HERMAN DELEECK
CENTRE FOR SOCIAL POLICY

Tine Hufkens, Tim Goedemé, Katrin Gasior, Chrysa Leventi, Kostas Manios, Olga Rastrigina, Pasquale Recchia, Holly Sutherland, Natascha Van Mechelen, and Gerlinde Verbist

The Hypothetical Household Tool (HHoT) in EUROMOD: a new instrument for comparative research on tax-benefit policies in Europe

WORKING PAPER

No. 18.19

December 2018

Universiteit Antwerpen

University of Antwerp
Herman Deleeck Centre for Social Policy
centrumvoorsociaalbeleid.be

The Hypothetical Household Tool (HHoT) in EUROMOD: a new instrument for comparative research on tax-benefit policies in Europe

Tine Hufkens[1], Tim Goedemé[2], Katrin Gasior[3], Chrysa Leventi[3], Kostas Manios[3], Olga Rastrigina[4], Pasquale Recchia[3], Holly Sutherland[3], Natascha Van Mechelen[5], Gerlinde Verbist[6]

[1] Herman Deleeck Centre for Social Policy – University of Antwerp; European Commission, Joint Research Centre (JRC), Seville, Spain

[2] Corresponding author, Herman Deleeck Centre for Social Policy – University of Antwerp; INET and Department of Social Policy and Intervention – University of Oxford, tim.goedeme@spi.ox.ac.uk

[3] Institute for Social and Economic Research - University of Essex

[4] Organisation for Economic Co-operation and Development (OECD)

[5] Federal Public Service Social Security - Belgium; formerly Herman Deleeck Centre for Social Policy – University of Antwerp

[6] Herman Deleeck Centre for Social Policy – University of Antwerp

1. Abstract

This paper introduces the Hypothetical Household Tool (HHoT), a new extension of EUROMOD, the tax-benefit microsimulation model for the European Union. With HHoT, users can easily create their own hypothetical data, which enables them to better understand how policies work for households with specific characteristics. The tool creates unique possibilities for an enhanced analysis of taxes and social benefits in Europe by integrating results from microsimulations and hypothetical household simulations in a single modelling framework. Furthermore, the flexibility of HHoT facilitates an advanced use of hypothetical household simulations to create new comparative policy indicators in the context of multi-country and longitudinal analyses. In this paper, we highlight the main features of HHoT, its strengths and limitations, and illustrate how it can be used for comparative policy purposes.

JEL: [H20, D31, C88]

Keywords: HHoT, microsimulation model, hypothetical household simulations, European Union

Corresponding author:

Tim Goedemé, tim.goedeme@spi.ox.ac.uk

2. Introduction

In this paper, we introduce the **H**ypothetical **Ho**usehold **T**ool (HHoT). HHoT is an extension of the European tax-benefit microsimulation model EUROMOD that allows the user to generate hypothetical households with a wide range of characteristics in a flexible environment. These households can subsequently be used as an input database for EUROMOD to assess how tax-benefit policies work and interact with each other. Traditionally, EUROMOD is used for analysing the distributive, labour market and budgetary impact of tax-benefit policies and policy changes. To do so, detailed and representative data on persons and households are required. With the HHoT extension, users can create their own hypothetical data, which allows them to better understand how policies work for households with specific characteristics, while giving them full control over the characteristics of interest. This creates unique possibilities for an enhanced analysis of taxes and social benefits in Europe by integrating results from microsimulations and hypothetical household simulations in a single modelling framework. The flexibility of HHoT facilitates the simulation of a range of comparative indicators such as the marginal effective tax rate, the net replacement rate and unemployment or inactivity traps for a large set of hypothetical households in a comparative setting.

In what follows, we first briefly elaborate on the differences and synergies between microsimulation based on representative microdata and hypothetical household simulations in the context of analysing tax-benefit policies. Subsequently, we introduce the EUROMOD framework and the HHoT extension. In the third part we illustrate several ways in which HHoT can be used for policy analysis. This paper accompanies a paper by Gasior and Recchia (2018), which presents baseline results of HHoT for 2017 policies in the EU.

3. The complementarity of microsimulation and hypothetical household simulations

With hypothetical household simulations, also known as model-family analysis or standard simulations, the researcher specifies detailed characteristics of a limited set of households. In the case of tax-benefit simulation, these households and their specifications are used to compute the households' tax liabilities and benefit entitlements as well as detailed information on income components and total disposable income. In contrast to hypothetical household simulations, microsimulation makes use of representative microdata for which tax liabilities and benefit entitlements are computed, thus taking into account the full heterogeneity of household characteristics in the population.

EUROMOD is the cross-country tax-benefit model for the European Union, used by both academics and policy analysts. Many countries also have national models (e.g. IZAΨMOD for Germany, TAXBEN for the UK, FASIT for Sweden, etc.) (Li, O'Donoghue, Loughrey, & Harding, 2014). Microsimulation studies require the availability of (comparable) representative household microdata with sufficient information to assess tax liabilities and benefit entitlements. Such data have only been available since the late 1990s in many EU countries. The advantage of running microsimulation models on representative household data is the possibility to carry out distributional analyses, and to show the effects of tax-benefit policies and tax-benefit reforms on work incentives and government budgets (Li et al., 2014; Sutherland & Figari, 2013; Van Mechelen & Verbist, 2005). With regard to hypothetical household simulations, several databases have been created which contain for a limited set of hypothetical households tax-benefit simulations that span an extended time period and cover a wider range of countries. Examples include the CSB Minimum Income Protection Indicators database CSB-MIPI (Van Mechelen, Marchal, Goedemé, Marx, & Cantillon, 2011) and the Social Assistance and Minimum Income Protection Interim Dataset SaMIP (Nelson, 2013). The main drawback of these databases is that they contain information for a limited number of cases, and simulations are hard-wired: one cannot assess what would happen if the policy rules were changed. Furthermore, updating is typically done in a more ad-hoc way given that it is rather demanding to generate the data (see, for instance, Marx and Nelson (2013), for a more detailed description and applications of the use of these databases). An exception to these two limitations is the OECD Tax-Benefit Calculator, which is specifically designed to carry out hypothetical household simulations for tax-benefit policies, in a relatively flexible and user-friendly environment (e.g. Immervoll, 2010; OECD, 2014)[1].

Hypothetical household simulations have several strengths that make them an attractive tool for policy analysis. (1) Given that users can fully control the characteristics of hypothetical data, it is possible to generate indicators of the institutional functioning of tax-benefit systems that are independent of cross-national or longitudinal variations in population characteristics (e.g. regarding work incentives, benefit generosity, income adequacy, targeting, replacement rates, implicit equivalence scales), thus allowing for a purer comparative analysis of the institutional structure of tax-benefit systems. (2) For the same reason, it is possible to illustrate in an accessible way for very simple (or rather complex) households how tax-benefit systems operate and how policies interact with each other. This allows users to grasp more easily how tax-benefit systems (or potential policy reforms) work and facilitates the validation of tax-benefit calculations. (3) Given that users generate their own hypothetical households, it is possible to assess the functioning of tax-benefit policies when adequate representative household data are lacking. For instance, this applies to studying households that are too rare in household samples for a reliable statistical analysis (e.g. single-parent families with 3 or more children under the age of 7); to situations when very up-to-date simulations are required (representative survey data or register data typically become available with quite some delay); or when aspects of policies require variables which are unavailable in the dataset (e.g. on health or assets).

