon_j < \epsilon_i] = \exp(-\exp(\epsilon_i - \epsilon_j)), \quad \epsilon_i \in \mathbb{R}. \quad (10)$$

If combination j turns out to be the best possible choice for the family, we have:

$$\Pr[\hat{U}_j > \hat{U}_k, \forall k \neq j] = \frac{\exp(\hat{U}(c^j; l_f^j; l_m^j))}{\sum_{k=1}^N \exp(\hat{U}(c^k; l_f^k; l_m^k))}. \quad (11)$$

The above expression corresponds to the density function of the multinomial logit model. It also represents the household's contribution to the likelihood.

The following restrictions can then be tested:

$$i \hat{U}_c^{-1} \begin{pmatrix} c_{1f} & 1 & 0 \\ c_{1m} & 0 & 1 \end{pmatrix} H \hat{U} \begin{pmatrix} c_{1f} & c_{1m} \\ 1 & 0 \\ 0 & 1 \end{pmatrix} \mathbf{A} > 0, \quad (12)$$

where $\hat{U}_x = \frac{\partial \hat{U}}{\partial x}$, $c_x = i \frac{\partial x}{\partial c}$, $H \hat{U} = \frac{\partial^2 \hat{U}}{\partial x \partial y}$ with $x, y = c; l_f; l_m$.

This restriction is a consequence of the quasi-concavity of the household utility function and of the fact that \hat{U} is increasing in c (see. e.g. van Soest et al., 1990). This last assumption is verified if:

$$2 (\partial_{cc}^2 \hat{U} + \partial_{fc}^2 \hat{U} + \partial_{mc}^2 \hat{U}) + \partial_{cc}^2 \hat{U} > 0. \quad (13)$$

Similar restrictions apply to the other arguments of \hat{U} .

4 Simulation

Data were generated from a sequential representation of the collective model (Beninger, 2000):

$$\begin{aligned} \max_{c_i, l_i} & U^i(c_i; l_i) & (14) \\ \text{u.c.} & c_i \cdot g_i(l_f; l_m; w_f; w_m; y) \leq T_i - l_i \cdot H, \quad \forall i = f; m, \end{aligned}$$

where $g_i(l_f; l_m; w_f; w_m; y) \equiv w_i (T_i - l_i) + y_i$ (the equivalence with the central problem can be shown with the implicit functions theorem). The chosen functional form for the utility function is:

$$U^i(c_i; l_i) = k_i \log(c_i - \bar{c}) + (1 - k_i) \log l_i, \quad (15)$$

where k_i denotes the preference for consumption, and \bar{c} is a minimum level of consumption, assumed identical for men and women.

4.1 Specification of the budget constraint

For this exercise, the income sharing rule is assumed known and equal to:

$$\alpha = \frac{w_f}{w_f + w_m} = \frac{y_f}{y}. \quad (16)$$

The richer spouse, the one with the higher wage, also receives the greater share of the non-working income. This choice is motivated by results from several studies (see e.g. Bourguignon et al., 1994).

In the case of a linear budget constraint, we have:

$$g_i(\cdot) = w_i(T - l_i) + y_i, \quad \forall i = f; m. \quad (17)$$

If the household is taxed individually with a piece-wise linear progressive taxation rule, i 's disposable income ($i = f; m$) is:

$$g_i^p(\cdot) = \sum_{k=1}^{\infty} \lambda_{i,p}^k S_p^{k+1} + \lambda_{i,p}^s R_i^p S_p^s, \quad (18)$$

where R_i^p is i 's gross income: $R_i^p = w_i(T - l_i^p) + y_i$. In that case, the assumptions made here imply complete separation of the problems solved by the two agents.

In the case of jointed taxation with a piece-wise linear progressive taxation rule, i 's disposable income is:

$$g_i^c(\cdot) = w_i(T - l_i^c) + y_i - l_i^c, \quad \forall i = f; m, \quad (19)$$

where l_i^c is i 's amount of taxes. Total taxes I^c paid by the couple are:

$$I^c(\cdot) = \sum_{k=1}^{\infty} \lambda_c^k S_c^{k+1} + \lambda_c^s (R^c - S_c^s), \quad (20)$$

where $R^c = \sum_i w_i(T - l_i^c) + y$ is household gross income; vector $\lambda_q = (\lambda_q^1; \dots; \lambda_q^{t_q})$ is the vector of marginal tax rates for individual taxation ($q = p$)

or for joint taxation ($q = c$); $S_q = (S_q^1; \dots; S_q^{t_q})$ is the corresponding vector of tax brackets: there are t_q tax brackets; s represents the imposition bracket for which $S_q^s \cdot R_i^p$; $R^c < S_q^{s+1}$ if $s < t_q$ and $S_q^s \cdot R_i^p$; R^c if $s = t_q$. In the application we choose: $\lambda_p = \lambda_c = (0; 0; 3; 0; 5)$, $S_p = (0; 5000; 10000)$ and $S_c = (0; 7800; 15000)$, so that tax revenues are almost identical in both cases.

We suppose that the tax burden of the household is shared proportionately to incomes, i.e.: $\frac{l_i^c}{I^c} = \frac{R_i^c}{R^c}$. This assumption is arbitrary and clearly deserves more justification. We use it because it is the most convenient rule we are aware of. For more details, see Beninger (2000).

We suppose that each agent has eleven choices for his or her weekly labor supply:

$$h_i = T - l_i = \sum_{n=0}^{10} n \cdot g_i, \quad n \in N. \quad (21)$$

If $\sum = 10$ and since $H = 100$, we have $n_{10} = 11$. This yields a set of 121 choices for the leisure demands ($N = 121$).

