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Microsimulation

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IN A NUTSHELL:

Microsimulation is a quantitative method for estimating the expected impact of an intervention (e.g. the modification of a tax rate) and describing its effects (winners, losers, budgetary envelope, effect on inequality indicators). It is based on taking into account the characteristics of the target population (e.g. age, income, etc.) and modelling public policy effects concerning this population. Because of the diversity of situations that it makes it possible to integrate, this technique provides more precise and complete results than estimates based on average or aggregate reasoning of the representative individual type. Its development has been encouraged by the improvement in computing power and the increase in statistical information (surveys or administrative data). It is an essential tool for *ex ante* evaluation of the impact of public policies and can also be used for *ex post* evaluation.

Keywords: Quantitative method, modeling, static/dynamic microsimulation, demography, socio-fiscal policies, pensions

I. What does this method consist of?

Microsimulation is a method developed by research institutions or government agencies by modelling economic agents, mainly individuals or companies, for the purpose of evaluating public policies. It was developed to address the limitations of macroeconomic analysis, which relies on a single agent representative of the economy (Orcutt, 1957). The general principle is based on the representation of the economy as a collection of elementary units (e.g. individuals) with specific characteristics (e.g. age, marital status, family size, income). As opposed to modelling on the basis of an average individual, this approach allows for the measurement of variation among individuals and the modeling of changes in their situations.. For example, dynamic methods that model simulate the birth, aging, and death of individuals, which may be useful for assessing pension systems. Other models can study the effect of changes in taxes or social benefits on household disposable income. This is the purpose of socio-fiscal microsimulation. In other words, the microsimulator will use a variety of observed data and simulate changes in situations, unit by unit, either through deterministic relationships (if family benefits increase, households with children see their income increase) or probabilistic relationships (each year, children are born with a certain probability). Microsimulation is said to be dynamic if it incorporates phenomena such as demographic changes (ageing, fertility, mortality) or adjustments in different markets (employment, trade, etc.); it is otherwise said to be static.

Microsimulation relies on computer software to model the range of socio-economic situations. It uses dedicated statistical softwares (e.g. R or Python) to process both the individual data and to write the model itself. The model simulates situations based on observed variables and relies in particular on programming based on the legislation and how the criteria it sets affect individuals' variables (such as the age of retirement or the calculation of income tax). The current legislation is used as a baseline and the proposed reforms are modeled to evaluate their impact. In concrete terms, a microsimulation model is based on three building blocks: the subject matter, the data used and a "calculator", i.e. the core of the code describing the changes or effects of the socio-economic phenomena studied. In the typical framework of static socio-fiscal microsimulation, this allows, for example, for the simulation of the direct effects of policy changes in the form of aggregate total effects (the budget of a tax change, for example), the direct effects on households (such as the number of winners or losers as well as the average gains and losses) and the redistributive effects (as measured by changes in inequality indicators or the description of the populations concerned). More advanced models consider the behaviour of agents in response to simulated policies.

The initial principle of microsimulation methods dates back to the 1960s (Orcutt, 1960), but their development in the 1980s was mainly based on the widespread use of representative survey databases by statistical institutes and greater use of administrative data in quantitative evaluation methods in the 1990s. With the improvement in the power of computer calculations and access to a large variability of individual information, academic or administrative work has become more widespread since the 2000s. In the United Kingdom and the United States, and to a lesser extent in France, these tools have become established in the public debate, particularly in the context of the evaluation of pension systems or social and fiscal proposals, during budgetary debates for example.

Microsimulation techniques are established and recognised methods and deal with a wide variety of subjects: taxation and socio-fiscal transfers, pension systems, health expenditure and the health insurance system, environmental policies, employment and professional trajectories, educational choices, demography, dependency, etc.

II. How is this method useful for policy evaluation?

Microsimulation is commonly used for the ex-ante evaluation of socio-fiscal, educational or environmental reforms. Its results are used in impact assessments of laws or studies published by microsimulation teams. Microsimulation is based on the calculation, the "simulation", of fictitious situations. The core of the evaluation enabled by microsimulation is based on the comparison of counterfactual situations in the form of 'with or without reform'. The simulation of new legislation or of developments modified by socio-demographic changes makes it possible to compare two situations. To evaluate a tax change, for example, the model compares individual situations with and without the reform. By difference, it is then possible to estimate the gains and losses and to write down the totals (costs or revenues) and the associated distributions. The microsimulation estimates the population concerned: the better-off, pensioners, single-parent families, etc. The prospective scenarios can be numerous and thus provide both a decision-making aid for the legislator and an *ex ante* evaluation of public policies.

In France, ministerial departments use models to construct government policies. The Treasury Department uses the Saphir model for monetary social benefits and direct taxes such as income tax. The Direction de la Recherche, des Études, de l'Évaluation et des Statistiques (Drees), the statistical department of the Ministry of Health and Social Affairs, is developing several models, such as Trajectoire for pensions, OMAR for health expenditure, Autonomix for dependency or INES (co-developed with INSEE and Cnaf and freely available since 2016) for socio-fiscal policies. The Ministry of the Environment's Prometheus model, for example, studies the heating and transport expenditure of French households.

