Progressive Income Taxation and Swiss Married Women's Labour Supply : a Conditional preferences life-cycle consistent Approach

Christophe Kolodziejczyk*
Center for Applied Microeconometrics,
University of Copenhagen
and Deep, HEC,
University of Lausanne

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Abstract

Using a cross-section of a Swiss household expenditure survey, we estimate a labour supply function for married women conditional on husband's work hours. We embed the model within a life-cycle framework, where we account for progressive income taxation. We derive the implications of taxation on participation in the labour market and on the labour supply elasticities. Preliminary results show that the marshallian wage elasticity conditional on husband's earnings and household saving is positive at the sample mean but negative for some women in the sample, especially for women whose husband's earnings are high, implying that taxation may negative incentives for women labour supply. Furthermore, we find that consumption and wife's work hours are separable from the husband's labour supply. This last variable is also found to be exogenous to the wife's labour supply suggesting the existence of some rationing on mens' hours.

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1 Introduction

In Switzerland income tax represents a large fraction of the fiscal incomes of the government and amounted in 1999 around 16% of the GDP and a little more than half of the total fiscal incomes. The income tax is a large source of financing for the government but also has a big impact on the labour supply. Because of its progressivity, this tax has potentially large disincentive effects since an increase in the work hours for a given gross wage rate will decrease the marginal wage and then leads to a decrease of the labour supply. Moreover if households optimize over the life-cycle and substitute consumption and leisure because of variations in the wage rate this will also influence savings.

The study of the labour supply, and particularly the estimation of the wage and income elasticities, in presence of a progressive income tax is important for economic policy evaluations on the labour market and more specifically for tax reforms. Most of the studies on the labour market estimate the labour supply function considering a static model and a linear budget constraint. However the economic analysis differs greatly and gives less clear predictions once we take into account explicitly the progressivity of the income tax. The results of the classical model remains valid only when the income tax is proportional (Hausman [10]), an assumption clearly unrealistic for our economies and especially for Switzerland. When the budget set is a convex but non-linear set we have economic and econometric implications. From a theoretic point of view, we will have distortions on the labour market since depending on the number of hours chosen by the individual the marginal wage rate will not be constant. Econometrically this implies that the marginal wage and the marginal and the virtual income are endogenous variables since they depend on the number of work hours.

Static models of labour supply use the sum of capital income, transfers and other exogenous incomes as the measure of the non-labour income. The problem with this measure is that it does not contain information on savings and the estimation of this kind of models are interpretable in a life-cycle context under very restrictive assumptions such as an impossibility of transferring capital across periods (capital markets completely constrained) or under a myopic behavior from the households. Moreover these models confuse an increase of the wage profile and an increase along the wage profile. In a life-cycle model there is a trade-off between consumption and leisure within the periods but also an intertemporal substitution between consumption and leisure which is reflected by savings. Then, savings observed today will summary the whole allocation process of consumption and leisure. So the estimation of labour supply functions with cross-section data which are compatible with the life-cycle model needs data on households' expenditures and incomes (see Blundell and Walker [3]). When we assume that preferences are weakly separable over time we can apply the idea of the two-stage budgeting, where in a first stage households allocate their full income over the life-cycle and then choose in every period optimally their consumption and their labour supply for a given full income. These models allow us to give an interpretation to the labour supply elasticities (see Blundell and Walker [3] and Blundell and MaCurdy [2]).

If the study of labour supply in the context of a life-cycle is interesting per se, the study of labour supply for married couples seems to find a more particular interest. The taxation of married couples income implies the aggregation of the incomes of both spouses who then face the same marginal tax rate. The estimation of the labour supply of married couples has to be made jointly since both partners have to choose their common marginal tax rate. Moreover in Switzerland and like in many countries, we do not observe a large variation among men's work hours. Many of them have a full-time activity and seem for institutional reasons unable to increase their labour supply. Around 50% of the married women are outside the labour force and around 50% of the active married women have a part-time job. The study of the women labour supply is then important since it seems that we can act on this market particularly. Among the many studies on female labour supply, few of them take into account explicitly the progressivity of the income tax, but also neither take into account neither the special treatment of married couples nor control for savings. For example Gerfin [9] estimates a discrete-choice model for swiss married women and takes into account for the progressivity of income tax but does not explicitly model the interaction between the husband's and the wife's labour supplies and implicitly suppose that men's work hours are separable from disposable income and their wife's work hours. He does not control for savings either. The progressivity of income tax has also implications on the participation decision of the wife. When she evaluates her utility between working a positive amount of hours and not working, she has to consider the marginal tax rate that the household will face when only the husband is working. The reservation wage will depend on the net income of the husband. The treatment of this additional problem is complicated and the developed techniques to solve this problem are quite recent. Blundell and MaCurdy [2] make a review of this literature., but few of the empirical studies have dealt with the life-cycle aspects of labour supply (see for example Hausman [10], Moffit [12] and Bourguignon and Magnac [4].

Here is the main contribution of our study. The aim of this paper is to estimate the swiss married women labour supply in the context of the life-cycle unitary model taking into account the progressivity of income tax. In order to be consistent with the life-cycle allocation of consumption labour supply we take the two-stage budgeting approach due to Goreman (see Deaton and Muellbauer [7]) and applied by Blundell and Walker [3] in the context of cross-section data. In order to be consistent with the unitary model we take the approach of the conditional preferences due to Pollak [14] and Browning and Meghir [5](see also Pollak and Wales [15]). This approach allows us to derive a labour supply function for married women conditional on their husband's work hours. Then we can test whether the work hours of both spouses are substitutes or complements, whether the hours of the husband are separable from consumption and the wife's labour supply and finally whether the labour supply of the husband is exogenous to the wife. As far as we are concerned this approach has never been implemented to the married women in the context of the unitary model. Also the two-stage-budgeting assumption is a simple way of considering the interaction between savings and labour supply.

In section 2, we present the theoretical framework. We show how the assumption of weak separability of preferences over time allows us to decompose the problems in two-steps and how with the concept of conditional preferences we can derive a conditional labour supply function for married women. We also show the analysis change when we introduce taxation in the problem. Section 3 presents the econometric methodology. We implement an econometric model which deals with the endogeneity of the marginal wage and the virtual income due to the progressivity of income tax, and also with the high rate of non-participation of the swiss married women. In section 4 we give a description of the data and provide the empirical results. Section 5 gives some concluding comments.

2 Theoretical framework

2.1 Life-cycle and labour supply : two stage budgeting

When preferences are weakly separable over time, we can apply the idea of two-stage budgeting (see Blundell and MaCurdy [2], and Blundell and Walker [3]. Assume the household's intertemporal utility function is represented by the weakly overtime separable utility (1)

$$\mathcal{U}_t = \mathcal{U}\left(U_t\left(c_t, h_{f,t}, h_{m,t}\right), .., U_T\left(c_T, h_{f,T}, h_{m,T}\right)\right) \tag{1}$$

where c_t is consumption, h_{ft} the wife's work hours and h_{mt} the husband's hours. Under this assumption the marginal substitution rate between consumption and leisure of each member is equal to her (his) own wage rate, that is $-U_{h_f,t}/U_{c,t} = w_{f,t}$ and $-U_{h_m,t}/U_{c,t} = w_{m,t}$ for all t.

We can decompose the problem in two steps. In a first stage the household allocates the full income over the life-cycle. Then in a second stage, the household decides its consumption and its labour supply for a given full income. This has two implications. First savings will summary all the past, present and future information on the resource allocation over the life-cycle. Second in the second step of the allocation process the measure of the non labour income must contain information about savings. According to Blundell and MaCurdy [2], the solution of this problem can be found in reversing the order of the two-stages of the process. First, the household maximizes its utility in every period for a given full income. Then we can find an indirect utility function depending on the wage rates and the full income which can be substituted in the intertemporal utility function. Finally we can maximize this utility function with respect to the full income in every period.

2.2 Married couples' labour supply : unitary model and conditional preferences

Consider the following unitary and static labour supply model

$$\begin{aligned} \max_{c,h_f,h_m} U &= U\left(c, h_f, h_m\right) \\ s.c.\ c &= w_f h_f + w_m h_m + N \end{aligned} \tag{2}$$

The household maximizes its utility under its budget constraint. In this model, the household chooses simultaneously the work hours of its two members[1]. The first order conditions are $-U_{h_f}/U_c = w_f$ and $-U_{h_m}/U_c = w_m$ and allow us to find marshallian labour supply functions $h_f = h_f\left(w_f, w_m, N\right)$ and $h_m = h_m\left(w_f, w_m, N\right)$.

We can also obtain labour supply functions conditional to the spouse's labour supply of the. For instance, the wife's optimization problem can be rewritten as follows.

$$\begin{aligned} \max_{c,h_f} U &= U\left(c, h_f; h_m\right) \\ s.c.\ c &= w_f h_f + w_m h_m + N \end{aligned} \tag{3}$$

[1] Blundell et MaCurdy [2] font remarquer que beaucoup de gens ont tendance à interpréter ce modèle comme une situation où les indivdus choisissent leurs heures de travail pour un salaire fixe avec un seul employeur. En réalité, ce type de modèle peut caractériser des situations où les personnes choisissent leurs heures de travail en sélectionnant différents employeurs offrant différentes possibilités de salaires. La fonction d'offre de travail approxime la relation moyenne pour les préférences des agents entres les heures de travail et la consommation.

