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RESEARCH ARTICLE

# Modeling Behavioural Response in EUROMOD

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**Abstract** The EUROMOD Preparatory Project examined a number of aspects of the technical feasibility of constructing a Europe-wide tax-benefit model. This paper reports on the issues relating to incorporating behavioural response into the model. It explores the problems and prospects of modelling changes in behaviour within the static microsimulation approach, using cross-sectional data. In the case of labour supply it concludes that not only are there problems related to the timing of responses using the static approach, but also a lack of comparable studies (or data) across all 15 countries. A dynamic approach using panel data has more potential and should be explored for a small group of countries. In the case of consumer demand, behavioural adjustment can be assumed to be quick and there is some potential for including demand responses in EUROMOD.

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## 1. Introduction

Static microsimulation models of the tax-benefit type have been used in several countries to analyse the effects on the income distribution of changes in the tax and benefit system: who wins and who looses? The EUROMOD project was started to build a tax-benefit model for all countries in the European Union. This model will, to the extent possible, build on common concepts to make feasible EU-wide studies of tax and benefit changes. An issue which was raised at the beginning of the project was to what extent it would become possible to include behavioural response in the model. This paper discusses this issue.

## 2. First and second order effects

Changes in tax rates, tax bases and deduction rules, replacement rates of benefits and eligibility rules all have direct effects on peoples' incomes but also incentive effects on the willingness to work more hours, to report sick, to remain unemployed, to retire etc. It has now become more or less routine to analyse the distributional effects of proposed policy changes by using microsimulation tax-benefit models. These models are computer programs of all the details of the tax and benefit systems applied to a random sample of individuals. For each individual one knows all incomes and all other circumstances of importance for the eligibility of various transfers and for the computation of taxes and benefits, and it is thus possible to compute incomes after tax and benefits for each individual, taking into account all interactions between the tax system and the transfer and benefit systems. Such models are static in the sense that they operate on a given population of individuals. The population does not change as a result of the simulation. They only give the first order effects of tax and benefit changes, because gross incomes and other variables are assumed not to change when taxes and benefits change. The behavioral adjustments which follow from new incentives are thus not included in these static microsimulation models.

EUROMOD will also become a static model with the same limitations unless behavioural response is accounted for in one way or another. This paper discusses the inclusion of behavioural response in

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EUROMOD, if it is conceptually meaningful and if it is feasible from a more practical point of view. The whole discussion is limited to behavioural responses of single individuals. There is no discussion of macroeconomic feedback mechanisms. A model which jointly simulates the macro economy and the micro-economic distributions is not yet practical. The conceptual problems are approached first in Section 3. Then follows in Section 4 a discussion of what kind of behaviour one would like to model with an emphasis on two examples. Estimation, validation and weighting problems are briefly addressed in Sections 5 and 6, while Section 7 concludes.

## 3. Static microsimulation with behavioural adjustments

Assume there are three kinds of variables: policy variables P, target variables Y and all other variables Z. For instance, one could think of P as tax rates and tax bases, Y as taxes paid and after-tax income, while Z would include both variables like wage rates, hours worked, gross incomes, and group indices like sex, nationality, region, occupation, etc. In a conventional non-behavioural static model policy variables are related to the target variables through the tax and benefit system conditional on Z. For a single individual we could write this relation as,

$$\mathrm{Y} = \mathrm{T}(\mathrm{P}, \mathrm{Z}) \tag{1}$$

In a microsimulation application of this model we compare the distributions of

$$\mathrm{Y}_1 = \mathrm{T}(\mathrm{P}_1,\ \mathrm{Z}_0) \tag{2a}$$

and

$$\mathrm{Y}_2 = \mathrm{T}(\mathrm{P}_2,\ \mathrm{Z}_0) \tag{2b}$$

for two different policy regimes $P_1$ and $P_2$ and a given set of population characteristics $Z_0$. Replicated static microsimulation actually approximates the distribution,

$$f\left(Y_1, Y_2 | P_1, P_2, Z_0\right) \tag{3}$$

from which we can compute the marginal distributions by simple summation,

$$f(Y_1|P_1) = \int f(Y_1|P_1,\ Z_0)f(Z_0)dZ_0 \tag{4a}$$

$$f(Y_2|P_2) = \int f(Y_2|P_2,\ Z_0)f(Z_0)dZ_0 \tag{4b}$$

and various distributions conditional on subsets of $Z_0$, for instance on gender, type of family, region, etc. It is here assumed that the empirical distribution of $Z_0$ in the microsimulation model closely approximates the true distribution of $Z_0$, which for instance would be the case if the sample used for microsimulation is a simple random sample from the target population. (If the sample is drawn with unequal sampling probabilities one would have to compensate for this by using appropriate sampling weights).

