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Abstract

The present study tries to overcome some of the shortcomings of the standard empirical labor supply models by applying an alternative approach which allows for complex non-convex budget sets, highly non-linear labor supply curves and imperfect markets with institutional constraints.

The model is estimated on Italian microdata. The empirical results demonstrate that the model reproduces the distributions of labor supply for married males and married females quite well. Moreover, the results show that male labor supply is rather inelastic while labor supply among females, especially participation, is considerably more elastic.

Keywords: Labor supply, joint decision of husband and wife, non-convex budget sets, unobserved heterogeneity in opportunities, hours restrictions.

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1. Introduction

This paper presents a labor supply model estimated on Italian household data from 1987. The econometric model is based on Dagsvik and Strøm (1992) and implies a modeling and estimation strategy which is very different from the one proposed by Hausman and coauthors (cfr. Hausman (1980, 1981 and 1985), Burtless and Hausman (1978), Hausman and Ruud (1984)), and adopted in numerous studies (cfr. Blomquist (1983), Arrufat and Zabalaza (1986), Moffit (1986)).

The "Hausman-approach" is essentially a generalization of a Tobit model in which account is taken of the fact that taxes and benefits generate a kinked piece-wise linear and non-convex budget constraint. In this approach the individual is free to choose his/her optimal position along the budget constraint. The observed choice is allowed to differ from the preferred one, both because the individual herself is unable to optimize and/or because the econometrician has an incomplete knowledge of the budget constraint. However, the assumptions inherent in the Hausman-approach exclude the possibility that individuals are facing severe quantity and institutional constraints. For instance in the Italian case the structure of labor costs makes it in general inattractive to the firms to offer contracts that allow for flexible work schedules. As a consequence, the set of choices available to the individual is severely reduced, or alternatively the costs of searching for non-standard contracts are high. There have been a few attempts of estimating labor supply models which account for restrictions on hours (Ilmakunnas and Pudney, 1990, and Dickens and Lundberg, 1993) and jobs (Blundell et al., 1987), but these attempts have not been combined with complex non-convex budget sets and flexible forms of the supply functions. Dickens and Lundberg op.cit refer to a number of Surveys which report strong evidence of hours constraints. Thus, the neclection of institutional constraints in standard labor supply models may explain why these models fail to reproduce the observed distributions of hours of work. Dickens and Lundberg op.cit specify and estimate models that account for hours restrictions in male labor supply, conditional on working. Our study extends their approach by allowing a more flexible treatment of job offers and the relationship between wages and hours within jobs.

Another problematic aspect of the Hausman approach is that consistency of the maximum likelihood method requires that Slutsky restrictions are imposed (Kapteyn et al., 1990 and MaCurdy et al., 1990), which can be difficult to do even with rather simple functional forms for the utility function. Finally, experiences with the Hausman procedure prove that it is difficult to locate a maximum of the likelihood function and thus a unique extremal point cannot be guaranteed. Furthermore, the analysis of two-person households - which is the case considered in this paper - leads to rather insurmountable calculation problems when the Hausman procedure is applied.

There are several features that distinguishes the model in this paper from the Hausman tradition and related labor supply models with taxes. First, it is designed to deal with non-convex budget sets for multifamily households together with rather flexible functional forms for the utility functions. Second, the framework presented here is consistent with the notion of qualitative aspects of jobs as well as hours determined by institutional regulations. The choice environment is assumed to consist of a set of opportunities called matches. A match is defined as a particular combination of working conditions including hours, wages and non-pecuniary characteristics. The set of matches available to the individual is unobserved and individual specific and is therefore perceived as random to the econometrician. Thus, in contrast to previous labor supply studies our framework allows for unobserved heterogeneity in opportunities as well as in preferences. Furthermore, the model allows for opportunity sets which are consistent with quantity constraints on hours of work, and job-rationing; i.e. unvoluntarily unemployment.

As already mentioned this paper deals with the labor supply of married couples and it is assumed that married couples make a joint decision in supplying labor. Possible endogeneity bias introduced by the assumption of an exogeneously given income of the spouse is thus avoided. Since these joint dicisions are modelled together with the complex factors alluded to above this paper develops further the modelling of family labor supply in Hausman and Ruud (1987). Thus this paper extends previous analyses of the impact of taxes on labor supply in Italy, cfr. Colombino (1985) and Colombino and Del Boca (1990).

The microeconometric analysis of labor supply in Italy - up to the inclusion of hours of work in the Bank of Italy's Survey of Households' Income and Wealth of 1987 - has been severly limited by the lack of nation-wide data sets with relevant information to compute wage rates. The situation was rather paradoxical since Survey of Labor Force conducted by the Central Bureau of Statistics included hours of work but not incomes, while Survey of Households' Income and Wealth conducted by the Bank of Italy included incomes but not hours. Analysts had to resort to local samples or to the matching of different samples of households.

The recent analyses using Italian micro data are Colombino (1985), Colombino and Del Boca (1990) and Rettore (1990). The first two are based on a local sample of 1000 households. Colombino (1985) estimates a CES utility function and models quantity constraints and disequilibrium by using specific information upon the willingness to work more or less, in a way similar to Ham (1982). Taxes are accounted for by using a continuous differentiable approximation to the piecewise-linear budget; however, taxes are not the main focus and no specific tax effects or costs are evaluated. Colombino and Del Boca (1990) use the Hausman approach mentioned above and report estimates of the behavioral and welfare effects of the current as well as of alternative tax systems. Both these analyses ignore those features of the tax system which might imply non-convexities of the budget set. Only the wife's labor supply is analysed in Colombino (1985). In Colombino and Del Boca (1990) husband's and wife's decisions are analysed separately, taking the spouse's labor income as exogenous. Rettore (1990) makes a joint use of regional subsamples of both the Labor Force Survey and the Survey of Households' Income and Wealth of 1984 in order to have a measure of wage rates. Taxes are ignored but institutional constraints are somewhat taken into account by assuming that the individual faces a dichotomous choice between zero hours and observed hours of work.

The present study are based on data from the 1987 Bank of Italy Survey, which is the first and so far the only survey collecting detailed information on incomes and hours of work of each household member.

The paper is organized as follows. Section 2 gives a brief, but self-contained, description of the model. Section 3 describes the data used to estimate the model. Section 4 deals with the employed empirical specification and discusses the estimation results. Section 5 presents the results of various policy simulations.

2. The model

For expository reasons we start the presentation of the model with focusing on one-person households. Later in this section we demonstrate how the model can be extended to the case of married couples.

A match Z is characterized by a four-dimensional vector variable $\{H(Z),W(Z),T_1(Z), T_2(Z)\}$. The attribute-vector $T_1(Z)$ accounts for variables that have a direct influence on preferences as well as on pecuniary rewards, while the attribute-vector $T_2(Z)$ is assumed only to affect the pecuniary rewards. H(Z) and W(Z) are hours of work and the wage rate, respectively, associated with the match. In this paper we assume that hours of work, H(Z), and the match attributes $T(Z) \equiv (T_1(Z),T_2(Z))$ are exogeneously given and determined by firms or institutional regulations. The match-specific requirements embedded in the attribute variables $\{T(Z)\}$ give rise to variations in wage rates across matches (and hence individuals). Specifically, the distribution of wage rates are determined within an equilibrium framework which will be presented below.

Let U(C,h,Z) denote the household utility function where C is annual disposable income, h is annual hours of work and Z indexes the matches. The individual is assumed to choose a match, denoted $\hat{Z}$, that maximizes utility under some specific constraints. Formally, the maximization problem can be posed as follows:

$$
(2.1) \qquad \begin{cases} \max U(C,h,Z) \quad \text{with respect to } Z \\ \text{given} \\ h = H(Z) \\ \text{and} \\ C \equiv C(Z) = f(W(Z)H(Z),I), \end{cases}
$$

where I is annual non-labor income and $f(\cdot)$ is a function that transforms gross income into after-tax income (disposable income). The form of $f(\cdot)$ depends on tax and benefit rules and may have discontinuous jumps. It accounts for a non-convex budget set due to regressive marginal tax and benefit rates. For our analysis it is sufficient to assume that $f(\cdot)$ is piecewise continuous.