The first order condition is equivalent to the one obtained with the unconditional approach, i.e.

$$-\frac{U_{h_f}(c, h_f; h_m)}{U_c(c, h_f; h_m)} = w_f \tag{4}$$

Substituting the budget constraint in (4), we obtain the wife's labour supply function conditional on her husband's work hours

$$h_f = \widehat{h}_f(w_f, w_m h_m + N, h_m). \tag{5}$$

In the same way for the husband we have

$$h_m = \widehat{h}_m(w_m, w_f h_f + N, h_f). \tag{6}$$

The relation between the conditional and the unconditional labour supply function is given by (see Browning and Meghir [5], and Pollak and Wales [15])

$$\begin{aligned} h_f &= \widehat{h}_f(w_f, w_m h_m + N, h_m(w_f, w_m, N)) \\ &= h_f(w_f, w_m, N). \end{aligned}$$

Define $m_f = w_m h_m + N$ the other income of the wife Note that h_m is separable from c and h_f if

$$h_f = \widehat{h}_f(w_f, m_f) \tag{7}$$

(see Browning and Meghir [5]).

As Browning and Meghir [5] make notice, there are several advantages in applying the conditional preferences approach. First it is particularly suited when the conditioned good is rationed. Second, this approach allows a simple test of separability between consumption and leisure of one member from the leisure of his spouse. Third, we do not have to model explicitly the determination of the conditioning good. It is important to understand that the conditional approach does not imply that the conditioned good is considered exogenous. It just consists in a rewriting of the unitary model. It can happen that this good is an endogenous and therefore we should test this eventuality. In such a case we should use instrumental instruments when we come to estimate the model[2].

However, there exists a drawback to our approach. All the implications in terms of policy evaluation will be conditional on the hours of the spouse's work hours. In a unitary model a variation in the wage will have the effect on the labour supply as shown by the derivative (8)

$$\frac{dh_f}{dw_f} = \frac{\partial \widehat{h}_f}{\partial w_f} + \left(w_m \frac{\partial \widehat{h}_f}{\partial m_f} + \frac{\partial \widehat{h}_f}{\partial h_m} \right) \frac{dh_m}{dw_f} \tag{8}$$

[2] This suggests also to find instruments for this variable.

The conditional approach implies we can only recover $\partial\widehat{h}_f/\partial w_f$. Also an increase in the other spouse's wage rate will have an effect on the labour supply of the other member only through an income effect through the earnings of the spouse, i.e.

$$\left.\frac{dh_f}{dw_f}\right|_{h_m} = w_m \frac{\partial\widehat{h}_f}{\partial m_f}. \tag{9}$$

However the assumption of rationing on work hours may justify the predictions given by economic policy reforms implemented with this approach. We can obtain $\partial\widehat{h}_f/\partial w_f$, $\partial\widehat{h}_f/\partial h_m$ and $\partial\widehat{h}_f/\partial m_f$ by regressing h_f on w_f and m_f and conditioning on h_m and test three hypothesis. First, if c and h_f are separable from h_m. Second, if h_f and h_m are complements and substitutes. Third if h_m is exogenous in the labour supply decision of her (his) spouse, that is if she (he) is subject to some rationing in her (his) labour supply.

2.3 Labour supply, life-cycle allocation and progressive taxation of income : conditional approach

2.3.1 The intertemporal problem

Let $U(c_s, h_{f,s}, h_{m,s,}E_s, Z_s)$ designate the instantaneous utility function at time s, where c_s is consumption, $h_{f,s}$ and $h_{m,s}$ are respectively work hours for the wife and the husband and Z_s is a set of demographic characteristics. Let $w_{f,s}$ and $w_{m,s}$ be respectively the hourly wage rates of the wife and the husband, N_s an exogenous income, A_s the assets held by the household, $T_s(Y_s, E_s)$ the taxation function representing the the progressive income tax schedule E_s a set of demographic variables (number of children for instance.) which determines the taxable income. In order to simplify the exposition, we assume that intertemporal utility is additively separable over time. The household is assumed to live T periods. The household maximizes the expected sum over time of the discounted utilities under its intertemporal budget constraint, i.e.

$$\begin{aligned}
V_t(A_t) &= \max_{\{c_s\}_{s=t}^{T}} \sum_{s=t}^{T} \beta^{s-t} E_t \left[U(c_s, h_{f,s}, h_{m,s}; E_s, Z_s)\right] \qquad (10)\\
s.t.\ A_s &= A_{s-1}(1+r_s) + w_{f,s}h_{f,s} + w_{m,s}h_{m,s} + N_s - T_s(Y_s, E_s; \theta_s) - c_s \\
Y_s &= w_{f,s}h_{f,s} + w_{m,s}h_{m,s} + A_{s-1}r + N_s \\
A_{T+1} &= 0 \\
& \quad A_{t-1} \text{ given}
\end{aligned}$$

where Y_s is taxable income. We obtain the usual Euler equations

$$
\begin{aligned}
U_{c,t} &= \beta E_t \left[\left(1 + r_{t+1} \left(1 - T_{Y,t+1} \right) \right) U_{c,t+1} \right] && (11) \\
-\frac{U_{h_f,t}}{U_{c,t}} &= w_{f,t} \left(1 - T_{Y,t} \right) && (12) \\
-\frac{U_{h_m,t}}{U_{c,t}} &= w_{f,t} \left(1 - T_{Y,t} \right) && (13)
\end{aligned}
$$

The Euler equation (11) tells us that the household will smooth over time the marginal utility of consumption[3] corrected by a discount factor which depends on marginal tax rate in future periods of the life-cycle. Equations (12) and (13) differ from the static case since the marginal rate of substitution between consumption and leisure is equal to marginal wage rate. Solving equations (11) to (13) gives a solution for the optimal asset allocation at time t which is defined by the function (14)

$$
A_t^* = \widehat{\phi} \left(\mathbf{w}_f, \mathbf{w}_m, \mathbf{N}, \mathbf{E}, \mathbf{Z}, \mathbf{r}, A_{t-1}, \Theta \right), \tag{14}
$$

where $\mathbf{w}_f = E_t \left(w_{ft}, .., w_{fT} \right)$, $\mathbf{w}_m = E_t \left(w_{mt}, .., w_{mT} \right)$, $r = E_t \left(r_t, ..., r_T \right)$, $\mathbf{N} = \left(N_t, .., N_T \right)$, $\mathbf{E} = \left(E_t, .., E_T \right)$ and $\mathbf{Z} = \left(Z_t, .., Z_T \right)$. $\Theta = \left(\theta_t, .., \theta_T \right)$ is the set of parameters vectors of the taxation function $T \left(\cdot, \cdot \right)$. The two Euler equations (12) and (13) do not depend on future values so that we can apply the two-stage budgeting process. In a first stage, the household allocates its full income over life-cycle given the time profile of the wages, number of children, demographic characteristics, non labour income and the income taxation. Once wealth has been allocated, the household optimizes at every period its labour supply for a given wealth allocation.

2.3.2 Conditional labour supply

Once wealth has been allocated, we obtain optimal values for the assets $\{A_s^*\}_{s=t}^T$. Let $\Delta A_t^* = A_t^* - A_{t-1}^*$ designate household's savings. In the second step of the two-stage budgeting approach the optimization problem for the household at each period is written as

$$
\begin{aligned}
&\max_{c, h_f, h_m} U(c, h_f; h_m, E, Z) && (15) \\
s.t.\ c &= w_f h_f + w_m h_m + r A_{t-1}^* + N - T(Y, E) - \Delta A_t^* \\
Y &= w_f h_f + w_m h_m + r A_{t-1}^* + N
\end{aligned}
$$

[3] The dynamic lagrange multiplier of this problem can be interpreted as the marginal utility of wealth. This multiplier follows a first-order difference equation. Then we see that agents will try to smooth the marginal utility of wealth over time and at the optimum, the marginal utility of wealth is equal to the marginal utility of consumption.

According to the budget constraint, consumption is equal to the sum of the household's gross earnings minus taxes and savings. We can find a conditional labour supply function for the wife by solving the problem (16)

$$\max_{h_f} U(Y - T(Y,E) - \Delta A_t^*, h_f; h_m, E, Z). \tag{16}$$

Let $\widehat{w}_f = w_f\left(1 - T_Y\left(Y, E\right)\right)$ and $\widehat{w}_m = w_m\left(1 - T_Y\left(Y; E\right)\right)$ be respectively the wife's the husband's marginal wage rates. The marginal wage rate depends on the gross income and on the number of children present in the households who grant fiscal deductions. Let $Y^d = Y - T(Y, E)$ be the net after-tax income, the marginal rate of substitution between consumption and leisure is equal to the marginal wage rate, i.e.

$$-\frac{U_{h_f}(Y^d - \Delta A_t^*, h_f, h_m, E, Z)}{U_c(Y^d - \Delta A_t^*, h_f; h_m, E, Z)} = \widehat{w}_f. \tag{17}$$

We can rewrite the budget constraint as

$$c = \widehat{w}_f h_f + m_f, \tag{18}$$

where $m_f \equiv T_Y\left(Y; E\right) w_f h_f + w_m h_m + r A_{t-1}^* + N - T\left(Y; E\right) - \Delta A_t^* = c - \widehat{w}_f h_f$.is the virtual non-labor income of the wife and corresponds to the intercept of the derivative of the utility function at the wife's optimal labour supply (see figure (1)).

- *insert figure 1* -

We can define the wife's labour supply conditional on the spouses work hours (19) which results from the maximization of household's utility function conditional on the spouse's labour supply under a budget constraint where non-labor income is m_f and the price of leisure is the marginal wage rate $\widehat{w}_f$.

$$h_f = \widehat{h}_f\left(\widehat{w}_f, h_m, m_f, E, Z\right) \tag{19}$$

$\widehat{w}_f$ and m_f are endogenous variables which depend on the wife's work hours, the earnings of the husband, the non labour income, the amount of income tax and savings. From the budget constraint we can directly observe m_f since this quantity is the difference between consumption and the marginal wage rate times work hours.