If the model T(..) is just a non-stochastic tax-benefit model the distribution (3) could be a degenerate one-point distribution. It is of course still possible to compute the marginal distributions (4a) and (4b) and various conditional distributions. If T(..) is a stochastic model and the simulation is only done once we might not get a good approximation of the distribution (3), depending on how frequently $Z_0$ is replicated in the simulated population. The reason is of course that we will only get one observation ($Y_1$, $Y_2$) for each individual. However, we can still compute good approximations of the marginal distributions (4a) and (4b) and various interesting conditional distributions.

The marginal distribution $f(Y_1, Y_2|P_1, P_2)$ is of particular interest, because it tells us, for instance, about the after-tax income mobility. What share of the population moves from one after-tax income decile to another as a result of the change in policy? Although $Z_0$ has been integrated out, $f(Y_1, Y_2)|P_1, P_2)$ is only valid for a population with the characteristics $Z_0$. Please also note that nothing is said and nothing can be said about the individual trajectories through time which result from a policy change. Nor do we say anything about changes through time in the distribution of Y or when a certain share of the population has moved from one decile to another.

Assume now that in addition to the tax-benefit model some of the variables Z also depend on the policy regime. Partition the vector Z into two subvectors, one including variables which depend on policy, $Z_p$ and one which is truly exogenous, $Z_{np}$. A model with behavioral adjustments could be written as,

$$Y = T(P, Z_p, Z_{np}) \tag{5a}$$

$$Z_p = C(P, Z_{np}) \tag{5b}$$

Microsimulation of this model will, for instance, involve a comparison of the following two distributions,

$$f(Y_1, Z_{p1}|P_1, Z_{np0}) \text{ and } f(Y_2, Z_{p2}|P_2, Z_{np0}) \tag{6}$$

and the corresponding pairs of marginal distributions,

$$f(Y_1|P_1, Z_{np0}) \text{ and } f(Y_2|P_2, Z_{np0}) \tag{7}$$

and

$$f(Y_1|P_1) \text{ and } f(Y_2|P_2) \tag{8}$$

Again, there is no time dimension in this model. Although it is possible to compute the distribution $f(Y_1, Y_2, Zp_1, Zp_2 \mid P_1, P_2)$, which, for instance tells us what share of the unemployed became employed as a result of the policy change, it does not tell us when. Depending on how the model is designed and the simulations done this distribution might also vastly overestimate mobility. If C(..) is a stochastic model such that the implicit random error is drawn independently for each policy regime then the model neglects any unobserved individual heterogeneity and it would simulate too much mobility. Although such a model could not be used to evaluate the distribution.

$$f(Y_1, Y_2, Z_{p1}, Z_{p2}|P_1, P_2)$$

it might still simulate the marginal distributions (6), (7) and (8). However, a model and simulation system which properly accounts for individual heterogeneity would be preferred.

It is conceivable that a model with state dependence would reduce the need to include individual heterogeneity. Assume, for instance, that,

$$Z_p = C(P, P_0, Y_0, Z_{p0}, Z_{np}) \tag{9}$$

In this model behaviour does not only depend on the policy P chosen and the exogenous characteristics Znp, but also on a reference "level" of policy $P_0$, target variables $Y_0$ and behavioural response variables Zpo. For instance, the effect of a tax change on labour supply might depend on whether an individual is unemployed or not when the tax change is implemented. It might also depend on the nature of the tax system used immediately before the taxes change. A decrease in marginal tax rates from a very high level might induce different adjustments compared to the same change from a relatively low level.

From this discussion first follows a conclusion which might seem rather trivial: static microsimulation involves a comparison between two or more policy regimes. A static model is not a forecasting tool, and it is not very meaningful to simulate just one policy regime. Another conclusion is that we have so far found no theoretical reasons why a static model could not include behavioural adjustments. The predictions from such a model have, however, the same limitations as those from a conventional static simulation model. There is no time dimension, and no statement can be made as to when, if at all, policy changes will have full effect. However, this does not preclude the comparisons between policy regimes which can be made within a static model being of interest. It all hinges on the behavioural model having a natural equilibrium or steady state interpretation. (Conceptual problems with static behavioural models will however, become apparent when it comes to their estimation and validation; see below.)