4.2 Distribution functions of the parameters

Parameter values are either common to all individuals (like total available time, for instance), or particular to each individual. In the latter case, the individual values result from i.i.d. sampling for each individual (for wage rates and preference parameter for consumption) and for each couple (unearned income). The sampling distributions are detailed below.

4.2.1 Fixed parameters

The fixed parameters, i.e. minimum consumption (\bar{c}), total time available (T) and maximal working time (H) are common to the whole population. All pertain to a week. Minimum consumption corresponds to the vital needs of an individual and is set to $\bar{c} = 200$ monetary units.

Total time available, in hours, is the duration of a week minus the time devoted biological needs (sleeping, eating, etc.): $T = 120$ hours: This corresponds to the upper bound for leisure.

The maximum duration of work is set to $H = 100$ hours (note that we do not consider any domestic production in this model).

4.2.2 Wages

Typical wage distributions have specific characteristics: the distribution is highly skewed to the left, and extremely low wages are rare in the rich countries (see e.g. Hildenbrand, 1993 and 1998). With these characteristics in mind, we specify the following density:

$$f_{w_i}(w_i) = \begin{cases} \frac{\mu}{d_i^2} \exp\left(-\mu \frac{w_i}{d_i}\right) & \text{if } w_i \geq 0 \\ 0 & \text{otherwise} \end{cases} \quad \forall i = f, m. \quad (22)$$

The corresponding cumulative probability function is:

$$F_{w_i}(w_i) = \begin{cases} 1 - \exp\left(-\mu \frac{w_i}{d_i}\right) & \text{if } w_i \geq 0 \\ 0 & \text{otherwise} \end{cases} \quad (23)$$

$$\text{where } d_i = \begin{cases} \frac{1}{2} & \text{if } i = f \\ 40 & \text{if } i = m \end{cases}$$

Expectation, variance and mode are respectively $E(w_i) = 2d_i$, $V(w_i) = 2d_i^2$, and $\text{mode}(w_i) = d_i$.

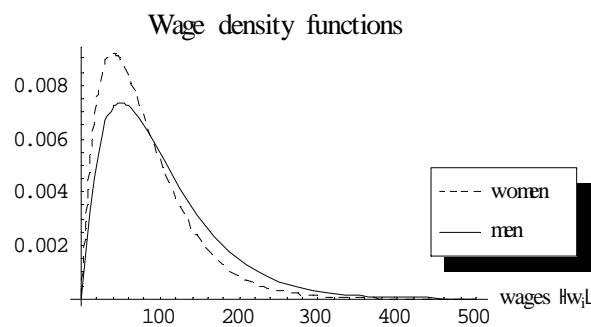


Figure 1: Wage densities for men and women.

4.2.3 Unearned income

For unearned income we assume the exponential distribution:

$$f_y(y) = \begin{cases} \frac{1}{\mu} \exp\left(-\frac{y}{\mu}\right) & \text{if } y \geq 0 \\ 0 & \text{otherwise} \end{cases}, \quad (24)$$

where $\mu = 5000$. Then $E(y) = \mu$, $V(y) = \mu^2$, and $\text{mode}(y) = 0$:

4.2.4 Preference for consumption

Agents are assumed to have either weak preference for consumption ($k_i = 0; 4$), a medium one ($k_i = 0; 5$) or a strong one ($k_i = 0; 6$). Define τ as a realisation of the Beta distribution $B(2; 6; 2; 6)$: We set:

$$\begin{aligned} k_i &= 0; 4 & \text{if } \tau < 0; 4 \\ k_i &= 0; 5 & \text{if } 0; 4 < \tau < 0; 5 \\ k_i &= 0; 6 & \text{if } \tau \geq 0; 6 \end{aligned}$$

Thus $E(k_i) = 0; 5$, $V(k_i) = 0; 0064$, and $\text{mode}(k_i) = 0; 5$. The dummy $\mathbb{1}_{i1}$ (respectively $\mathbb{1}_{i2}$ or $\mathbb{1}_{i3}$) takes value 1 if $k_i = 0; 4$ (respectively $k_i = 0; 5$ or $k_i = 0; 6$) and 0 otherwise.

5 Simulated data

We have generated data for 2000 couples in three different cases: no taxation, joint taxation and individual taxation. Each agent is characterised by an observed heterogeneity factor: the preference for consumption. Each agent has a working income depending on his or her wage (given) and labour supply, and on a certain amount of unearned income which depends on household unearned income and on a given income sharing rule α . Given these, the labour supply and consumption of each agent is computed for each tax situation using (3). These computations have been conducted with Mathematica. A summary of the results is given in Table 1. A more complete description is given in Appendix A.

Table 1: simulated data (means)

variable	no tax	joint taxation	indiv. taxation.
h_f	46,8	39,6	42,8
h_m	45,8	38,6	40,7
c	13730	10695	11026
w_f		77,3	
w_m		102,3	
y		5054	
α_{f1}		0,31	
α_{f2}		0,34	
α_{f3}		0,35	
α_{m1}		0,33	
α_{m2}		0,33	
α_{m3}		0,34	

Whatever the tax situation is, the wife's labour supply, h_f , is on average a little higher than the husband's, h_m . When the agents are not taxed, women are more likely to prefer a part-time job (about 20 hours weekly), or to work overtime. Men are slightly more likely to work an "average" number of hours (30 to 40 weekly hours). But despite the wage differential, the distribution of labour supply is roughly the same for both sexes. Compared to real data for most countries, labour supply here is the high side, with a majority of agents working between 30 and 70 hours per week. About 7% do not participate: these are essentially agents with a high level of unearned income. Agents with a high preference for consumption are underrepresented among non participants.

