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Exploring EUROMOD: research, policy and teaching

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Resumen

This article provides an overview of EUROMOD, a tax-benefit microsimulation model for the European Union and explores its main uses for research and policy analysis and its great potential as a tool for teaching in the field of public economics. The article discusses the multiple functionalities of EUROMOD, including its ability to compute the effects of tax-benefit systems on household incomes and its use for the assessment of distributional, redistributive, and poverty impacts of tax-benefit policies. The article highlights how EUROMOD can be used for teaching public economics, including the use of training data, the Hypothetical Household Tool, and the EUROMOD Online simulator. The article concludes by emphasizing the potential of EUROMOD as an educational tool to enhance students' understanding of tax-benefit systems and their fiscal and distributional impact.

Palabras clave: microsimulation, EUROMOD, tax-benefit, redistribution.

Códigos JEL: A20, C88, H24, I32, I38

1. INTRODUCTION

Public economics is a branch of economics that focuses on applying modern economic theory and quantitative methods of analysis for the design and evaluation of economic policies, such as the design of national tax-benefit systems, its impact on government budget as well as its distributional impacts on households and other agents of the economic system. Teaching public economics involves focusing, among other topics, on understanding the whole tax-benefit system implemented within countries as well as identifying tools for the assessment of distributional, redistributive, and poverty impacts of existing, past, or prospective tax-benefit policies.

EUROMOD, a tax-benefit calculator harmonised across the 27 EU-countries, is a valuable tool that could be used to support teaching of public economics within universities as well as among professional researchers/public policy experts, especially supporting the development of practical hands-on and concrete activities complementing the understanding of economic theory. EUROMOD has more than 25 years of history: originally maintained, developed and managed by the Institute for Social and Economic Research (ISER) of the University of Essex, it has been fully internalised by the Joint Research Centre of the European Commission since 2021. EUROMOD provides a harmonised environment for research analysis by using a standard set of modelling conventions that guides the coding of the policy system of each EU country while also guaranteeing enough flexibility to be able to accommodate differences in tax-benefit systems across countries. Moreover, EUROMOD is an open source, freely distributed and a well-documented model with an extensive community of users.

In the following, we will first discuss in more detail about EUROMOD and its multiple functionalities in section 2, followed in section 3 by a specific description of the analyses that can be performed with EUROMOD. Section 4 focuses specifically on how EUROMOD can be used for teaching, including a description of the main tools and functionalities that are suitable for teaching purposes. A conclusion section follows.

2. WHAT IS EUROMOD?

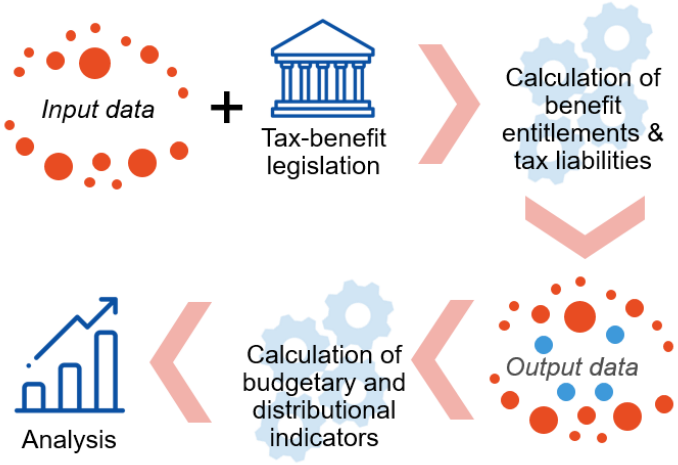
EUROMOD is a tax-benefit microsimulation model for the European Union that computes the effects of tax-benefit systems, and their reforms, on household incomes. EUROMOD is a fully harmonised model at EU level, and it enables researchers and policy analysts to perform analysis that are comparable across all 27 EU countries, as well as aggregate analysis at EU level. In practice EUROMOD is a sophisticated calculator that performs algebraic operations to compute tax liabilities, benefit entitlements and disposable income for each individual and household on representative population samples. Further, using the data processed at individual level, EUROMOD users can compute indicators that measure the distributional impacts of the tax-benefit system rules of each of the 27 EU country and for the EU as a whole. Figure 1 summarises the EUROMOD workflow.