# 4. Which behavioural adjustment?

If behavioural adjustment is to become added to a future EUROMOD, for obvious reasons one would like to concentrate, at least at the start, with a few key submodels. There are at least three criteria which could be used to choose between alternatives,

- the kind of behaviour modelled should be relevant for the purpose of the model (to analyse social exclusion, the income distribution, etc.),
- there should be major behavioural adjustments to the policy changes the model is built to analyse,
- behaviour which influences the fiscal balance should be included (balanced budget).

There are at least three areas or types of behaviour which are prime candidates for inclusion in a future EUROMOD,

- labour force participation - labour supply - unemployment,
- demand for goods and services,
- the take-up of benefits,

all of which satisfy the three criteria. The inclusion of labour market responses in a tax-benefit model designed for the analysis of income distributions and social exclusion is perhaps rather self-evident. The demand for goods and services is needed if one wants to have indirect taxes in the model and be able to simulate budget effects of policy changes. Simulations of take-up rates are needed because not everyone who is eligible for benefits collects them. Other types of behaviour one could consider are, for instance, the demand for housing, schooling choices and decisions about fertility, marriages and separations.

## 4.1. A labour market model

A labour market model could, for instance include a labour force participation equation, an annual work hours model conditional on work, and a model which explains months or weeks of unemployment. It is relatively straightforward to include tax and benefit incentives and to estimate all these models from cross sectional data. Models of this kind have been estimated for several countries. Although data might not be fully comparable there should be some data available for several countries.

A special problem of making endogenous decisions about labour force participation and hours of work, is the interdependence of these decisions and the eligibility for benefits. Decisions about work depend on the composite marginal effect of taxes and benefits, including their marginal effects which depend sometimes on labour incomes. For instance, housing benefits depend in some countries on taxable income which includes labour income. A model of this kind might give computational problems. If it is not possible to solve the model analytically for the target variables as a reduced form function of the policy variables, which is usually not the case, then one would have to iterate back and forth between the submodels. For instance, in the case of a Hausman labour supply model and housing benefits, one might start by computing the housing benefits for some set of taxable incomes, then plug in the resulting benefits into the budget set and compute hours of work and labour income, then turn to the benefits again, and so on until some kind of convergence criterion is satisfied. The time needed for a simulation will thus increase.

A more important question is what do these cross-sectionally estimated incentive effects really tell us? Do they give us a steady state solution or are they just a mixture of past changes? A more ambitious approach is to estimate a truly dynamic model from panel data and to derive a steady state relation from it. But then, why not take the full step to a dynamic microsimulation model?

## 4.2. A demand model

Model specification and data need should be discussed relative to the purpose of including a demand model in EUROMOD. There are at least three different reasons to use demand systems in EUROMOD:

1. We want to analyse the impact of income tax and benefit changes on the distributions of consumption expenditures by commodity. In this case we would for each country need demand

systems which allow for heterogeneity in the responses to income changes. It is probably not sufficient to allow the "intercept" to depend on household characteristics.[1]

In this case the focus is not on price responses, and one might then be able to estimate them from aggregate data. As a minimum we would need (at least) one cross section of microdata combined with aggregate data to estimate the model. If it is static, no consumption data are needed to simulate the model.

2. We want to analyse the impact of changes in indirect taxes on the distribution of consumption expenditures. In this case we would need demand models which allow for heterogeneity of the price responses. We are not aware of any study which has attempted to do this, but in principle it should be possible. If a demand system can be estimated for the whole population of households it should be possible to estimate it for subpopulations. In this case microdata are needed, either in the form of repeated cross sections or panel data.

3. We are only interested in assessing the budget effects of changes in the indirect taxes. In this case one could perhaps do with a demand model estimated completely from aggregate data. All we would need to do is to simulate well the total (average) revenue effect of a tax change. Such a model would not really be part of the EUROMOD microsimulation model, but rather an add-on.

Given that EUROMOD is to be a tool to analyse social exclusion one could perhaps argue that it is of interest to simulate, for instance, the distribution of food consumption or the distribution of housing consumption. With this focus it is obviously necessary to have a model which permits heterogeneity in the responses from groups which are "socially excluded" compared to those which are not. Another argument in support of including demand systems in a static model like EUROMOD is that demand changes are relatively immediate.