It is also a long-standing tradition of the economists of the Paris-Jourdan campus with the Sysiff model developed in the 1970s-1980s at the Delta laboratory (a predecessor of the Paris School of Economics - PSE), the contribution to the EUROMOD model used by Eurostat and various research laboratories in Europe, the tax simulator of Camille Landais, Thomas Piketty and Emmanuel Saez on which the general public book Landais, Piketty, Saez (2011) is based. Currently, the Institute for Public Policy (IPP) is developing the TaxIPP (social tax) or PensIPP (pensions) models. In the United Kingdom, for example, the budget is evaluated by an institute (Institute for Fiscal Studies) prior to debates in Parliament on the basis of microsimulation models. In the United States, the TaxSim model is developed by the National Bureau of Economic Research (NBER) and is accessible to researchers.

However, *ex post* uses of microsimulation are also possible. The principle is identical to the *ex ante* methods but they apply to public policies that are actually implemented. The advantage of this use is that it no longer requires assumptions to be made about the state of the economy; the simulations are then applied to observed data over the study period and the counterfactual situation is compared with the

actual situation. Ex-post microsimulation is the subject of studies in the socio-fiscal field, which is described in the following section.

III. Two examples of the use of this method: socio-fiscal policy and pension policy

The Ines model, which was co-developed by INSEE and DREES at the time, played an active role in the creation of the activity allowance (*prime d'activité*, individual allowance given to low wage workers) in 2016, as well as the active solidarity income (*Revenu de solidarité active* or RSA, allowance given lowest income households) in 2009. The first step was to design this benefit on the basis of the legislator's objectives. Numerous scenarios were calculated. Once the principle of the benefit and the target budget had been set, microsimulation was used to determine the amount of the scale, in this context the individual bonus, corresponding to the criteria. It is with these means that the impact study of the law is then drafted. Microsimulation has thus made it possible to construct the scale of a social policy.

Two cases of widespread use of microsimulation for policy evaluation are the study of the pension system (see Cheloudko and Martin, 2020) and that of socio-fiscal reforms (Fredon and Sicsic, 2020). On this subject, the Ines model team publishes an annual assessment of the past year's socio-fiscal reforms and draws up a redistributive balance sheet based on a precisely defined methodology (André et al., 2015). The most recent study (Buresi et al., 2022) states that “the new social and fiscal measures introduced in 2020 and 2021, once fully implemented, increase the standard of living of people living in metropolitan France by 1.1% compared to a situation without their implementation. The average gain is 280 euros per year per person: 240 euros for the 2020 measures and 40 euros for those of 2021. This increase mainly benefits the wealthier half of the population, which is particularly affected by the main permanent reforms implemented.”

In a similar exercise, the IPP and the OFCE published evaluations of reforms, *ex ante* in the context of the budget (Fabre et al., 2020) or sometimes *ex post* over a five-year period (Madec, Plane and Sampognaro, 2022). These analyses are often taken up in the public debate, whether in the media, with numerous press articles based on them, or in the context of parliamentary activity, with quotations in reports or in statements by political representatives. This is also the case for the reform of the taxation of wealth with the transformation of the solidarity tax on wealth (ISF) into a tax on real estate wealth (IFI), which has seen a debate on the population actually concerned by this reform and the amounts involved.

IV. What are the criteria for judging the quality of the mobilisation of this method?

The quality of a microsimulation method depends both on the quality of the underlying data and on the quality of the model used. The representativeness of the survey or the administrative databases ensures the external validity of the results, i.e. the capacity of the model to estimate the effects on the entire target population. The richness of the variables in the employment survey produced by INSEE, for example, allows representations to be made from different angles (activity status, diploma, etc.), whereas the fine granularity of the administrative data provides large samples in order to represent the results for specific populations (the wealthiest 1%, for example).

A systematic method of comparing model results with external sources guarantees the quality of the simulations. The Ines model is thus subject to an annual "validation" note. Each benefit and tax is compared to the real administrative aggregates. For income tax, for example, the number of taxable individuals, the total and the average amount are quality criteria for the simulations. Precise documentation and the availability of the source code in open format, i.e. accessible to all, are also a guarantee of transparency and therefore of the quality of a microsimulation model.

Finally, disparities may appear between the results of different models. The comparison of results, as well as the explanation of the differences, makes it possible to judge the advantages and disadvantages of the different models (André and Sicsic, 2020).

V. What are the strengths and limitations of this method compared to others?

The main strengths of microsimulation lie in the very reason for its creation: the models allow for the great diversity of individual situations. Writing legislation in an integrated way makes it possible to simulate 'detailed effects of policies whose rules depend on a large number of individual characteristics, very often non-linear, for example because of threshold or ceiling effects', such as housing benefits or income tax (Blanchet, 2020).

The main limitations are based on the exercise without equilibrium effects: the units in the models are assumed not to change their behaviour (especially in static models) or to interact other than through the limited assumptions of the model (demographic or pension choices in dynamic models). The assessments are thus described as "first round", i.e. they do not take into account macroeconomic closure effects (such as labour market effects) or behavioural responses (such as savings or consumption adjustments). Nevertheless, the inclusion of non-use of certain social benefits is sometimes taken into account in evaluations and in static models and thus constitutes an integration of household behaviour in relation to social and fiscal policies.

Some studies aim to take these limitations into account and integrate behavioural effects following the estimations of microsimulation models (Paquier and Sicsic, 2021) or second-round effects (André and Biotteau, 2021).

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