EUROMOD includes tax-benefit policies of a country coded using the EUROMOD language. The input data used for the modelling, prepared using EU-SILC datasets[1], includes detailed information on various income components earned by each person, e.g. income from employment and self-employment, private pensions, income from capital, as well as socio-demographic characteristics. Starting from this, EUROMOD calculates and adds (or subtracts) the additional income provided to (or withdrawn from) individuals because of personal income taxes, property taxes, social insurance contributions and means-tested and non-means-tested benefits (family benefits, housing benefits, unemployment benefits, social assistance benefits, etc.).

The final dataset produced by EUROMOD includes the final disposable income for each individual, along their simulated taxes and benefits, and can be used for further aggregated analysis, as well as to evaluate the impact of changes in tax policy parameters (e.g. changes in tax rates) or more structural changes (e.g. changes in the requirements to obtain minimum income). Finally, EUROMOD allows to compute various aggregates regarding all types of taxes and benefits (revenue and spending) and distributional impacts (inequality, progressivity,

redistribution, and poverty) both for the entire population or specific groups without the need to use any specialised statistical software.

Figure 1. EUROMOD workflow



Source: Own elaboration

EUROMOD's functionalities have been also extended over the years through two types of tools, Add-Ons and applications. An Add-On is a versatile tool which allows for the modification of the default sequence of tax-benefit calculations performed by EUROMOD. The following additional functionalities are provided to the users via Add-Ons: (1) computation of effective Marginal Tax Rates, (2) computation of Net Replacement Rates, (3) now-casting by accounting for labour market adjustments, and (4) adjustments for tax compliance.[2]

The EUROMOD software also includes numerous applications which facilitate the analysis and validation of the microsimulation results. The EUROMOD software comes with two reporting tools that allow to easily compute budgetary and distributional indicators and compare baseline and reform scenarios: the Statistics Presenter, which computes a standardized set of distributional and aggregate statistics, and the In-depth Analysis tool, which is highly customisable to the needs of the analyst. Furthermore, the Policy effect tool (PET) allows the user to disentangle the effect of policy changes and changes driven by the underlying data. Finally, the Hypothetical Household Tool (HHoT) allows the user to produce their own input datasets with customised households, which can be then run in EUROMOD exactly like the EU-SILC-based data.

All the features mentioned above run on the EUROMOD software, programmed mostly in C# and specifically designed for microsimulation purposes. The software is not only used by the EU 27 model, but also by other country-specific models in the EU (BELMOD for Belgium), other European countries (UKMod for the UK) and the rest of the world. Regarding the latter, most of them lie under either the umbrella of SOUTHMOD[3] - model for the global south, managed by UNU WIDER - or LATINMOD[4] - for some Latin American countries.[5]

However, EUROMOD can be also linked to other models and software. Its ability to compute counterfactuals for changes in tax and benefit policies on a micro-level has been exploited by behavioural econometric models. Some examples are the estimation of labour supply responses (see e.g. Narazani et al., 2021, for JRC's in-house model EUROLAB), the estimation of the impact of tax-benefit reforms on macroeconomic variables (e.g. links to DSGE models like Quest, see Barrios et al. (2019) and impact of tax policy reforms on pensions and demographic issues (e.g. JRC's in-house EDGE-M3 model, see D'Andria et al. (2020).

Additionally, EUROMOD now features compatibility with various scientific programming languages and statistical software through the use of language-specific connectors. This means users can operate the model directly from their preferred programming language, without needing to access the EUROMOD user interface. The model operates directly on data stored in the memory of the respective tool, with EUROMOD's output microdata loaded back into the tool's memory. These connectors enable adjustments to EUROMOD tax-benefit parameters (e.g. tax rates, benefit amounts, etc.) and alterations to the input data, allowing for advanced policy analysis, optimal taxation exercises, integration with macroeconomic models, behavioural microsimulation and more. EUROMOD already offers support for Stata and will also offer connectors for MATLAB, Python, R and Julia.

