Evaluating alternative tax reforms in Italy with a model of joint labor supply of married couples

by

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Abstract

In this paper we estimate a model of household labor supply using an econometric approch that allows simultaneous decisions of household members, complex and non-convex choice sets induced by tax and benefit rules, and quantity constraints on hours choice. The model is estimated using the 1993 Bank of Italy's Survey of Household Income and Wealth, and used to simulate three hypothetical tax reforms: namely, a flat tax and two versions of a negative income tax system, under the constraint of equal tax revenue. All these reforms contain both incentives to work less and incentive to work more. The incentives to work more seem to prevail, at least for the more productive: the labor supply elasticities, although modest, are sufficiently large (especially female participation elasticity), so that all the reforms produce a larger household average disposable income, without worsening much the equality of the income distribution as measured by the Gini index. A remarkable result is that no significant "poverty trap" effect is associated with the negative income tax reforms. All the reforms are supported by a majority of winners in the sample, although the proportion of winners varies considerably across income deciles.

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1. Introduction

In this paper we examine the effects of different tax regimes on household labor supply and on the distribution of income in Italy. During the last years an increasing interest has been observed in Italy concerning the efficiency and distributional performance of the tax system. By and large we can identify two focal area of interest. One is centerered around the possible merits of a flatter profile of the tax rates, as an instrument to reduce distortions and incentives to tax evasion [1]. The other focuses upon a restructuring of the policies in favor of low-income groups, possibly swtching from a system essentially based on implicit in-kind transfers and cathegorical benefits to a system based to a larger extent upon means-tested income transfers [2]. Although interesting, this discussion has been lacking support from appropriate mesurement of the effects of the policies which were proposed. The models used by default are microsimulation models which do not account for behavioral responses [3]. But in this matter, behavioral responses and incentive effects are the crucial point[4]. In this paper we use a microeconometric model which features:

- simultaneous treatment of both spouses' choices;
- exact representation of income taxes;
- quantity constraints on the distribution of hours.

Previous structural analyses of labor supply in Italy based on microdata have been carried out for example by Colombino and Zabalza (1982), Colombino (1985), Colombino and Del Boca (1990), Del Boca and Flinn (1984) and Rettore (1990). Most of these studies are based on local samples. None of them develops a truely simultaneous model of partners' decisions. Taxes are either ignored or given a simplified representation.

For the estimation and the simulation we use the data from the 1993 Bank of Italy's Survey of Household Income and Wealth (SHIW93). The analysis is restricted to married couples, with both partners in the age interval 18-54. Self-employed and retired persons are excluded. Household decisions must therefore be interpreted as conditional on not being self-employed nor retired.

We run the model to simulate the labor supply responses and welfare effects of replacing the current (1993) tax system (on personal incomes) with hypothetical alternatives, namely a flat tax and a flat tax *cum* negative income tax, under the constraint of equal tax revenue. The hypothetical reforms are connected to the above mentioned discussion since the flat tax is an extreme and simple way to reduce distortion costs and the negative income tax is a general, means-tested, way to support the poor.

The paper is organized as follows. Section 2 gives a brief description of the model. Section 3 illustrates the main behavioral implications of the estimates, i.e. the wage elasticity of household labor supply. Section 4 presents the results of various policy simulations. Section 5 is dedicated to the final remarks and to perspectives for future research. The Appendix gives a more detailed description of the emprical specification, of the data and of the estimation results.

2. The model

Our study draws upon the framework introduced by Dagsvik (1994) and may be viewed as an extension of the model in Dickens and Lundberg (1993). Our approach to modeling labor supply is rather

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[1] See various contributions on *Rivista di Diritto Finanziario e Scienza delle Finanze*, **54**, 1995.

[2] See Commissione Ministeriale (1997).

[3] Interesting applications of non-behavioral microsimulation models to the analysis of recent italian tax policies or proposals are represented for example by Rizzi (1995) and ISPE (1997).

[4] Besides labor supply, there are of course many other household choices which are also important to take into acount in the evaluation of tax and benefit reforms: fertility, education, occupational choice, savings, housing choices etc.

different from the traditional one, originally adopted in a well-specified microeconometric framework by Heckman(1974). A similar model which also included taxes was later estimated by Hausman and co-authors for the U.S. (cfr. Hausman (1979, 1980, 1981 and 1985), Burtless and Hausman (1978), Hausman and Ruud (1984)), and also adopted in numerous other studies (e.g. Blomquist (1983) for Sweden, Arrufat and Zabalaza (1986) for the U.K., Kaptein et al. (1990) for Holland, Colombino and Del Boca (1990) for Italy).