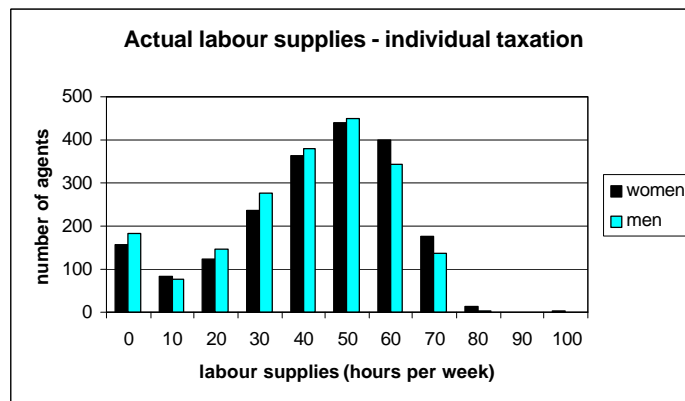
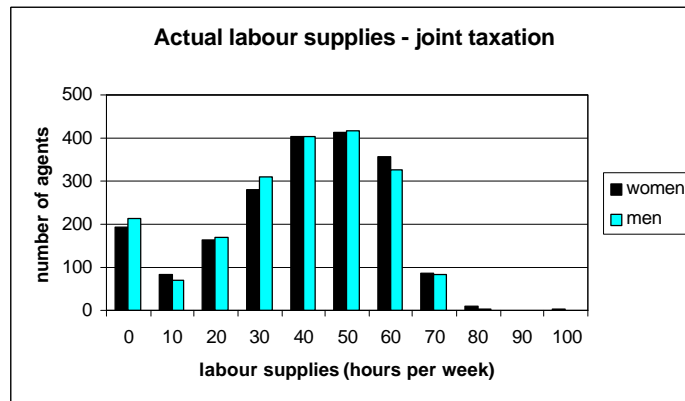
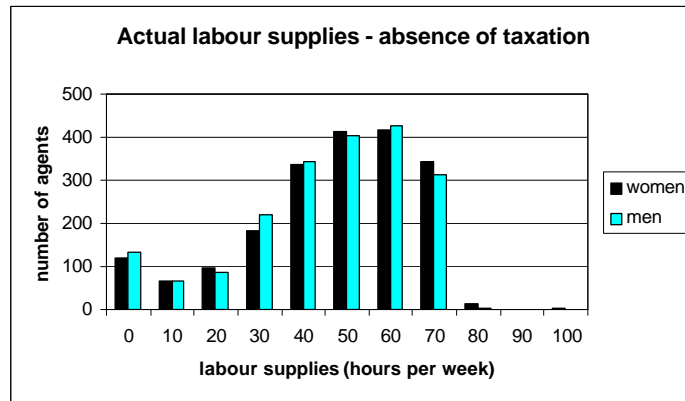


Figure 2: Labour supplies.

The introduction of taxation has a large disincentive impact, but this varies with individual and household characteristics. Agents with high wages and high unearned incomes are more affected, while the poorest are not affected at all.

In the specific case of the introduction of individual taxation, take two individuals of same sex with near characteristics (same preference for consumption, similar wages and unearned incomes). The one whose spouse is "poorer" supports a larger disincentive effect than the other because of the specification of the income sharing rule.

In the case of joint taxation the disincentive effect is even larger, and again, better endowed individuals are more affected. The new aspect here is that, in case of a large wage gap between the spouses, the poorer one will also reduce his or her labour supply: a comparatively low wage rate implies inequality on two accounts within the household: as regards wage income $w_i (T_i - l_i)$, and as regards the sharing of unearned incomes y_i . Joint taxation is relatively unfavourable to the less well endowed spouse, as the latter bears part of the tax burden of the richer spouse. Again, individuals with a high preference for consumption are more affected.

The fact that joint taxation has a larger disincentive effect than individual taxation does not result from differences in tax revenue: the tax brackets have been specified in such a way that tax revenues are virtually identical in both situations (see Section 4.1 and Appendix C). In fact, it turns out that joint taxation is more favourable for households than individual taxation: for the tax parameters used here and for identical gross incomes (labour supplies and unearned incomes fixed), a couple pays more tax in the case of individual taxation than in the case of joint taxation (about 25% more). However, joint taxation is relatively more favourable to the richer spouse (see Section 6.4).

We now examine more specifically the impact of different variables and parameters on reactions to the introduction of one type of taxation or the other, and begin with household unearned income, y . As leisure is a normal good for each individual, leisure demand l_i ($i = f; m$) will increase with y . However, there are other effects in the presence of joint taxation, as there is then a certain degree of interdependence in the behaviour of the spouses. It then becomes difficult to say a priori what the impact of a change in y will be.

The effect of a change in the wage rate w_i on labour supply h_i is even more ambiguous, as it depends on the other characteristics of the agent. Yet our simulated data show generally a negative association between wages and labour supply. In particular, agents with the lowest wages often have a relatively high labour supply. Still a clear effect is that an increase in w_i ($i = f; m$) has a negative impact on the spouse's labour supply h_j ($j = f; m$, $j \neq i$), because of the specification of the sharing rule (16).

Of course, an increase in the preference for consumption k_i induces agents to work more.

The impact of changes in parameter values on c_i are less ambiguous. There is a positive impact of y , w_i and k_i on c_i : By contrast, w_j ($j = f; m$, $j \neq i$) has a negative impact through the sharing rule. And, almost needless to say, introducing taxation has a negative effect on consumption.