The utility function is assumed to have the structure

$$
(2.2) \qquad U(C,h,Z) = v(C,h,T_1(Z)) + \varepsilon(Z),
$$

where $v(\cdot)$ is a deterministic function and $\varepsilon(Z)$ is a variable which is random to the observer (the econometrician).

The presence of C and h in the utility function accords with the text-book story of household behavior. The inclusion of $T_1(Z)$ and $\varepsilon(Z)$ are new and needs a justification. First, to the individual both $T_1(Z)$ and $\varepsilon(Z)$ are known. Given Z, hours, wages and other attributes follow and this is assumed to be known by the individual for all Z. Hence, the individuals are assumed to decide under certainty. Second, in addition to the consumption C(Z), derived from match Z, and hours of work H(Z), non-pecuniary attributes affect the well-being of the individuals. Some of these non-pecuniary rewards are in principle observable and can be measured through survey questionaires or obtained from official statistics (see Hartog (1987)). In our model these non-pecuniary rewards are accounted for by the vector-variable $T_1(Z)$. Other non-pecuniary rewards are not observable and they are accounted for by $\varepsilon(Z)$. Thus, for a given individual $\varepsilon(\cdot)$ reflects unobservable taste variation across matches.

Inserting the budget constraint (2.1) in (2.2) gives

(2.3) $$U(C(Z),H(Z),Z) = v(C(Z),H(Z),T_1(Z)) + \varepsilon(Z),$$

and the match $\hat{Z}$ that solves the individual maximization problem is therefore given by

(2.4) $$\max_Z[v(C(Z),H(Z),T_1(Z)) + \varepsilon(Z)] = v(C(\hat{Z}),H(\hat{Z}),T_1(\hat{Z})) + \varepsilon(\hat{Z}).$$

As already mentioned, the maximizing agent have perfect knowledge of market opportunities. For all Z, he knows the outcomes of choosing a match, Z. The econometrician only observes the realized values $\{C(\hat{Z}),H(\hat{Z}),W(\hat{Z}),T_1(\hat{Z})\}$. Thus, the challenge to the econometrician is to specify a joint distribution for the realized values $\{C(\hat{Z}),H(\hat{Z}),W(\hat{Z}), T_1(\hat{Z})\}$; or rather $\{H(\hat{Z}),W(\hat{Z}),T_1(\hat{Z})\}$ since the function $f(\cdot)$ is assumed to be known to the econometrician, and then to use this specification to estimate the parameters of the utility function and wage functions related to market opportunities.

Let $\Phi(\cdot|s)$ be the joint cumulative distribution of $\{H(\hat{Z}),W(\hat{Z}),T_1(\hat{Z})\}$ conditional on s, i.e.,

(2.5) $$\Phi(h,w,t_1|s) = P\left\{H(\hat{Z})\leq h,\ W(\hat{Z})\leq w,\ T_1(\hat{Z})\leq t_1|s\right\}$$

where s represents the qualifications of the agent. The functional form of Φ depends on distributional assumptions with respect to the taste-shifters $\{\varepsilon(Z)\}$, and to unobserved heterogeneity in market opportunities. Note that for a given Z, $\varepsilon(Z)$ accounts for unobserved heterogeneity across individuals and for a given agent, $\varepsilon(\cdot)$ accounts for unobserved heterogeneity across matches. Before we proceed with the formal analysis it is necessary to make assumptions about the distribution of the set of attributes (market opportunities), and the associated taste-shifters that are feasible to the agent. We assume that while market opportunities are assumed to be known to the agents they are not known to the econometrician. The reason why the choice set is random to the econometrician is because he does not have the same information about the determinants of market opportunities as the agent.

Furthermore, we assume that the random variables, $\{H(Z),T(Z),\varepsilon(Z)\}$, are realizations of a Poisson process on $[0,\bar{h}] \times [0,1]^2 \times R$ with intensity measure

$$\lambda(dh, dt|s)e^{-\varepsilon}d\varepsilon\,; \quad t=\{t_1,t_2\}, \tag{2.6}$$

where $\bar{h}$ and 1 are upper bounds on hours and the other attributes of the match, respectively, and $\lambda(\cdot|s)$ is a finite measure that depends on s. The formalism introduced above means that the probability that a match for which

$$(H(Z)\in(h,h+\Delta h), T(Z)\in(t,t+\Delta t), \varepsilon(Z)\in(\varepsilon,\varepsilon+\Delta\varepsilon))$$

is equal to

$$\lambda(\Delta h, \Delta t|s)e^{-\varepsilon}\Delta\varepsilon + o(\Delta h\Delta t\Delta\varepsilon).$$

It is easily demonstrated (cf. Dagsvik and Strøm op.cit) that the mean number of feasible matches for which

$$(H(Z)\leq h,\ T(Z)\leq t,\ \varepsilon(Z)>b),$$

relative to the mean number of feasible matches for which $\varepsilon(Z)>b$ for an arbitrary real number b, is given by

$$\tilde{G}(h,t|s) \equiv \frac{\lambda(h,t|s)e^{-b}}{\lambda(h,\bar{1}|s)e^{-b}} = \frac{\lambda(h,t|s)}{\lambda(h,\bar{1}|s)}. \tag{2.7}$$

Note that $\tilde{G}(\cdot|s)$ is independent of the threshold value b which is due to the assumption that $\varepsilon(Z)$ is independent of $(H(Z),T(Z))$. Thus, $\tilde{G}(\cdot|s)$ remains unchanged if we let $b \to -\infty$, and accordingly, it makes sense to interpret $\tilde{G}(\cdot|s)$ as the mean number of points in the Poisson process for which $\{H(Z)\leq h, T(Z)\leq t\}$ relative to the mean number of points in the process. We shall therefore call $\tilde{G}(h,t|s)$ the cumulative opportunity distribution. The associated density is denoted $\tilde{g}(h,t|s)$.

The particular structure of the intensity measure in (2.6), with the implied opportunity distribution in (2.7), is given a choice theoretic justification in Dagsvik (1993). In Dagsvik and Strøm (op.cit) it is demonstrated that the Poisson process formulation above implies that the distribution of the indirect utility, given that the individual works, is extreme value distributed. For the sake of simplicity we postulate that the utility of non-participation also is extreme value distributed.

To derive the opportunity density for wages, hours and other match-specific attributes in equilibrium (constrained or unconstrained), we need to say how individual labor is priced out. Hours are assumed to be exogeneously determined by institutional regulations and/or firms. These exogeneously set hours vary across firms and the individual chooses hours of work as part of her choice of a match.

Let $\tilde{w}$ denote the function that specifies how labor is priced out. In equilibrium the form of the wage-function ($\tilde{w}(\cdot)$) will be determined by labor supply and demand. This equilibrium framework will be discussed below, but first we will address the question of how wages vary across matches. Wages are match-specific and depend on match Z through the attributes (H(Z),T(Z)); i.e. for match Z

$$W(Z)=\tilde{w}(H(Z),T(Z)). \tag{2.8}$$

For given values of H(Z) and $T_1(Z)$, (2.8) says that wages vary across matches according to match-specific skills $T_2(Z)$. Let $\tilde{t}_2(\cdot)$ denote the value of these match-specific skills. Provided $\tilde{w}(h,t_1,t_2)$ is invertible as a function of t_2 for given (h,t_1), (2.8) can be solved for T_2 to yield

$$T_2(Z) = \tilde{t}_2(H(Z),W(Z),T_1(Z)), \tag{2.9}$$

where $\tilde{t}_2$ is the function that solves $w=\tilde{w}(h,t_1,\tilde{t}_2(h,w,t_1))$. Provided that $\tilde{t}_2(\cdot)$ is differentiable with respect to w we can utilize this, together with the opportunity density $\tilde{g}(h,t_1,t_2|s)$, to obtain the density for the <u>observable</u> attributes $\{H(Z),W(Z),T_1(Z)\}$. Let $g(h,w,t_1|s)$ denote this density which is given by

(2.10)
$$g(h,w,t_1|s) = \tilde{g}(h,t_1,\tilde{t}_2(h,w,t_1)|s)\left|\frac{\partial \tilde{t}_2(h,w,t_1)}{\partial w}\right|.$$

Let $\varphi(h,w,t_1|s)$ denote the density of the cumulative distribution function in (2.5), hereafter called the supply density. It can be demonstrated that the particular structure of the intensity measure (2.6) yields the following expression for the supply density, (cf. Dagsvik and Strøm, op.cit.):

(2.11)
$$\varphi(h,w,t_1|s) = \frac{\theta(s)\,[\exp(\psi(h,w,t_1))]\,g(h,w,t_1|s)}{\theta(s)\iiint[\exp(\psi(x,y,u))]\,g(x,y,u|s)dx\,dy\,du + \exp(\psi(0,0,0))},$$

for $h>0$, $w>0$, $t_1>0$, and

(2.12)
$$\varphi(0,0,0) = \frac{\exp(\psi(0,0,0))}{\theta(s)\iiint[\exp(\psi(x,y,u))]\,g(x,y,u|s)dx\,dy\,du + \exp(\psi(0,0,0))},$$

where $\psi(h,w,t_1) \equiv v(f(w,h,I),h,t_1)$ and $\theta(s) = \lambda(\bar{h},1|s)$.