By their specific nature, hypothetical household simulations are not fit for distributive analysis and for drawing conclusions about the population as a whole (see also Immervoll, Marianna, and Mira d'Ercole (2004) for a discussion of some limitations of hypothetical household analysis). In other words, they do not show what the impact of policies or policy reforms are on poverty, inequality, budgetary effects, or overall labour market participation. This can only be done on the basis of representative household data (either through a sample or population data). Thus, microsimulation is required whenever researchers want to say something about the effect on a population, rather than

[1] See https://www.oecd.org/els/soc/tax-benefit-web-calculator/ (last accessed December 2018).

describing the pure institutional architecture of tax-benefit systems. It stands out, though, that in many cases hypothetical household simulations and microsimulations are complementary to each other. For instance, when studying the progressiveness of taxation it is useful to see how progressive personal income taxes are in relation to the population under study. However, given that results depend on the composition of the population under consideration, when comparing countries it is useful to complement such an analysis with an analysis of how different systems would perform for the same set of (hypothetical) households. Both approaches can also generate different indicators of closely related phenomena (e.g. hypothetical household simulations of the extent to which social assistance benefits reach the poverty threshold, jointly with a study of social assistance coverage and non-take-up). So far though, most comparative studies either make use of one approach or the other, rather than using them jointly in a synergetic way because models are either based on micro or hypothetical data. With HHoT integrated in EUROMOD, the same tax-benefit model can be used for both microsimulation and hypothetical household simulations, in a single framework, implying that it is much easier to combine the strengths of both approaches. It furthermore allows doing this in a comparative manner as well as analysing the effect of policy reforms rather than just the status quo.

4. The integration of hypothetical household simulations in EUROMOD

EUROMOD is both a software platform and the tax-benefit microsimulation model for the EU (Sutherland & Figari, 2013). From the beginning, the aim of EUROMOD was to develop an accessible model that facilitates comparative research. As a result, EUROMOD is characterised by a drive for comparable policy modelling and the use of largely comparable and detailed microdata (now mostly EU-SILC). Typically, the scope of the simulated tax-benefit policies is limited to parameters for which the household data provide sufficient information. Consequently, policies that require longitudinal information on contribution records are not simulated (in particular contributory pensions). The model is built and maintained by a group of researchers from universities, research institutes and ministries from all EU countries under the coordination of a team of researchers at the University of Essex[2].

[2] The European Commission is in the process of taking over responsibility for carrying out the annual update and release of EUROMOD. The transfer of responsibility is expected to be complete by the end of 2020 and the

Continuing support from the European Commission ensures regular updates of the model (policy rules) and the data (Sutherland & Figari, 2013). The cross-country comparability, the flexibility of the modelling software, the regular updates and the standardised validation of the model create an ideal setting to meet the increasing demand from users of hypothetical household simulations.

For many years, EUROMOD contained a very basic hypothetical household generator. However, it was not very flexible: there were strong limits on the extent to which household characteristics could be manipulated. To enlarge the possibilities of hypothetical household simulations with EUROMOD, the Hypothetical Household Tool (HHoT) was designed. The tool, based on the experience of experts in both microsimulation and hypothetical household analysis, was developed as part of the InGRID-project, an infrastructure project funded by the European Union's 7th Framework Programme (Hufkens et al., 2016). A first version of EUROMOD incorporating HHoT was released to the user community in December 2017, covering policies from 2009 up to 2017.

HHoT is a EUROMOD extension for generating hypothetical households. It can be accessed within the standard EUROMOD user interface under *Applications*. The user generates a EUROMOD dataset by specifying households and the characteristics of the household members. Once the households are generated, the dataset can be used within EUROMOD to simulate tax liabilities and benefit entitlements as well as detailed information on income components and total disposable household income for the hypothetical households. This EUROMOD output dataset can thereafter be analysed with software of the user's choice. By defining the group at risk (e.g. employed, unemployed, inactive) in the tool, HHoT follows a 'risk-type approach' for hypothetical household simulations: the user defines the characteristics of the households on the basis of generic assumptions, subsequently the simulation model 'decides' which policies are applicable (cf. Van Mechelen et al., 2011). When running the simulation model, the hypothetical households are considered as if they were real households in a microdataset. Thus, the user needs to make sure to specify the personal and household characteristics such that the hypothetical household is eligible for the taxes and benefits of interest.

---

transition is being facilitated by close cooperation between the University of Essex and the Joint Research Centre (JRC) of the European Commission as well as Eurostat. The EC intends to continue to provide the model and the software to its users.

The tool allows the user to specify the characteristics of households for all parameters that are used in the EUROMOD model. To make it more user-friendly, a distinction is made between standard and advanced variables. In the case of standard variables the user manipulates a limited number of characteristics and makes use of default values for all other variables. In the case of advanced variables, users have full control over all characteristics that are used in the simulations. The user can define in a flexible way the characteristics of the hypothetical households: in contrast to typical hypothetical household data or simulations, multi-generational households and complex household compositions can be generated and, there is no limit on the number of children. The possible employment statuses are employee, self-employed, unemployed, pensioner, student/pupil or preschool. All numeric variables (e.g. age, earnings or housing costs) can be specified either as a single value or as a range. When specifying a range, the same hypothetical household is reproduced for each value within the range while keeping all other characteristics constant. It is also possible to include a 'reference table' to specify quantitative variables as a percentage of a value in the reference table rather than in absolute terms. For instance, gross earnings can be specified as a percentage of the country and year specific minimum wage, the average wage or another reference wage. The tool allows users to include their own reference tables. Hypothetical households can be given recognisable names and can be saved for later use.

It is easy to run EUROMOD for the same set of hypothetical households simultaneously for multiple policy years and countries. As is the case for microsimulations, users have full control over the simulated policies and can decide to 'switch on' or 'switch off' policies, or simulate the effect of a policy reform or 'policy swap'. Furthermore, advanced users can revise the EUROMOD baseline by introducing new policy parameters and new policies that require data that are not available in the microdata, but can be taken into account when specifying the characteristics of the hypothetical households in HHoT. A user manual of HHoT is available online (EUROMOD, 2018).

Flexibility is a key characteristic of HHoT. This implies that users can easily create numerous hypothetical households (especially when specifying a range for more than one numeric variable) for several countries and years. Thus, it is essential to always assess whether the assumptions hold equally across countries or policy years. Previous validation exercises showed that, compared to other hypothetical household simulations (e.g. CSB-MIPI), results based on HHoT are not always the same, largely because of differences in the level of detail with which some policy measures are modelled (see Hufkens et al., 2016 and Marchal, Siöland, and Goedemé (2019)). The scope of HHoT is restricted to the overall scope of the modelled policies in EUROMOD. Especially regional or local policies are not modelled for all countries. As a user of HHoT it is therefore important to be aware of the extent to which policies are simulated in EUROMOD.

5. Potential applications of HHoT

The possibilities of policy relevant uses of HHoT are numerous. In this section we describe briefly four examples of how HHoT can create an added-value for the analysis of tax-benefit policies. In the first example we show how hypothetical household simulations can complement insights from microsimulations in the case of a simple policy reform. In subsequent illustrations, we only present results based on hypothetical household simulations, even though there could be complementarities with microsimulations. In the second example, we identify the gross wage level that is required to reach the level of the poverty line in a selection of EU-countries. This exercise makes use of the option to vary flexibly the range of gross income for each household member. Then we calculate implicit equivalence scales for children in four EU-countries, showing that with HHoT it is also very easy to change other household characteristics, such as household composition. In the last exercise we show the marginal effective tax rates for all EU-countries and explain some of the differences across countries and income levels.

Example 1: Combining microsimulation and hypothetical household simulations to measure the impact of a policy change

In Germany, like in many other countries, children in single parent families face a relatively high poverty risk (Eurostat, 2017; Lenze, 2014). Reforming child benefits (Kindergeld) can reduce the at-risk-of-poverty rate for families with children. We simulate a simple reform aimed at reducing child poverty in single parent families in Germany to illustrate how hypothetical household simulations and microsimulations can jointly help to design and understand policies. With the current child benefit system, the level of child benefit depends on the rank of the child in the family. In 2016, the level of the child benefit was 190 euro per month for the first and second child, 196 euro per month for the third and 221 euro per month for all other children. The benefit is paid to one of the parents. Apart from child benefits, families with children are entitled to a tax allowance for children. This allowance is only granted to parents if it is more beneficial to receive the tax allowance than the child benefit and is mostly relevant to higher income households. A third benefit that aims at improving the financial situation of families with children is the additional child benefit (Kinderzuschlag) The additional child benefit is, in contrast to the *Kindergeld*, means-tested. To be eligible to the additional child benefit, households also need to be eligible to *Kindergeld.* (e.g. Gallego Granados & Harnisch, 2017). In the reform that we simulate below, we focus on the design of the child benefits only. The reform scenario is budgetary neutral compared to the baseline.