6 Results

6.1 Estimation of the unitary model

Maximum likelihood estimates of the parameters of the utility function specified in Section 3, and based on equation (11), are given in Appendix B. The only heterogeneity factor considered is the preference for consumption. The estimation procedure consists in comparing utility levels attained for the different choices. Each agent has eleven possible choices of labour supply, and this leads to $N = 121$ possible choices for the household. Estimation was conducted in the three cases "absence of taxation", "joint taxation" and "individual taxation", yielding three vectors of estimates denoted $\hat{\mu}^0$, $\hat{\mu}^c$ and $\hat{\mu}^p$, respectively. These estimation results differ significantly. It is important to stress this point: as the individual underlying preferences are unchanged throughout this exercise, estimation results at the level of the household should in principle be fairly similar in all three situations. The fact that estimates for household preference parameters are affected by the form of the household budget constraint results solely from the misspecification embodied in the unitary representation.

The estimated linear impact on household utility (as opposed to the quadratic impacts), i.e. the coefficients γ_i of consumption, c , and leisure demands, $(l_i)_{i=f,m}$ — see equation (8) — differ considerably depending on the data set used — and thus on the tax system. The coefficients of leisure demand are all significant in one case only, that of individual taxation, and this corresponds to coefficients with a larger magnitude. The signs of significant coefficients are identical for joint and individual taxation, but all significant coefficients for labour supply are positive in the absence of taxation, whereas they are negative for individual taxation. The linear impact of consumption on utility, Δ_c , is strongly and significantly negative in all cases, but its magnitude doubles when going from absence of taxation to individual taxation, with the value for joint taxation inbetween. Note that, even if the linear impact of consumption on utility (when the household is not taxed) is strongly negative, the overall effect of consumption on household utility is positive for almost all observations: the second restriction (equation (13)) is satisfied, except for a few households where both spouses have a very large

labour supply (connected with low wages and unearned income) especially in the case of individual taxation. The situation as regards labour supplies is less favourable, though.

The restriction of concavity of the utility function (12) is satisfied for most observations.

Quadratic effects, both direct and cross effects, all significant in all three estimations, are a little more stable w.r.t. the tax system, as no sign reversals appear here. The direct effects (coefficients β_{ii}) concerning leisure have similar magnitudes, although they are a little weaker in the case of individual taxation. Coefficient β_{cc} is more sensitive to the tax system, and the same holds for cross effects (coefficients β_{ij} , with $i \neq j$), especially the cross effects consumption-leisure demand. Estimation concerning the quadratic effects are fairly similar to those obtained with real data (see for example van Soest, 1995 for Dutch data, and Wolf, 1998 for German data).

6.2 Predictions with the unitary models

These estimation results can be used to make predictions of labour supplies. Predicted labour supplies have a lower dispersion than effective labour supplies, and a more symmetric distribution (see Figure 3 for women; similar results are obtained for men). In particular the number of non-working agents is under-estimated in all cases and for all predictions.

The estimation of household labour supply on the basis of real-world data (see for instance van Soest, 1995) also indicates an over-estimation of the participation rates. Van Soest argues that this phenomenon may result from the endogeneity of wage rates and from characteristics of the demand side of the labour market, and proposes a correction taking account of restrictions on hours. But here wages are perfectly exogenous and known for all agents, and labour supply is not constrained in any way. Thus the over-estimation of participation rates does not result from the neglect of institutional factors in the specification.

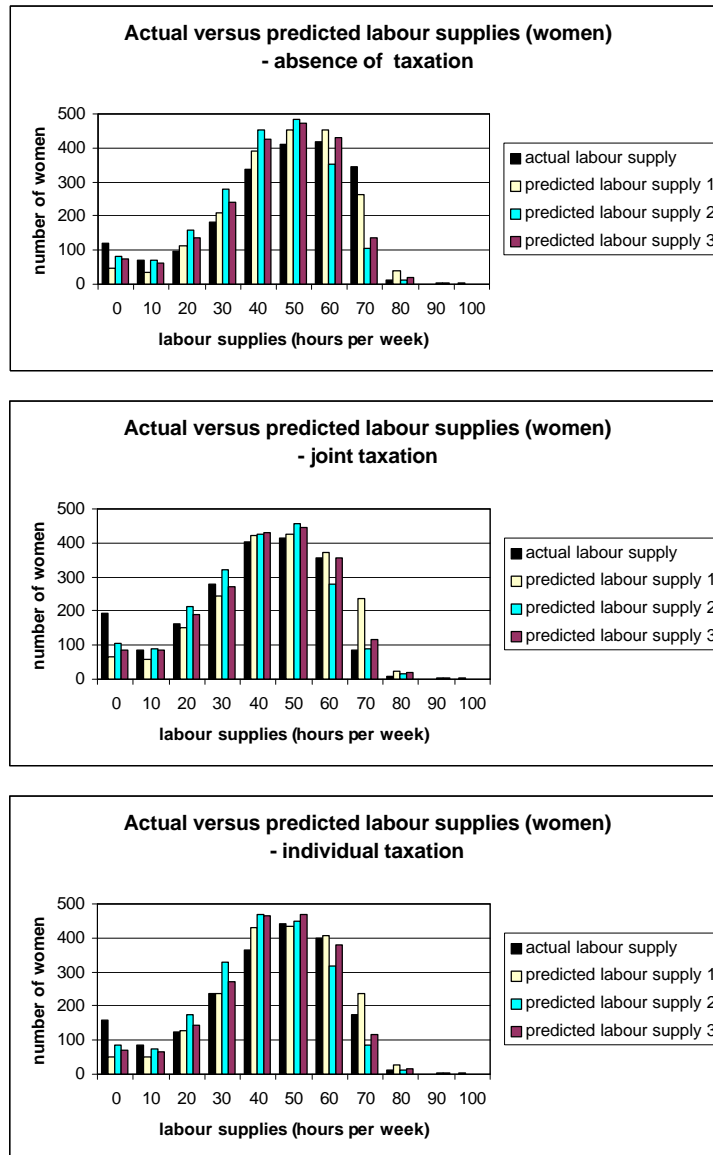


Figure 3: Actual and predicted labour supplies

Explanations:

predicted labour supplies 1, 2 and 3 correspond to the use of parameter vectors $\hat{\mu}^0$, $\hat{\mu}^c$ and $\hat{\mu}^p$, respectively.