We shall call $\theta(s)$ the opportunity measure of market opportunities. Thus, eqs. (2.11)-(2.12) express the supply density $\varphi(h,w,t_1|s)$ in terms of the mean utility $\psi(\cdot)$, and opportunity densities and measures, $g(\cdot|s)$ and $\theta(s)$. Thus, while previous econometric labor supply models only account for unobserved heterogeneity in preferences the present model accounts for unobserved heterogeneity both in opportunities and preferences.

For the sake of interpretation, we decompose the opportunity density $g(h,w,t_1|s)$ as

(2.13)
$$g(h,w,t_1|s) = \tilde{g}_1(h,t_1|s)\cdot g_2(w|h,t_1,s).$$

We may think of $\tilde{g}_1(h,t_1|s)$ as the fraction of market matches with attributes t_1 and h for which a worker with skills s is qualified for. This fraction is assumed exogeneously determined by institutional regulations and firm-specific factors. The conditional density $g_2(w|h,t_1,s)$ can be interpreted as the fraction of matches with wage rate w that is feasible for a worker with skill s among all matches with $H(Z)=h$ and $T_1(Z)=t_1$.

From (2.11) and (2.13) we observe that (2.11) can be written on the form $\pi(h,w,t_1;\theta(s)\tilde{g}_1(\cdot|s)g_2(\cdot|\cdot,s))$ where $\pi(\cdot)$ is the functional defined by

$$\text{(2.14)} \quad \pi(h,w,t_1;q(\cdot|s)) = \frac{q(h,w,t_1|s)\exp(\psi(h,w,t_1))}{\iiint q(x,y,z|s)\exp(\psi(x,y,z))\,dx\,dy\,dz + \exp(\psi(0,0,0))}.$$

Let $\gamma(\cdot|s)$ denote the density of labor demand, which corresponds to the supply density (2.11). The empirical counterpart of $\gamma(h,w,t_1|s)$ is the number of jobs - with the attributes h, w, t_1 -occupied by workers with skills s in a world with full employment, relative to the total number of jobs in the economy. Equating supply and demand densities yields

$$\text{(2.15)} \qquad \pi(h,w,t_1;\theta(s)\tilde{g}_1(\cdot|s)g_2(\cdot|\cdot,s)) = \gamma(h,w,t_1|s).$$

Eq. (2.15) can be interpreted as an equilibrium condition that determine the opportunity density $g_2(w|h,t_1,s)$ so that the supply density equals the demand density. Thus, in (2.15) $g_2(w|h,t_1,s)$ is determined so that all markets clear. Note that the "clearing instrument" is not the wage itself but the fraction of jobs with a specific wage w that is feasible for an individual worker with skill s, within job categories with attributes h and t_1.

Note that the full employment case in (2.15) is expressed in terms of probability densities. This is in accordance with Tinbergen (1956). It should be emphasized that in small samples the empirical distributions of supply and demand do not necessarily perfectly coincide.

If (2.15) were to hold irrespective of preferences and characteristics of jobs (parameters of the v-function and the $g_1(h,t|s)$ density), then $g_2(w|h,t_1,s)$ had to be rather flexible. A lack of flexibility in $g_2(w|h,t_1,s)$ could imply unemployment. Assume that $g_2(w|h,t_1,s)$ is fixed and given equal to $g_2^*(w|h,t_1,s)$. If we shall maintain the interpretation of $\pi(\cdot)$ as the supply density, then obviously

(2.16) $$\pi(h,w,t_1;\theta(s)\tilde{g}_1(\cdot|s)g_2^*(\cdot|\cdot,s)) \neq \gamma(h,w,t_1|s).$$

If we assume that the distribution of taste-shifters $\{\varepsilon(Z)\}$ and the form of the utility function is invariant with respect to changes in $\theta(s)$,$\tilde{g}_1(\cdot|s)$ and $g_2(\cdot|\cdot,s)$, then the form of the functional $\pi(\cdot)$ will remain the same. Thus in this case the term $\theta(s)\tilde{g}_1(\cdot|s)$ has to change to restore equality in (2.16). For simplicity we shall assume that the demand side is not rationed, i.e. the demanders are always able to realize their demand. Given that $g_2(\cdot)$ is fixed at $g_2^*(\cdot)$, then $\theta(s)\tilde{g}_1(\cdot|s)$ has to adjust to say $\theta^*(s)g_1^*(\cdot|s)$ where $\theta^*(s)g_1^*(\cdot|s)$ is determined from

(2.17) $$\pi(h,w,t_1;\theta^*(s)g_1^*(\cdot|s)g_2^*(\cdot|\cdot,s)) = \gamma(h,w,t_1|s).$$

The interpretation is that the left hand side in (2.17) now expresses the "constrained" labor supply density, i.e. the workers are facing choice sets of feasible matches that differ from the ones generated by $\theta(s)\tilde{g}_1(\cdot|s)$.

It is beyond the scope of this paper to develop a full structural model of labor demand together with labor supply. The sole purpose of this paper is to derive an empirical labor supply model which shows to be consistent with different stories about market clearing.

It should be noted that $\theta^*(s)g_1^*(\cdot|s)$ represents the actual constrained distribution of feasible matches. Furthermore, $\pi(\cdot)$ to the left in (2.16) equals the labor supply density, given $g_2^*(\cdot|\cdot,s)$ while $\pi(\cdot)$ to the left in (2.17) is the "constrained" labor supply density. Obviously,

(2.18)
$$\pi(h,w,t_1;\theta^*(s)g_1^*(\cdot|s)g_2^*(\cdot|\cdot,s)) = \pi(h,w,t_1;\theta(s)\tilde{g}_1(\cdot|s)g_2^*(\cdot|\cdot,s))(1-\rho(h,w,t_1|s)),$$

where $\rho(h,w,t_1|s)$ is the rate of unemployment for jobs with attributes H(Z)=h, W(Z)=w and $T_1(Z)=t_1$. Note that $\rho(\cdot|s)$ is determined so that equation (2.18) holds for all h, w and t_1. Provided data on unemployment, for each category of attribute combination, is available then the parameters of the supply density $\pi(h,w,t_1;\theta(s)\tilde{g}_1(\cdot|s)g_2^*(\cdot|\cdot,s))$ can be estimated and identified.

In order to reduce the problems related to identification and estimation we introduce some simplifications. First, we assume that wages W(Z) depend on Z only through the attribute variable $T_2(Z)$, and consequently $g_2(w|\cdot,s)=g_2(w|s)$. Second, since we have no reliable information about $T_1(Z)$ we assume that the non-pecuniary attribute variable $T_1(Z)$ does not affect utility, and hence, $v(C,h,t_1)=v(C,h)$. Finally, the unemployment rate is assumed to only vary with gender, region and education.

In an environment of unemployment the densities in (2.11)-(2.12) then reduce to

(2.11a)

$$\varphi^*(h,w|s) = \frac{\theta(s)\tilde{g}_1(h|s)g_2^*(w|s)\exp(\psi(h,w))(1-\rho(s))}{\theta(s)(1-\rho(s))\int\int\tilde{g}_1(x|s)g_2^*(y|s)\exp(\psi(x,y))dx\,dy+\exp(\psi(0,0))}$$

for h>0, w>0, and

$$\text{(2.12a)}\quad \varphi^*(0,0|s) = \frac{\exp(\psi(0,0))}{\theta(s)(1-\rho(s))\int\int\tilde{g}_1(x|s)g_2^*(y|s)\exp(\psi(x,y))dx\,dy+\exp(\psi(0,0))},$$

for h=w=0, where $\tilde{g}_1(h|s) = \int\tilde{g}_1(h,t_1|s)dt_1$.