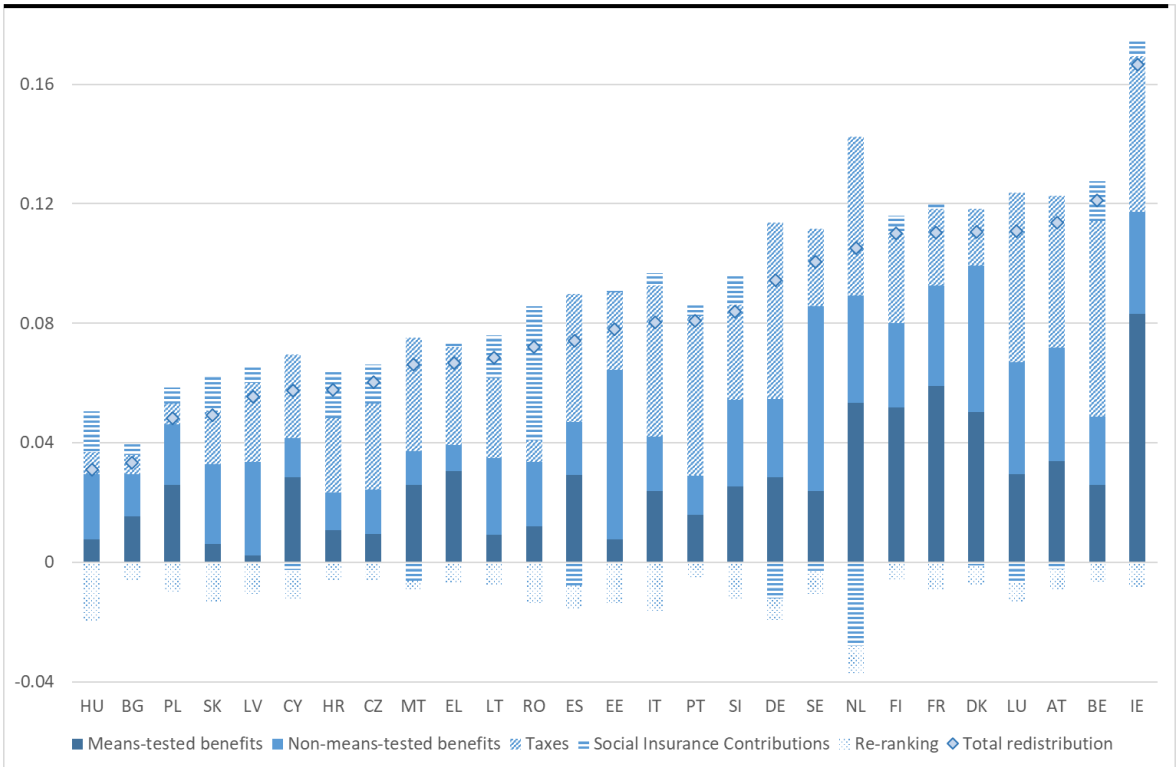
3. WHAT CAN EUROMOD DO?

EUROMOD finds application in diverse contexts. We can distinguish between more traditional uses of microsimulation models, and more advanced/new uses that were recently enabled by the development of new tools and applications included in or compatible with EUROMOD.

First, EUROMOD enables the assessment of the redistributive and poverty impact of existing, past, or prospective tax-benefit policies, offering insights into the economic and social effect of reforms. This is probably the most common use of EUROMOD, and questions like how an increase of a personal income tax rate or of a benefit amount affect inequality and poverty can be answered by EUROMOD. There are numerous recent examples of studies that focus on the redistributive and poverty impacts of specific tax-benefit policies either applied or proposed across the European Union Member States. For instance, the annual EUROMOD baseline report presents a selection of key inequality, distributional and poverty indicators derived from the most recent publicly available EUROMOD version.[6] As an illustration, Figure 2 offers a comparative decomposition of the redistributive effect of the tax-benefit systems across the EU.[7] It can be observed that countries with the most pronounced redistributive effect (situated on the right side of the figure) achieve this mostly through means-tested benefits, as seen in Ireland, France, Finland, and Denmark, and direct taxes, notably observed in Belgium and Luxembourg.

