

A microeconomic model for analysing efficiency and distributional effects of tax reforms

A review of results for Italy and Norway*

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*"La microsimulación como instrumento de evaluación de las políticas: métodos y
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1. Introduction

In this contribution we illustrate various applications of a behavioural microsimulation model that we have been developing during the last years. Behavioural models are complex and costly tools to develop, use and maintain, but also very powerful ones as we wish to show through the examples that follow. In Section 1 we present the main features of the microeconomic model. In Section 2 we comment upon the labour supply elasticities implied by the estimates. In Section 3 we illustrate a simulation of the behavioural and welfare effects of some tax reform proposals. In Section 4 we report on an exercise where we look for the optimal tax system. In Section 5 we report on an on-going project aimed at integrating the microeconomic model and a Computable General Equilibrium model. Last, in Section 6, we show an out-of-sample test of the model, where we compare the predictions of a model estimated on 1994 data to the observed effects of a reform in 2001.

2. The microeconomic model

During the last ten years, together with other colleagues we have developed a structural model of labour supply¹ which features:

- simultaneous treatment of spouses' decisions,
- exact representation of complex tax rule,
- quantity constraints on the choice of hours of work,
- choice among jobs that differ with respect to hours, wage rate and other characteristics.

We assume that the agents choose among “jobs”, each job being defined by a wage rate w , hours of work h and other characteristics z . As an example of z , 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 both singles and married couples. The problem solved by the agent is:

¹ See for example Aaberge, Colombino and Strøm (1999), Aaberge, Colombino, Strøm and Wennemo (2000) and their references.

$$\begin{aligned}
& \max_{h,w,j} U(C, h, z) \\
& s.t. \\
& C = f(wh, I) \\
& (h, w, z) \in B
\end{aligned} \tag{1}$$

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 number of available 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 probability density functions to represent B . Let us denote with $p(h, w)$ the density of jobs of type (h, w) . By specifying a probability density function 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.

From expression (1) it is clear that what we adopt is a choice model; choice, however, is constrained by the number and the characteristics of jobs in the opportunity set. Therefore the model is also compatible with the case of involuntary unemployment, i.e. an opportunity set that does not contain any market opportunity; besides this extreme case, the number and the characteristics 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.

We assume that the utility function can be factorized as

$$U(f(wh, I), h, z) = V(f(wh, I), h) + \varepsilon(z) \tag{2}$$

where V and ε are the systematic and the stochastic component respectively, and ε is i.i.d. Type I extreme value.

The term ε is a random variable that 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 turns out that the probability that a job of type (w,h) is chosen is²: $f'(\cdot,\cdot)$

$$\varphi(w, h) = \frac{\exp(V(f(wh, I), h)) p(w, h)}{\iint_{x,y} \exp(V(f(xy, I), y)) p(x, y) dx dy} \quad (3)$$

Expression (3) is analogous to the continuous multinomial logit developed in the transportation and location analysis literature. The intuition behind expression (3) is that the probability of a choice (w,h) can be expressed as the relative attractiveness – weighted by a measure of “availability” $p(w,h)$ – of jobs of type (w,h) .

We choose convenient parametric forms for $V(\cdot,\cdot)$ and $p(\cdot,\cdot)$, which also include personal and household characteristics. Using a sample of households with observations on h, w, I and characteristics, the parameters of $V(\cdot,\cdot)$ and $p(\cdot,\cdot)$ can be estimated by Maximum Likelihood (expression (3) being the individual contribution to the likelihood function). Once the model is estimated, expression (3) can be used to simulate the probability of any choice (w,h) given a new tax-transfer rule $f'(\cdot,\cdot)$ or a new opportunity density $p'(\cdot,\cdot)$ induced by some policy or some exogenous event.

Versions of the above model have been estimated for Norway, Italy and Sweden³.

² For the derivation of the choice density see Aaberge, Colombino and Strøm (1999).

³ For more details upon the model see for example Aaberge, Colombino and Strøm (2000) and Aaberge, Colombino, Strøm and Wennemo (2000). The former paper also presents a comparative simulation exercise for Italy, Norway and Sweden.

3. Labour supply elasticity

The main purpose of behavioural modelling is to account for labour supply responses to policies. But is labour supply really responsive, i.e. elastic with respect to economic incentives?

If, for example, we look at the overall (average) labour supply elasticity in Norway 1994, we read a modest 0.12. At this point we might be tempted to forget about behavioural modelling (also accounting for the fact that developing a behavioural model requires a considerable amount of time and effort).