For clarity reasons in the notation and to simplify the exposition, in the remaining part of the theoretical discussion we will derive.

2.3.3 Comparative statics

In order to have progressivity of income tax we assume the function $T(Y, E)$ is increasing and strictly convex. The budget set of the wife is convex (see figure (1)). An increase in the gross hourly wage rate will increase the set of possibilities between consumption and leisure. It translates in a shift-up of budget constraint, as illustrated in figure (**??**) This will lead at the same time to a modification for the marginal wage rate and the virtual non-labor income. An increase of the wage rate induces an income effect through the change in the marginal wage rate and the virtual non-labor income. This can lead to an increase or a decrease of the labour supply. Then, progressive income taxation can have disincentives to paid work. In the last section we mentioned that the current wealth allocation, that is also savings, is determined by the lice-cycle profile of all the variables of the model, especially the wage rates. In theory, a variation in the wage rates will not only affect labour supply but also savings. This effect will be different if it is temporary or permanent. If we assume that the work hours of the spouse and savings are constant[4], we can derive elasticities for the labour supply conditional on savings and the spouse's work hours, and which we can estimate with our conditional approach. If households have time horizon sufficiently long, we can assume that their savings will remain approximately constant. On figure (2) an increase in the wife's gross wage keeping husband's earnings and savings constant leads to a shift of the budget constraint. The marginal wage rate at point B is greater than the marginal wage at point A. This shift implies a change in the virtual non-labor income m_f.

- insert figure 2 -

Formally, the derivative of the labour supply function with respect to the marginal wage is

$$\left.\frac{dh_f}{d\widehat{w}_f}\right|_{h_m,\Delta A_t^*} = \left.\frac{\partial \widehat{h}_f}{\partial \widehat{w}_f}\right|_{h_m,\Delta A_t^*} + \left.\frac{\partial \widehat{h}_f}{\partial m_f}\right|_{h_m,\Delta A_t^*} \cdot \left.\frac{dm_f}{d\widehat{w}_f}\right|_{h_m,\Delta A_t^*}$$

With some algebra, we obtain the derivative of the conditional labour supply function with respect to the gross wage rate

$$\left.\frac{dh_f}{dw_f}\right|_{h_m,\Delta A_t^*} = \frac{1}{D_f}\left[\frac{\partial \widehat{h}_f}{\partial \widehat{w}_f}\left(1 - T_Y - w_f h_f T_{YY}\right) + \frac{\partial \widehat{h}_f}{\partial m_f}\left(2T_Y - w_f h_f T_{YY}\right) h_f\right] \tag{20}$$

[4]Or at least does not change much

where $D_f = 1 + T_{YY} w_f^2 \left(\partial \widehat{h}_f / \partial \widehat{w}_f - \partial \widehat{h}_f / \partial m_f h_f \right)$. In a model without taxation $h_f = \widehat{h}_f \left(w_f, w_m h_m + N + r A_{t-1}^* - \Delta A_t^* \right)$ and the derivative (20) is equal to

$$\left. \frac{dh_f}{dw_f} \right|_{h_m, \Delta A_t^*} = \frac{\partial \widehat{h}_f}{\partial w_f}$$

Compared to the model without taxation, our model highlights a multiplier effect through the term $1/D_f$ which takes into account of the endogeneity of $\widehat{w}_f$ and m_f due to the progressive income taxation and the the income pooling of both spouses in the taxation process. The effect of the marginal wage is corrected by a factor taking into account the position of the household in the tax schedule. We also see that the endowment effect depends on this position.

- *insert figure 3* -

The substitution effect is given by

$$\left. \frac{dh_f}{dw_f} \right|_{U, h_m, \Delta A_t^*} = \left. \frac{dh_f}{dw_f} \right|_{h_m, \Delta A_t^*} - \frac{\partial \widehat{h}_f}{\partial m_f} \frac{dm_f}{dw_f} > 0$$

with $dm_f / dw_f = D_f^{-1} h_f T_{YY} \left[w_f^2 \left(1 - T_Y\right) \partial \widehat{h}_f / \partial \widehat{w}_f + w_f h_f + T_Y \partial \widehat{h}_f / \partial \widehat{w}_f \right]$

In order to determine the effects on the labour supply function from exogenous changes in the variables of the model we have to specify a functional form to $T(Y, E)$. We show in the econometric section which functional form we chose. Here $T(Y, E)$ is assumed to be increasing and strictly convex in Y to ensure progressivity, that is $T_Y > 0$ and $T_{YY} > 0$. Moreover, we suppose $T_E < 0$, $T_{EE} = 0$ and $T_{YE} < 0$. An additional child allows to benefit from deductions and corresponds to a reduction in the taxable income. The marginal effect is constant, i.e. deductions are lump-sum. In the appendix we derive the derivatives of the labour supply function with respect to the exogenous variables of the model.

2.4 Non-participation

In Switzerland, almost half of the women population are in the home-production section. In the past twenty years most of the empirical literature on labour supply has been dealing with this problem and has stressed the importance of this issue (see for example Heckman and Mroz [13]). Women who do not participate to the labour market are on a corner solution. In our theoretical framework we can easily deal with this problem. The wife will participate when the utility she gets from working is higher from not working. The important issue in our analysis of the determinants of the participation is that not only the earnings of the husband and the non-labor income of the household, also the marginal tax rate faced by the household and savings will influence this decision. Figure 3 illustrates this case. The reservation wage is the slope of the indifference curve when the wife does not work. The wife will not work when the reservation wage is higher than the offered marginal wage evaluated at zero hours. This variable depends on the marginal tax rate of the households evaluate at the wife's zero work hours and then on the earnings of her husband. Let $\widehat{w}_f^R$ designate the reservation wage. It corresponds to the wage rate which makes the wife indifferent between working and not working that is it is the wage which equalizes the labour supply function to zero. Condition (21) has to hold,

$$-\frac{U_{h_f}(Y_0^d - \Delta A_t^*, 0, h_m, E, Z)}{U_c(Y_0^d - \Delta A_t^*, 0, h_m, E, Z)} = \widehat{w}_f^R \tag{21}$$

where $Y_0^d = w_m h_m + rA_{t-1}^* + N - T\left(Y^0; E\right)$ and $Y^0 = w_m h_m + rA_{t-1}^* + N$.

- *insert figure 4* -

Let $m_{f0} = Y_0^d - \Delta A_t^*$, we can rewrite the reservation wage as $\widehat{w}_f^R = g_f\left(h_m, m_{f0}, Z\right)$. We define $\widehat{w}_{f0} \equiv w_f\left(1 - T_Y\left(Y_0, E\right)\right)$ the marginal wage rate evaluated at zero hours. A woman will work condition (22) is satisfied

$$\widehat{w}_{f0} > g_f\left(h_m, Y_0^d - \Delta A_t^*, Z, E\right). \tag{22}$$

3 An econometric model of labour supply with taxation and non-participation

3.1 Self-selection two-steps Heckman estimator

As we have shown in section 2, the marginal wage and the virtual non-labor income due to the progressivity of income tax are endogenous and functions of number of work hours and earnings of their spouse. When we come to estimate the model, we have to instrument these two variables. Note that are $\widehat{h}_i$ and $\widehat{w}_i$ are only observed for those who participate to the labour force. We have shown that the individual will choose to work if her marginal wage evaluated at zero hours is greater then her reservation wage. As the reservation wage is the one which equalizes the labour supply function to zero, this variable will depend on the net non-labor income evaluated at zero hours for the individual. The model for the wife is described as follows

$$\begin{aligned} h_{f,i} &= \max\left[0, \widehat{h}^*_{f,i}\left(\widehat{w}^*_{f,i}, h_{m,i}, m_{f,i}, E_i, Z_i\right) + u_{h_{f,i}}\right] \\ \widehat{w}_{f,i} &= \begin{cases} \widehat{w}^*_{f,i} \text{ if } h_{f,i} > 0 \\ 0 \text{ otherwise} \end{cases} \end{aligned} \tag{23}$$

$\widehat{h}^*_{f,i}$ and $\widehat{w}^*_{f,i}$ are two latent variables. Model (23) corresponds to a generalized Tobit formulation. However $\widehat{w}^*_{f,i}$ and $m_{f,i}$ are two endogenous variables and $\widehat{w}^R_{f,i}$ depends on the taxation profile since it depends on $m_{f0,i}$.