The European Commission also routinely uses EUROMOD to conduct analyses for selected reforms in Member States and present the results to underpin policy assessment in the European Semester country reports. During the last cycle, semester country reports included EUROMOD-based analysis for 10 Member States (European Commission, 2023a). For instance, EUROMOD was used to evaluate the impact of the new supplements for children in Spain, as well as the new employment activation system included within the national minimum income scheme on poverty indicators. The results of the simulation show that the two measures are expected to prevent poverty traps and reduce child poverty.

Figure 2. Redistribution of the tax-benefit system by component



Source: EUROMOD baseline report 2022 (De Poli et al, 2023), figure 4.

Additionally, policymakers and researchers might also be interested in the estimated fiscal effect of reforms. To this end, EUROMOD is also used to simulate the financial implications of proposed policy changes, helping to understand the governmental budgetary cost of tax and benefit reforms. For instance, OECD (2022) studies, using EUROMOD, the implementation of an intermediate Personal Income Tax (PIT) bracket in Lithuania as an option to increase revenues, while not increasing inequality. By incorporating a middle PIT bracket kicking in at the threshold of two annual Average Wages (AW) with three possible rates (24%, 26% and 28%), the anticipated increase in PIT revenues would be substantial (1.5%, 2.3%, and 3.2%, respectively).[8] Notably, EUROMOD can be used to understand who the main losers of this reform are. In this case, the primary contributors to this augmented revenue stream would be individuals within the top income quintile, particularly concentrated in the top decile.[9] Finally, it was also estimated that such reform would result in a moderate reduction in income inequality, as assessed by the S80/S20 ratio.[10]

Moreover, policymakers and researchers are sometimes interested in how effective policies existing in one country will be in another one. EUROMOD, thanks to its unique feature of using a harmonised modelling framework, allows to perform policy swaps, a type of analysis aiming at understanding the potential impact of adopting policies from other countries. These exercises are particularly valuable for comprehending the estimated effectiveness of national

policies from other countries on specific population of interest. For instance, Bargain et al. (2017) analyse the distributional effects of the Ecuadorean and Colombian tax-benefit systems by means of "swapping" the whole tax-benefit rules between the two countries, using microsimulation models for the two countries based on EUROMOD. The paper uses the EUROMOD-based models ECUAMOD and COLMOD, which are part of the SOUTHOMOD bundle. The findings highlight the limited redistributive impact of tax-benefit systems in Ecuador and Colombia, based on 2014 tax-benefit systems. The Ecuadorian system exhibits a higher level of redistribution compared to its Colombian counterpart. In hypothetical scenarios where the Colombian (Ecuadorean) tax-benefit system is applied to the Ecuadorian (Colombian) population, the Gini coefficient in Ecuador (Colombia) would rise (fall) by 1.9 (1.7) points. A decomposition analysis reveals that disparities in tax-benefit regulations contribute 1.8 points, on average, to the overall inequality difference between Ecuador and Colombia. Similar results are found for income poverty. These outcomes are attributed to the more generous and redistributive benefit system in Ecuador, which specifically target the elderly.

A strength of EUROMOD is that it allows comparable analysis among European Union countries. A common use of EUROMOD is to evaluate the performance of EU Member States policies and compare the situation and the impact of tax-benefit policies of certain socio-demographic groups across the EU. A recent study that supported the Child Guarantee Recommendation by the European Commission investigated how much EU countries spend on children through benefits and taxes (tax allowances and credits) and how that impacts child poverty. To this end, the authors of the study used EUROMOD to compare fiscal policies in households with children and in the same households where the children were hypothetically removed. The results show that the impact of child-related cash support on child poverty varies widely in the EU, from 4 to 16 percentage points poverty reduction; that over 60% of the total child cash support is received by non-poor households and that where the support is targeted at poor households, it is often not enough to lift them above the poverty line (Bornukova et al, 2024).

Other examples of EU-wide assessment of the tax and benefit systems are the timeliness analysis of the cushioning effect of the tax and benefit systems during the COVID-19 pandemic (Christl et al., 2023), the analysis of the budgetary and distributional impact of fiscal drag and benefit erosion caused by inflationary shocks which translate into wage increases the distributional impact of inflation (European Commission, 2023b) and the distributional assessment of the measures to compensate households for the recent rise in energy prices (Amores et al., 2023).