The traditional approach is essentially based on the standard textbook model. The agent's behavior is interpreted as the solution to the problem:

$$\begin{aligned} &\max\nolimits_h U(wh+I,h) \\ &s.t. \\ &h \in [0,T] \end{aligned} \qquad (2.1)$$

where

h = hours of work

w = wage rate

I = other (exogenous) income

T = total available time

$wh + I$ = total income.

In this model the wage rate w is fixed. Given the wage, a job is just described by a value of h belonging to the interval [0,T]. The individual is free to choose any value of h in that interval. Under standard regularity conditions, if we define $h(w,I)$ as the value of h which solves $\partial U(wh+I,h)/\partial h = 0$, then the solution to problem (2.1) is:

$$h^* = \begin{cases} 0 & \text{if} \quad h(w,I) \le 0 \\ h(w,I) & \text{if} \quad 0 \le h(w,I) \le T \\ T & \text{if} \quad h(w,I) \ge T \end{cases} \qquad (2.2)$$

The solution h^* is typically a random variable, due to some unknown preference parameter which is treated as random.

When taxes are introduced, problem (2.1) becomes:

$$\begin{aligned} &\max\nolimits_h U(f(wh,I),h) \\ &s.t. \\ &h \in [0,T] \end{aligned} \qquad (2.3)$$

where f is the function which transforms gross income into net income. In most countries, f defines a piece-wise linear budget, with each segment k defined by a net wage rate w_k (the slope) and a "virtual" income I_k (the intercept of the extention of the segment). The solution can be easily characterized in terms of the functions $h(w_k, I_k)$ [5]. In principle, this approach can be generalized to any type of tax system which can be approximated by a piece-wise linear tax rule, and to simultaneous decisions of household members. In practice it may become prohibitively burdersome for complex rules f and for the decisions of a married

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[5] A very useful and clear exposition of the "Hausman approach" is given by Moffit (1986).

couple. Therefore the analyses based on this approach tend to rely on some simplified representation of the tax rule and on some recursive structure of household decisions. It seems also very unrealistic to assume that for each individual there is just one market wage and that hours can be freely chosen in the interval [0,T] [6].

The approach that we follow here assumes the the agents choose among jobs, each job being defined by a wage rate *w*, hours of work *h* and other characteristics *j*. As an example of *j*, think of commuting time or specific skills involved in the job. For expository simplicity we consider in what follows a single person household, although the model we estimate considers married couples[7]. The problem solved by the agent looks like the following:

$$\max_{h,w,j} U(f(wh,I),h,j)$$
$$s.t. \qquad (2.4)$$
$$(h,w,j) \in B$$

The set B is the opportunity set, i.e. it contains all the opportunities available to the household. For generality we also include non-market opportunities into B; a non-market opportunity is a "job" with $w = 0$ and h=0. Agents can differ not only in their preferences and in their wage (as in the traditional model) but also in the numerosity of jobs of different type. Note that for the same agent, wage rates (unlike in the traditional model) can differ from job to job. As analysts we do not know exactly what opportunities are contained in B. Therefore we use densities to represent B. Let us denote with $p(x,y)$ the relative frequency (density) in the opportunity set B of jobs with $(h,w)=(x,y)$. By specifying a density on B, we can for example allow for the fact that jobs with hours of work in a certain range are more or less likely to be found, possibly depending on agent's characteristics; or for the fact that for different agents the relative number of market opportunity may differ.

We assume that the utility function can be factorized as

$$U(f(wh,I),h,j) = V(f(wh,I),h)e(h,w,j) \qquad (2.5)$$

and that ε is i.i.d. according to:

$$\Pr(e \le u) = \exp(-u^{-1}) \qquad (2.6)$$

The term ε is a random taste-shifter which accounts for the effect on utility of all the characteristics of the household-job match which are observed by the household but not by us. We observe the chosen *h* and *w*. Therefore we can specify the probability that the agent chooses a job with observed characteristics (*h*,*w*). It can be shown that under the assumptions (2.4), (2.5) and (2.6) the probability density of a choice (*h*,*w*) is [8]:

[6] A critical analysis of other aspects of the "Hausman approach" can be found in MaCurdy et al. (1990).

[7] See Aaberge, Colombino and Strom (1998) for the extention to married couples as decision units.

[8] For the derivation of the choice density see Aaberge, Colombino and Strom(1998).

$$j(h,w) = \frac{V(f(wh,I),h)\,p(h,w)}{\iint\limits_{x,y} V(f(yx,I),x)\,p(x,y)\,dx\,dy} \qquad (2.7)$$

Expression (2.7) is essentially a multinomial logit where the preference terms V are weighted by the associated opportunity density.

From (2.7) we also see that this approach does not suffer from the complexity of the tax rule *f*. The tax rule, however complex, enters the expression as it is, and there is no need to simplify it in order to make it differentiable or manageable as in the traditional approach [9].