However, the effects (on tax revenue, on welfare etc.) we are interested in, are typically non-linear with respect to changes in labour supply, and therefore the average elasticity might be quite irrelevant. In order to appreciate the value of behavioural microeconometrics we have to abandon the representative agent perspective. In fact, if we look behind the aggregate figure the picture changes quite a lot. Tables 1 and 2 show the labour supply elasticities of couples respectively for Norway 1994 and Italy 1993, disaggregated by household income decile. These elasticities are obtained by simulating the individual responses to an increase in wage rates. In both countries we observe:

- A large difference in elasticity between the partners
- A strong inverse dependence of elasticity on household income
- Important cross effects

The pattern of elasticities turns out to be quite important in shaping the results of policy simulations.

Tab. 1 Wage elasticity of labour supply in couples, by household income decile (Norway 1994).

Household income decile	Female		Male	
	Own	Cross	Own	Cross
I	2.54	-0.29	1.77	-0.12
II	0.97	-0.67	1.17	-0.08
III-VIII	0.41	-0.47	0.31	-0.24
IX	0.20	-0.34	0.08	-0.14
X	0.26	-0.10	0.05	-0.42
All	0.52	-0.42	0.39	-0.23

Tab. 2. Wage elasticity of labour supply in couples, by household income decile (Italy 1993).

Household income decile	Female		Male	
	Own	Cross	Own	Cross
I	4.44	0.82	0.32	0.06
II	2.31	-0.15	0.17	0.00
III-VIII	0.73	-0.24	0.10	-0.04
IX	0.20	-0.20	0.08	-0.03
X	0.13	-0.17	0.06	-0.02
All	0.66	-0.20	0.12	-0.02

4. A simulation of some reform proposals

In this section we illustrate the use of a version of the model estimated on 1993 Italian data. We simulate the effects of three hypothetical reforms that are stylised representations of ideas that are a matter of debate and proposal in Italy as well as in other OECD countries, with differing focus on different aspects of the tax regime. On the one hand there is a quest for a flatter profile of the marginal tax rates in order to reduce disincentives and enhance efficiency. On the other hand, and specifically in Italy, it is recognised that the system of basic income support provides transfers that are not cost-effective and do not respond to any explicit design of social or family policy, and that therefore the system needs to be rationalised on a more transparent and universalistic basis. Under different labels, the ideas belonging to this second strand, converge on proposing some type of basic income scheme, either in the form of a universal transfer or in the form of transfer that compensate incomes up to a basic level. The quests for more efficiency *via* a flatter tax profile and for more, or not less, equality *via* a more cost-effective system of income support are far from being mutually exclusive. In what follows, we evaluate three different systems that in one way or another can satisfy these criteria⁴. The first is a proportional or flat tax (FT). If Y represents total gross income, the tax R^{FT} to be paid by the household is

$$R^{FT} = t_{FT}Y \quad (4)$$

where t_{FT} is a constant marginal tax rate. Besides incorporating the idea of minimising distortions, it is also a benchmark system, useful for comparison.

The second reform is a simple negative income tax (NIT), where a flat tax is complemented with a transfer (a negative tax) that guarantees households' income up to a basic level G :

⁴ For more details see Aaberge, Colombino and Strøm (2004)

$$R^{NIT} = \begin{cases} Y - G & \text{if } Y \leq G \\ t_{NIT} (Y - G) & \text{if } Y \geq G \end{cases} \quad (5)$$

Last, we consider the so-called Work-Fare (WF) system, which essentially is a modification of NIT where the transfer is received only if the household works a minimum required amount of hours,

$$R^{WF} = \begin{cases} 0 & \text{if } Y \leq G \text{ and } H < H_{\min} \\ Y - G & \text{if } Y \leq G \text{ and } H > H_{\min} \\ t_{WF} (Y - G) & \text{if } Y \geq G \end{cases} \quad (6)$$

where t_{WF} is a constant marginal tax rate, H represent the total hours worked by the wife and the husband and H_{\min} is a minimum required number of hours worked (set equal to 1000 in the simulation). Although similar to the NIT, the WF system is interesting to analyse, both because it may have better chances to receive political support and because of the theoretical argument according to which under certain conditions it can be proved to be Pareto-superior to NIT.

The simulations consist of solving for every household problem (1) where the original tax-transfer rule $f(\cdot)$ is replaced by the rules define by (5) and (6). The three reforms are simulated under the constraint that they generate the same total net tax revenue as the current tax rule.