4. HOW CAN EUROMOD BE USED FOR TEACHING?

EUROMOD can be a valuable tool for teaching public economics to both undergraduate and postgraduate students. The model is open source, freely available for downloading. Although access to its underlying SILC-based microdata is restricted by Eurostat to individuals who have valid Research Project Proposals[11], a clause that excludes access to most undergraduate students, it comes with readily available training data. Those are synthetic microdata that can be used for teaching purposes for all countries. Training material, such as slides and exercises, is also freely available under a Creative Commons license.[12]

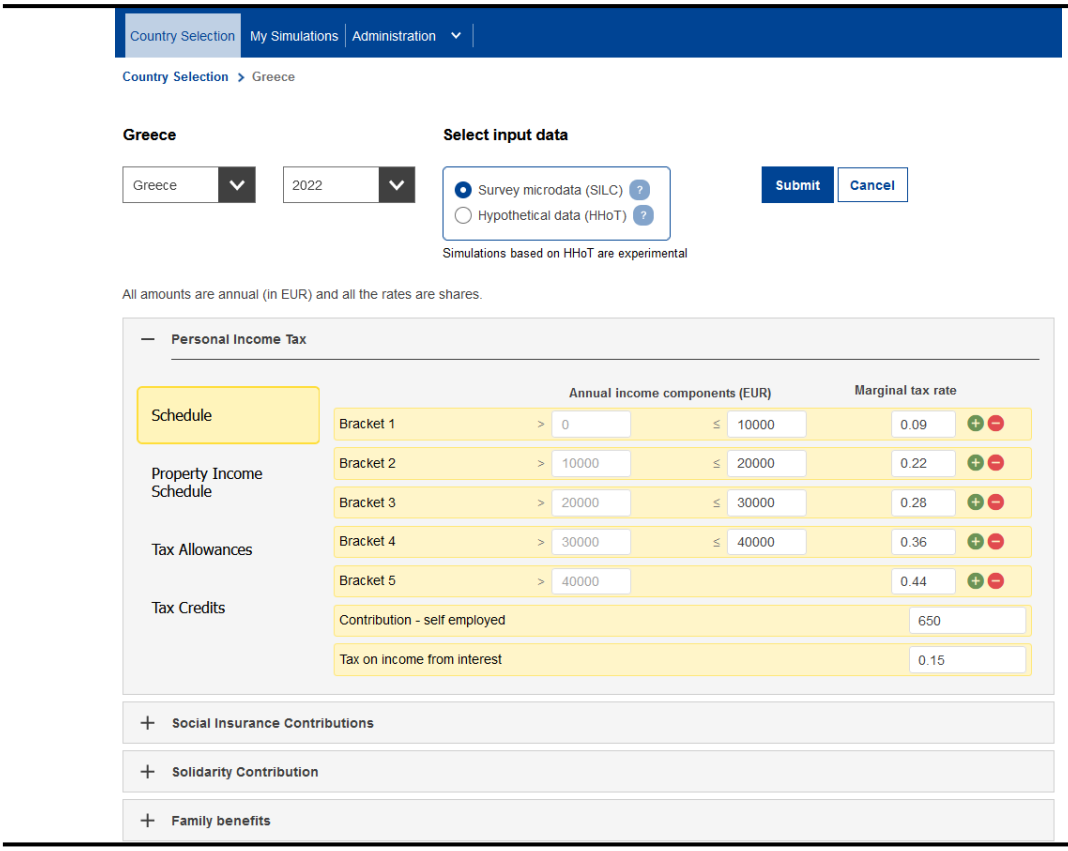
Apart from training data, EUROMOD calculations can also be run on hypothetical households that users can define with the model's built-in Hypothetical Household Tool (HHoT), mentioned in the previous section. HHoT generates customised datasets in the standard EUROMOD input format, accommodating a wide range of household compositions, labour market statuses and income sources. By allowing users to design their own hypothetical data, HHoT grants a deeper understanding of policy dynamics for households with specific characteristics, while providing full control over the variables of interest. The tool even allows for the creation of families that are identical in their characteristics, but with income ranges defined by users. This type of microdata does not offer a realistic representation of the income distribution of a country's population, but they allow for a clearer understanding of the effects of tax-benefit reforms on (specific) families, as they eliminate the complexity and noise present in real data.[13] Therefore, they are particularly suitable for calculating and teaching policy-relevant indicators such as average tax rates, marginal tax rates, tax wedges, etc.