Depending on the functional form of the labour supply function, we cannot find an analytical solution for the reservation wage. Let d_{fi} denote a dummy variable which takes value 1 if the wife works and 0 otherwise. Let $S_{f,i}$ designate a measure of the difference in utilities of working and not working (see Mroz [13]).We assume we can summary the selection mechanism via the selection equation (24)

$$d_{f,i} = \begin{cases} 1 \text{ if } S_{f,i} = W_{f,i}s_f + u_{S_f,i} > 0 \\ 0 \text{ otherwise} \end{cases}, \tag{24}$$

where $W_{f,i}$ is the set of the determinants of the participation decision, s_f is a vector parameter and $u_{S_f,i}$ is an error term with zero mean. In theory this variable will depend on the marginal wage at zero hours and the reservation wage. For the non-working wives the offered wage is not observed and we assume that some of its determinants are known to the econometrician. In particular it will depend on demographic characteristics and the on the marginal tax rate evaluated at zero hours for the wife. The reservation wage will depend on the number of work hours of the husband, the virtual non-labor income evaluated at zero wife's work hours corrected by savings, the number of children and demographic characteristics. We assume u_{h_f} and u_{S_f} follows a bivariate normal distribution with zero mean.

$$\left(u_{h_f}, u_{S_f}\right) \rightsquigarrow N\left(0, 0, \sigma_{h_f}, \sigma_{S_f}, \rho\right). \tag{25}$$

The probability of participation is equal to

$$P\left(h_{f,i} > 0\right) = P\left(d_{f,i} = 1\right)$$

The conditional expectation of $\widehat{h}^*_{f,i}$ given that we select the sub-sample of working wives is equal to.

$$E\left[\left.\widehat{h}^{*}_{f,i}\right| d_{f,i}=1\right]=\widehat{h}_{f,i}\left(\widehat{w}^{*}_{f,i},h_{m,i},m_{f,i},E_i,Z_i\right)+E\left[\left.u_{h_{f,i}}\right| d_{f,i}=1\right]. \quad (26)$$

Let $W_{f,i}\eta_f \equiv \left[W_{f,i}s_f\right]/\left(\sigma_{S_f}\right)$. Let $\phi(\cdot)$ designate the standard normal pdf, $\Phi(\cdot)$ its cumulative distribution and $\lambda(\cdot)=\phi(\cdot)/\Phi(\cdot)$ the inverse of the mills ratio. Then $E\left[\left.u_{h_{f,i}}\right| d_{f,i}=1\right]$ is equal to

$$E\left[\left.u_{h_{f,i}}\right| W_{f,i}s_f>0\right]=\rho\lambda\left(W_{f,i}\eta_f\right). \quad (27)$$

We can obtain a consistent estimator of the model by regressing on the sub-sample of working wives $\widehat{h}^{*}_{f,i}$ on the explanatory variables of the model and a consistent estimator of the inverse of the mills ratio. We can obtain this regressor by estimating a probit model for the participation decision with $W_{f,i}$ as explanatory variables. Since $\widehat{w}^{*}_{f,i}$ and $m_{f,i}$ are endogenous, we use an instrumental variable estimator in the second step. This implies we have to find instruments for the marginal wage and the virtual non-labor income. This issue is discussed in the empirical part of this paper. We include as instruments the inverse of the mills ratio. We also have to correct the covariance matrix for the presence of generated regressors (see Wooldridge [17]).

3.2 Functional forms

In order to be able to estimate the model and to compute the wage and income elasticities of the labour supply function, we have to choose a functional form. We have chosen the semi-logarithmic (28) and generalized semi-logarithmic (28) specifications, i.e.

$$\widehat{h}_f = \alpha\ln\widehat{w}_f+\beta m_f+\delta h_m+Z\gamma+u_{h_f} \quad (28)$$

$$\widehat{h}^{*}_f = \alpha\ln\widehat{w}^{*}_f+\beta\frac{m_f}{\widehat{w}^{*}_f}+\delta h_m+Z\gamma+u_{h_f} \quad (29)$$

For specification (28), $\partial\widehat{h}_f/\partial h_m=\delta$, $\partial\widehat{h}_f/\partial\widehat{w}_f=\alpha/\widehat{w}_f$ and $\partial\widehat{h}_f/\partial m_f=\beta$. This functional form allows a non-linearity of the wage effect since the wage elasticity declines with work hours, but its sign is always positive for all work hours and is linear in income. The parameter α can be interpreted as a semi-elasticity. As for specification (29) $\partial\widehat{h}_f/\partial\widehat{w}_f=\widehat{w}_f^{-1}\left(\alpha-\beta\left(m_f/\widehat{w}_f\right)\right)$ and $\partial\widehat{h}_f/\partial m_f=\beta/\widehat{w}_f$. This functional form allows a change in the sign of the wage derivative when m_f varies, but stays linear in income. These two specifications implies quasi-homothetic preferences. With these two specifications, we can test whether h_f and c are separable from h_m, whether they are complements and substitutes.

These two specifications are very useful and convenient since they allow to model the logarithm of the marginal wage as the sum of the logarithm of the gross wage and the logarithm of the marginal tax rate. We assume that the logarithm of the gross wage rate is determined by the equation $\ln w_f = D_f\theta_f + u_{w_f}$, where D_f is a set of instruments for the gross wage rate. The marginal wage can be decomposed as follows

$$\ln \widehat{w}_f^* = \ln w_f + \ln(1 - T_Y) = D_f\theta_f + \ln(1 - T_Y) + u_{w_f} \tag{30}$$

In the semi-logarithmic case, we easily find that $\ln \widehat{w}_{f0} = D_f\theta_f + \ln(1 - t_0) + u_{w_f}$ and $\ln \widehat{w}_f^R = -\frac{1}{\alpha}\left(\beta m_{f0} + Z\gamma + \delta h_m + u_{h_f}\right)$, where $t_0 = T_Y(Y_0, E)$. For the generalized semi-logarithmic model we cannot find an explicit solution for the reservation wage [5]. The solution will be a nonlinear function f of the other explanatory variables of the model and u_{h_f}, i.e. $\ln \widehat{w}_f^R = f\left(\alpha, \beta, \gamma, \delta, Z, h_m, m_{f0}, u_{h_f}\right)$. We assume that the reservation wage satisfies equation (31)

$$\ln \widehat{w}_f^R = Z_f a_0 + a_1 h_m + a_2 m_{f0} + u_{R_f}. \tag{31}$$

where u_{R_f} is an error term with zero mean and correlated with u_{h_f} and u_{w_f}. In the case of model (28), $u_{S_f} = u_{h_f} - \alpha^{-1}u_{w_f}$, as in model (29) $u_{S_f} = u_{h_f} - u_{R_f}$

3.3 Taxation function

In order to estimate our econometric model we have to approximate the function $T(Y, E)$. We show in an appendix how we estimate such a function in context of fiscal swiss data. In Switzerland, income tax is taken at the common, canton and federal state level. Taxation profiles are different for each canton. Consider first the direct federal income tax. The Statistical Office provides data points for typical married households (without child and with two children) between gross income and tax burden. We used these points for estimating our taxation function. The Statistical Office provides the same kind of data for each canton for tax burden at the common and the canton level. We selected a functional form where average tax rate is non-decreasing in income to ensure progressivity. We chose the generalized

[5] We have to solve in $\ln \widehat{w}_f^R$ the following equation $\ln \widehat{w}_f^R = -\frac{1}{\alpha}\left[\beta\left(m_{f0}/\widehat{w}_f^R\right) + Z\gamma + \delta h_m + u_{h_f}\right]$

logistic function (32)

$$\begin{aligned}\tau(Y,E) &= \frac{T\,(Y,E)}{Y} = \tau(Y-E\delta) = t_o + \frac{(t_1 - t_o)}{1+e^{-(\alpha+\beta(Y-E\delta))}}, \qquad (32)\\ \alpha &> 0 \text{ and } \beta > 0\\ \tau'(\cdot) &> 0 \text{ and } \tau''(\cdot) > 0 \text{ if } Y > \overline{Y}\end{aligned}$$

where τ is the average tax rate and Y is the household's gross income. In order to take into account of the possible deductions due to the presence of children in the household, we estimate the function $\tau(Y - E\delta) = T\,(Y,E)\,/(Y - E\delta)$, where$E$ is the number of children present in the household and δ is a parameter to be estimated. The functional form must satisfy the following properties $T_Y > 0$, $T_{YY} > 0, T_E < 0$, $T_{EE} > 0$ and $T_{YE} < 0$

4 Empirical analysis

4.1 Data

In our empirical analysis, we use the data of a swiss family expenditure survey the *Enquête sur les Revenus and la Consommation 1998* (ERC 98). This survey provides detailed information about consumption and income data for swiss households. We also find information on labour supply of the household, occupation status, the structure of the household and housing. In particular, the ERC 98 provides the number of work hours for each member of the household. But the data on earnings were only collected for workers. We had to drop from the sample people who have an independent status. We selected households consisting of couples where both spouses are workers or in the home-production sector and children don't work for pay. We also limited the samples for wages between 10 and 150 swiss francs. Finally we have obtained a sample of 2136 households. The figure *4* shows the distribution of monthly work hours for the wives and figure *6* husbands's distribution. Approximately 50 % of the women population is outside of the labour force and around 30% are working full-time. Working wives tend to work shorter hours than their husbands who tend to concentrate around 160 hours (40 hours a week). It seems that the typical number for the part-time job is around 20 hours a week. Moreover less than 1% of men do not participate to the labour market.

Consumption expenditures are defined as monthly sum of usual groups like food, tobacco and alcohol, clothing, housing, furniture, transports, communication, leisure, education and others. Since we make the assumption of intertemporal separability of preferences, we excluded durable goods. We also excluded health expenses, because they are supposed to help to maintain the welfare of the household rather than increase their utility[6]. We also excluded expenses for health insurance since it constitutes a reduction in income rather than an increase in welfare.

- Insert Figures 4 and 6 -

Table 1

Descriptive Statistics , married couples ERC 98

Variable	Mean	s.-d.
Wives' wage rate[a]	31.70	14.52
Wives' work hours[a]	119.06	44.95
Husbands' wage rate	41.93	16.89
Husbands' work hours	170.32	22.31
Non-labour income	1372.49	2393.00
Consumption expenditure	5243.09	2010.68
Wives' age	38.61	9.75
Wives' number of years of education	12.23	9.94
Husbands' age	41.12	10.00
Husbands' number of years of education	12.97	2.06
% of swiss married women	79.51	–
Wives' participation rate	51.20	–
Husbands' participation rate	0.99	–
Number of children less than 10 years old	0.86	0.99
Number of children between 10 and 15 years	0.23	0.54
Number of children between 15 and 20 years	0.08	0.30
Number of children between 20 and 25 years	0.021	0.17
1(youngest child between 0 and 2 years)	20.78	–
1(youngest child between 2 and 5 years)	15.66	–
1(youngest child between 5 and 10 years)	14.15	–
Average tax rate	14.18	5.43
Marginal tax rate	26.13	7.78
1(big city)	31.51	–
Number of observations	2136	

a=for working wives

Source : ERC 98

[6]Moreover it was impossible to distinguish between the actual amount paid by the household and the amount of the invoice.