Since we are able to estimate the utility function, we can also identify the winners and the losers (in terms of utility) as a consequence of each reform. The percentages of winners are

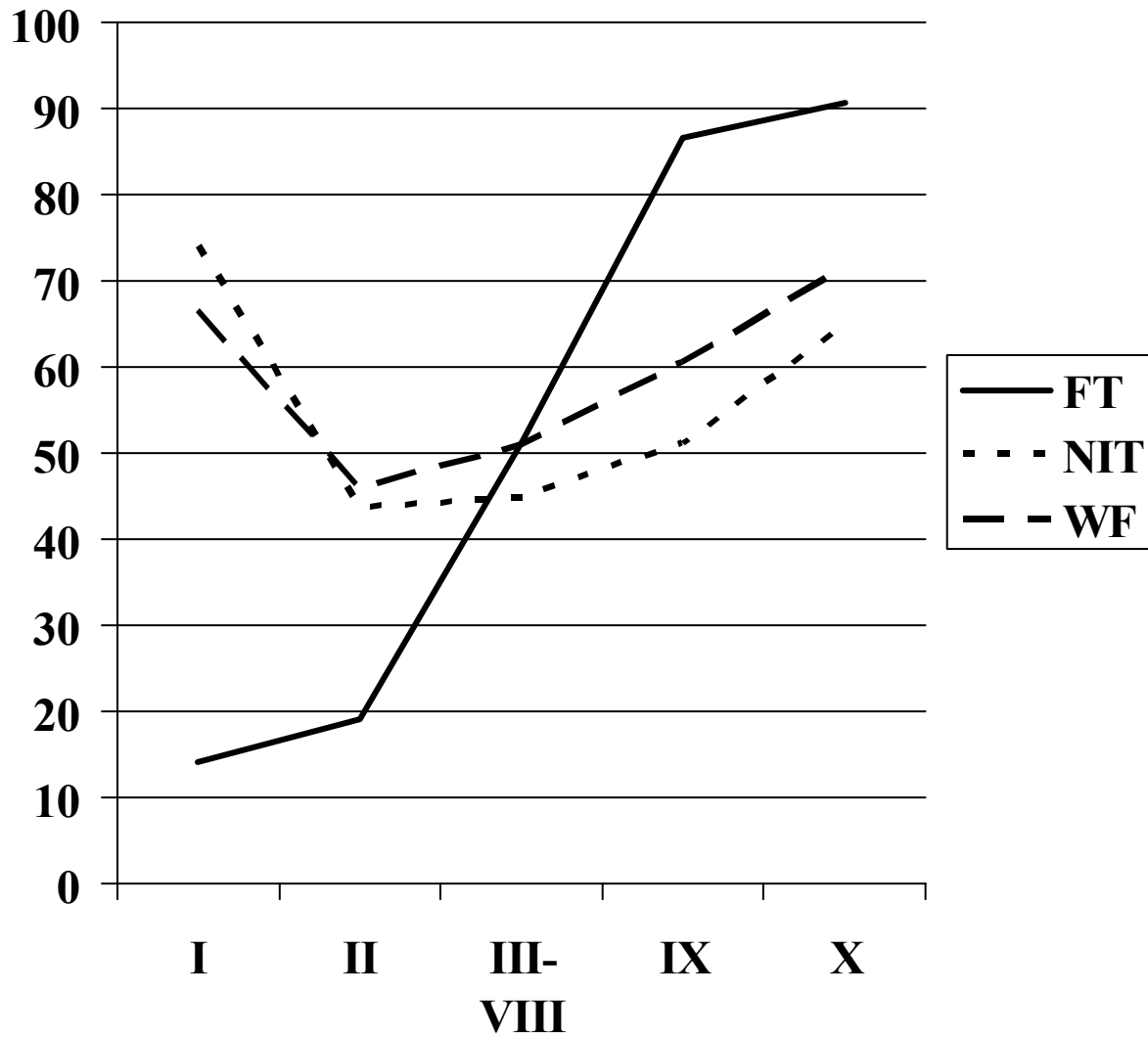
FT: 51.8

NIT: 55.0

WF: 55.6

Therefore any of the reforms would win a referendum against the current system. However, the distribution of gains and losses is very different within the population depending on the reform (Fig. 1). The efficiency and the distributional effects can be summarised by using an appropriately defined Social Welfare Function. It turns out that the percentage variation of Social Welfare can be

Fig. 1. Percentage of winners from each reform, by household income decile



decomposed into the sum of the percentage variation of Efficiency (i.e. the dimension of the “cake” = sum of all the households’ utility levels) and the percentage variation of Equality (= 1-Index of Inequality), where the index of inequality can be defined in various ways depending on the social degree of aversion to inequality⁵. Table 3 shows the results when the Gini coefficient is used as the index of inequality. It’s worthwhile noticing that:

- All the reforms are efficiency-enhancing, i.e. they induce the production of a bigger cake
- FT is disequalising, i.e. it implies more unequal slices
- NIT and WF are equalising, i.e. they imply more equal slices
- There is scope for designing tax systems that produce bigger “cakes” and more equal “slices” too.