A final way to circumvent the restrictions in accessing EUROMOD's SILC-based data is the use of EUROMOD Online.[14] This online simulator provides a simplified access to EUROMOD, with the objective of making it accessible to a wider audience. It allows for the use of EU-SILC-based data without the need to request authorisation from Eurostat, as users do not have direct access to the microdata, but only to the indicators that the tool produces. No software installation is required; users can simply modify the parameters provided by the interface, run the model, and download the results. The main limitation, but probably not very relevant for teaching purposes, is that it only allows for parametric changes for direct taxes, social contributions and (some) family benefits. For example, for Greece it is possible to change parameters of the personal income tax (rates, tax credits and tax allowances), social security contributions (employees, employers, self-employed, farmers and pensioners) and family benefits (see Figure 3).[15] The output of the tool is an Excel file with detailed fiscal and distributional indicators for the baseline system and the reforms designed by users.[16]

The teaching topics that can be explored with the help of EUROMOD vary widely. For instance, in the case of Greece the model was used to design a course for students in their final semester of their undergraduate studies ('Microsimulation Techniques for the Social Sciences', taught at the Athens University of Economics and Business).[17] Students were first introduced to the concept of microsimulation and the evaluation of the fiscal and distributional impact of tax-benefit policies. The latter is crucial and helps in the understanding of complex concepts and indicators, such as the at-risk-of poverty indicators (e.g. FGT indices), income inequality indicators (e.g. Gini, S80/S20, Atkinson index), indicators related to progressivity and redistribution (e.g. Kakwani, Reynolds-Smolensky) and indicators related to labour market incentives (e.g. marginal effective tax rates, participation tax rates).

As mentioned in the previous section, EUROMOD provides two built-in tools for obtaining such indicators: the Statistics Presenter and the In-depth Analysis tool. The Statistics Presenter generates fixed sets of statistics from EUROMOD output files, offering aggregates and distributional indicators for incomes, taxes and benefits, including inequality and poverty indices. The In-depth Analysis tool is an advanced version of the Statistics Presenter that offers a set of customisable tables for analysing tax-benefit reforms. Users can choose variables for analysis, breakdown variables, target populations and indicator parameters. Besides those two tools, EUROMOD results can be analysed using any available statistical software, such as Stata, R, Excel etc.

Figure 3. EUROMOD Online for Greece



Source: EUROMOD Online

After being accustomed to those notions, students can also start designing their own tax and benefit policies or modify existing ones. Examples of such modifications include changes in the design of the personal income tax, making it more -or less- progressive or flat, changes in tax credits and tax allowances, altering the rates of social insurance contributions, or changes in the design of benefits (e.g. introducing or abolishing eligibility criteria, making them more -or less- generous, etc.). Starting from parametrical changes, which are the most straightforward, students can gradually move towards designing more complex structural changes to tax-benefit policies, introducing EU-wide policies or doing policy swaps between countries, such as the ones discussed in the previous section.

Apart from the models of EU-27, EUROMOD comes with an additional "country" called Simpleland. This is a hypothetical country model, solely used for training purposes; it has a very simple tax-benefit system that users can experiment with, and enrich with new, innovative policies.

Another tool that can be proven useful for teaching purposes is EUROMOD's labour market adjustments add-on. The tool allows users to modify the labour market situation of individual observations in the input data. Individuals can, for example, transit from employment to unemployment and vice versa, as well as from employment to monetary compensation schemes, available during the COVID years. Intuitively, the tool modifies the values of specific socio-demographic variables of observations eligible for transitions (such as earnings, months

in work, labour market characteristics, etc.) in order to reflect their new labour market status. Students can thus understand how such changes affect the underlying income distribution, and indicators such as income inequality and poverty.[18]

The main 'teaching audiences' of the above-mentioned topics could be undergraduate students, typically at their final years of their studies. It could accompany the teaching of classes related to public/welfare economics, labour economics, microeconomics and social policy analysis or as a research tool for undergraduate theses. The model has also been frequently used for the writing of master and PhD theses.[19]

5. CONCLUSIONS

With more than 25 years of history, EUROMOD is a well-established scientific resource that has helped to bridge the gap between academic research and policymaking. This article attempts to highlight another aspect of this model that has been explored to a relatively lesser extent: its usefulness as an educational tool.