From expression (2.4) it is clear that what we adopt is a choice model; choice, however, is constrained by the numerosity and by the characteristics of jobs in the opportunity set. Therefore the model is also compatible with the case of unvoluntary unemployment, i.e. an opportunity set which does not contain any market opportunity; besides this extreme case, the number and the caracteristics of market (and non-market) opportunities in general vary from individual to individual. Even if the set of market opportunities is not empty, in some cases it might contain very few elements and/or elements with bad characteristics.

In order to estimate the model we choose convenient but still flexible parametric forms for V and p, which are illustrated in the Appendix. The parameters are estimated by maximum likelihood. Once the parameters have been estimated, we can simulate the effects of different policies. A policy can be defined as the introduction of a new opportunity set B^* and /or of a new tax rule f^*. Then we can evaluate the effect of the policy by solving the new problem:

$$\begin{aligned} &\max_{h,w,j} U(f^*(wh,I),h,j) \\ &s.t. \\ &(h,w,j) \in B^* \end{aligned} \qquad (2.8)$$

Since from our point of view the opportunity set and the preferences are random, this is an exercise in stochastic simulation. We have to simulate B^* and ε by drawing from the estimated opportunity density $p(h,w)$ and from the density of the taste-shifter ε, and then look for the job that maximizes U.

3. Wage elasticities

The empirical specification and the estimates are illustrated in the Appendix. Here we focus upon the main behavioral implications of the estimates, i.e. the supply elasticities with respect to wages.

Table 1 reports uncompensated elasticities. They are derived by predicting (by stochastic simulation) labor supply for each household (wife and husband) under the current tax regime and when the wage rates are increased by 1%. The aggregate elasticity of, for example, female labor supply is obtained by calculating the relative change in the average female labor supply (over all females in the sample) that results from a 1 per cent wage increase. In other words, for each household we solve a problem like (2.8) where the wages of all the jobs in the opportunity set are increased by 1%, and then we average the individual households' responses across the sample[10].

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[9] The crucial difference is that in the traditional approach the functions representing household behavior are derived on the basis of a comparison of marginal variations of utility, while in the approach that we follow a comparison of levels of utility is directly involved.

[10] The resuls reported are in fact the means of 10 stochastic repetitions of the outlined procedure.

The own-wage elasticities for males are numerically small which is in accordance with the findings in almost all labor supply studies, as found for instance in similar studies on Swedish (Aaberge et al, 1990) and Norwegian (Aaberge et al, 1995) data.

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

Table 2 reports income-dependent aggregate labor supply elasticities. The purpose is to examine how the labor supply responses for females and males vary with household income. A striking result in Table 2 is that the wage elasticities tend to decline with household income. This result is also in accordance with what was previously found for Sweden and Norway (Aaberge et al., 1990 and 1995).

Note that the elasticities reported in Tables 1 and 2 depend on the tax system and on the quantity and institutional constraints that the households faced in 1993. Moreover, the reported elasticities are aggregated across a heterogeneous popoluation of married females and males. Thus the elasticities may change if the tax system or the constraints or the socio-demographic characteristics of the population change.

Table 1. 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	0.02	-0.01	0.51	-0.16
Elasticity of the conditional expectation of total supply of hours	0.09	-0.01	0.15	-0.04
Elasticity of the unconditional expectation of total supply of hours	0.11	-0.02	0.66	-0.20

Table 2. Aggregate labor supply elasticities for husbands and wifes belonging to different deciles of the distribution of household disposable income in 1993

Type of elasticity		Male elasticities		Female elasticities	
		Own wage elasticities	Cross elasticities	Own wage elasticities	Cross elasticities
Elasticity of the probability of participation	I	0.04	-0.02	1.45	0.26
	II	0.05	-0.02	2.33	-0.19
	III	0.01	-0.01	0.71	-0.18
	IV	0.02	-0.01	0.28	-0.16
	V	0.02	-0.00	0.22	-0.15
Elasticity of the conditional expectation of total supply of hours	I	0.28	0.08	0.23	0.55
	II	0.12	0.02	0.73	0.05
	III	0.08	-0.02	0.16	-0.06
	IV	0.06	-0.02	0.18	-0.04
	V	0.04	-0.01	0.10	-0.02
Elasticity of the unconditional expectation of total supply of hours	I	0.32	0.06	1.67	0.82
	II	0.17	-0.00	3.27	-0.15
	III	0.09	-0.04	0.87	-0.24
	IV	0.08	-0.03	0.43	-0.20
	V	0.06	-0.02	0.33	-0.17

Note that
I = first decile of household disposable income in 1993
II = second decile of household disposable income in 1993
III = third to eight decile of household disposable income in 1993
IV = ninth decile of household disposable income in 1993
V = tenth decile of household disposable income in 1993

4. Policy simulations

The empirical estimates of household preferences and opportunity sets allow us to perform tax simulations. The procedure – as in the previous section - consists in solving problem (2.8) for each household using a different tax rule [11]. The purpose of the simulation experiments is to examine the influence of certain tax reforms on labor supply, income and welfare effects and income inequality among households.