A problem with including demand systems in EUROMOD is that we will also need savings functions to establish a link between income and total expenditures. An approach to tackling the problem is to view the consumer's inter-temporal optimization problem as one of maximizing a utility function defined as the discounted sum of the present and future streams of instantaneous utility, subject to an intertemporal budget constraint. The complete demand systems can be perfectly incorporated within this framework.

We are thus interested not only in the price and budget (i.e. total consumption) elasticities, but also in the elasticity of total consumption and of single goods to real current income. In changing the vector of consumption shares, the income effects following changes in real income could be significantly greater than those brought about by modifications in relative prices. A proposal could thus be to estimate the following model:

$$W_{hit} = W_{hit}(C_{ht},\ P_t,\ Z_{ht}) \tag{10}$$

$$C_{ht} = C_{ht}(Y_{ht},\ P_t,\ Z_{ht}) \tag{11}$$

where $W_{hit}$ is the share of the i-th good for household h at time t, $C_{ht}$ total expenditure, $P_t$ the price vector, $Y_{ht}$ real disposable income, $Z_{ht}$ a vector of demographic characteristics.

The first equation is the Marshallian demand, the second expresses the dependency of current consumption on current income and on variables which reflect (like current income itself) lifetime income.

Assuming that policy changes are no greater than to warrant stable model parameters, the steps of the simulation of behavioural reactions could be:

a. Prices of the base solution are changed: this also causes a change in the deflator of real disposable income.
b. The change in real disposable income translates into a change in real consumption level (as a proportion of current income).
c. Relative prices are changed: together with a new total expenditure level, they determine a new vector of budget shares.

1. The study by ***Blundell et al. (1993)*** is an example although in this study the specification of how the income responses depend on household characteristics is not very elaborated.

d. Given the new real expenditure level and price levels, we can compute new levels of post-reform nominal expenditure.
e. It is thus possible to forecast the revenue.
f. If the policy switch also includes other tax changes, one could estimate their effects on consumption demand.
g. Traditional distributive analyses on real disposable income or expenditure may be carried out.

As far as the quantitative significance of the behavioral effects is concerned, some studies (***Banks et al., 1994***; ***Symons and Warren, 1996***) seem to suggest that the welfare and revenue effects of indirect taxation changes in the aggregate may not be particularly large. The second cited study, for example, finds that in Australia the replacement of an existing wholesale sales tax with a 5.2% general consumption tax causes a revenue change which differs only by about 0.2 per cent from the change computed in the absence of behavioural effects. If this is true and not too specific to the single case, not evaluating the behavioural response might not give any major error. The same study, however, also concludes that it is important to allow for the interaction between the sales tax and other taxes and that allowing for behavioural responses has effects on the distributive impacts of indirect taxes.

For most European countries many studies on price and budget elasticities are already available, while there may be problems in finding the elasticities to current income.[2] For some countries price elasticities have only been estimated from aggregate time series, and this can pose some problems in their application to microdata. A further problem is the heterogeneity in the level of commodity aggregation and differences in commodity definitions. Comparable data are not available for all countries. For instance, the presence of data about both income and consumption in the same survey should not be taken for granted for most of the countries. When both are present, they are not always of good quality.

## 5. Estimation and validation

Static models are usually estimated from cross-sectional data with the implicit assumption that the underlying dynamic process which has generated the observations of the cross-section has reached some kind of steady state or long run equilibrium. If the adjustment process is quick this assumption should not be a problem, but if the adjustment takes a year or more annual cross-sectional data will only show relations which are mixtures of the past but in general not equilibrium relations. This situation is usually characterized by unstable cross sections, and large policy changes will then tend to change the cross-sectional relations. Cross-sectionally estimated models then have little meaning. With reference to the two examples given above one might perhaps suggest that adjustments in the market for consumer goods are quicker than adjustments in the labour market. This suggests that it would make more sense to include a static consumption model in EUROMOD than a labour supply model.