The model can offer students the opportunity to gain hands-on experience in simulating tax-benefit policies and analysing the impact of real or hypothetical policy reforms on different segments of the population. It can also be used to introduce them to complex economic concepts, such as distributional indicators, work incentives and labour supply effects, in a more straightforward way.

As EUROMOD continues to evolve and expand its functionalities, including the development of simplified online interfaces, compatible programming language-specific connectors and its use with hypothetical microdata, its potential for both policy analysis and educational purposes is greatly enhanced. Its continuous development and possible integration into academic curricula could further advance students' understanding of tax-benefit systems and their fiscal and distributional impact.

Notes

[1] Information about EU-SILC can be found at https://ec.europa.eu/eurostat/web/microdata/european-union-statistics-on-income-and-living-conditions. Retrieved 05/12/2023.

[2] Detailed information about these four add-ons can be found in the EUROMOD model documentation at https://euromod-web.jrc.ec.europa.eu/resources/model-documentation. Retrieved 05/12/2023.

[3] More information at https://www.wider.unu.edu/project/southmod-%E2%80%93-simulating-tax-and-benefit-policies-development. Retrieved 05/12/2023.

[4] More information at https://www.celag.org/publicacion/latinmod/. Retrieved 05/12/2023.

[5] Comprehensive information about EUROMOD-based models around the world can be found at https://www.microsimulation.ac.uk/euromod/models/. Retrieved 05/12/2023.

[6] The latest baseline report (De Poli et al., 2023) is available at https://publications.jrc.ec.europa.eu/repository/handle/JRC132899.

[7] For details on how the decomposition of the redistributive effect is calculated, please see appendix 5 in the latest baseline report (De Poli et al., 2023)

[8] Figure 3.10, Panel A.

[9] Figure 2.8, Panel B.

[10] Figure 3.10, Panel C.

[11] Detailed information can be found at https://euromod-web.jrc.ec.europa.eu/download-euromod#inline-nav-3 and https://ec.europa.eu/eurostat/web/microdata. Retrieved 05/12/2023.

[12] See https://euromod-web.jrc.ec.europa.eu/resources/training. Retrieved 05/12/2023.

[13] However, by creating households with heterogeneity in terms of demographic composition and incomes, it is possible to use HHoT with methodological purposes. The same applies to the training data offered by default with EUROMOD. Examples of methodological teaching-oriented papers where EUROMOD could be useful are Badenes Plá (2007) (on the measurement of poverty) and Bárcena-Martín (2011) (on the redistributive impact of flat taxes).

[14] Available at https://euromod-web.jrc.ec.europa.eu/info-euromod-online. Retrieved 05/12/2023.

[15] These parameters allow to assess the inequality-reducing impact of hypothetical or proposed parametrical reforms. See for example Ayala Cañón (2015) for a discussion on changes in progressive tax schedules to reduce inequality, which could be potentially assessed using EUROMOD Online.

[16] A potential field of application are survey experiments about knowledge and preferences on tax-benefit systems. After spontaneously giving their views, students can be confronted with the real impact of tax-benefit systems and potential reforms using EUROMOD Online. Treatment and control groups may be used, so that only some students have the opportunity to change their views after seeing the results (see for example Castellano et al., 2023, for an experiment on tax systems in Spain).

[17] Programme available at https://www-2.dept.aueb.gr/en/deos/content/microsimulation-techniques-social-sciences. Retrieved 05/12/2023.

[18] More details about the LMA add-on can be found in the EUROMOD model documentation, available at https://euromod-web.jrc.ec.europa.eu/resources/model-documentation. Retrieved 05/12/2023.

[19] Other relevant audiences include public policy practitioners working at ministries, research institutes and international organisations. For this kind of audiences, the JRC offers regular general training courses that run twice per year. They combine theory with several hands-on exercises on the main EUROMOD functionalities.

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