It should be noted that the simplification introduced above imply that hours and wages are independently distributed in the opportunity set, but this does not imply that realized hours and wages are independent. In general, the marginal density of realized wage will differ from the opportunity density $g_2(w|s)$. This difference is due to the well-known selectivity bias problem.

The extension of (2.11a) and (2.12a) to cover the case of married couples is straightforward and completely analogous to the case of single person households. In this case the household is assumed to maximize a joint utility function $U(C,h_F,h_M,Z)$ under the constraints that $(h_F,h_M)=(H_F(Z),H_M(Z))$ and $C(Z)=f(H_F(Z),H_M(Z),W_F(Z),W_M(Z),I)$, where $H_j(Z)$ and $W_j(Z)$ are the hours and wages of gender j derived from match $Z=(Z_M,Z_F)$. M stands for male and

F for female.

We define $\theta_{11}(s)$ as the joint opportunity measure for husband and wife. Furthermore, $\theta_{01}(s_F)$ is the opportunity measure for females. By replacing wife and husband $\theta_{10}(s_M)$ is defined analogously.

The analogue of (2.11a) is

(2.19)

$$\varphi(h_F,h_M,w_F,w_M|s) = \frac{\theta_{11}(s)(\exp(\psi(h_F,h_M,w_F,w_M)))\tilde{g}_{1F}(h_F)\tilde{g}_{1M}(h_M)g_2(w_M,w_F|s)(1-\rho_M(s))(1-\rho_F(s))}{D}$$

for $h_F>0$, $h_M>0$, $w_F>0$, $w_M>0$, where

(2.20)

$$\psi(h_F,h_M,w_F,w_M) = v(f(h_F w_F, h_M w_M, I), h_F, h_M),$$

and

(2.21)

$$\begin{aligned} D = {} & \theta_{11}(s)(1-\rho_M(s))(1-\rho_F(s))\iiiint(\exp(\psi(x_1,x_2,y_1,y_2)))\tilde{g}_{1F}(x_1)\tilde{g}_{1M}(x_2)g_2(y_1,y_2|s)dx_1\,dx_2\,dy_1\,dy_2 \\ & + \theta_{01}(s_F)(1-\rho_F(s))\iint(\exp(\psi(0,x_2,0,y_2)))\tilde{g}_{1F}(x_2)g_{2F}(y_2|s_F)dx_2\,dy_2 \\ & + \theta_{10}(s_M)(1-\rho_M(s))\iint(\exp(\psi(x_1,0,y_1,0)))\tilde{g}_{1M}(x_1)g_{2M}(y_1|s_M)dx_1\,dy_1 \\ & + \exp(\psi(0,0,0,0)). \end{aligned}$$

For $\{h_F>0, h_M=0, w_F>0, w_M=0\}$, $\{h_F=0, h_M>0, w_F=0, w_M>0\}$ and $\{h_F=h_M=w_F=w_M=0\}$ there are analogous expressions.

Here $g_2(w_M,w_F|s)$, with $s=(s_F,s_M)$, denotes the joint opportunity wage density and we observe that we allow for a dependency between the wage rates of wife and husband. This possible dependency is to account for correlation in unobserved variables arising from the fact that men with high education tend to marry women at similar education level. $g_{2j}(\cdot|s_j)$; j=M,F, are marginals of the joint density $g_2(\cdot|s)$.

3. Data

The estimation of the model is based on data from the Survey of Households' Income and Wealth of 1987. This survey is now conducted every two years by the Central Bank of Italy and contains detailed information on incomes and wealth of each household component. Moreover, it contains information on some sociodemographic characteristics. The basic sampling design is a two-stage sample with stratification in the first stage.

We use the 1987 survey because it is the first one collecting hours of work, thus allowing to compute individual wage rates.

The labor incomes measured by the survey are net of social security contributions and of the contributions payed by the employer toward the personal income tax. Employers compute and pay the income tax for each employee on the basis of the wage income, taking standard allowances and tax credit into account. Therefore, in order to get gross incomes we have to apply the "inverse" tax code.

Hourly wage rates are derived on the basis of gross annual wage income in different jobs and observed hours.

Detailed tax and benefit rules are accounted for in the derivation of household disposable income. The most distintictive feature of the tax and benefit system is the individual-based income tax. In April 1977 joint taxation of husband(s) and wife(s) was abolished and since then spouses are entitled to separate assessment. Individual income comprehends incomes form any sources, excluding a few - such as interests - which are taxed according to a different code. Various allowances can be subtracted from individual income before applying tax rates. Among tax allowances we can only take into account compulsory social security contributions. Other major allowances (usually up to a ceiling) are: certain medical expenditures, passive interests, secondary and university education expenditures, some voluntary insurances. The survey does not contain sufficient information to include them in the model.

The following marginal tax rates, as of 1987, are applied to the tax base:

Income (1000s of lire)	Marginal tax rate (%)
up to 6,000	12
6,000 - 11,000	22
11,000 - 28,000	27
28,000 - 50,000	34
50,000 - 100,000	41
100,000 - 150,000	48
150,000 - 300,000	53
300,000 - 600,000	58
over 600,000	62

From the gross tax, tax credits can be subtracted (up to the amount of the gross tax). There are two main types (in 1000 lire:

- Credit for income production expenditures. Standard deduction for dependent workers is 492 plus a further 156 if taxable income does not exceed 11,000.

- Credits for dependent family members. Assuming for simplicity that the husband is the primary earner, he is given a credit of 360 provided the wife's income does not exceed 3,000. For every child or dependent family member the credit amount to 96. The credits for children are halved if the wife's income exceeds 3,000.

There is a system of benefits transferred to families. The benefit amount depends on the number of household members and on the level of total gross family income. In 1987, a typical three member household, was eligible to the following monthly benefits:

Total gross yearly houshold income (1000s of lire)	Monthly benefit (1000s of lire)
up to 12,000	160
12,001 - 15,000	140
15,001 - 18,000	110
18,001 - 21,000	80
21,001 - 24,000	50
24,001 - 27,000	20
over 27,000	0

Married couples with income from self-employment, which exceeds 20 per cent of gross household income, have been excluded from the sample. The exclusion of families whose income is in large part due to self-employment is justified since their decision process is substantially different from employees' and typically involves a permanent element of uncertainty in the decision process. Moreover, we do not observe hours for the self-employed. For the included households, observed income from self-employment has been added to net household income. It has been required that at least either the husband or the wife is working. Age is restricted to the interval 20-68 years.

The estimates show very little sensitivity to changes in the age interval. In principle there might be a problem due to the fact that after an age varying from 55 to 70 (depending on sector of employment and gender) retirement is feasible or even mandatory. However, we observe pension payments, and the modification in the budget set due to opportunity of retiring is therefore taken into account.

The sample covers 2953 households. Summary statistics are presented in table 1.