4.2 Results

4.3 Results

4.3.1 Associated probit for wives' participation decision

On table 2, we present the results of the associated probit for the estimations of the inverse of the mills ratio needed for the Heckman two-step estimator. The dependant variable is a binary variable which takes the value 1 if the wife is working and 0 otherwise. We give the marginal effect on the probability of participation of a variation of the exogenous variables of the model. As we have exposed it in the theoretical discussion, the determinants of the participation decision are the offered marginal wage evaluated at zero hours and the reservation wage. For the wives who are not working we do not observe the offered wage. We assume that its determinants are the age, the age squared and the number of years of education. The reservation wage depends on the consumption expenditures evaluated at zero hours, the husband's work hours and the demographics entering the wife labour supply function. We took the gross earnings of the husband as a proxy for the marginal tax rate and the virtual income both evaluated at zero hours. We included the number children for different categories of age and dummy variables for the age of the youngest child. These variables control for the presence of monetary and time fixed costs of work. We also include variables that control for the occupation status and the nationality of the husband. These variables seem to have an important impact on the participation decision.

We see that the gross earnings has an important negative impact on the participation decision. Theoretically the virtual income of the wife is increasing in the husband's earnings and if leisure is a normal good, an increase in the male's earnings should decrease the propensity to enter the labour market. At the same time, an increase in the male's earnings will increase the marginal tax rate of the household and so will decrease the marginal wage of the wife evaluated at zero hours and will also decrease the probability of participation. The gross non-labor income has no impact on the participation decision. The number of children less than 15 years old has a negative impact, as the number of children above this age increase the probability of participation. We also notice that the age of the youngest child has a great negative impact. The younger the child, the stronger is the effect. The husband's work hours do not seem to impact the decision.

Table 2

Results of the associated probit
for the married women participation decision

	dF/dx
Age	0.047 (3.75)
Age^2	−0.0768 (−5.18)
Number of years of education	0.043 (5.79)
Number of children less than 10 years old	−0.15 (−5.39)
Number of children between 10 and 15 years	−0.10 (−4.30)
Number of children between 15 and 20 years	−0.005 (−0.12)
Number of children between 20 and 25 years	0.013 (0.18)
1(youngest child between 0 and 2 years)	−0.479 (−9.01)
1(youngest child between 2 and 5 years)	−0.391 (−6.76)
1(youngest child between 5 and 10 years)	−0.182 (−3.44)
Husband's earnings[a]	−0.0347 (−6.94)
Non-labour income	−0.00 (−0.85)
Husband's work hours	−0.0007 (−1.34)
1(Husband swiss nationality)	−0.19 (−5.90)
1(Husband craftsman)	−0.128 (−3.84)
1(Big city)	0.101 (3.72)
Pseudo R^2	0.2561
Number of observations	2136
Log-likelihood	−1101.45
χ^2 p-value	0.00
Observed probability	0.501
Predicted probability	0.511

Note : z-statistics in parentheses

4.3.2 Estimates of the women's conditional labour supply function

On tables 3 and 4, we give the results of the estimation of the conditional labour supply function for married women. respectively for the semi-logarithmic and generalized semi-logarithmic specifications. We have estimated the model by OLS on the sub-sample of working women, by the maximum likelihood estimator of the Heckman model on the entire sample and a GMM estimator takes into account the self-selection problem and the endogeneity of the marginal wage and the virtual income. We included in the regression of the wife's work hours on the marginal wage, the virtual income and the husband's work hours the number of children in some categories of age, dummy variables for the age of the youngest child, the age and the age squared of the wife, the number of years of education, dummy variables for her occupation status and a dummy variable for swiss nationality as control variables. For both specifications we used as instruments for the marginal wage and the virtual income the number of years of education squared, the number of years of experience on the labour market and its squared, dummy variables for some occupation status (administration and services), a dummy variable for swiss nationality, dummy variables if the husband is a non-skilled worker and the husband's gross earnings. We notice that controlling for the self-selection problem through the MLE of the Heckman model changes the wage and income effects. When we estimate the model by the GMM estimator the coefficient of the marginal wage become positive compared two the other estimators and is significant. The sign of the virtual income coefficient is negative for the three estimators and is greater in magnitude for the GMM estimator. The coefficient on the husband's work hours is positive but is insignificant. We cannot reject the hypothesis that male's hours is separable from consumption and women's work hours. As we do not observe much variation in the number of work hours for the husbands this results suggests some rationing on the labour supply of men. Only the number of children less than 15 has a significant impact on the wife's labour supply. The strongest impact is for children less than 10 years old. The age of the youngest child does not seem to have a significant impact. These variables seem to have a impact on the extensive rather than on the intensive margin. The p-value of the J-statistic is 0.38 for the semi-logarithmic specification and 0.68 for the generalized semi-logarithmic specification. We also report the p-value of the F-statistic of the GMM's first-step regression.

Table 3
Married women labour supply
semi-logarithmic specification

	OLS	*MLE*	G*MM*
$\ln \widehat{w}_f$	-15.22	-15.98	59.33
	(-4.63)	(-4.89)	(2.58)
m_f	-0.0057	-0.0054	-0.0064
	(-9.90)	(-9.38)	(-2.31)
h_m	-0.125	-0.091	0.058
	(-3.24)	(-2.26)	(0.79)
Number of children under 10 years old	-18.01	-13.44	-19.72
	(-5.30)	(-3.71)	(-3.26)
Number of children between 10 and 15 years	-11.93	-9.69	-9.78
	(-5.07)	(-3.93)	(-2.99)
Number of children between 15 and 20 years	-5.04	-4.85	-2.55
	(-1.42)	(-1.35)	(-0.49)
Number of children between 20 and 25 years	-10.65	-11.18	-6.08
	(-1.76)	(-1.81)	(-0.77)
1(youngest child between 0 and 2 years)	-5.80	2.25	-3.13
	(-0.90)	(0.33)	(-0.27)
1(youngest child between 2 and 5 years)	-1.06	3.74	1.97
	(-0.15)	(0.53)	(0.20)
1(youngest child between 5 and10 years)	-7.24	-5.86	-1.19
	(-1.25)	(-1.01)	(-0.15)
1(swiss nationality)	-3.30	-0.82	-11.64
	(-1.16)	(-0.28)	(-2.38)
Age	0.95	-0.03	-3.97
	(0.83)	(-0.00)	(-2.40)
Age^2	-0.023	-0.0077	0.037
	(-1.67)	(-0.52)	(1.80)
1(craftsman)	15.68	17.05	26.68
	(2.49)	(2.71)	(3.40)
$\widehat{\lambda}$	-	-	-15.87
			(-0.31)
Constant	218.79	229.80	69.93
	(9.31)	(9.60)	(0.85)
R^2	0.340	–	–
Number of observations	1070	2136[a]	1070
Log-likelihood	–	-6462.26	-
χ^2 p-value	0.00	0.00	-
J Statistic (p-value)	-		0.38
$\widehat{\rho}$	-	-0.44	-
LR Test $H_0 : \widehat{\rho} = 0$, χ^2 p-value	-	0.0019	-

Note : z-statistics in parentheses
a=number of censored observations 1066

Table 4

Married women labour supply

Generalized semi-logarithmic specification

	OLS	*MLE*	*GMM*
$\ln \widehat{w}_f$	-35.50 (-9.07)	-35.68 (-9.18)	46.11 (2.30)
$\frac{m_f}{\widehat{w}_f}$	-0.122 (-11.53)	-0.117 (-11.14)	-0.145 (-2.49)
h_m	-0.142 (-3.77)	-0.105 (-2.66)	0.058 (0.81)
Number of children less than 10 years old	-17.86 (-5.34)	-13.17 (-3.68)	-21.03 (-3.34)
Number of children between 10 and 15 years	-11.89 (-5.13)	-9.58 (-3.93)	-10.02 (-2.85)
Number of children between 15 and 20 years	-4.14 (-1.19)	-3.91 (-1.10)	-0.99 (-0.17)
Number of children between 20 and 25 years	-12.03 (-2.01)	-12.50 (-2.06)	-6.84 (-0.82)
1(youngest child between 0 and 2 years)	-5.22 (-0.82)	2.93 (0.44)	-4.87 (-0.40)
1(youngest child between 2 and 5 years)	-1.85 (-0.27)	3.06 (0.44)	-0.281 (-0.03)
1(youngest child between 5 and 10 years)	-7.26 (-1.28)	-5.88 (-1.03)	-1.04 (-0.13)
1(swiss nationality)	-2.42 (-0.87)	0.142 (0.05)	-12.49 (-2.40)
Age	1.64 (1.45)	0.67 (0.57)	-3.45 (-1.99)
Age^2	-0.031 (-2.24)	-0.015 (-1.04)	-0.11 (-0.09)
1(craftsman)	13.82 (2.22)	15.17 (2.44)	25.54 (3.22)
$\widehat{\lambda}$	-	-	-0.392 (-0.01)
Constant	270.08 (11.65)	279.19 (11.84)	167.16 (2.18)
R^2	0.360	–	–
Number of observations	1070	2136[a]	1248
Log-likelihood	–	-6446.073	-
χ^2 p-value	0.00	0.00	-
J Statistic (p-value)	-	-	0.68
$\widehat{\rho}$	-	-0.458	-
LR Test $H_0 : \widehat{\rho} = 0$, χ^2 p-value	-	0.0016	-

Note : z statistics in parentheses

a : number of censored observations 1066

Table 5 reports the different elasticities of the labour supply function with respect to the exogenous variables of the model. We notice that the elasticities computed at the sample mean are similar for the two specifications. The wage elasticity is 0.48 for the semi-lo specification and 0.615 for the generalized semi-log specification. With this specification we found that some women are in the backward-bending part of the labour supply function. We also found for both specifications that the Slutsky equation was satisfied for the entire sample. The estimates imply respectively for the semi-log specification and the generalized semi-log specification an elasticity of the number of hours with respect to the husband's wage rate for the husband's work hours kept constant of -0.528 and -0.611 and an elasticity with respect to the husband's labour supply of -0.627 and -0.705. The elasticity with respect to the non-labour income is -0.12 and -0.13. The number of children under 10 years old has the greatest impact.