Of course there might be even better reforms. In the next section we look for optimal reforms.

Tab. 3. Effects of the reforms on social welfare and on its components

% variations of:	FT	NIT	WF
Efficiency (a)	2.1	0.8	1.1
Equality (b)	-1.2	0.7	0.5
Social Welfare (a + b)	0.9	1.5	1.6

⁵ This exercise uses the so-called rank-dependent Social Welfare function. See for example R.Aaberge, U Colombino and J. Roemer (2001) and the references cited there.

5. An empirical exercise in optimal taxation

In this section we use a version of the model estimated on 1994 Norway data to identify optimal tax-transfer rules, where “optimal” means maximizing a Social Welfare Function.

We consider 4-parameter tax-transfer rules:

$$\text{Net} = T - \tau_1 \min(\text{Gross}, A) - \tau_2 \max(0, \text{Gross} - A)$$

where

T = lump-sum transfer⁶

τ_1 and τ_2 = marginal tax rates for the two brackets

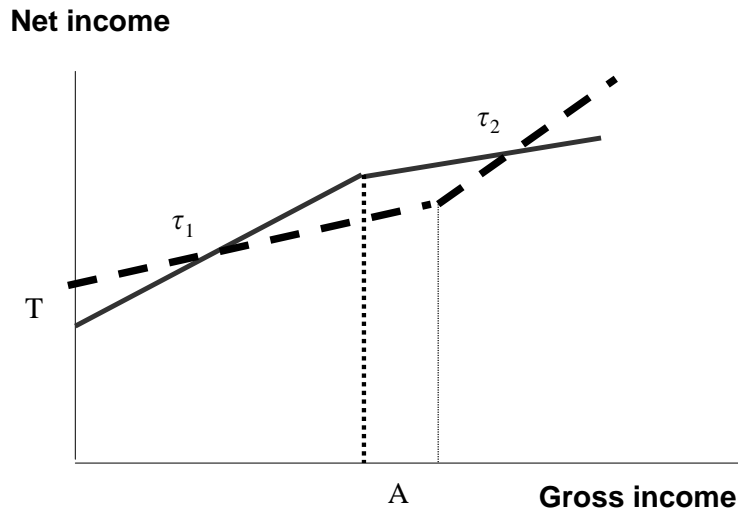
A = cut-off value between the two brackets.

Fig. 2 shows two examples from the family of 4-parameter tax-transfer rules.

As in section 4, the Social welfare function is defined as the average individual welfare (efficiency) times $(1 - \text{Inequality Index})$. There are many types according to how we define the Inequality Index. We apply alternatively four types: the Utilitarian (with Inequality index always = 0), the Gini type (with Inequality Index = Gini Coefficient), the Bonferroni type (more egalitarian than Gini) and a fourth type less egalitarian than the Gini type. The simulation consists in running iteratively the model until we find the parameters (T, A, τ_1, τ_2) that maximize Social Welfare under the constraint that the net total tax revenue is the same as under the current tax rule. The results are shown in Table 4.

⁶ In this exercise, the current transfers of the Norwegian system are left unchanged: therefore T is to be interpreted as a transfer on top of them.

Fig. 2 Two examples of 4-parameter tax systems



Tab. 4. Optimal tax-transfer rules

	W_1 (Bonferroni)	W_2 (Gini)	W_3	W_∞ (Utilitarian)
T (NOK)	7230	3650	10510	930
τ_1	0.26	0.24	0.36	0.36
τ_2	0.60	0.60	0.16	0.02
A (NOK)	475000	475000	150000	175000