In the reform scenario we abolish the current system based on ranks and replace it by a fixed amount for each child. Children in two-parent households receive 180 euro per month while children in single parent households are entitled to 248 euro per month. As illustrated in Table 1, we simulate the effect of the reforms for four different households, while varying the labour market status of the adults. In households with only one child, the child is 8 years old, in households with three children, the children are aged 5, 8 and 12. We first present the effect of the reform on the situation of households in which all adults work full time at the minimum wage, and subsequently on the situation in which all adult household members are inactive.

Table 1. Summary of hypothetical households used in example 1

<table>
<tr><td>Demographic composition</td><td colspan="2">Labour market status adults</td></tr>
<tr><td>Couple (2 earners) with one child (8 years)</td><td rowspan="4">Employee – full time at minimum wage</td><td rowspan="4">Inactive</td></tr>
<tr><td>Single with one child (8 years)</td></tr>
<tr><td>Couple (2 earner) with 3 children (5, 8 and 12 years)</td></tr>
<tr><td>Single with 3 children (5, 8 and 12 years)</td></tr>
</table>

The table below shows the effect of the policy change for the four hypothetical households in the case that adult household members are at work. From Table 2 it can be seen that the financial situation of single parent households improves after the reform while disposable income decreases in two parent households irrespective of the number of children.

Table 2. Net disposable income and different income components for four hypothetical households, minimum wage, 2016

	Two adults with 1 child		One adult with 1 child		Two adults with 3 children		One adult with 3 children	
	Baseline	Reform	Baseline	Reform	Baseline	Reform	Baseline	Reform
	Total	Total	Total	Total	Total	Total	Total	Total
Gross earnings	2,947	2,947	1,473	1,473	2,947	2,947	1,473	1,473
Total taxes	220	220	70	70	220	220	70	70
SIC employee	602	602	301	301	602	602	301	301
Means-tested benefits	0	0	0	0	0	0	410	410
Non-means-tested benefits								
Child benefit	190	180	190	248	576	540	576	744
Disposable income	**2,315**	**2,305**	**1,293**	**1,351**	**2,701**	**2,665**	**2,089**	**2,257**

Source: own calculations based on EUROMOD H1.0+ and HHoT.

Because child benefits are not taxed in Germany and the sociodemographic and labour market characteristics of the simulated hypothetical households are unchanged, Table 2 shows that the benefit reform does not interact with any other part of the tax-benefit system. However, this is not the case for all households. If we change the labour market status of adults in the hypothetical households from 'employee' to 'inactive'[3], there is an interaction between the non-means-tested child benefit and means-tested benefits. For all households illustrated in Table 3, the reformed child benefit does not result in a changed disposable income. The increase or decrease of the child benefit is fully compensated by a lower or higher unemployment II benefit. This shows how hypothetical simulations can help researchers and policy-makers to understand how tax-benefit systems operate and how policies interact with each other.

[3] This refers to people that are out-of-work but are able to work at least three hours per day. They are entitled to the unemployement benefit II.

Table 3. Net disposable income and different income components for four hypothetical households, inactive, 2016

	Two adults with 1 child		One adult with 1 child		Two adults with 3 children		One adult with 3 children	
	Baseline	**Reform**	**Baseline**	**Reform**	**Baseline**	**Reform**	**Baseline**	**Reform**
	Total	**Total**	**Total**	**Total**	**Total**	**Total**	**Total**	**Total**
Gross earnings	0	0	0	0	0	0	0	0
Total taxes	0	0	0	0	0	0	0	0
SIC employee	0	0	0	0	0	0	0	0
Means-tested benefits	1,096	1,106	861	803	1,082	1,118	886	718
Non-means-tested benefits								
Child benefit	190	180	190	248	576	540	576	744
Disposable income	**1,111**	**1,111**	**876**	**876**	**1,658**	**1,658**	**1,462**	**1,462**

Source: own calculations based on EUROMOD H1.0+ and HHoT

Tables 2 and 3 show the income components of some hypothetical households, illustrating the possible impact of the reform. Besides, they help researchers and policy-makers to grasp the effect on vulnerable groups that might be underrepresented in the microdata. As discussed earlier, hypothetical households do not show a representative picture of the population. Using a representative sample of the population we calculate the poverty effects of this reform. Table 4 shows poverty levels for the baseline and the reform and the difference between the two. Even though the hypothetical household simulations make clear that for some household types disposable income would be substantially increased, the overall (first order) effect on poverty in Germany is not significant. In contrast, the poverty risk of persons living in single parent households decreases significantly at the 90% confidence level, which was the objective of the reform. For persons living in households consisting of two adults and at least one child there is a small, but significant increase in the poverty risk. By taking better account of the interactions with other policies, as identified in the hypothetical household simulations, the effect of the reform could probably be strengthened. Even though we focused in this example on the impact on the level of disposable income and poverty, HHoT could also be used to assess other implications of a reform, such as the effect on marginal effective tax rates (for an illustration, see example 4; see also Gasior and Recchia, 2018).

Table 4. At-risk-of-poverty rate of persons living in Germany, by family type, 2016

	Baseline	Reform	Difference			
			change	Standard error	90% confidence interval	
					Lower bound	Upper bound
Population	15.15	15.19	0.04	0.04	-0.02	0.11
One adult with children	25.04	24.28	-0.75	0.44	-1.48	-0.03
Two adults with children	11.53	11.75	0.21	0.12	0.02	0.41

Source: own calculations based on EUROMOD H1.0 and EU-SILC 2014, full sample design information is not available. For estimating the standard errors and confidence intervals, we take account of clustering within households and the covariance between the simulated scenarios (cf. Goedemé, 2013; Goedemé, Van den Bosch, Salanauskaite, & Verbist, 2013).
Note: We use a fixed poverty line at 60% of the median equivalised disposable income in the baseline.

Example 2: How much should one earn to have an income above the at-risk-of-poverty threshold?

In the EU, the at-risk-of-poverty indicator is one of the headline indicators for monitoring poverty and social exclusion. Given that the threshold is set at 60 percent of the national median equivalent disposable household income, it may be difficult to grasp the kind of living standard that is feasible in each member state with an income at the level of the threshold (Goedemé et al., 2019). By using the flexibility of HHoT, it is relatively easy to identify at which wage level a household can have a disposable income at the level of the poverty threshold. This is helpful for further contextualising the at-risk-of-poverty indicator, i.e. to make clear what the implications are of using a relative poverty threshold specified in this way. Also, more information on the required gross wage level to reach the at-risk-of-poverty threshold could help to better understand quantitative analyses of (cross-country variations in) in-work poverty. The required wage does not only depend on the level of the poverty threshold, but also on the applicable tax liabilities and benefit entitlements.