Table 3 reports the results of four simulations. The first is a reference case in which the actual tax rules (as of 1993) 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. The marginal tax rates applied in 1993 are as follows:

Income (1000 LIT)	Marginal tax rate (per cent)
Up to 7,200	10
7,200 - 14,400	22
14,400 - 30,000	27
30,000 - 60,000	34
60,000 - 150,000	41
150,000 - 300,000	46
Over 300,000	51

Besides the application of the basic marginal tax rates, the tax system envisages other tax rates for special cathegories of income, deductions from taxable income, tax credits and family benefits. All the details of the tax-and-benefit system are accounted for in the model [12].

In the second simulation the actual taxes are replaced by a flat tax (FT) on total income. The flat tax rate is determined so as to yield a constant total tax revenue.

In the third and fourth simulations we replace the actual taxes by a negative income tax (NIT). Let us define the *guaranteed* household income *G(N)* as:

$$G(N) = ag(N)m \qquad (4.1)$$

where $0 \le a \le 1$, *m* is the average per capita disposable income in the total sample and γ(N) is given by the equivalence scale proposed by the Commissione di Indagine sulla Poverta' (1985):

$$g(N) = \begin{cases} 1.00 & for \quad N = 2 \\ 1.33 & for \quad N = 3 \\ 1.63 & for \quad N = 4 \\ 1.90 & for \quad N = 5 \\ 2.16 & for \quad N = 6 \\ 2.40 & for \quad N = 7. \end{cases} \qquad (4.2)$$

[11] As for the computation of elasticities, we perform 10 stochastic repetitions of the simulation.

[12] To be more precise, the tax program that we use accounts for all the details for which the dataset is sufficiently informative.

The tax R is then given by

$$R = \begin{cases} Y - G(N) \text{ if } Y \leq G(N) \\ t(Y - G(N) \text{ if } Y > G(N) \end{cases} \tag{4.3}$$

where t is a marginal (constant) tax rate and Y is total household gross income. The tax is negative if total gross income is less than G. Otherwise the tax is a fixed proportion t of the part of income exceeding G[13].

In the simulations shown here we set $m = 13473$ (1000 ITL), a is alternatively set equal to 0.5 or to 0.75 and t is determined so that total tax revenue in the sample is constant. According to the definition used in Commissione di Indagine sulla Poverta'(1985) the term $g(N)m$ is the poverty threshold for a household with N members. Therefore we simulate a system where household income is supported up to half (or alternatively, three quartes of) the poverty threshold, if necessary; otherwise, income exceeding the poverty threshold is taxed at a constant marginal rate equal to t.

In interpreting the following results of reform simulations, it should be kept in mind that what we are using is just a supply model. We assume that the opportunity densities remain unchanged, while of course one might argue that they would change too as a consequence of a new tax regime[14].

Table 3 indicates that the effects on labor supply of the two tax-reforms are modest but not irrelevant. Note that the average tax rate paid by the household in 1993 was 0.20. A shift to a FT(t = 0.184) increases the labor supply of men and women, in particular poor women who are predicted to participate more in the labor market and to work longer hours, given participation. A shift to a NIT produces an increase of aggregate supply in the (a = 0.5, t = 0.234) version, and a decrease in the (a = 0.75, t = 0.284) version, with very modest variations in both versions.

All the reforms would produce a significantly larger disposable income for the households. Together with the fact that aggregate hours of work do not increase much, this provides a rough indication that the reforms might be efficient although disequalizing when income inequality is measured by the Gini coefficient[15].

There is one apparently counter-intuitive result in Table 3 which provides a good example of the possibly different implications of our model as compared to the traditional approach. Since the flat tax (18.4%) is higher than the first marginal tax under the 1993-system (10%), we might expect a decrease in participation rates. This is even more true of the negative income tax system, which introduces a guaranteed minimum income coupled with a 23% or alternatively 28% flat tax. Our model predicts instead an increase in aggregate supply as a consequence of the shift to a FT(t = 0.184) or to NIT(a = 0.5, t = 0.234) system. A traditional model would assume that every value of h is equally available in the choice set; moreover, given preferences, the utility associated to a particular point in the choice set would be uniquely determined by (h,w). Under these assumptions a traditional model would indeed predict a decrease in participation rates under either reform. In the model presented in this paper, however, not every value of h is equally likely to be available in the choice set. Job opportunities offering less than 1846 or more than 2106 hours are

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[13] One can think of many different variants of NIT. See Fortin et al.(1993) for a theoretical and empirical analysis of NIT systems.