Predictions obtained with estimated coefficients $\hat{\mu}^c$ and $\hat{\mu}^p$ tend to underestimate labour supplies (except predictions using $\hat{\mu}^p$ in the case of joint taxation). The under-estimation is larger when $\hat{\mu}^c$ is used. The predictions amplify the reactions of labour supplies to the introduction of taxation. Predictions based on $\hat{\mu}^0$ over-estimate part-time work and under-estimate

“overtime”. Yet all vectors $\hat{\mu}$ are meant to estimate the same preference parameters, and predictions obtained with these vectors should not be too dissimilar.

The predictions look better when the coefficient vector used corresponds to the situation described (for example using $\hat{\mu}^c$ to predict labour supplies in the case of joint taxation), in the sense that more agents have identical predicted and actual labour supplies .

6.3 Analysis of ...scal reforms: positive aspects

The adjustment of labour supplies following the introduction of taxation is also poorly predicted using the unitary model, especially in the case of joint taxation (see Tables 2 and 3).

Table 2: Effect of the introduction of joint taxation
unitary versus collective model (women)

	-30	-20	-10	0	total
-10	3	43	406	143	595
0	10	106	718	562	1396
10	0	4	0	5	9
total	13	153	1124	710	2000

1. using estimates $\hat{\mu}^o$

	-30	-20	-10	0	total
-10	3	49	381	111	545
0	10	96	738	591	1435
10	0	8	5	7	20
total	13	153	1124	710	2000

2. using estimates $\hat{\mu}^c$

	-30	-20	-10	0	total
-10	6	38	347	110	501
0	7	109	770	589	1475
10	0	6	7	11	24
total	13	153	1124	710	2000

3. using estimates $\hat{\mu}^p$

Table 3: Effect of the introduction of individual taxation
unitary versus collective model (women)

	-20	-10	0	10	total
-10	19	209	184	2	414
0	44	473	1010	0	1527
10	2	3	54	0	59
total	65	685	1248	2	2000

1. using estimates $\hat{\mu}^0$

	-20	-10	0	10	total
-10	18	212	139	1	370
0	47	465	1028	1	1541
10	0	8	81	0	89
total	65	685	1248	2	2000

2. using estimates $\hat{\mu}^c$

	-20	-10	0	10	total
-10	19	205	117	2	343
0	45	468	1000	0	1513
10	1	12	131	0	144
total	65	685	1248	2	2000

3. using estimates $\hat{\mu}^p$

Explanations for Table 2 (resp. Table 3):

columns show the actual change in labour supply when joint (resp. individual) taxation is introduced,

rows show corresponding predicted changes using the unitary model, in the three versions $\hat{\mu}^0$, $\hat{\mu}^c$ and $\hat{\mu}^p$.

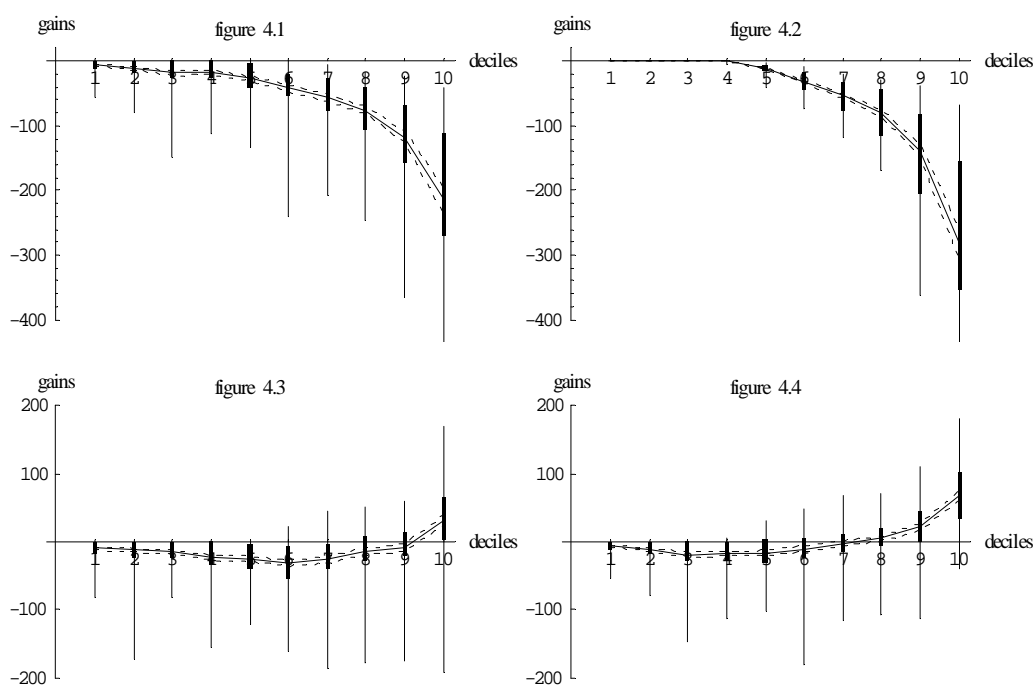
For example, with the unitary model at least 96 women are predicted to offer unchanged numbers of hours, whereas they actually reduce their weekly labour supply by 20 hours after the introduction of joint taxation, and more women are predicted to keep their labour supply unchanged than is actually the case. The reduction in hours offered after the introduction of any type of taxation is underestimated by the unitary models.