The approach is very similar to first estimating budget constraints, and subsequently selecting the gross wage which corresponds with the relevant disposable household income (see Gasior and Recchia (2018) for HHoT baseline results for budget constraints in the EU). In a first step we calculate the 60%

at-risk-of-poverty threshold on the basis of EU-SILC, with net incomes simulated by EUROMOD[4]. In a second step, we use HHoT and EUROMOD to calculate the disposable income for hypothetical households earning a predetermined percentage of the average wage, which we vary between 60% and 200%. Average gross wages refer to 2014 and were downloaded from the OECD database (OECD, 2017). In a third step we identify the gross wage level which corresponds with a disposable income at, or just above, the level of the poverty threshold. As illustrated in the table below, simulations are carried out for a hypothetical single-person household consisting of a 35 years old male, working full time. The second hypothetical household is a married couple, 35 years old, both working full time. They have two children aged 5 and 8 years old. For the couple-household, we assume both partners are working, and we vary the gross income of both partners from 60% to 200% of the gross OECD wage (of which we imported a separate table in HHoT). Different combinations of the gross wages of both parents are possible; in this exercise we select the income that results in a total disposable household income closest to, but above the poverty threshold.[5]

Table 5. Summary of hypothetical households used in example 2

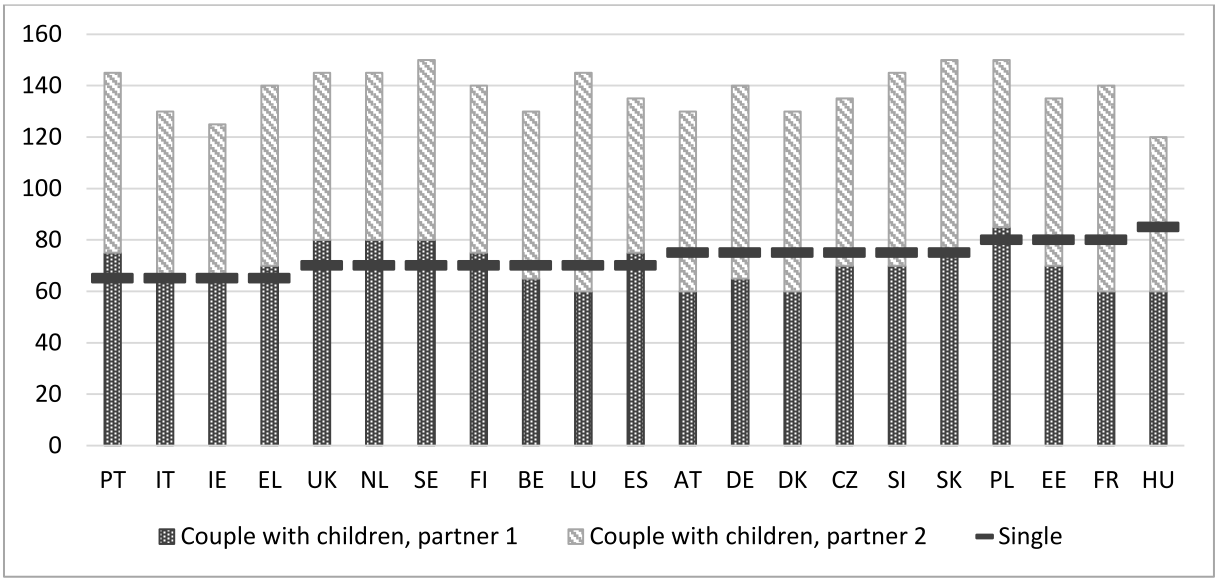
Demographic composition	Labour market status adults
Single	Employee(s), full time, wage varying from 60% to 200% of OECD average gross wage[6]
Couple (2 earners) with 2 children (5 and 8 years)	

Figure 1 shows the gross income, presented as a percentage of the average OECD wage, that is required to reach a disposable income at the level of the at-risk-of-poverty threshold in each country and for the two hypothetical households. In Poland, Estonia, France and Hungary a single person working full time requires a gross income of around 80% of the average wage or more to reach the threshold. In contrast, in Portugal, Italy, Ireland and Greece 60% of the gross average wage suffices to reach an income just above the poverty line. Despite the relative character of the poverty threshold,

[4] Please note that the computed poverty thresholds differ somewhat from those published by Eurostat, and the cross-national variation in this deviation depends on the size of simulation error. In this exercise, we preferred to keep consistency between HHoT outputs and the estimated threshold, both simulated with the use of EUROMOD.
[5] We assume both hypothetical households are renters, but, given that we only want to illustrate the approach, we do not include housing-related expenditures in the simulation (which may affect housing benefits and tax reductions).
[6] Although we show only one outcome, different combinations of the wages of both partners are possible.

this is quite a substantial difference. A similar observation can be made for two-earner couples (both working full time) with two children, even though countries score differently as compared to single-person households. While a single person in Hungary should earn about 85% of the average gross wage to reach the threshold, a couple with two children requires a total level of earnings of about 120% of the average gross wage. This variation is remarkable, given that the at-risk-of-poverty threshold of a household with two children is 2.1 times as high as the threshold for a single-person household. At the other extreme, in Portugal a couple with two children should earn about 145% of the average gross wage, while 65% of the average gross wage suffices for a single-person household. Obviously, the variation is the result of a different architecture of tax-benefit policies across European countries, affecting – among others – the implicit equivalence scale of tax-benefit policies, a topic to which we return in the next example.

Figure 1: Gross income, as a percentage of the gross OECD wage, for a hypothetical family, needed to reach the poverty line, 2014



Source: own calculations using EUROMOD H1.0+ and HHoT; poverty threshold and average wages based on EUROMOD calculations using EU-SILC.

Note: countries sorted from lowest to highest percentage of the gross average wage needed to reach a disposable income at the level of poverty threshold for a single-person household. The selection of countries is based on availability in EUROMOD and availability of the OECD average wage (for 2014).

Example 3: Implicit equivalence scales

Microsimulations based on survey data could show how the net incomes of persons living in different household types compare to each other and how, on average, the level and composition of incomes vary. However, these comparisons are limited by the fact that hours worked and wage levels tend to be partially determined by household composition. This implies that it is difficult to judge from these results alone how tax-benefit systems support different household types. For this reason, it can be revealing to calculate 'implicit equivalence scales' based on hypothetical data. This is done by expressing the disposable income of otherwise similar households as a percentage of the disposable income of a single-person household. This shows how policies work in their pure form, and can help to better understand, for instance, the distribution of poverty risks by household type. The calculations are similar to those done in the previous exercise, but now we compare more directly incomes between household types with a similar level of gross income. Further breakdowns can show how not only the level, but also the composition of net incomes differs by household type as a result of tax-benefit policies such that one can identify the policies that drive the implicit equivalence scales.

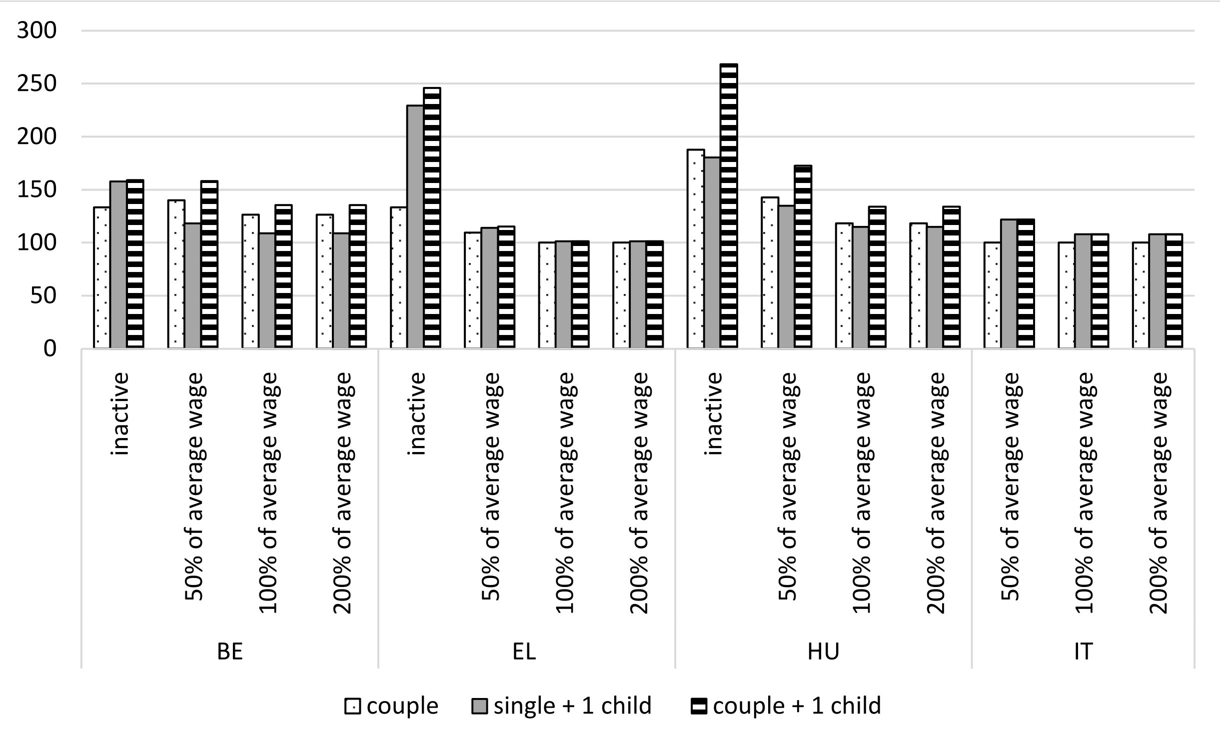
Table 6. Summary of hypothetical households used in example 3