It is usually emphasized that validation is very important. A policy analyst is not likely to put any faith in a model which is not able to reproduce what are considered facts and general knowledge. This is usually a nonexistent problem for a conventional static tax-benefit model without behavioural adjustments because if the tax and benefit legislation has been translated into computer code with sufficient detail and care that there is little to validate. However, if models for behavioural adjustments are added there is a validation problem. How would one go about validating a static behavioural model? Is it at all possible? The problem with the comparative statics of a static microsimulation model is that it does not give predictions for any specific time point or time interval, and thus, it is hard to know to what the predictions should be compared. Suppose, for instance, that a labour force participation equation is estimated from a cross section at the end of a long period of unchanged tax and benefit systems and a stable labour market. Then a major tax reform takes place. Is it a good idea to validate the predictions from this model by comparing with observed participation rates from the first, second, third, or later year after the reform?

2. See ***Sutherland (1997)***, Chapter 5.

## 6. Weighting and reweighting

Sampling weights are attached to each individual (or household) and in static microsimulation individuals and households do not change. The sample space is given. The introduction of behavioural response does not change this. Even if behaviour is such that it influences the value of variables which have been used to design the sample, it is of no consequence for the choice of weights in the simulation.

In static microsimulation one could pose two different questions to the model. One is what is the effect of a switch in policy regime for a given population of individuals? Another question is what is the difference in effect on two different populations of a given policy? In the first case one would thus use the same weights for both policy regimes. In the second case one would use two different set of weights but apply the same policy. In static microsimulation changes in the composition of the population is usually achieved by changing the weights. (There is of course an issue of the applicability of the estimated behavioural relations to the new population implicitly defined by the new weights.) In principle one could also ask a third question: what is the difference, say in income inequality, between policy 1 applied to population 1 and policy 2 applied to population 2? But it is not obvious that this is a meaningful question. Note that a static model does not give a prediction on the change in inequality from one year to another, not even if one changes the weights to account for changes in the population of this country.

## 7. Conclusions

By definition static models can be used for comparative statics. They can give answers to questions about the sign and relative magnitude of effects following policy changes. All questions related to the time sequence of events are beyond the scope of a static model. Although there are no conceptual problems with the comparative statics as such, the statistical inference of a static model does present conceptual problems. There is usually a lack of coherence between model and data. Is it possible to estimate a model which only describes steady states but not the process of gradual adjustment between two steady states from cross-sectional data or short sequences of data? Do the estimated parameters represent a steady state? The validation problem mentioned above is another side of the same coin.

These problems become small if the behavioural adjustment processes are quick. An area in which we believe adjustments are relatively quick is that of demand for consumer goods. This is thus a reason to consider the inclusion of a demand system in EUROMOD.

For the same reason it is probably not advisable to include models of processes which take a long time to have full effect although they might be highly relevant in studies of social exclusion. Examples are, retirement, migration, student finances and investments in human capital, fertility and family formation, etc. Transitions into and out of the labour force and between employment and unemployment could perhaps be counted in the same category. They all need a dynamic perspective which is better handled in a dynamic microsimulation model.

Dynamic models are based on the assumption that the probabilities of changing state, which have usually been derived from data from the recent past, are applicable to the time frame addressed by the model. Similarly, models of behavioural response to policy change (either static or dynamic) assume that the econometrically estimated relationships based on data from specific points in time can be applied to hypothetical new situations. In a European perspective, these difficulties are compounded by lack of comparable studies of behaviour across countries. Either new studies must be carried out, constrained in the short term to using available data, or results for one country must be assumed to apply in another. It is most unlikely that behaviour is consistent across Europe, given the wide variation in cultural, historical and institutional factors. While in principle it is possible to estimate new models which take these factors into account, this is itself another major project. Further problems occur in the European context if cross-border issues arise. This is of particular relevance to changes in consumption following changes in indirect tax but could also be an issue if labour mobility (or indeed, the mobility of capital) is thought to be affected by changes in policy.

Within a model which concentrates on modelling first round effects that can be estimated arithmetically within a static framework, it is possible to provide tools for the understanding of changes in individual incentives which, in some circumstances, may be expected to lead to changes in individual behaviour. Marginal tax rates and marginal effects of benefits are examples. Thus for example, if a policy change improves the incentives to work of a socially excluded group, this will be interpreted by EUROMOD as potentially improving the extent of social integration.

The problems of data availability and comparability and for some countries, weak research results, even in such well-researched areas as consumer demand and labour supply, imply that the inclusion of behavioural response in EUROMOD would become a major research project in itself. Rather than to attempt to do it for all EU countries a better research strategy is to start with a few countries with good data.

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## Data and code availability

Please contact the authors for information on data and code availability.

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