Table 1: Sample values - Married couples

	Mean	St.dev.	Min.	Max.
Individual variables:				
Annual hours of work				
Males	1 995	544	0	3 432
Females	690	909	0	3 432
Participation rates, per cent				
Males	96	18	-	-
Females	40	49	-	-
Hourly wage rates (1000 lire)				
Males	12	6	0	63
Females	4.3	6	0	51
Gross annual earnings (1000 lire)				
Males	24 700	13 900	0	13 900
Females	7 000	9 500	0	43 900
Age of wife	40.1	9.6	20	67
Age of husband	43.7	9.8	21	68
Household variables:				
Annual net taxes paid	9 600	6 600	0	59 000
Gross annual income (1000 lire)	37 500	19 400	5 600	142 500
Disposable annual income (1000 lire)	27 900	13 300	5 400	93 600
Number of children below 6	0.33	0.59	0	4
Number of children 6-15	0.58	0.78	0	4

4. Empirical specification and estimation results

We have chosen the following form for the function $v(C,h_F,h_M)$. The subscripts F and M index females and males, respectively:

$$
\begin{aligned}
v(C,h_F,h_M) = {} & \left[\alpha_2(1-K_M)(1-K_F) + \alpha_3 K_F + \alpha_4 K_M\right] e^{\alpha_1 C} \\
& + \left[\alpha_6 + \alpha_7 \log A_M + \alpha_8 (\log A_M)^2\right]\left(\frac{L_M^{\alpha_5}-1}{\alpha_5}\right) \\
& + \left[\alpha_{10} + \alpha_{11}\log A_F + \alpha_{12}(\log A_F)^2 + \alpha_{13} CU6 + \alpha_{14} CO6\right]\left(\frac{L_F^{\alpha_9}-1}{\alpha_9}\right)
\end{aligned}
\tag{4.1}
$$

where A_j is the age of gender j, CU6 and CO6 are number of children below and above 6 years old, C is household consumption and L_j is leisure for gender j, defined by

$$L_j = 1 - \frac{h_j}{8760}.$$

$K_j = 1$ if spouse j is working; otherwise $K_j = 0$, and the specification implies that the marginal utility of consumption differs with respect to the reported labor market participation. The reason for doing this is the possible existence of non-reported income. The underground economy in Italy is believed to be of some importance. To capture some of these effects on income and hence on consumption, the marginal utility of consumption is specified as shown above.

The wage densities are specified as follows

$$\log W_j(z) = \beta_{0j} + \beta_{1j} s_j + \beta_{2j} Exp_j + \beta_{3j}(Exp_j)^2 + \beta_{4j} Reg_j + \eta_j(z) \tag{4.2}$$

j=F,M, where $(\eta_F(z),\eta_M(z))$ are jointly normally distributed, s_j denotes years of schooling, gender j, Exp_j = experience = A_j-s_j-6 and Reg_j=1 living in Northern Regions (North of Toscana) and 0 otherwise. Moreover,

$$\text{(4.3)} \qquad \log\left(\frac{\theta_{10}(s_F)}{\theta_{11}(s)}\right) = \alpha_{15} + \alpha_{16}\mathrm{Reg}_F + \alpha_{17}\mathrm{UE}_F,$$

and

$$\text{(4.4)} \qquad \log\left(\frac{\theta_{01}(s_M)}{\theta_{11}(s)}\right) = \alpha_{18} + \alpha_{19}\mathrm{Reg}_M + \alpha_{20}\mathrm{UE}_M$$

where UE_j is the ratio between the number of unemployed and employed for gender j.

It should be noted that the specifications (4.3) and (4.4) imply the following interpretation of the model parameters. If α_{16} and α_{19} are negative, then living in Northern Italy improves the chances of finding a market match, compared to living in Central and Southern Italy. Likewise positive values of α_{17} and α_{20} indicate that unemployment has a negative impact on job opportunities.

Feasible hours in the market is assumed to be uniformly distributed except at full-time intervals.

The logarithm of hourly wages are assumed to be normally distributed. The expectations is specified to depend on potential experience and education and the wage density $g_2(W_F,W_M|s)$ in (4.2) is estimated jointly with the densities for realized hours and wages.

The estimation is based on a procedure suggested by McFadden (1978) which yields results that are close to the full information maximum likelihood method. We are not able to use the exact likelihood function to estimate the model because the evaluation of the integrals in (2.19) would be too costly and cumbersome. The estimation procedure applied replaces the quadruple integral in the denominators of the densities by a sum over 30, (alternatively 70), random points, where each term is adjusted by appropriate weights. In other words, the continuous logit model is replaced by a discrete logit version. McFadden has demonstrated that this method yields consistent and asymptotically normal parameter estimates. We found the McFadden estimation procedure to be remarkably efficient. Our experience suggest that it is enough to replace the choice set by 10 random points (draws in R^4) to obtain good results. When the number of draws increases to 30, then the estimated standard errors seem to be close to the ones obtained by the full maximum likelihood procedure.

The result of the estimation are reported in tables 2 and 3.

Table 2: Estimates of the parameters of the utility function and of the opportunity density

Variables	Coefficients	Estimates	t-values
Consumption	α_1	$-0.780 \cdot 10^{-4}$	-7.7
	α_2	-15.938	-8.3
	α_3	-10.020	-19.1
	α_4	-15.364	-11.4
Male leisure	α_5	-18.651	-16.4
	α_6	-0.180	-1.4
	α_7	0.102	1.5
	α_8	-0.015	-1.4
Female leisure	α_9	-6.805	-8.1
	α_{10}	34.428	2.2
	α_{11}	-19.039	-2.2
	α_{12}	2.716	2.3
	α_{13}	0.225	1.8
	α_{14}	0.275	2.7
Female opportunity density	α_{15}	0.464	2.8
	α_{16}	-0.705	-6.5
	α_{17}	0.594	0.9
Male opportunity density	α_{18}	2.834	8.4
	α_{19}	-0.310	-1.2
	α_{20}	-0.243	-0.1
Full-time peak, females	α_{21}	2.406	28.0
Full-time peak, males	α_{22}	2.501	51.9

The estimates imply that the utility function is an increasing and strictly concave function of leisure and consumption. The basic crucial parameters of the utility function are α_1, α_5 and α_9. These parameters are measured with good precision. The marginal utility of consumption and leisure depends also on personal characteristics such as age and number of children. The estimates for the coefficients of these variables are less precise. Children have the expected positive effect on the value of wife's leisure. However, a rather surprising result it that older children have essentially the same effect as younger ones; as a matter of fact the point estimate for the former ones is even larger (this result accords with other analysis of Italian data, e.g. Colombino and Del Boca (1990)). A possible explanation might be found in a cohort effect. Women with older children on average belong to older cohorts. For a variety of unobserved factors (attitudes, supply of child-care services, etc.) which change from one cohort to the other, older cohort presumably tend to use a more leisure-intensive technology in child-care.

The estimated parameters of the job-opportunities density confirm - at least for females - a more favourable environment in Northern regions. On the other hand, the effect of unemployment is not measured precisely enough to draw any clear conclusion.

Figures 1, 2 and 3 give the observed and simulated distributions for hours of work and consumption and demonstrate that the model reproduce the observed distributions quite well.

A remarkable result shown in table 3 is that the wage densities estimated jointly with hours densities differ very little from OLS estimates. This result indicates that the selection effect is very weak. It should be noticed that all coefficients are precisely determined and with signs as expected. Wages are strictly concave functions of experience with a maximum at 40 and 51 years of age for males and females, respectively. Wages in Northern regions of Italy are estimated to be higher than in Central and Southern Italy. The regional effect is stronger for men than for women.

Table 3: Wage opportunity density. Simultaneous ML estimates procedure versus OLS[*)]

Variables	Males		Females	
	OLS	Simultaneous ML	OLS	Simultaneous ML
Intercept	1.312 (33.2)	0.970 (17.6)	1.010 (16.9)	0.765 (10.2)
Education	0.058 (38.0)	0.063 (28.6)	0.077 (29.1)	0.086 (25.0)
Experience	0.030 (12.7)	0.035 (12.3)	0.025 (6.9)	0.024 (5.8)
Experience squared	$-0.397 \cdot 10^{-3}$ (-9.6)	$-0.440 \cdot 10^{-3}$ (-9.1)	$-0.307 \cdot 10^{-3}$ (-4.2)	$-0.234 \cdot 10^{-3}$ (-2.9)
Region	0.152 (13.2)	0.175 (12.7)	0.081 (4.2)	0.082 (3.5)
Standard error		0.301 (58.2)		0.327 (41.7)
R^2	0.39		0.44	

[*)] t-values in parenthesis.