<table>
<tr><td>Demographic composition</td><td colspan="4">Labour market status adults (one-earner families)</td></tr>
<tr><td>Single</td><td rowspan="4">Inactive</td><td rowspan="4">Employee, 50% of average EU-SILC wage</td><td rowspan="4">Employee, 100% of average EU-SILC wage</td><td rowspan="4">Employee, 200% of average EU-SILC wage</td></tr>
<tr><td>Couple</td></tr>
<tr><td>Single with a child of 10 years old</td></tr>
<tr><td>Couple with a child of 10 years old</td></tr>
</table>

We calculate implicit equivalence scales for hypothetical households living in Belgium (Flanders), Italy (Lombardia), Greece (capital region) and Hungary (capital region), and take account of the relevant regional policies. The household types included in the analysis in terms of demographic composition and labour market status are displayed in Table 6. For this exercise, the income ranges are based on the average wages calculated using the EUROMOD microdata files (based on EU-SILC).

Depending on the size of the households a minimum housing cost was included for each hypothetical household[7] (Van den Bosch, Goedemé, Schuerman, & Storms, 2016).

Figure 2. Net income for three household types expressed as a percentage of the net income of a single-person household with the same gross wage, but without children, 2014



Source: own calculations using EUROMOD H1.0+ and HHoT; average wage based on EUROMOD calculations using EU-SILC.
Note: the child in the households shown in the graph is 10 years old. An inactive person refers to a person that is not working and is not entitled to unemployment benefits. In Belgium and Hungary inactive persons are entitled to social assistance. In Greece there is a lump sum benefit for low incomes (social dividend) in 2014. In Italy there is no nation-wide social assistance. In Lombardia there is no minimum income protection scheme.

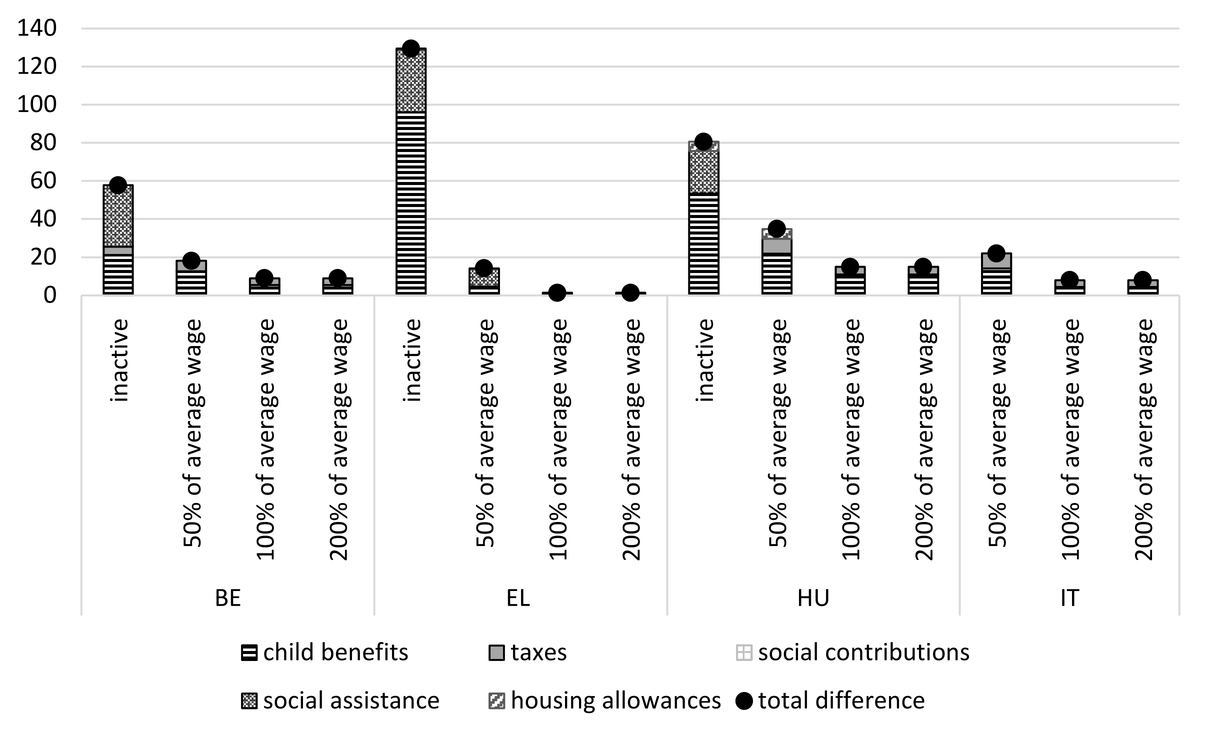
In Figure 2 we show the ratio between the net income of three household types and the net income of a single-person household without a child of 10 years old, having the same level of gross earnings. All households are one-earner households, one partner in a couple-household is inactive. With HHoT it is easy to make variations for more complex households, but we limit ourselves in this illustration to households with one child. First, when looking at differences within countries across different levels

[7] For this exercise we assumed that households are renting an apartment on the private market. We took the estimated housing costs from Van den Bosch et al. (2016), which correspond to those at the 30th percentile for adequate dwellings.

of earnings, it is clear that implicit equivalence scales are generally above 1 and higher for inactive persons and for households with lower wages[8]. This probably has a mitigating effect on poverty for multi-person households living on a low income. In contrast, in all four countries included in Figure 2, the implicit equivalence scale at 200% of the average wage is the similar as compared to households with earnings at 100% of the average wage. While in Greece and Hungary equivalence scales are higher for inactive households as compared to working households earning 50% of the average wage (both for adding a partner or a child), in Belgium the implicit equivalence scale for adding an inactive partner is lower than the scale for adding a partner in a working low-income household. Second, countries vary strongly in the level of implicit equivalence scales, and the ranking of the four countries differs substantially depending on the household composition under consideration. It is remarkable that in Italy adding a partner to a single-person household does not make a difference for the tax-benefit system, while adding a child does make a difference. For working families in Belgium and Hungary the implicit equivalence scales of the tax-benefit system are higher for an additional partner as compared to a child, while in Greece and Italy it is the other way around. This shows how the tax-benefit systems across the four countries result in different outcomes in the degree to which they support households with a different demographic composition. Apart from showing how these tax-benefit systems operate, more insight into implicit equivalence scales can also help to better understand varying patterns of poverty and inequality.

[8] When the labour status is inactive, EUROMOD\HHoT simulates full take-up of social assistance for hypothetical households. In Italy (Lombardia) there is no social assistance (Frazer & Marlier, 2015).