Tables 2 and 3 also show that predictions obtained with coefficients $\hat{\mu}^c$ and $\hat{\mu}^p$ are worse than those obtained with $\hat{\mu}^0$, especially when $\hat{\mu}^p$ is used to predict the effect of introducing joint taxation and $\hat{\mu}^c$ is used for individual taxation.

6.4 Analysis of ...scal reforms: normative aspects

As expected in the absence of redistribution of tax revenues, the introduction of taxation has a negative impact on welfare (see Figures 4.1 and 4.2). These show the distribution of individual welfare gains, here negative, by decile of the distribution of gross income. Men with low incomes do not incur losses when individual taxation is introduced, as they are not taxed at all. But some of them are affected by the introduction of joint taxation: their wives are rich enough for the couple to be taxed.

Figures 4.3 and 4.4 show that individual taxation is relatively more advantageous than joint taxation for low income agents. By contrast, high income agents are relatively better off with joint taxation as it allows them to share the burden of taxation with the less well endowed spouse. Individual taxation is thus relatively more interesting for women, as their wage rates are on average 20% lower than men's.



Figures 4: gains in individual utility for different ...scal reforms
collective model

Explanations: the ...gures represent mean utility gains by decile of the gross income distribution for the introduction of joint taxation (Figure 4.1), individual taxation (Figure 4.2) and for the move from individual taxation to joint taxation (Figures 4.3 and 4.4), for women (Figure 4.3) and men (Figures 4.1, 4.2 and 4.4).

The vertical lines show the range of gains, the rectangles show inter-quartiles intervals, the solid line shows average gains, and the dotted lines show confidence intervals (\pm twice the standard error of the mean).

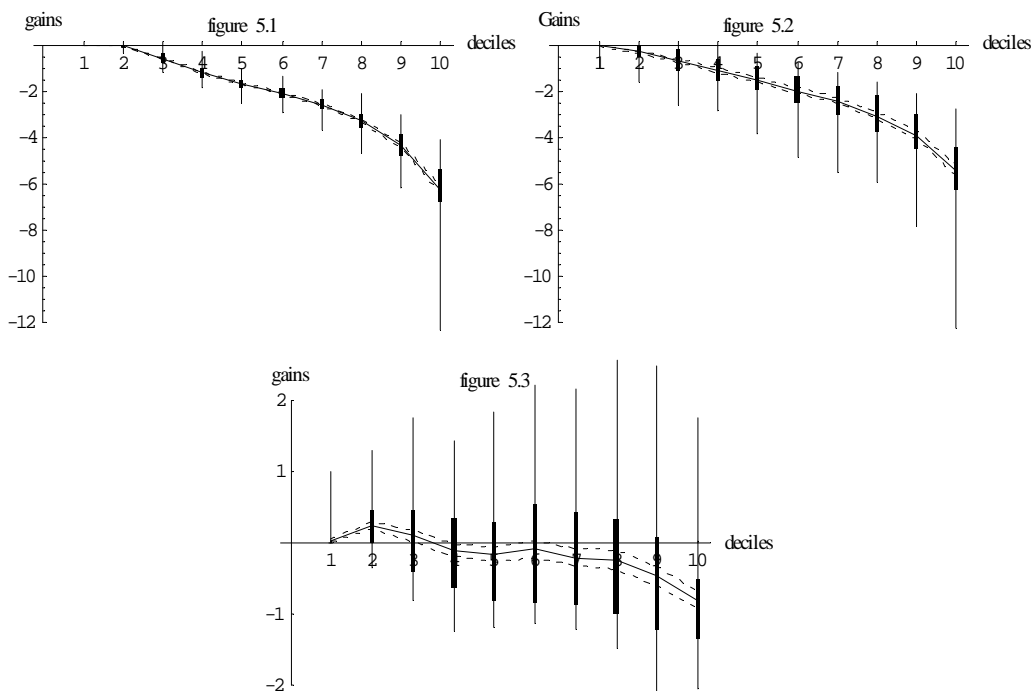
In terms of welfare gains, about 62% of women gain from individual taxation. Some 20% are indifferent between joint and individual taxation. The remaining 18% gain from joint taxation (see Table 4). By contrast, more men gain from joint taxation (about 36.5%), 17% are indifferent and the rest (46.5%) gain from individual taxation.

Moreover, there are relatively few couples for which the direction of the relative advantage of each fiscal system is identical for both partners. This "conflictual" situation is essentially due to the wage rate differential and the ensuing difference in incomes: the richer partner finds joint taxation advantageous. For only 42% of the couples both partners fall in the same category (winner, loser, indifferent) in the switch between the two systems. These are partly households whose members are indifferent to each tax system anyway, as their incomes are too low to be taxed.

The preference for consumption has an important impact on the welfare effects of the fiscal systems. The proportion of winners from joint taxation increases with the marginal propensity to consume.

By contrast, unearned income has no notable impact on the relative advantage of one system over the other in terms of welfare.

Figures 5 show the distribution of household utility gains by decile of the distribution of gross household income, with utility gains computed from the unitary models. Results concerning the introduction of taxation (joint or individual) are not in conflict with those obtained with the collective representation of the household. However, results diverge as regards the move from individual to joint taxation: whereas the richest individuals were mostly winners for the collective model, the majority of the richest households lose.



Figures 5: household utility gains for different fiscal reforms, unitary model

Explanations: the figures represent household utility gains by decile of the distribution of gross incomes after the introduction of joint taxation (5.1), individual taxation (5.2) and in the move from individual to joint taxation (5.3).