Figure 1. Distribution of hours conditional on working. Married males, 1987

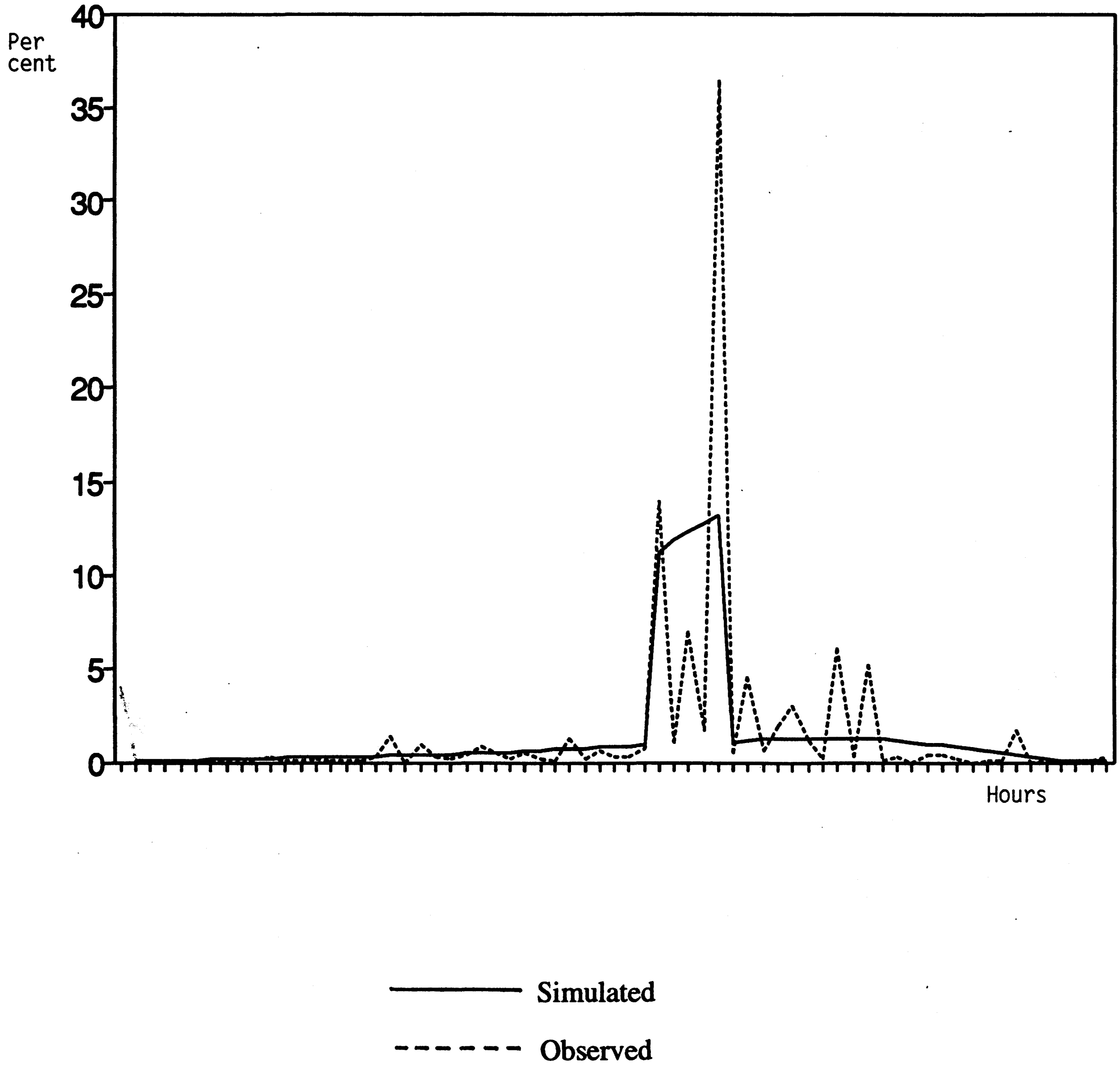

Figure 2. Distribution of hours, conditional on working. Married females, 1987

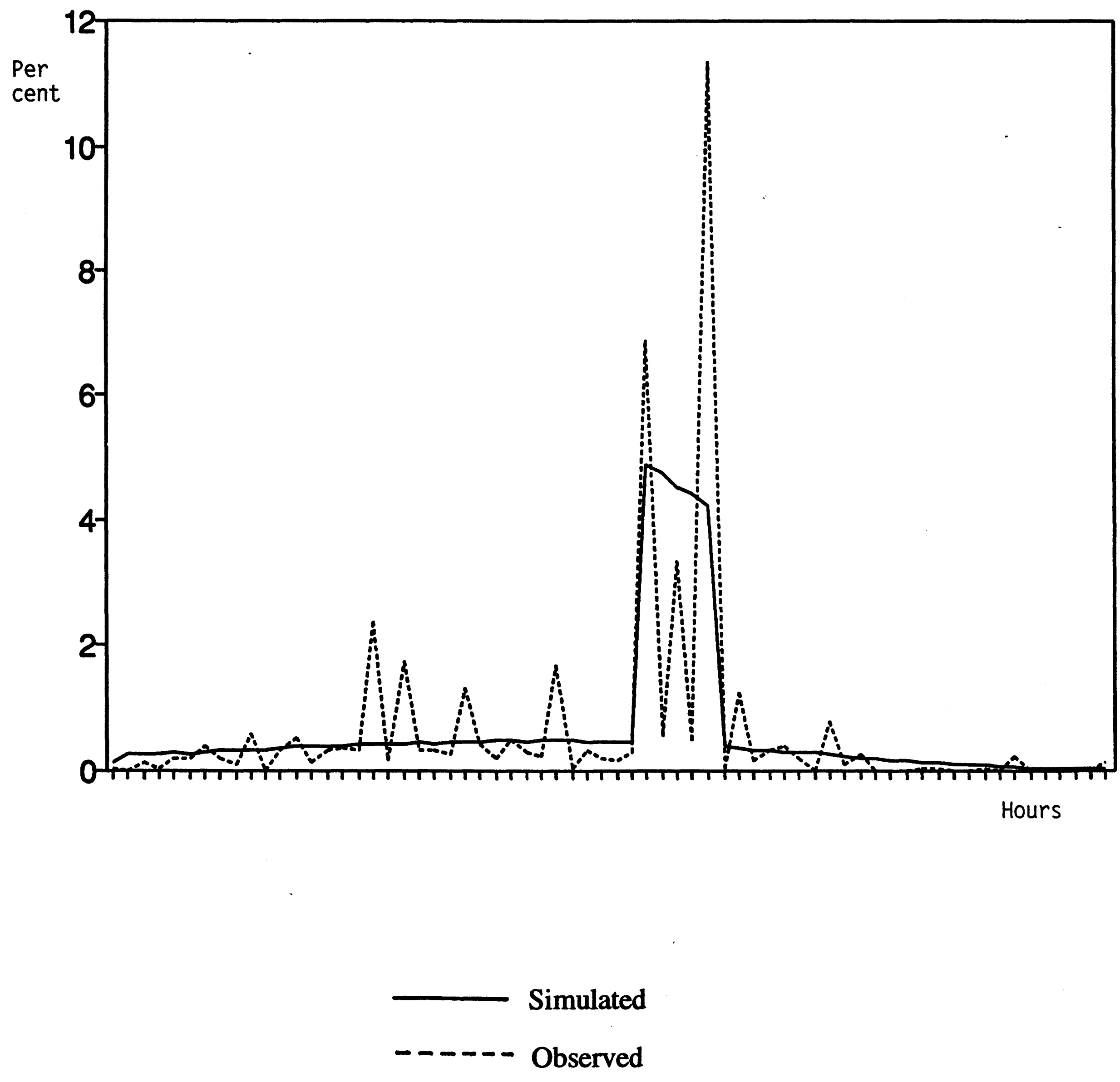

Figure 3. Distribution of family consumption, 1987

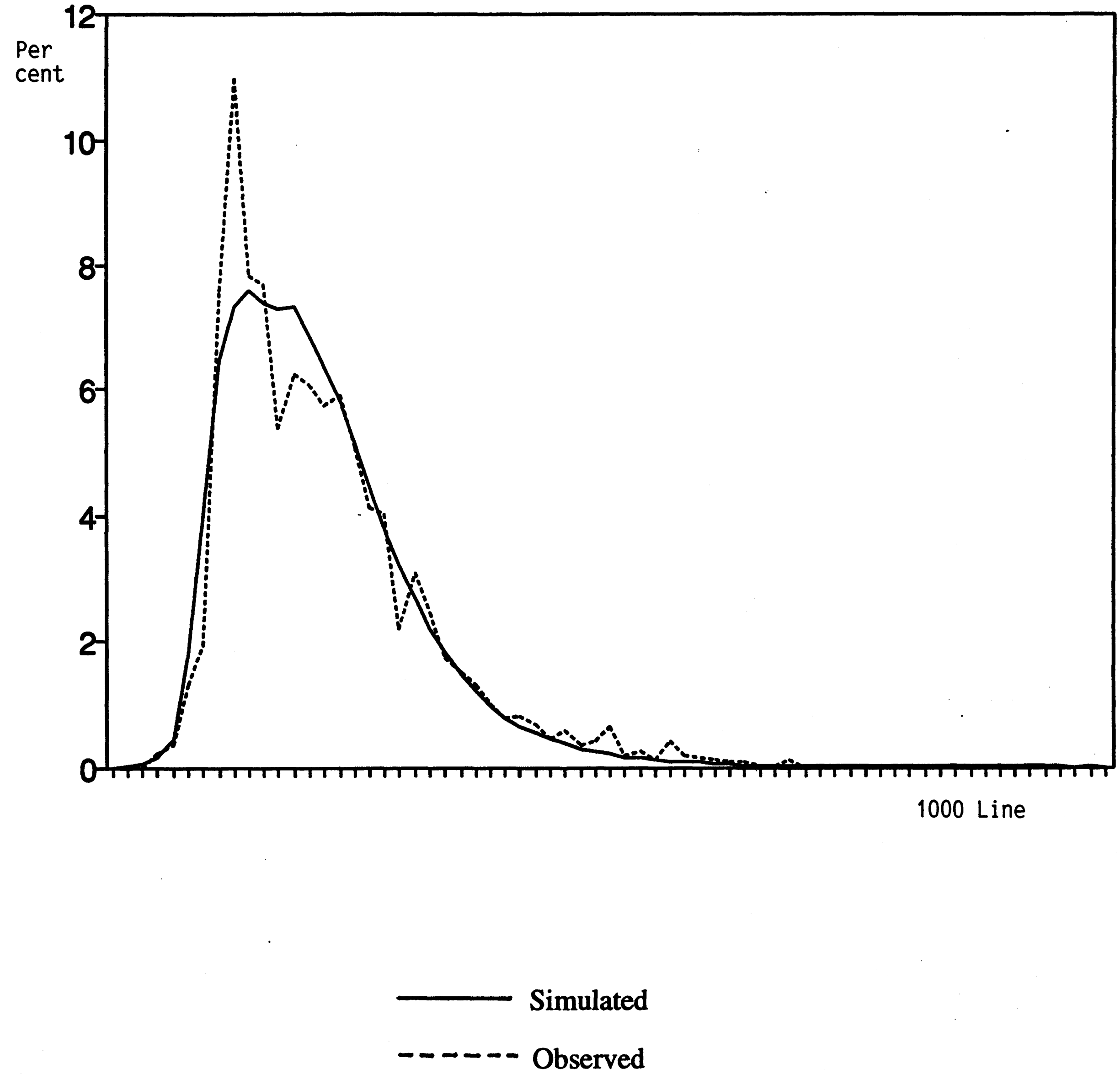

Table 4 reports what we have called aggregate Cournot elasticities. They are calculated as follows. The model is used to simulate (stochastic simulations) the labor supply for each household (wife and husband) under the current regime and when the wage rates are increased by 10 per cent. The aggregate elasticity of, for example, female labor supply is obtained by calculating the relative change in the mean female labor supply (over all females in the sample) that results from a 1 per cent wage increase. Note that the "estimates" in Table 4 are based on 10 sets of simulations and that the standard deviations inform about the simulation uncertainty. The aggregate Slutsky elasticities are calculated by the same procedure, but under the restriction that utility levels should remain unchanged.

The own-wage elasticities for males are numerically small which is in accordance with the findings in almost all labor supply studies, for instance as found in similar studies on Swedish (Aaberge et al, 1990a) and Norwegian (Aaberge et al, 1990b) data. In a majority of other studies mean-sample/mean-utility elasticities are reported. These elasticities do not capture the heterogeneity of the population and can lead to severe mistakes in the interpretation of empirical labor supply models.

Wage elasticities for females are significantly higher than among males. This is especially the case for the elasticity of the probability of participation with respect to wages.

A remarkable result is the strong cross-effect, which neutralize the own-wage effects. If all wages are raised by 1 per cent, our results indicate that the unconditional expectation of labor supply among men is nearly unaffected (reduced by 0.06 per cent). The females net response is a modest increase of 0.25 per cent. This result should be kept in mind when we later present the results of some policy simulations. This result can also explain why labor supply estimates based on time series give numerically small and often insignificant wage elasticities. Overall wage changes are the rule rather than the exception in real life and hence is reflected in the time-series of wages.

A striking result reported in table 5 is that wage elasticities are declining with household income. This result is in accordance with what we previously have found for Sweden and Norway, cfr. Aaberge et al., op.cit. For the poorest households we find very strong wage responses among females, but these responses are sharply decreasing with increasing income. We also note that among the poorest females the income elasticity, defined as Cournot minus Slutsky, is numerically quite high.

Only in one of the specified groups we find a negative Cournot elasticity (males belonging to the 10 per cent richest households). Thus, in this group the negative income effect of wage changes dominate and make the male labor supply curve (slightly) backward bending.