Figure 3. Tax-benefit package for a child in a single parent household, income components expressed as a percentage of the net income of a single-person household without children, 2014

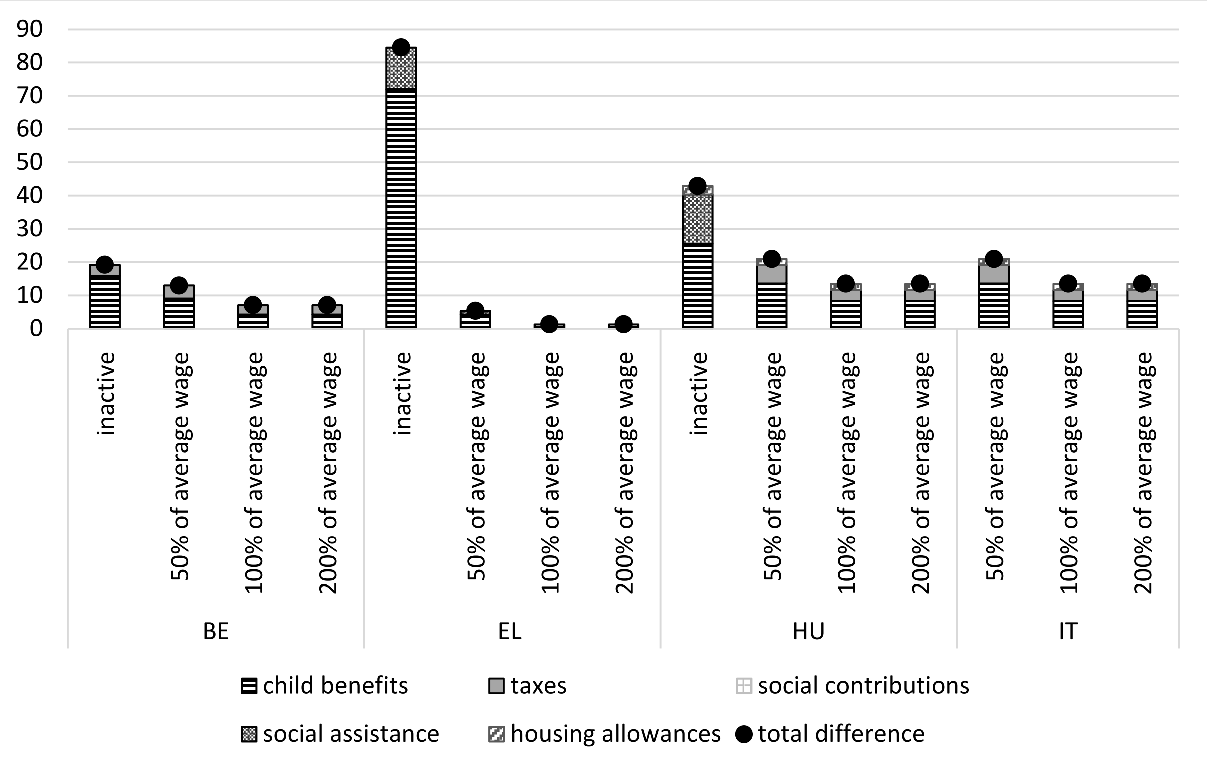


Note: Positive values for taxes and social contributions indicate that a household with a child pays less in taxes or social contributions, or receive higher tax credits.

Source: own calculations using EUROMOD H1.0+ and HHoT; average wage based on EUROMOD calculations using EU-SILC.

It is also interesting to see which part of the tax-benefit system contributes to the observed implicit equivalence scales. Therefore, in Figure 3 and 4 we describe the different income components that increase the income for a family with a child compared to a family without a child. More specifically, it shows the difference in the level of each income component (when adding a child), expressed as a percentage of the net income of a similar household without a child, at a similar level of gross earnings. Not surprisingly, child benefits tend to account for most of the difference, while social contributions are no different for households with a child as compared to those without a child. As an exception, for inactive households in Belgium and households earning 50% of the average gross wage in Greece the child-specific increase of the net income is mostly due to a higher level of social assistance benefits, especially for single-parent households: compared to single-person households the difference in social assistance in the tax-benefit package is much smaller for couples. Even though the contribution of personal income taxes is significant at higher levels of earnings (especially for couples with a child), it is relatively small, and non-existent in Greece. In Hungary the housing allowance also varies by household composition, resulting in higher benefits for households with a child.

Figure 4. Tax-benefit package for a child in a couple parent household, income components compared to the net income in a couple household without children, 2014.



Source: own calculations using EUROMOD H1.0+ and HHoT; average wage based on EUROMOD calculations using EU-SILC.

Example 4: Work incentives

Another area where hypothetical data can be of use is the analysis of work incentives. One way to look at tax-benefit systems is to analyse to what extent they encourage their workforce to take up a job (work incentive on the extensive margin) and to what extent they encourage to work/earn more (work incentive on the intensive margin). In this example, we focus on the marginal effective tax rate (METR) which measures the (dis)incentive to work/earn more, expressed as the share of an earnings increase that is taxed away due to higher employee social insurance contributions, higher taxes, or the loss of benefit entitlement. We assume a 3% earnings increase in our calculations using the methodological approach suggested by Jara and Tumino (2013). METRs take values between 0 and 100, indicating respectively high work incentives when individuals keep the full earnings increase and low incentives when individuals lose the full earnings increase. We visualise how different elements of the tax-benefit system react to the 3% earnings increase.

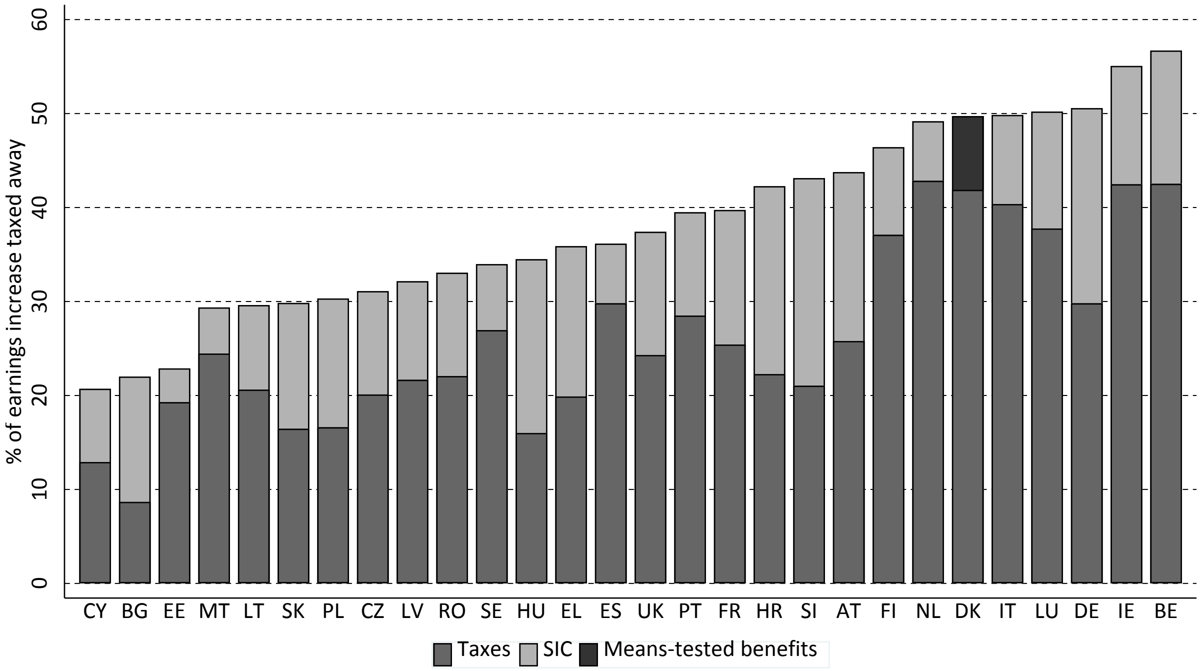
Table 7. Summary of hypothetical households used in example 4

Household composition	Labour market status
Single	Employee, full time with between 80 and 120% of the EU-SILC average wage (in 1% steps).