Table 5
Within-period labour supply elasticities

	Semi-log	*Generalized Semi-log*
ε_{h_f,w_f}	0.480	0.615
ε_{h_f,h_m}	-0.528	-0.611
ε_{h_f,w_m}	-0.627	-0.705
$\varepsilon_{h_f,N}$	-0.123	-0.133
$\varepsilon_{h_f,\#\text{ children}<10}$	-0.286	-0.289
$\varepsilon_{h_f,\#\text{ children }10-15}$	-0.108	-0.110
$\varepsilon_{h_f,\#\text{ children }15-20}$	-0.012	-0.013
$\varepsilon_{h_f,\#\text{ children }20-25}$	-0.003	-0.004

We shall now compare our estimates with respect to those similar studies done for Switzerland and other countries. For Switzerland, Gerfin[9] estimates a trichotomous choice model derived from a discrete choice model for labour supply. This study also considers the labour supply of married women. The author takes the progressivity of income tax into account by computing the budget constraint of each individual of his sample. The theoretical model assumes a quadratic utility function which is convenient for estimation by maximum likelihood and which allows to derive labour supply elasticities. For women outside the labour force, he obtains a wage elasticity of 1.06 and an income elasticity of -0.36 as for the working women he obtains a wage elasticity of 0.51 and an income elasticity of -0.24. Leu and Kugler obtained through the use of a conventional Tobit model a wage elasticity of 2.85. We can point out two contributions with respect to Gerfin's study. First he assumes implicitly that the husband's labour supply is separable from income and the wife's work hours. Second he uses a static model and does not correct the non-labour income to take into account for life-cycle allocation of labour supply, i.e. does not take into account savings. This may justify why we find different results for the elasticity.

Bourguignon and Magnac [4] use Hausman's methodology [10] to estimate a labour supply model for french married women labour supply in presence of a piece-wise linear budget constraint. Because the presence of children and children allocations generate non-convexities in the budget constraints they convexify the budget set. They also incorporate fixed costs of work. They obtain a wage elasticity of 1.0 and an income elasticity of -0.3 when they do not take into account the fixed costs and respectively 0.05 and -0.2 when they take this element into account. However the estimated fixed cost is high and does not seem plausible (around twice the average earnings of the women) Note also they in their data they are not able to observe the non-labour income of the household. Bourguignon and Magnac do not take into account the life-cycle aspects of the labour supply allocation as well. Moreover, when they come to estimate the model they make two different assumptions. First, they assume that the wife decides of a labour supply as if she were single and second they assume a sequential decision in the household, that is the wife decides of her labour supply taking the labour supply of the husband as exogenous. Moreover, MaCurdy et al. [11] have shown that the Hausman's methodology impose restrictions on the preferences, typically that the Slutsky equation is always satisfied, that should be tested. These restrictions are linked to the statistical formulation of the model instead of economical implications.

Mroz [13] make a review of the different articles which treat the non-participation problem on the estimation of the wage elasticity of married women labour supply and on the exogeneity assumptions of some explanatory variables used in these models. He uses the American data from the Panel Study of Income Dynamics (P.S.I.D.) in order to replicate the results of previous studies. Through the estimation of a semi-logarithmic specification of the labour supply function he shows that most of the previous studies should be rejected because of both statistical end economic misspecification. He also considers the impact on labour supply of the progressivity of income tax. Mroz assumes that the hours are a continuous variable and uses the marginal wage and the virtual non-labour income as explanatory variables of the labour supply function. He emphasizes that these two variables cannot be considered as exogenous and must be instrumented during estimation. The results show that the extension of his model mainly affects the marginal wage coefficient which tends to be lower compared to the model without progressive taxation. He obtains a wage elasticity of 0.031 and an income elasticity of -0.0029 when he estimates his equation by 2SLS and drop the experience as an instrument for the wage rate[7]. Mroz does not proceed neither on the conditioning on the husband's labour supply nor on a correction of the labour income compatible with the life-cycle model.

4.3.3 Exogeneity test on the husband's work hours

In this section we test the exogeneity assumption of the husband's work hours for both specification proposed in this paper. This test is particularly important since the conditional approach has more sense for policy evaluation when the spouse's work hours are exogenous. The procedure of this test involves the use of extended regressions (see Davidson and McKinnon [6]). The idea of the test is to regress the variable suspected of endogeneity on the whole set of exogenous variables of the model and some instruments for this variable and then to estimate by OLS the reduced form of the model considering the husband's work hours as exogenous and to include in the regression the residuals of the previous regression as an explanatory variable. The test of weak exogeneity of the husband's work hours is performed through a t-test of equality to zero on the coefficient of the residuals. Table 6 reports the results of this test for both specifications. The results indicate that the weak exogeneity assumption of the husband's work hours in the wives' labour supply cannot be rejected.

Table 6

Exogeneity test for the husband's work hours

	Semi-log	*Generalized Semi-log*
$\widehat{u}_m$	-0.25 (-0.33)	0.020 (0.06)

[7]Mroz points that the error term may reflect taste for work and could be correlated with the experience of the women.

5 Conclusions

In this paper, we have estimated the labour supply function for swiss married women in the context of a life-cycle model and taking into account the progressivity of the income tax with cross-sectional data. We have considered a sample of married couples. We have noticed that the elasticity of the labour supply with respect to the gross wage is positive at the sample mean and from the generalized semi-logarithmic specification that for some of the wives this elasticity was negative, especially for women whose husband has high earnings, so that the income effect dominates the substitution effect. We have also found that the husband's work hours has no significant impact on the participation decision and on the number of work hours of their wife and that we cannot reject the assumption of weak exogeneity of this variable. This can be explained by the lack of variation of the men's hours in the data. These different results suggest that men are to a certain extend rationed in their labour supply. The labour supply of men affect the labour supply of their wife only through an income effect. The aggregation of income of both partners for taxation implies that both spouses have the save marginal tax rate. This could have a potentially high negative incentive for married women labour supply. Moreover some rationing or a lack of flexibility in men's hours can lead to distortions on the allocation of the labour supply of the households. For instance, if the husband has a high gross wage rate and is constrained to work full-time, this will imply a high marginal tax rate for the wife who could lead her to work a fewer number of hours or even to choose to go out from the labour force compared to a situation where she is not married. We can also mention that children are the source of high fixed costs to work, monetary and in terms of time, which tend to increase the reservation wage. One solution to this problem would be to increase the fiscal deductions per child or to allow a separation of the incomes in the tax declaration. This could lead to a decrease in the marginal tax rate.

In order to estimate the married women labour supply we have applied the concept of conditional demand and shown that we can obtained a labour supply function conditional on the husband's work hours which is consistent with the unitary model. We would like to point out that few empirical studies on the married women labour supply consider explicitly the interaction among the household for the allocation of labour supply. We have shown that empirically husband's work hours have no significant impact on their wife's labour supply. The idea of estimating a labour supply function without conditioning on the husband's work hours seems to rely else on the implicit assumption that men's are rationed in their labour supply or that men's labour supply is relatively inelastic and does not contain much variability. However this assumption is never explicitly described. The results of the exogeneity tests have shown that though we have estimated conditional elasticities, those have some relevance for policy evaluation on the labour market, since the husband's work hours has been found to be exogenous to the wife and has an impact on their labour supply only on through an income effect.

The estimates of the elasticities have also can be interpreted in a precise economic way as the within-period elasticity, i.e. for a given amount of savings. Unless we make very restrictive assumptions on the dynamic behavior of the swiss households, the elasticity usually estimated in the context of the static model have no economic meaning. If we would like to be complete we should estimate the intertemporal elasticity of substitution in order to distinguish shift in the wage profile and along the wage profile. This would imply the use of longitudinal data which are not available in the swiss context. However the assumption that savings change few may be justified by a long time-horizon from the agent.