[14] The assumption that the opportunity densities remain unchanged is equivalent to assuming – in a traditional setting -that the aggregate demand for labor is perfectly elastic. This is the case, for example, if the conditions for the so-called *non substitution theorem* hold.

[15] The increase of avearage household disposable income is of course due to the household behavioral response. No such effect would be there in a non-behavioral simulation. Under the constraint of equal tax revenue, if household behavior remains unchanged, also average gross income and average net income should remain unchanged. Note that most part of our behavioral effect comes from (female) participation elasticity, which is probably a robust enough concept even for those who do not particularly trust behavioral and structural modeling.

relatively unlikely to be found. The opportunities in the range 1846-2106 may carry lower tax rates under both reforms than under the 1993 tax code. Thus participation may become more attractive. Moreover, in our model the utility is random; there are unobserved components attached to every market or non-market opportunity which make it more or less desirable. Thus a market opportunity may turn out to be more desirable than a non-market opportunity (non-participation) even though the opposite is true when the comparison is made solely in terms of hours and disposable income.

There is another result which deserves a comment. When NIT(a=0.75, t=0.284) is applied, aggregate labor supply is slightly reduced. Still, aggregate net income increases, despite the fact that the opportunity densities and tax revenue are invariant by construction. More generally, in all the reforms, average gross income increases far more than labor supply. How does this happen ? It must be that the least productive, those with lower wages, reduce (or increase less) their supply, and at the same time the most productive, those with higher wages, increase (or reduce less) their labor supply. So it seems that the reforms interact in a virtuous way with the pattern of elasticities, inducing a sort of favorable selection process.

Table 3. Participation rates, annual hours of work, gross income, taxes and disposable income (1000 ITL) for couples under alternative different tax regimes by deciles of household disposable income in 1993. Means.

Tax system		Participation rates(%)		Expected annual hours of work, given participation		Gross income	Taxes	Dis-posable income
		F	M	F	M	Households		
1993 tax-rules	I	14.1	95.6	1030	1571	15221	525	14695
	II	20.0	97.6	1209	1832	24372	2109	22263
	III	43.8	98.9	1546	1991	48187	8960	39227
	IV	65.5	99.4	1731	2117	85135	19983	65152
	V	74.4	99.4	1828	2237	128396	34365	94032
	VI	43.7	98.6	1590	1972	54525	11074	43150
FT (t=0.184)	I	19.6	95.4	1264	1706	22933	4219	18714
	II	24.4	97.8	1397	1924	31761	5845	25917
	III	44.7	99.0	1585	2048	54142	9961	44181
	IV	64.5	99.0	1741	2162	89459	16460	72999
	V	73.2	99.5	1834	2267	132888	24452	108435
	VI	45.0	98.6	1623	2036	60189	11074	49115
NIT (*a*=0.5, *t*=0.23)	I	16.5	95.3	1165	1617	19348	1435	17912
	II	21.7	97.5	1345	1873	28979	4244	24735
	III	43.4	98.8	1562	2027	52147	9727	42420
	IV	64.1	99.3	1739	2155	88449	18256	70193
	V	72.9	99.5	1834	2261	131752	28445	103307
	VI	43.6	98.5	1608	2009	58141	11074	47067
NIT(*a*=0.75,*t*=0.28)	I	14.4	95.3	1056	1551	16404	-1952	18356
	II	19.9	97.1	1240	1820	26199	2537	23662
	III	41.4	98.6	1540	1996	49801	9538	40263
	IV	63.3	99.2	1733	2138	86985	20218	66767
	V	72.6	99.5	1832	2252	130581	32714	97867
	VI	41.9	98.3	1589	1976	55897	11074	44823

Note that
I = first decile of household disposable income in 1993
II = second decile of household disposable income in 1993
III = third to eight decile of household disposable income in 1993
IV = ninth decile of household disposable income in 1993
V = tenth decile of household disposable income in 1993
VI = whole sample

The Gini coefficients displayed in Table 4 suggest that the distribution of income (both gross and net) would be made slightly more unequal as a consequence of the introduction of any of the reforms, more markedly so for the flat tax. Note however that NIT (*a*=0.75, *t*=0.28) is more effective in redistributing than the 1993 tax rule, and its disequalizing effect on the distribution of net income is very small.