The comparison of the present results with previous results based on Italian data is problematic for the reasons mentioned in the introduction. Previous estimates are based on local samples or on data set created by merging different samples. None of those studies model the partners' decisions as simultaneous. Moreover, a less precise approximation of the tax system is used in previous studies. Table 6 reports the Cournot elasticities estimated by Colombino and Del Boca (1990) for married women. The table gives us some suggestions about the differences in the results that appear by applying the present approach compared to the standard approach. As one should expect, the table suggests that the standard approach tends to exaggregate the hours response among workers, especially with respect to own wage.

Table 4: Aggregate labor supply elasticities*)

Type of elasticity		Male elasticities		Female elasticities	
		Own wage elast.	Cross elast.	Own wage elast.	Cross elast.
Elasticity of the probability of participation	Cournot	.046 (.001)	-.081 (.002)	.654 (.006)	-.357 (.008)
	Slutsky	.043 (.002)	-.065 (.005)	.640 (.029)	-.141 (.017)
Elasticity of the conditional expectation of total supply of hours	Cournot	.007 (.001)	-.035 (.002)	.078 (.003)	-.136 (.002)
	Slutsky	.054 (.004)	-.033 (.003)	.096 (.008)	-.058 (.005)
Elasticity of the unconditional expectation of total supply of hours	Cournot	.053 (.002)	-.116 (.002)	.737 (.006)	-.489 (.008)
	Slutsky	.098 (.004)	-.098 (.005)	.742 (.034)	-.198 (.017)

*) Standard deviations in parenthesis.

Table 5: Aggregate labor supply elasticities*) for male and female members of the 10 per cent poorest, the 10 per cent richest and the 80 per cent "middleclass" houesholds

Type of elasticity			Male elasticities		Female elasticities	
			Own wage elasticities	Cross elasticities	Own wage elasticities	Cross elasticities
Elasticity of the probability of participation	Cournot	I	.053 (.005)	-.109 (.006)	2.837 (.127)	-1.089 (.097)
		II	0.51 (.001)	-.086 (.002)	.742 (.007)	-.356 (.009)
		III	-0.10 (.002)	-.013 (.001)	.031 (.004)	-.122 (.004)
	Slutsky	I	.052 (.011)	-.084 (.018)	9.621 (1.100)	2.767 (.586)
		II	.047 (.002)	-.064 (.004)	.646 (.030)	-.198 (.016)
		III	.004 (.004)	-.054 (.014)	.082 (.018)	-.057 (.016)
Elasticity of the conditional expectation of total supply of hours	Cournot	I	.021 (.004)	-.017 (.009)	.467 (.061)	-1.410 (.059)
		II	.011 (.001)	-.045 (.002)	.100 (.003)	-.150 (.002)
		III	-.030 (.002)	-0.15 (.002)	.004 (.003)	-.060 (.003)
	Slutsky	I	.176 (.023)	.002 (.011)	1.261 (.250)	-.226 (.177)
		II	.046 (.003)	-.039 (.004)	.111 (.009)	-.066 (.007)
		III	.015 (.006)	-.014 (.007)	.014 (.007)	-.008 (.003)
Elasticity of the unconditional expectation of total supply of hours	Cournot	I	.075 (.008)	-.126 (.008)	3.441 (.189)	-1.454 (.111)
		II	.062 (.002)	-.130 (.002)	.832 (.007)	-.501 (.008)
		III	-.041 (.003)	-.029 (.003)	.035 (.004)	-.181 (.005)
	Slutsky	I	.229 (.030)	-.082 (.022)	12.086(1.316)	2.459 (.560)
		II	.093 (.004)	-.103 (.005)	.764 (.036)	-.263 (.015)
		III	.019 (.007)	-.067 (.018)	.096 (.024)	-.066 (.017)
Note that	I = 10 per cent poorest household II = 80 per cent in the middle of the consumption distribution III = 10 per cent richest household					

*) Standard deviations in parenthesis.