NOK = Norwegian Kroner

1000 NOK \approx 120 EURO

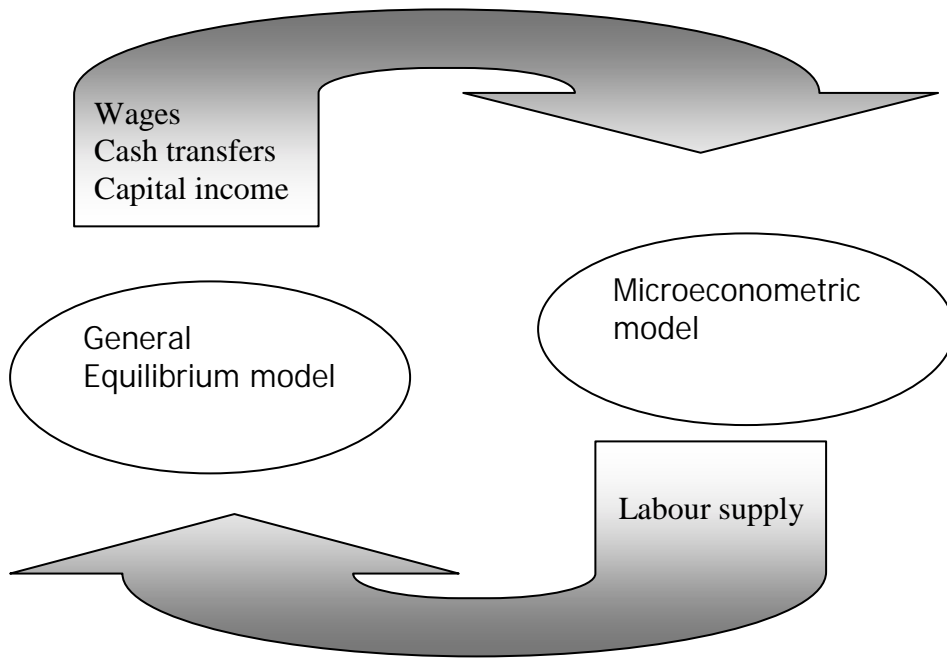
6. Integrating the Micro- and the CGE- model

One important limitations of the microeconomic model illustrated above in a variety of applications is the partial equilibrium perspective. In order to overcome this limitation we are currently working at the integration of the microeconomic model with a Computable General Equilibrium model. The interaction between the two models is sketched in Fig. 3. We illustrate this work-in-progress with an exercise done with the specific purpose of computing the equilibrium flat tax rate at 2050, i.e. the flat tax rate (on personal incomes) compatible with fiscal equilibrium taking into account a planned

evolution of the Welfare State in Norway⁷. The exercise is a nice opportunity to illustrate both the implications of accounting for behavioural responses and for general equilibrium effects. Tab. 5 summarizes some of the results for 1994 (the estimation year). Not accounting for behavioural responses nor for GE effects simply means computing the average tax rate (26.0%). By taking into account the behavioural responses to the new tax rule, the equilibrium rate goes down to 22.0%. Analogously, if one brings GE effects into the picture (but without labour supply responses), then gets 24.0%. By taking both GE effects and labour supply responses into account, the equilibrium rate turns out to be 18.0%. Then we run GE model up to the 2050. The variables that the microeconomic model receives as inputs have to be simulated by the general equilibrium model anyway; therefore we can only compare predictions with and without behavioural effects (Table 6). We see that the equilibrium tax rate is dramatically different depending on whether we account for (22.9) or not (32.6) labour supply responses.

⁷ A full account can be found in Aaberge, Colombino, Holmøy, Strøm and Wennemo (2004), where a description of and references for the GE model (developed at the Research Department of Statistics Norway) are also provided.

Fig. 3. Integrating the Microeconomic and the General Equilibrium Models



Tab. 5. Equilibrium Flat Tax rate (%) in 1994

		General Equilibrium Effects	
		NO	YES
Behavioural Effects	NO	26.0	24.0
	YES	22.0	18.0

Tab. 6. Equilibrium Flat Tax rate (%) in 2050

Behavioural Effects	NO	32.0
	YES	22.9

7. Out-of-sample predictions

How much can we trust the microeconomic model? The most convincing evidence in this respect should consist in testing out-of-sample predictions. In fact we are able to illustrate this sort of exercise. In 2001 we observe the effects of a reform of the tax rule actually implemented in Norway. We take the model estimated on 1994 data and we apply it to the 2001 population using the reformed tax rule, to simulate the effects of the reform. We then compare the model predictions to the observed effects. Tab. 7 reports the remarkably similar observed and predicted values of household disposable income. The Norway macroeconomic scenario is pretty similar in 1994 and in 2001. Therefore the parameters estimated in 1994 really seem to capture the preference structure that – given the new tax-transfer rules - generates the changes in 2001.

Tab. 7. Observed and predicted disposable income (000's NOK)

	Couples		Single Males		Single Females	
	Observed	<i>Predicted</i>	Observed	<i>Predicted</i>	Observed	<i>Predicted</i>
1994	320	318	155	152	145	145
2001	456	452	207	218	184	192

NOK = Norwegian Kroner

1000 NOK ≈ 120 EURO

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