Table 4. The Gini coefficient for distributions of households gross and disposable income, and degree of redistribution under various tax regimes

Tax regime	Gross income	Disposable income	Degree of redistribution
1993 tax-rules	0.323	0.283	0.875
FT (t=0.184)	0.332	0.332	1.000
NIT (*a*=0.5, *t*=0.23)	0.338	0.315	0.935
NIT (*a*=0.75, *t*=0.28)	0.343	0.298	0.869

Applied welfare analyses of tax reforms commonly compare changes in welfare by relying on monetary measures like compensating or equivalent variation and require utility differences to be comparable across households. However the determination of winners and losers of a reform can be achieved even though we do not permit comparison of utility differences. In Table 5 we give the fraction of winners for deciles of the distribution of household disposable income. A household is a winner if the utility level reached under 1993 system is lower than the utility level reached after the reform. The results show that the majority of the households would support all the three reforms, with a more robust majority for NIT (*a*=0.5, *t*=0.23). Behind this almost uniform result, we observe that the effects of the reforms differ dramatically across deciles. No reform receives a majority support in all deciles, although NIT (*a*=0.75, *t*=0.28) gets close to it, which suggests that some careful design of a NIT system might be supported by a diffuse majority across the deciles, and possibly even reach a higher degree of equality in view of the results of Table 4. It is also interesting to note that NIT (*a*=0.75, *t*=0.28) would be supported in a referendum both by the poorest and by the richest income decile. Of course a definite judgement upon the reforms would depend on the relative magnitude of gains and losses, and thus ultimately on the comparability issue[16].

Table 5. Decile-specific proportions of winners from two alternative tax reforms, by household disposable income in 1993. Per cent

Tax reform	Deciles of the distribution of household disposable income in 1993					
1993 tax-rules	1	2	3-8	9	10	All
FT (*t*=0.184)	14.2	19.0	51.3	86.5	90.6	51.8
NIT (*a*=0.5, *t*=0.23)	45.9	29.9	50.7	76.5	83.3	53.9
NIT (*a*=0.75, *t*=0.28)	74.1	43.7	44.8	51.1	64.9	50.2

[16] We are currently working on the application of appropriate procedures for the social evaluation of reforms.

5. Conclusions

The present study employs an econometric framework of the multinomial logit type, which allows for complex non-convex budget sets, highly nonlinear labor supply curves and imperfect markets with institutional constraints. The model can be improved along many directions. We are currently working on the following:

- including occupational choice (wage employment vs self-employment);
- replacing the wage rate with labor income as a job characteristic; the data that we use do not contain a direct measure of the wage rate, which has to be derived as average hourly income: this procedure is known to introduce a possibly serious bias if income and/or hours are measured with error;
- allowing for non-proportionality between labor income and hours (as a way to allow for dependence between wage rates and hours in the distribution of offered opportunities).

Policy simulations indicate that less distortionary tax systems such as a flat tax or a negative income tax system would have modest but not irrelevant impacts on aggregate labor supply and on the distribution of disposable income among married couples. The reforms contain incentives to work less for some and to work more for others. The incentive to work more seem to prevail at least for two of the reform, and the supply elasticity is large enough to induce a significant increase of average household disposable income. There is also some indication that the reforms activate a sort of favorable selection process, by inducing the more productive to work more and the less productive to work less. The results suggests that the reforms might be efficient but slightly disequalizing. A majority – although not a large one - of households would support the reforms. The proportion of winners varies widely across the deciles, depending on the reform. There is some indication that a careful design of a NIT-like system might attain an improvement in both efficiency and equality, and possibly also get a majority support in all the deciles. Thus a more systematic search of the reform-space looks promising. Future work will also attempt to produce comprehensive measures of social welfare effects which compound efficiency and equality effects.

Appendix

This Appendix provides a sinthetic description of the data, of the empirical specification of the model and of the estimates.

Data

The estimation of the model is based on data from SHIW93. This survey is conducted every two years by the Bank of Italy and contains detailed information on labor, income and wealth of each household component. Moreover, it contains information on some socio-demographic characteristics.

The labor incomes measured by the survey are *net* of social security contributions and of taxes on personal income. Therefore, in order to get gross incomes we have to apply the "inverse" tax code. In turn, the “direct” tax code has to be applied to every point in each household’s choice set to compute disposable income associated to that point [17].

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

Only married couples with at least one of the partners working in the wage employment sector are included in the sample used for estimation and simulation. Couples with income from self-employment are excluded from the sample: this is due to the assumption that their decision process may be substantially different from wage-employees' and typically involves a permanent element of uncertainty[18].

We have restricted the ages of the husband and of the wife to be between 18 and 54 in order to minimize the inclusion in the sample of individuals who in principle are eligible for retirement, since the current version of the model does not take the retirement decision into account.

Due to the above selection rules, the estimates and the simulations should be interpreted as conditional upon the decisions not to be self-employed and not to retire for both partners. The sample covers 2160 households.