Table 6. Elasticities from Colombino and Del Boca (1990)

	Wage	Income
Participation	.64	-.44
Conditional hours	.54	-.22
Unconditional hours	1.18	-.66

5. Policy simulations

Let $V(h_F,h_M,w_F,w_M)$ denote the value of the utility function when married couples have maximized utility with respect to non-pecuniary attributes given specified levels of hours and wages, i.e.

$$(5.1) \qquad V(h_F,h_M,w_F,w_M) = \max_Z (v(C(Z),H_F(Z),H_M(Z),T_{1F}(Z),T_{1M}(Z)) + \varepsilon(Z)).$$

Replacing h_F and h_M in (5.1) by the stochastic counterparts it can be demonstrated that

$$V(H_F(Z),H_M(Z),W_F,W_M) \overset{D}{=} \psi(H_F(Z),H_M(Z),W_F(Z),W_M(Z)) + \varepsilon(Z)$$

$\overset{D}{=}$ means equality in distribution and $\{H_F(Z),H_M(Z),\varepsilon(Z)\}$ are the points of the Poisson process described in section 2.

Since we have estimated $g_{1F}(h_F),g_{1M}(h_M)$ and $\psi(h_F,h_M,w_F,w_M)$ we are able to perform policy simulations (changes in tax rates) given the wage rate and given that the couple works; provided it makes sense to keep the opportunity densities $g_{1F}(h_F)$ and $g_{1M}(h_M)$ unchanged. Recall that the densities of offered hours are assumed to be determined by institutional constraints and/or firm-specific hours of work regulations. These constraints are not likely to change as a consequence of say, changes in the tax system.

One purpose of the simulation experiments is to examine the influence of certain tax reforms on labor supply, income levels and income inequality among households (married couples with or without children). The basic income concepts are gross income (Y) and disposable income (equal to consumption C) defined as:

$$(5.2) \qquad Y = w_F h_F + w_M h_M + I_1 + I_2,$$

and

$$(5.3) \qquad C = Y - S(w_F h_F, w_M h_M, I_1)$$

where I_1 and I_2 are taxable and non-taxable non-labor family income, respectively, and S is the tax function.

Income inequality is examined by employing a transfer sensitive inequality measure. This measure of inequality, denoted the A-coefficient, is discussed in Aaberge (1986). The A-coefficient is defined by

$$(5.4) \qquad A = 1 - \frac{1}{\mu}\int_0^1 E\left(X \mid X \le F^{-1}(u)\right) du$$

where X is an income variable with distribution F and mean μ.

The A-coefficient has a similar geometric interpretation as the Gini-coefficient, but gives more weight to transfers that occur in the lower part of the distribution. The maximum attainable value of the A-coefficient is 1, which corresponds to the distribution where one family has all income, while the minimum attainable value is 0, which corresponds to perfect equality.

The simulation of the model can be performed as follows:

Draw r points,

$$\{H_F(Z), H_M(Z), \varepsilon(Z)\}, \quad z = 1,2,\ldots,r.$$

where $\{H_F(Z)\}$ and $\{H_M(Z)\}$ are drawn from uniform distributions with full-time peaks and $\{\varepsilon(z)\}$ are drawn from the extreme value distribution, $\exp(-e^{-\varepsilon})$.

Find the realized hours $(H_F(\hat{Z}))$ given the wages (w_F,w_M) by maximizing

$$\psi(H_F(Z), H_M(Z), w_F, w_M) + \varepsilon(Z)$$

with respect to Z=1,2,...,r. Repeat this procedure for every household in the sample. When r is large, this procedure yields results that are close to an "exact" simulation of the model.

Table 7 reports the results of three simulations. The first is a reference case in which the actual tax rules (as of 1987) are used to give the model predictions of participation rates, annual hours of work (given participation), gross earnings, gross family income, taxes and disposable income.

In the second simulation the actual taxes are replaced by a proportional tax on wage earnings and in the third simulation a more progressive tax structure replaces actual rules. In both cases total tax revenue is kept constant. With this constraint the proportional tax case ends up with a proportional rate of 26.3 per cent. In the third case, where the degree of progression is increased, the tax-revenue constraint determines the tax level. The increased degree of progression is exogeneously set to 0.86. Under the actual rules this degree is 0.94; cfr. table 8. The degree of progression is measured as the elasticity of disposable income with respect to gross income and it is less than 1 if taxes are progressive.

Table 7 indicates that the effects of these tax changes are remarkably weak. A shift to proportional taxes has a negative impact on females labor supply, and a positive, but weak, impact on male labor supply. Strong cross effects and weak own-wage effects among middle income and high income earners are the main reason for the stability in aggregate labor supply.

Increased degree of progression has a negative net-effect on female labor supply, while males supply are not affected at all.

Table 8 gives the A-inequality in the distributions of gross and disposable family income. A shift to a proportional tax makes the distribution of pre-tax income slightly more equal, but this effect is not strong enough to prevent an increase in the after-tax income inequality. An increase in the degree of aggregate progression has no effect on inequality in the pre-tax income distribution, but reduces after-tax income inequality.

Table 9 reports the corresponding Gini-coefficients which accord with the results obtained for the A-coefficient.

Table 7: Participation rates, annual hours of work, gross income, taxes and disposable income (1000 lire) for couples under three different tax regimes. Means

Tax	Participation		Annual hours of work		Gross earnings		Gross income	Taxes	Dis-posable income
	F	M	F	M	F	M	Housholds		
1987 tax rules	0.40	0.96	690	1932	7300	23600	36600	9400	27300
Proportional taxes[1)]	0.38	0.96	667	1952	7200	24300	37200	9400	27800
Increased degree of progression[1)]	0.36	0.96	625	1933	6700	23700	36100	9400	26800

[1)] The proportional tax rate 26.3 % and the progressive tax rates on gross earnings are derived under the restriction of constant tax revenue equal to the revenue under the 1987-rules.

Table 8: A-inequality[*)] in distribution of households gross and disposable income, and degree of aggregate progression under various tax regimes

Tax regime	Gross income	Disposable	Degree of aggregate progression
1987 tax rules	.356 (.001)	.335 (.001)	.94
Proportional taxes	.349 (.001)	.349 (.001)	1.00
Increased degree of progression	.356 (.001)	.313 (.001)	.86

[*)] Standard deviations in parenthesis.

Table 9: Gini-inequality*) in distribution of households gross and dispoable income, and degree of aggregate progression under various tax regimes

Tax regime	Gross income	Disposable	Degree of aggregate progression
1987 tax rules	.253 (.001)	.238 (.001)	.94
Proportional taxes	.247 (.001)	.247 (.001)	1.00
Increased degree of progression	.255 (.001)	.220 (.001)	.86

*) Standard deviations in parenthesis.

6. Conclusions

The present study tries to overcome some of the shortcomings of standard empirical labor supply models by applying a new approach which allows for complex non-convex budget sets, highly non-linear labor supply curves and imperfect markets with institutional constraints.

The empirical results demonstrate that the model reproduces the distribution of labor supply for males and females quite well. Moreover, the results show that male labor supply on average is rather inelastic while labor supply among females, especially participation, is an order of magnitude more elastic. Another important findings are strong cross-effects and wage elasticities that are sharply declining with family income.

Policy simulations indicate that tax changes which affect the take-home pay of all family members will have rather modest impacts on aggregate labor supply. These results are due to strong cross-effects and rather inelastic labor supply among individuals with middle and high incomes.

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