All results are based on a single-person household assuming full-time employment of 40 hours per week. Country-specific average monthly gross earnings levels are calculated using EU-SILC 2015 data and updated to 2017 using country-specific uprating factors (see Annex for estimated average wages and Gasior and Recchia 2018 for more detailed information). The person is assumed to live in rented accommodation with housing costs of 20% of the average gross earnings. As is the case for previous examples, we assume full take-up of benefits as well as full compliance in reporting incomes to tax authorities in all countries.

Figure 5 shows (unweighted) average METRs for earners with 80 to 120% (in 1 percentage point steps) of average earnings decomposed by taxes, social insurance contributions and benefits. The reason for averaging over 41 cases either side of the mean instead of using the example of an average earner is based on the sensitivity of METRs which can differ a lot between an average earner and someone earning slightly above or below average earnings. This is due to kinks in the tax and benefit schedule, where an earnings increase of 3% more can lead to a significant increase in taxes/SIC or the loss of tax credits or benefits in some countries. Thus, using the average METR of a certain earnings range produces results that are more in line with the actual situation.

Figure 5. Decomposition of average METRs at earnings levels from 80 to 120% of average earnings by income component, 2017 policy system



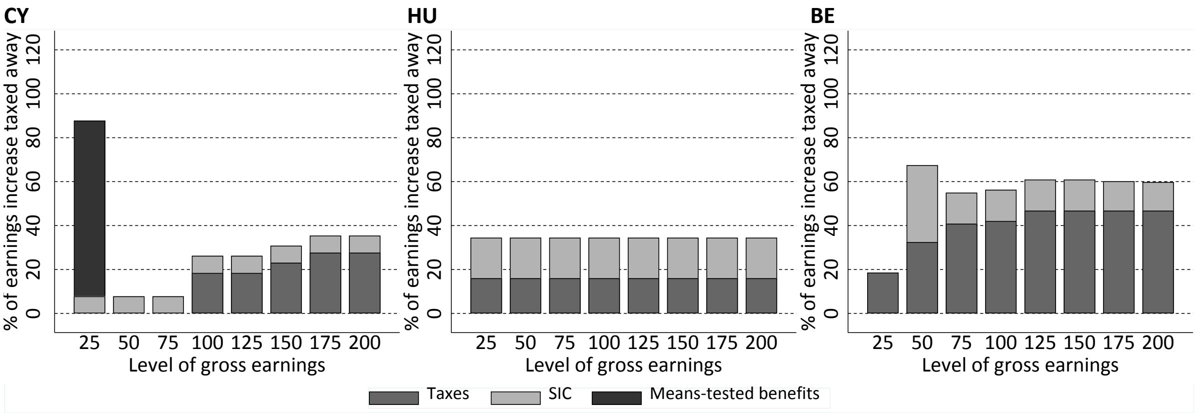
Source: own calculations using EUROMOD H1.0+ (Gasior and Recchia 2018).

Note: Countries are ranked by the percentage of marginal earnings increase taxed away. Policy system 2017 refers to the status quo on 30th of June 2017. Results are based on the assumption of full tax-compliance and full benefit take-up.

Across countries, increases in net earnings are lower than increases in gross earnings due to higher taxes and social insurance contributions. The incentive to earn more is very high in Cyprus, Bulgaria and Estonia, where only about 20% of the earnings increase is lost due to higher taxes and social insurance contributions. Belgium and Ireland are the countries with the highest work disincentives for earnings between 80 and 120% of average earnings. While taxes explain most of the overall level of METRs across countries, employee social insurance contributions play a similarly important role in Bulgaria, Hungary and Slovenia. Denmark is the only EU country where average earners are still eligible for means-tested benefits (housing benefit and green check) which are reduced when their earnings increase.

While this sheds light on how tax-benefit systems differ in their (dis)incentive to increase working hours/earnings, it is important to keep in mind that incentives can be quite different by earnings levels. We select three countries – Cyprus, Hungary and Belgium – to discuss such differences (see Figure 6). Cyprus represents the countries with the lowest METRs on average and Belgium the countries with the highest METRs (see Figure 5). Hungary represents a group of countries with flat tax system which leads to a quite different picture of METRs at different earnings levels.

Figure 6. Decomposition of METRs at different earnings levels in Cyprus, Hungary and Belgium by income component, 2017 policy system



Source: own calculations using EUROMOD H1.0+ (Gasior and Recchia 2018).

Note: Policy system 2017 refers to the status quo on 30th of June 2017. Results are based on the assumption of full tax-compliance and full benefit take-up. Level of gross earnings refers percentage of average gross earnings.

Results for Cyprus show relatively low METRs across all income levels except for people with very low earnings. This however corresponds to a very specific case in which the baseline earnings represent roughly the minimum wage and the 3% earnings increase leads to earnings above this level. While earnings below the minimum wage are disregarded from the income test for the Guaranteed Minimum Income (GMI), this is not the case for the earnings increase which leads to a slightly smaller benefit amount which creates a high disincentive to work more. All other income groups have incomes above the GMI and hence, are no longer eligible to receive the means-tested benefit. While the deducted SIC of the earnings increase amount to 7.8% of gross earnings across all income groups, only average and above earners are liable to income tax (which subsequently leads to higher METRs). The income tax paid for the earnings increase is progressive starting at 18% for average earners, going up to 28% for those with twice as high earnings. Nevertheless, METRs for everyone with earnings above the Minimum Wage are substantially lower than in other countries.

In Belgium on the other hand, incentives to work more hours are relatively low across the earnings distribution with more than 50% of the earnings increase being taxed away. Disincentives are especially high for those with 50% of average earnings due to the high contribution of SIC. While the contribution of the income tax increases relatively smoothly up to earnings levels of 125% of average earnings, the contribution of SIC to the METRs is highest for those with 45-70% of average earnings. This is due to the work bonus which has two parts. The first part is a reduction of SIC, the second part is a tax bonus for monthly gross earnings below € 2,510. Higher earnings lead to a lower work bonus and hence to a slightly higher income tax than before the earnings increase. In other words, when the work bonus is reduced, this reduction does not only apply to the increase in earnings, but to total earnings, which is why the METR is particularly high at this level of earnings.

The picture is quite different in Hungary due to the flat tax system. In relative terms, taxes and SIC deductions are the same across earnings levels (even for those with earnings below the minimum wage). Only certain household types (e.g. households with children) are eligible for tax allowances and are subject to lower deductions. In contrast to Cyprus and Belgium, low earnings are not exempted from contributions. This creates the same METR of 35% for all earnings levels. While increases in earnings are largely taxed away by the income tax system in Belgium and Cyprus, SIC play a relatively more important role in Hungary.

This example illustrates the usefulness of hypothetical household data for a better understanding of tax and benefit systems and their implicit work (dis)incentives. The selected country cases demonstrate different levels of METR and the contribution of different tax and benefit elements. It furthermore highlights the importance of taking different earnings levels into account rather than just focusing on average earnings. Even with this simple one-person household example, results are quite different by country and earnings levels. The possibilities to expand such analysis are unlimited by for example focusing on different household compositions and analysing the role of tax allowances and means-tested benefits for these households.