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A Derivatives of the conditional labour supply function

We have the following system of equations characterized by equations (33) to (36)

$$\begin{aligned} h_f &= \widehat{h}_f\left(\widehat{w}_f, h_m, m_f, E, Z\right) && (33)\\ \widehat{w}_f &= w_f\left(1 - T_Y\left(Y, E\right)\right) && (34)\\ Y &= w_f h_f + w_m h_m + rA^*_{t-1} + N && (35)\\ m_f &= T_Y\left(Y; E\right) w_f h_f + w_m h_m + rA^*_{t-1} + N - T\left(Y; E\right) - \Delta A^*_t && (36) \end{aligned}$$

Let's define $\mathbf{y} = \left(h_f, \widehat{w}_f, Y, m_f\right)$ and $\mathbf{x} = \left(w_f, h_m, w_m, E, Z, A^*_{t-1}, N, \Delta A^*_t\right)$ respectively the vectors of endogenous and exogenous variables. The system can be written as

$$f\left(\mathbf{y}, \mathbf{x}\right) = 0$$

By the implicit function theorem we obtain

$$\nabla_{\mathbf{x}}\mathbf{y} = -\left[\nabla_{\mathbf{y}} f\left(\mathbf{y}, \mathbf{x}\right)\right]^{-1} \nabla_{\mathbf{x}} f\left(\mathbf{y}, \mathbf{x}\right)$$

where

$$-\left[\nabla_{\mathbf{y}} f\left(\mathbf{y}, \mathbf{x}\right)\right]^{-1} = \frac{1}{D_f}$$

$$\begin{pmatrix} -1 & -\frac{\partial \widehat{h}_f}{\partial \widehat{w}_f} & T_{YY} w_f \left(\frac{\partial \widehat{h}_f}{\partial \widehat{w}_f} + \frac{\partial \widehat{h}_f}{\partial m_f} h_f\right) - \frac{\partial \widehat{h}_f}{\partial m_f} T_Y & -\frac{\partial \widehat{h}_f}{\partial m_f} \\ w_f^2 T_{YY} & 1 + \frac{\partial \widehat{h}_f}{\partial m_f} w_f^2 h_f T_{YY} & T_{YY} w_f \left(1 - T_Y w_f \frac{\partial \widehat{h}_f}{\partial m_f}\right) & w_f^2 \frac{\partial \widehat{h}_f}{\partial m_f} T_{YY} \\ -w_f & -w_f \frac{\partial \widehat{h}_f}{\partial \widehat{w}_f} & T_Y w_f \frac{\partial \widehat{h}_f}{\partial m_f} - 1 & -w_f \frac{\partial \widehat{h}_f}{\partial m_f} \\ -w_f^2 h_f T_{YY} & -w_f^2 \frac{\partial \widehat{h}_f}{\partial \widehat{w}_f} h_f T_{YY} & T_Y + T_{YY} w_f \left(T_Y w_f \frac{\partial \widehat{h}_f}{\partial \widehat{w}_f} - h_f\right) & -1 - \frac{\partial \widehat{h}_f}{\partial \widehat{w}_f} T_{YY} w_f^2 \end{pmatrix},$$

$$\nabla_{\mathbf{x}} f\left(\mathbf{y}, \mathbf{x}\right) =$$

$$\begin{pmatrix} 0 & -\frac{\partial \widehat{h}_f}{\partial h_m} & 0 & -\frac{\partial \widehat{h}_f}{\partial E} & -\frac{\partial \widehat{h}_f}{\partial Z} & 0 & 0 & 0 \\ -\left(1 - T_Y\right) & 0 & 0 & w_f T_{YE} & 0 & 0 & 0 & 0 \\ -h_f & -w_m & -h_m & 0 & 0 & -r & -1 & 0 \\ -T_Y h_f & -w_m & -h_m & -w_f h_f T_{YE} + T_E & 0 & -r & -1 & 1 \end{pmatrix}$$

and $D_f = 1 + T_{YY} w_f^2 \partial\widehat{h}_f / \partial\widehat{w}_f - T_{YY} w_f^2 h_f \partial\widehat{h}_f / \partial m_f$

Here we give the derivatives of the labour supply function with respect ot the exogenous variables of the model.

$$
\begin{aligned}
\frac{d\widehat{h}_f}{dw_f} &= \frac{1}{D_f}\left[\frac{\partial \widehat{h}_f}{\partial \widehat{w}_f}\left[1-T_Y-T_{YY}w_f h_f\right]+\frac{\partial \widehat{h}_f}{\partial m_f}\left(2T_Y-w_f h_f T_{YY}\right)h_f\right] \\
\frac{d\widehat{h}_f}{dh_m} &= \frac{1}{D_f}\left\{\frac{\partial \widehat{h}_f}{\partial h_m}+w_m\left[\frac{\partial \widehat{h}_f}{\partial m_f}\left(1-w_f h_f T_{YY}+T_Y\right)-\frac{\partial \widehat{h}_f}{\partial \widehat{w}_f}T_{YY}w_f\right]\right\} \\
\frac{d\widehat{h}_f}{dw_m} &= \frac{h_m}{D_f}\left[\frac{\partial \widehat{h}_f}{\partial m_f}\left(1-w_f h_f T_{YY}+T_Y\right)-\frac{\partial \widehat{h}_f}{\partial \widehat{w}_f}T_{YY}w_f\right] \\
\frac{d\widehat{h}_f}{dE} &= \frac{1}{D_f}\left[\frac{\partial \widehat{h}_f}{\partial E}-\frac{\partial \widehat{h}_f}{\partial \widehat{w}_f}w_f T_{YE}+\frac{\partial \widehat{h}_f}{\partial m_f}\left(w_f h_f T_{YE}-T_E\right)\right] \\
\frac{d\widehat{h}_f}{dZ} &= \frac{1}{D_f}\frac{\partial \widehat{h}_f}{\partial Z} \\
\frac{d\widehat{h}_f}{dN} &= \frac{1}{D_f}\left(\frac{\partial \widehat{h}_f}{\partial m_f}\left(1-w_f h_f T_{YY}+T_Y\right)-\frac{\partial \widehat{h}_f}{\partial \widehat{w}_f}T_{YY}w_f\right) \\
\frac{d\widehat{h}_f}{dA^*_{t-1}} &= \frac{r}{D_f}\left(\frac{\partial \widehat{h}_f}{\partial m_f}\left(1-w_f h_f T_{YY}+T_Y\right)-\frac{\partial \widehat{h}_f}{\partial \widehat{w}_f}T_{YY}w_f\right) \\
\frac{d\widehat{h}_f}{d\Delta A^*_t} &= -\frac{1}{D_f}\frac{\partial \widehat{h}_f}{\partial m_f} \\
\frac{dm_f}{dw_f} &= \frac{1}{D_f}\left\{h_f T_{YY}\left[w_f^2\frac{\partial \widehat{h}_f}{\partial \widehat{w}_f}\left(1-T_Y\right)+w_f h_f+T_Y\frac{\partial \widehat{h}_f}{\partial \widehat{w}_f}\right]\right\}
\end{aligned}
$$

B Covariance matrix of the GMM estimator

The equation to be estimated is given by

$$
h_{f,i}=\alpha\ln\widehat{w}_{f,i}+\beta m_{f,i}+\delta h_{m,i}+Z_i\gamma+\rho\lambda\left(W_i\widetilde{\eta}\right)+u_{h_f,i}\equiv\widehat{\mathbf{z}}_i\beta+u_{h_f,i}.
$$

Let $\widehat{\mathbf{z}}_i=\left(\widehat{w}_{f,i},m_{f,i},h_{m,i},Z_i,\lambda\left(W_i\widetilde{\eta}\right)\right)$ denot the vector of explanatory variables of the labour supply functionand $\mathbf{h}_i$ the matrix of instruments for $\widehat{\mathbf{z}}_i$. Let $\theta'=\left(\alpha,\beta,\delta,\gamma',a\right)$. $\widehat{\theta}$ is the instrumental variables estimator of θ. The vector $\widetilde{\eta}$ is the probit maximum likelihood estimator of η. The asymptotic covariance matrix of $\widehat{\theta}$ is given by

$$
Avar\left(\widehat{\theta}\right)=N^{-1}\left(\widehat{C}'\widehat{D}^{-1}\widehat{C}\right)^{-1}\widehat{C}'\widehat{D}^{-1}\widehat{M}\widehat{D}'^{-1}\widehat{C}\left(\widehat{C}'\widehat{D}^{-1}\widehat{C}\right)^{-1}
$$

with $\widehat{C} = N^{-1}\sum_{i=1}^{N} \mathbf{h}_i'\widehat{\mathbf{z}}_i$, $\widehat{D} = N^{-1}\sum_{i=1}^{N} \mathbf{h}_i'\mathbf{h}_i$, $\widehat{M} = N^{-1}\sum_{i=1}^{N}\left(\mathbf{h}_i'\widehat{u}_{h_f,i} - \widehat{G}\widehat{r}_i\right)\left(\mathbf{h}_i'\widehat{u}_{h_f,i} - \widehat{G}\widehat{r}_i\right)'$ and $\widehat{G} = N^{-1}\sum_{i=1}^{N}\left(\widehat{\theta}\otimes\mathbf{h}_i\right)'\nabla_\eta\lambda\left(W_i\widehat{\eta}\right)$, where $\nabla_\eta\lambda\left(W_i\widehat{\eta}\right)$ denotes the Jacobian of $\lambda\left(W_i\widehat{\eta}\right)$, $\widehat{r}_i = -\widehat{A}^{-1}s_i\left(\widehat{\eta}\right)$ is the influence function, $s_i\left(\widehat{\eta}\right)$ is the score of the log-likelihood of the associated probit and $\widehat{u}_{h_f,i} = h_{f,i} - \widehat{\mathbf{z}}_i\widehat{\theta}$. We recall that

$$\lambda\left(W_i\widehat{\eta}\right) = \frac{\varphi\left(W_i\widehat{\eta}\right)}{\Phi\left(W_i\widehat{\eta}\right)}$$

so we can deduce the following formulas

$$\begin{aligned}
\nabla_\eta\lambda\left(W_i\widehat{\eta}\right) &= \frac{-\varphi\left(W_i\widehat{\eta}\right)\left[\Phi\left(W_i\widehat{\eta}\right)W_i\widehat{\eta} + \varphi\left(W_i\widehat{\eta}\right)\right]W_i'}{\Phi\left(W_i\widehat{\eta}\right)^2} \\
s_i\left(\widehat{\eta}\right) &= \frac{\varphi\left(W_i\widehat{\eta}\right)W_i'\left[d_i - \Phi\left(W_i\widehat{\eta}\right)\right]}{\Phi\left(W_i\widehat{\eta}\right)\left[1-\Phi\left(W_i\widehat{\eta}\right)\right]} \text{ with } d_i = 1\left(h_{f,i} > 0\right) \\
\widehat{A} &= \sum_{i=1}^{N}\frac{\varphi\left(W_i\widehat{\eta}\right)^2 W_i'W_i}{\Phi\left(W_i\widehat{\eta}\right)\left[1-\Phi\left(W_i\widehat{\eta}\right)\right]}
\end{aligned}$$