Utility function

The deterministic part *V(f(wh,I),h)* of the utility function (2.6) is specified as follows:

$$\ln V(C,h_F,h_M) = [a_2 + a_3 N]\cdot\left(\frac{C^{a_1}-1}{a_1}\right) + [a_5 + a_6 \ln A_M + a_7(\ln A_M)^2]\cdot\left(\frac{L_M^{a_4}-1}{a_4}\right)$$
$$+ [a_9 + a_{10}\ln A_F + a_{11}(\ln A_F)^2 + a_{12}CU6 + a_{13}CO6]\cdot\left(\frac{L_F^{a_8}-1}{a_8}\right) \qquad \text{(A.1)}$$

[17] Dino Rizzi (University of Venezia) provided us with a program (TBM), written by him, which allows to apply detailed tax-benefit rules to gross incomes and also to recover gross incomes from net incomes by applying the inverse rule.

[18] We are currently working on a version of the model which includes the wage-employment / self-employment choice.

where the subscripts F and M denote female (wife) and male (husband), $C = f(wh,I)$ is household net (disposable) income, N is the size of the household, A_j is the age of gender j, *CU6* and *CO6* are number of children below and above 6 years old and L_j is leisure for gender j, defined as $L_j = 1 - \frac{h_j}{8760}$.

The random term $\varepsilon(h,w,j)$ is assumed to be i.i.d. according to (2.6) of section 2. Expression (2.6) amounts to assuming that $\ln(\varepsilon)$ is distributed according to type III extreme value distribution.

Hours and wage densities

For the purpose of estimating the model, it turns out that it is convenient to write the density of hours and wages $p(h,w)$ as follows:

$$p(h,w)=g(h,w)g_0 \qquad \text{(A.2)}$$

where $g(h,w)$ is the conditional opportunity density given that $(h,w) > 0$, and g_o is the probability density of market opportunities in the opportunity set.

We assume that hours and wages on market jobs available to the husband and hours and wages available to the wife are independent:

$$g(h_F,h_M,w_F,w_M)=g_{1F}(h)g_{1M}(h)g_2(w_F,w_M) \qquad \text{(A.3)}$$

The assumption of independence of *h* and *w* is standard in microeconometric labor supply studies, where the traditional approach dictates a constant wage rate for any amount of hours of work (an exception is Moffit, 1984). In our model it is essentially a computational simplification. There are certainly many theoretical arguments which suggest as more plausible a dependence between hours and wages in the opportunity set: fixed labor costs, productivity which varies with hours, selection/incentive effects of wages and/or hours etc. On the other end, in Italy as in most european countries, normal hours are usually set by law or by central negotiation: this procedure might weaken the potential dependence between hours and wages. We think that allowing for dependence is an interesting and important line of research, but it is left for future work.

Hours in the opportunity set are assumed to be uniformly distributed with a peak in the interval [1846,2106], corresponding to full-time jobs (36-40 weekly hours):

$$g_{1k}(h)=\begin{cases} g_k \; if \; h\in[0,1846) \\ g_k q_k \; if \; h\in[1846,2106] \\ g_k \; if \; h\in(2106,3432], k = F,M \end{cases} \qquad \text{(A.4)}$$

where 3432 is the maximum number of hours observed in the sample [19].

Moreover, we specify

$$q_F = \exp(a_{18}) \qquad \text{(A.5)}$$

[19] Alternative ways to account for hours constraints are represented by Ham (1982), Colombino (1985), Ilmakunnas and Pudney (1990), Kaptein et al. (1990), Dickens and Ludberg (1993) and van Soest (1994).

$$\theta_M = \exp(\alpha_{19}) \qquad \text{(A.6)}$$

The terms γ_F and γ_M cancel out in the likelihood, so that we estimate α_{18} and α_{19} (and therefore θ_F and θ_M). However, since g_{2F} and g_{2M} are defined to be probability densities we must also have that

$$g_k = \frac{1}{3172 + 260\theta_k}, \; k = F, M. \qquad \text{(A.7)}$$

The proportions of market opportunities g_{0F} and g_{0M} are assumed to depend on whether individuals are living in Nortern or Southern Italy according to:

$$g_{0F} = 1/(1 + \exp(-\alpha_{14} - \alpha_{15} RE_F)) \qquad \text{(A.8)}$$

$$g_{0M} = 1/(1 + \exp(-\alpha_{16} - \alpha_{17} RE_M)) \qquad \text{(A.9)}$$

where $RE_k = 1$ if the household is living in Northern Italy, $RE_k = 0$ otherwise. Note that a positive (negative) value of the coefficient of *RE* means that living in Northern Italy increases (decreases) the proportion of market opportunities in the opportunity set.