6. Conclusion

With HHoT, EUROMOD now includes a new tax-benefit hypothetical household generator that is freely accessible. The tool is unique in that it is very flexible, yet user-friendly, and – as part of EUROMOD – allows for comparable microsimulations and hypothetical household simulations in an integrated framework. Given that EUROMOD covers all EU Member States, for an increasing number of policy years, the tool has great potential to substantially contribute to (comparative) research in tax-benefit policies. In addition, EUROMOD is supported by a network of experts, responsible for regular updates and validations of the tax-benefit simulation model, ensuring the quality and timeliness of the simulations. In this paper, we introduced HHoT and described its potential for novel research in tax-benefit policies and for producing policy indicators. The uses and the advantages of the tool are manifold. HHoT can enhance tax-benefit analyses and studies of poverty and inequality with illustrations of how policies work and interact with each other in practice. It can also illustrate how proposed policy reforms and reform ideas would work and interact with other policies. Second, users can create (new) policy indicators that keep the composition of the population constant across time and countries, for instance on benefit adequacy and generosity, targeting, implicit equivalence scales and work incentives. By using HHoT and EUROMOD, a wide range of policy indicators can be generated on a timely basis and comparative manner for all EU countries. Thirdly, HHoT can be used to go beyond the possibilities of the microdata to study the operation and impact of policy parameters for which variables are lacking in the microdata or in cases where specific households are underrepresented in the microdata. An additional advantage for EUROMOD specifically is that HHoT helps to validate the model in a very detailed way and without any data constraints. Finally, it is also a valuable tool for introducing new users to EUROMOD and helping them setting the first steps in microsimulation modelling.

Undoubtedly, the main strengths of HHoT are the flexibility in defining hypothetical households and the ease with which comparisons across time and countries can be made. However, users should be aware that it is always necessary to reflect upon the validity of assumptions and the quality of the simulations made, especially in the case of comparative research, and not be tempted to jump all too quickly to (policy) conclusions. With this caveat in mind, we hope that users will quickly embrace the potential that HHoT offers to generate new insights into the functioning and impact of tax-benefit policies.

References

EUROMOD (2018). EUROMOD Hypothetical Household Tool (HHoT) – User manual. EUROMOD Technical Note 4.0. https://www.euromod.ac.uk/publications/euromod-hypothetical-household-tool-hhot-%E2%80%93-user-manual (last accessed February 2018).

Eurostat. (2017). Statistics by theme.

Frazer, H., & Marlier, E. (2015). *Minimum income schemes in Europe A study of national policies 2015*. Retrieved from http://ec.europa.eu/social/main.jsp?pubId=7882&langId=en&catId=738&furtherPubs=yes&:

Gallego Granados, P., & Harnisch, M. (2017). *EUROMOD Country Report Germany(DE) 2013-2017*. Retrieved from https://www.euromod.ac.uk/using-euromod/country-reports:

Gasior, K., & Recchia, P. (2018) The use of Hypothetical household data for policy learning - EUROMOD HHoT baseline indicators. *EUROMOD Working paper 6/18*: University of Essex.

Goedemé, T. (2013). How much Confidence can we have in EU-SILC? Complex Sample Designs and the Standard Error of the Europe 2020 Poverty Indicators'. *Social Indicators Research, 110*(1), 89-110.

Goedemé, T., Penne, T., Hufkens, T., Karakitsios, A., Bernát, A., Simonovits, B., . . . Storms, B. (2019). What Does It Mean To Live on the Poverty Threshold? Lessons From Reference Budgets. In B. Cantillon, T. Goedemé, & J. Hills (Eds.), *Decent incomes for all. Improving policies in Europe* (pp. 13-33). New York: Oxford University Press.

Goedemé, T., Van den Bosch, K., Salanauskaite, L., & Verbist, G. (2013). Testing the statistical significance of microsimulation results: A plea. *International Journal of Microsimulation, 6*(3), 50-77.

Hufkens, T., Leventi, C., Rastrigina, O., Manios, K., Van Mechelen, N., Verbist, G., . . . Goedemé, T. (2016). *HHoT: A new flexible Hypothetical Household Tool for tax-benefit simulations in EUROMOD*. Retrieved from Leuven:

Immervoll, H. (2010) Minimum Income Benefits in OECD Countries. (pp. 55). Paris: OECD Publishing.

Immervoll, H., Marianna, P., & Mira d'Ercole, M. (2004) Benefit Coverage Rates and Household Typologies: Scope and Limitations of Tax-Benefit Indicators. (pp. 91). Paris: OECD Social, Employment and Migration Working Papers.

Jara, H. X., & Tumino, A. (2013). Tax-Benefit Systems, Income Distribution and Work Incentives in the European Union. *International Journal of Microsimulation, 1*(6), 27-62.

Lenze, A. (2014). *Alleinerziehende unter Druck. Rechtliche Rahmenbedingungen, finanzielle Lage und Reformbedarf*. Retrieved from https://www.bertelsmann-stiftung.de/fileadmin/files/Projekte/Familie_und_Bildung/Studie_WB_Alleinerziehende_Aktualisierung_2016.pdf:

Li, J., O'Donoghue, C., Loughrey, J., & Harding, A. (2014). Static Models. In C. O'Donoghue (Ed.), *Handbook of Microsimulation Modelling (Contributions to Economic Analysis)* (Vol. 293, pp. 47 - 75): Emerald Group Publishing Limited.

Marchal, S., Siöland, L., & Goedemé, T. (2019). Using HHoT to generate institutional minimum income protection indicators. *EUROMOD Working paper 4/19*: University of Essex.

Marx, I., & Nelson, K. (Eds.). (2013). *Minimum Income Protection in Flux*. Houndmills: Palgrave Macmillan.

Nelson, K. (2013). Social Assistance and EU Poverty Thresholds 1990–2008. Are European Welfare Systems Providing Just and Fair Protection Against Low Income? *European Sociological Review, 29*(2), 386-401. doi:10.1093/esr/jcr080

OECD. (2014). *OECD tax-benefit models*. Paper presented at the InGRID Expert seminar 'Model family simulations of income policies: taking the next step with EUROMOD, University of Antwerp, Antwerp, Belgium.

OECD. (2017). *Average annual wages*. Retrieved from: https://www.oecd-ilibrary.org/social-issues-migration-health/data/oecd-employment-and-labour-market-statistics/average-annual-wages_data-00571-en
Sutherland, H., & Figari, F. (2013). EUROMOD: the European Union tax-benefit microsimulation model. *International Journal of Microsimulation, 6*(1), 4-26.
Van den Bosch, K., Goedemé, T., Schuerman, N., & Storms, B. (2016). Reference housing costs for adequate dwellings in ten European capitals. *Critical Housing Analysis, 3*(1), 1-9. doi:10.13060/23362839.2016.2.1.248
Van Mechelen, N., Marchal, S., Goedemé, T., Marx, I., & Cantillon, B. (2011). *The CSB-Minimum Income Protection Indicators dataset (CSB-MIPI)* (CSB WP 11/05). Retrieved from Antwerp:
Van Mechelen, N., & Verbist, G. (2005). Simulatiemodellen: instrumenten voor sociaal-economisch onderzoek en beleid. . *Tijdschrift voor Sociologie, 26*(1-2), 137-153.

Annex

Table A.1: Country specific 2017 average monthly earnings used in Example 4

Country	In EUR	In national currency
AT	3140.24	-
BE	3500.56	-
BG	601.72	1176.84
CY	1891.30	-
CZ	1024.31	27332.60
DE	3495.43	-
DK	4091.22	30425.57
EE	1363.38	-
EL	1412.15	-
ES	1965.41	-
FI	3167.61	-
FR	2730.09	-
HR	928.85	6913.83
HU	695.74	215012.62
IE	3984.27	-
IT	2251.91	-
LT	893.97	-
LU	4753.80	-
LV	1043.15	-
MT	1881.91	-
NL	3617.86	-
PL	912.65	3891.83
PT	1363.98	-
RO	479.33	2176.91
SE	3350.66	32152.29
SI	1539.31	-
SK	928.29	-
UK	4080.11	3526.11

Source: Own calculation based on EU-SILC 2015 (2014 for UK and DE) data and EM uprating factors and exchange rates.