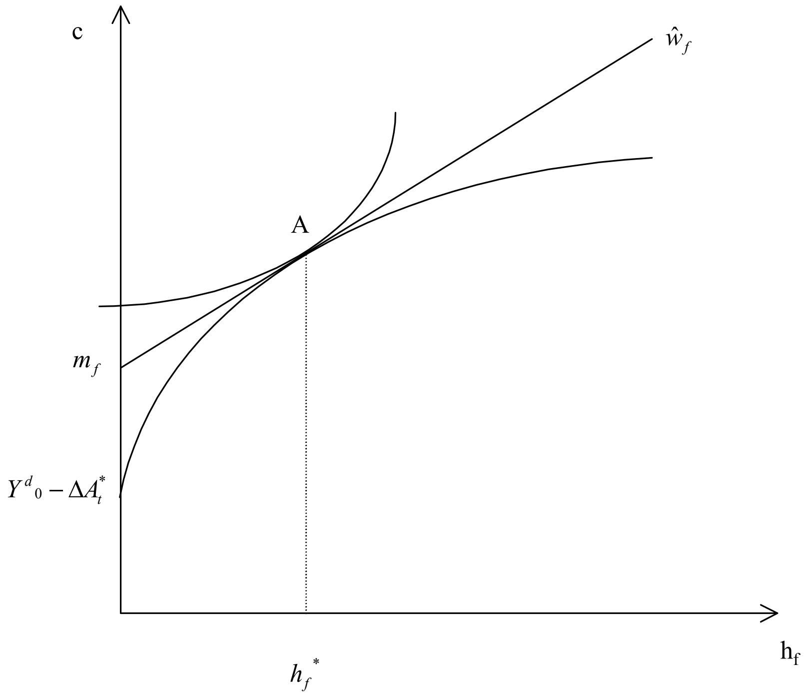

Figure 1: The optimal conditional labour supply

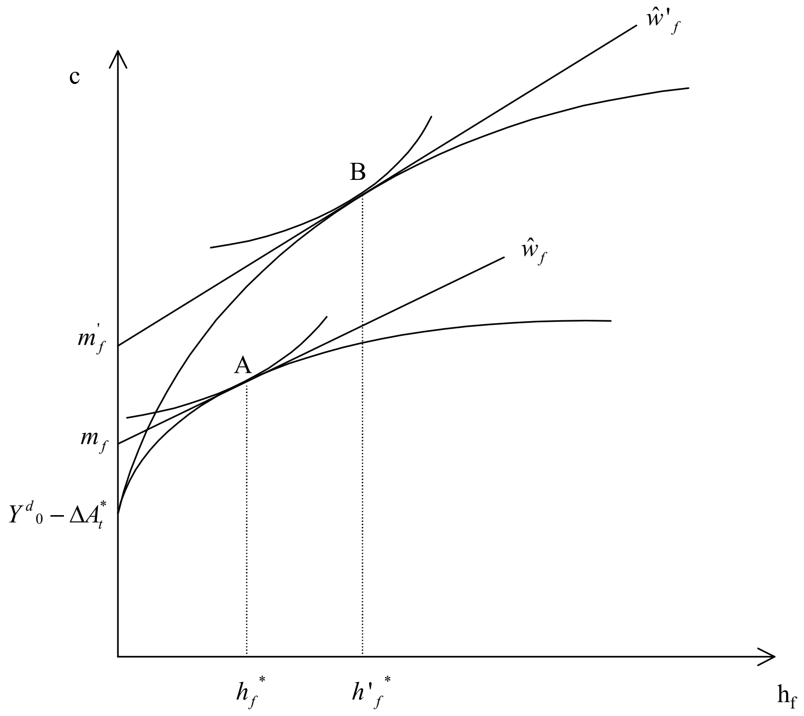

Figure 2: The effect of increase in the gross wage rate

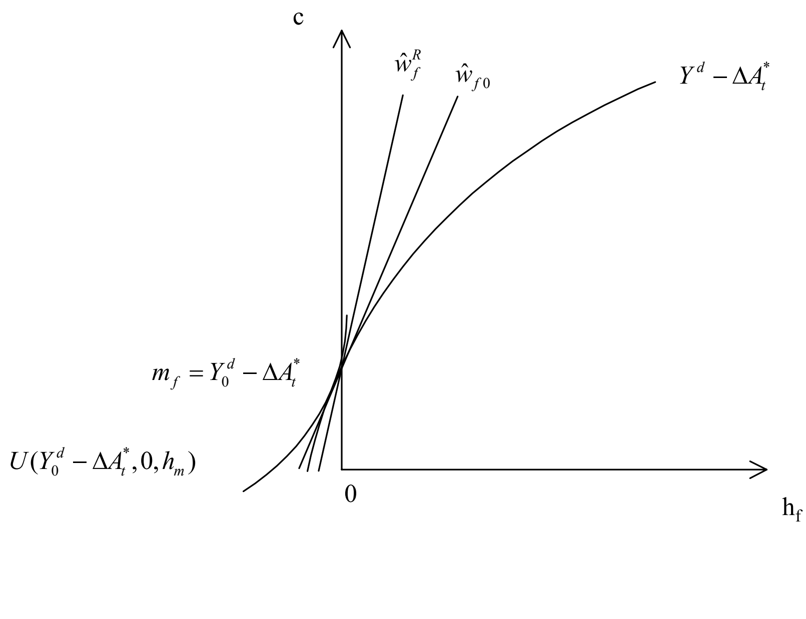

Figure 3: The participation decision

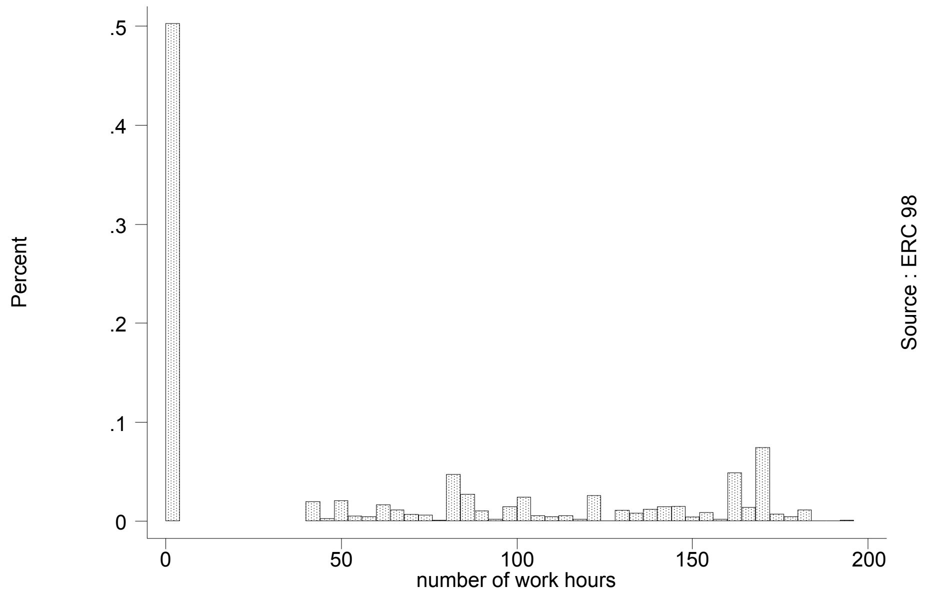

Figure 4: Distribution of the women's work hours

Figure 5:

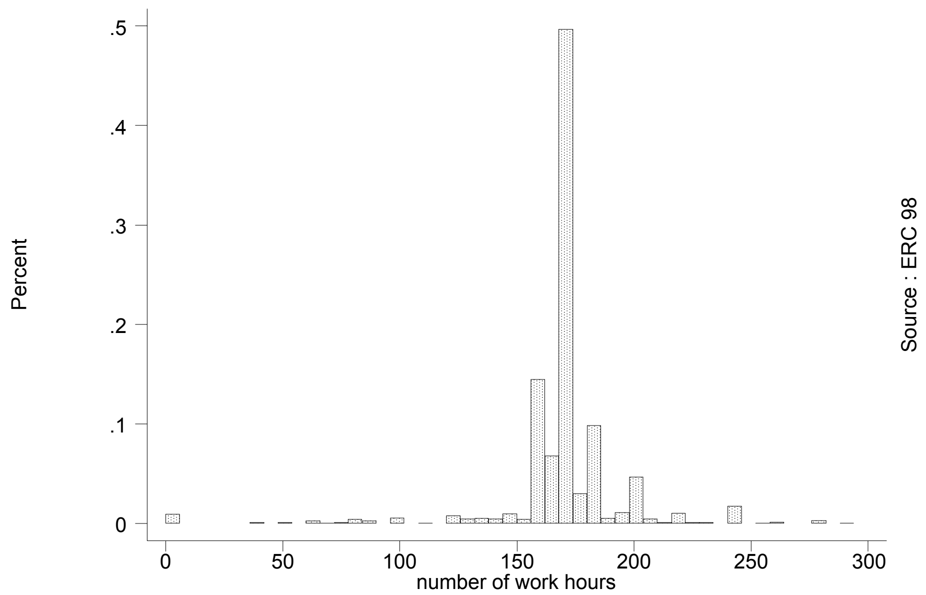

Figure 6: Distribution of the men's work hours