These results can be found in Table 4, which compares the effects of the move from individual to joint taxation, and of the inverse move, as predicted by both models. For about 90 households, these predictions are incompatible in the sense that at least one household member gains in a reform and the partner gains too or is indifferent in the collective framework, while the household loses or is indifferent using the unitary model. For the majority of these, both spouses are indifferent to the reform, whereas the household appears to be either to lose or to win in the unitary framework: the discrepancy results from the poor prediction of labour supply responses in that framework.

Note that both panels of Table 4 are not exactly symmetrical: the number of households losing in the move from individual to joint taxation should in principle coincide with the number of winners in the reverse move, whatever the estimate $\hat{\mu}$ used. This asymmetry results from the more pronounced under-estimation of labour supplies with $\hat{\mu}^C$ than with $\hat{\mu}^P$.

Table 4: Joint and individual taxation:
comparison of the collective and unitary models

	f_+			f_0			f_i			total
	m_+	m_0	m_i	m_+	m_0	m_i	m_+	m_0	m_i	
hous ₊	5	33	217	51	49	1	377	2	3	738
hous ₀	1	1	0	4	216	2	2	2	11	239
hous _i	1	2	141	2	18	16	286	18	539	1023
total	7	36	358	57	283	19	665	22	553	2000

	f_i			f_0			f_+			total
	m_i	m_0	m_+	m_i	m_0	m_+	m_i	m_0	m_+	
hous _i	5	30	214	46	39	1	387	3	3	728
hous ₀	1	5	1	9	230	4	2	3	15	270
hous ₊	1	1	143	2	14	14	276	16	535	1002
total	7	36	358	57	283	19	665	22	553	2000
total f	401			359			1240			2000
total m	(m_i)	729		(m_0)	341		(m_+)	930		2000

Explanations: the ...rst panel corresponds to the move from individual to joint taxation, the second panel to the inverse move.

Rows correspond to winning (hous₊), indiæerent (hous₀), and losing households (hous_i) on the basis of coefficients estimated in the departure situation, i.e. $\hat{\mu}^p$ for the ...rst panel and $\hat{\mu}^c$ for the second).

Columns correspond to winning females (f_+) and males (m_+) — resp. f_i , m_i and f_0 , m_0 for losers or indiæerent individuals), on the basis of the simulated data.

The “conflictual situation” uncovered by the collective model is masked by the unitary representation of household behaviour. The relative advantage of a tax system in the collective model is essentially linked to the intra-familial income differential, and not to the total household income.

7 Conclusion

On the basis of simulated data for 2000 households behaving in the collective framework in three different fiscal situations, we have provided evidence on the distortions connected with the use of estimates from a unitary model for the evaluation of fiscal reforms:

Firstly, the unitary model leads to fairly diverging estimates of household “preferences” depending on the budget constraint faced by the households; this is inasmuch problematic as these estimates are subsequently used as truly reflecting preferences.

Secondly, even using each time the estimate corresponding to the departure situation, we find significant discrepancies in the prediction of positive effects of fiscal reforms (adjustment in the labour supplies of the spouses). In particular, this shows that using a unitary representation may lead to non-negligible errors in the definition of revenue neutral reforms.

Finally, the comparison of the evaluation of welfare effects of fiscal reforms with the collective and unitary models reveals substantial divergences, but also points to the deep differences in their foundation itself: using a unitary model leads the investigator to neglect resource allocations within the household, and this may mask the fact that a reform that seems advantageous for a majority of couples can in reality generate increased tensions and inequality within the household. Symmetrically, using the collective model may lead to exaggerated emphasis on purely individual aspects.

An interesting development of this study would be to generate data in a realistic way for different countries, taking account of the existing fiscal systems and reforms under discussion, as well as of the structure and the population, and to investigate how important the distortions illustrated here may be for these different countries.

8 Appendix A: simulated data

Table A1: simulation results – no taxation

variable	obs.	mean	std. dev.	min.	max.
C_f	2000	5972	4115	218	29931
C_m	2000	7758	5331	291	52567
C	2000	13730	6404	1863	56310
h_f	2000	46.8	19.7	0	100
h_m	2000	45.8	19.6	0	89
l_f	2000	73.2	19.7	20	120
l_m	2000	74.2	19.6	31	120
w_f	2000	77.3	55.0	2.0	425.3
w_m	2000	102.3	71.3	2.8	440.8
y_f	2000	2205	2711	1	20627
y_m	2000	2850	3706	1	52567
y	2000	5055	5460	2	56310
η_{f1}	2000	0.31	0.46	0	1
η_{f2}	2000	0.34	0.47	0	1
η_{f3}	2000	0.35	0.48	0	1
η_{m1}	2000	0.33	0.47	0	1
η_{m2}	2000	0.33	0.47	0	1
η_{m3}	2000	0.34	0.47	0	1

Table A2: simulation results – joint taxation

variable	obs.	mean	std. dev.	min.	max.
C _f	2000	4693	2856	218	18134
C _m	2000	6001	3474	281	31829
c	2000	10694	3665	1863	34095
h _f	2000	39.6	19.6	0	100
h _m	2000	38.6	19.4	0	89
l _f	2000	80.4	19.6	31	120
l _m	2000	81.4	19.4	20	120

Table A3: simulation results – individual taxation

variable	obs.	mean	std. dev.	min.	max.
C _f	2000	4977	2684	218	17106
C _m	2000	6049	3132	291	29784
c	2000	11026	3906	1863	33527
h _f	2000	42.8	19.8	0	100
h _m	2000	40.7	19.6	0	89
l _f	2000	77.2	19.8	20	120
l _m	2000	79.3	19.6	31	120

Explanation: statistics concerning exogenous variables (wages, unearned income, and marginal propensities to consume) are identical across ...scal situations.