The density of offered wages is assumed to be lognormal with gender specific means that depend on length of schooling and on past potential working experience, where experience is defined equal to age minus length of schooling minus six. Thus, the wage equations are given by

$$\log w_k = \beta_{0k} + \beta_{1k} S_k + \beta_{2k} Ex_k + \beta_{3k} (Ex_k)^2 + \eta_k \; ; \; k=F,M \qquad \text{(A.10)}$$

where S_k = years of education and EX_k = years of potential experience and η_k is a random variable, bivariate normally distributed.

Estimation

The parameters appearing in expressions (A.1) and (A.4)-(A.10) are estimated by maximum likelihhood. The likelihood function is the product of the choice densities (2.8) for every household in the sample.

The estimation is based on a procedure suggested by McFadden (1978) which yields results that are close to the full information maximum likelihood method. The continuous multinomial logit of expression (2.8) is replaced by a weighted discrete multinomial logit. The choice set is represente by 200 draws

$\left(w_M, w_F, h_F, h_M\right)$ from previously estimated densities, and each term V is weighted, i.e. multiplied by the inverse density of the corresponding draw [20].

Estimates

Table A.1 reports descriptive statistics of the variables used Tables A.2 and A.3 report the parameter estimates.

[20] 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 even choice sets of 10 random points produce results which are close to the one obtained by 30 or more random point sets.

Table A.1. Descriptive statistics – Married couples

	Mean	St.dev.	Min.	Max.
Individual variables:				
Annual hours of work (unconditional)				
Husband	1 990	507	0	3640
Wife	742	893	0	3640
Annual hours of work (conditional)				
Husband	2017	453	130	3640
Wife	1640	538	108	3640
Participation rates				
Husband	0.99	0.12	0	1
Wife	0.45	0.49	0	1
Hourly wage rates (1000 LIT)				
Husband	16.7	9.8	0.3	121.1
Wife	16.0	8.8	1.8	111.1
Gross annual earnings (1000 LIT)				
Husband	32691	1912	0	185998
Wife	11228	14424	0	69195
Age of wife	39.4	7.8	18	54
Age of husband	38.1	7.6	18	54
Education (years)				
Husband	9.7	3.9	0	19
Wife	9.4	4.0	0	19
Experience				
Husband	27	9	4	48
Wife	24	9	4	48
Household variables:	41.3	7.5	22	54
Annual net taxes paid (1000 LIT)	11 026	10172	-5042	82623
Gross annual income (1000 LIT)	55 090	32831	1529	264907
Disposable annual income (1000 LIT)	44 064	23244	3000	198932
Region (North)	0.32	0.47	0	1
Number of children below 6	0.34	0.58	0	3
Number of children 6-15	0.58	0.73	0	3

Table A.2. Estimates of the parameters of the utility function and of the opportunity density

Variables	Coefficients	Estimates	t-values
Consumption	α_1	0.728	12.8
household size	α_2	-0.103	3.7
Constant	α_3	1.470	8.5
Husband's leisure	α_4	-12.763	-14.7
Constant	α_5	-1.408	-1.3
log age	α_6	0.760	1.2
log age squared	α_7	-0.097	-1.1
Wife's leisure	α_8	-8.012	-10.3
Constant	α_9	74.509	3.3
log age	α_{10}	-41.708	-3.3
log age squared	α_{11}	5.880	3.3
# children below 6 years old	α_{12}	0.302	2.4
# children 6 or above 6 years old	α_{13}	0.277	2.7
Wife's market opportunities density			
Constant	α_{14}	-0.796	-8.4
Region	α_{15}	0.631	6.2
Husband's market opportunities density			
Constant	α_{16}	-2.412	-10.9
Region	α_{17}	1.821	2.9
Full-time peak, wife	α_{18}	2.457	27.3
Full-time peak, husband	α_{19}	2.671	50.5

Table A.3. Wage opportunity density. Simultaneous ML estimates procedure versus OLS*)

Variables	Husband		Wife	
	OLS	Simultaneous ML	OLS	Simultaneous ML
Constant	1.052 (27.3)	1.212 (15.1)	0.863 (18.8)	0.888 (8.7)
Education	0.086 (40.7)	0.074 (25.3)	0.095 (35.3)	0.101 (24.2)
Experience	0.044 (14.8)	0.024 (4.4)	0.047 (13.7)	0.027 (3.6)
Experience squared	$-0.470 \cdot 10^{-3}$ (7.5)	$-0.154 \cdot 10^{-3}$ (-1.6)	$-0.600 \cdot 10^{-3}$ (7.6)	$-0.224 \cdot 10^{-3}$ (-1.4)
R^2	0.424	-	0.430	

*) t-values in parenthesis.

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