9 Appendix B: estimation of unitary model

Table B1: estimation results – no taxation
coefficient vector $\hat{\mu}^0$

	parameter	coef.	std. err.	t-ratio
-	f_{f1} (log I_f £ I_{f1})	23.22	5.72	4.1
-	f_{f2} (log I_f £ I_{f2})	15.56	5.69	2.7
-	f_{f3} (log I_f £ I_{f3})	7.24	5.61	1.3
-	m_{m1} (log I_m £ I_{m1})	14.30	6.58	2.2
-	m_{m2} (log I_m £ I_{m2})	5.15	6.53	0.8
-	m_{m3} (log I_m £ I_{m3})	-3.40	6.49	-0.5
-	c (log c)	-49.92	10.76	-4.7
®	ff (log I_f £ log I_f)	-17.59	0.57	-31.0
®	mm (log I_m £ log I_m)	-18.04	0.61	-29.8
®	cc (log c £ log c)	1.51	0.42	3.6
®	fm (log I_f £ log I_m)	25.39	0.81	31.4
®	fc (log I_f £ log c)	3.45	0.44	7.9
®	mc (log I_m £ log c)	5.23	0.52	10.1

Table B2: estimation results – joint taxation
coefficient vector $\hat{\mu}^c$

	paramètre	coef.	std. err.	t-ratio
-	f_{f1} (log I_f £ I_{f1})	-13.42	4.60	-2.9
-	f_{f2} (log I_f £ I_{f2})	-20.80	4.59	-4.5
-	f_{f3} (log I_f £ I_{f3})	-28.86	4.50	-6.4
-	m_{m1} (log I_m £ I_{m1})	4.45	5.26	0.8
-	m_{m2} (log I_m £ I_{m2})	-4.18	5.19	-0.8
-	m_{m3} (log I_m £ I_{m3})	-12.47	5.13	-2.4
-	c (log c)	-68.71	2.45	-28.0
®	ff (log I_f £ log I_f)	-19.02	0.64	-29.5
®	mm (log I_m £ log I_m)	-20.17	0.70	-28.8
®	cc (log c £ log c)	1.64	0.07	25.1
®	fm (log I_f £ log I_m)	30.80	0.96	32.1
®	fc (log I_f £ log c)	6.39	0.33	19.6
®	mc (log I_m £ log c)	5.95	0.37	15.9

Table B3: estimation results – individual taxation
 coefficient vector $\hat{\mu}^p$

	parameter	coef.	std. err.	t-ratio
-	f_{f1} ($\log I_f \text{ \textasciitilde } f_{f1}$)	-17.97	4.79	-3.7
-	f_{f2} ($\log I_f \text{ \textasciitilde } f_{f2}$)	-24.59	4.81	-5.1
-	f_{f3} ($\log I_f \text{ \textasciitilde } f_{f3}$)	-31.44	4.77	-6.6
-	m_{m1} ($\log I_m \text{ \textasciitilde } m_{m1}$)	-21.06	5.32	-4.0
-	m_{m2} ($\log I_m \text{ \textasciitilde } m_{m2}$)	-28.93	5.31	-5.4
-	m_{m3} ($\log I_m \text{ \textasciitilde } m_{m3}$)	-36.50	5.30	-6.9
-	c ($\log c$)	-91.34	3.50	-26.1
®	f_f ($\log I_f \text{ \textasciitilde } \log I_f$)	-13.80	0.52	-26.6
®	m_m ($\log I_m \text{ \textasciitilde } \log I_m$)	-15.01	0.58	-25.7
®	cc ($\log c \text{ \textasciitilde } \log c$)	2.35	0.09	26.5
®	f_m ($\log I_f \text{ \textasciitilde } \log I_m$)	21.23	0.73	29.2
®	f_c ($\log I_f \text{ \textasciitilde } \log c$)	6.22	0.44	14.1
®	m_c ($\log I_m \text{ \textasciitilde } \log c$)	8.14	0.49	16.6

10 Appendix C: tax revenue

The first column of Table C show the amount of tax revenue in the situations of joint and individual taxation, computed from the simulated data. The small discrepancy between both figures could of course be brought to be exactly 0 by adjusting, say, the tax brackets in the joint taxation situation. However the subsequent show that this would not necessarily make comparisons between the collective and unitary models easier: for each estimated parameter vector and for each fiscal system, we report the tax revenue associated with the predicted labour market situation of each household. Here also the misspecification associated with the unitary representation leads to important discrepancies: in all cases the unitary model predicts substantially larger tax revenues for joint taxation, whereas the actual tax revenue is actually marginally lower than for individual taxation. This point is important, because the evaluation of fiscal reforms often entails the specification of revenue neutral reforms.

The fact that the worst predictions are obtained using $\hat{\mu}^o$ is not surprising, since the introduction of taxation leads to large adjustments in labour supplies. However it is slightly puzzling to find that the revenue for individual tax is better predicted using $\hat{\mu}^c$ than $\hat{\mu}^p$. No such reversal appears for joint taxation. Another puzzle lies in the fact that tax revenues predicted using $\hat{\mu}^c$ and $\hat{\mu}^p$ are larger than the actual tax revenue, since the unitary model leads to an under-estimation of labour supplies (see Section 6.2). In fact low levels of labour supplies are rather over-estimated and notably the number of participants is overstated. But individuals with low labour supply have on average higher unearned incomes and are thus more likely to be taxed.

Table C: tax revenues

model	collective	unitary		
		$\hat{\mu}^o$	$\hat{\mu}^c$	$\hat{\mu}^p$
joint taxation	2 999 920	4 096 180	3 289 330	3 490 220
individual taxation	3 026 510	3 801 910	3 121 990	3 324 170
variation	-0.88%	+7.74%	+5.36%	+5.00%

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