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In-depth analysis of tax reforms using the EUROMOD microsimulation model

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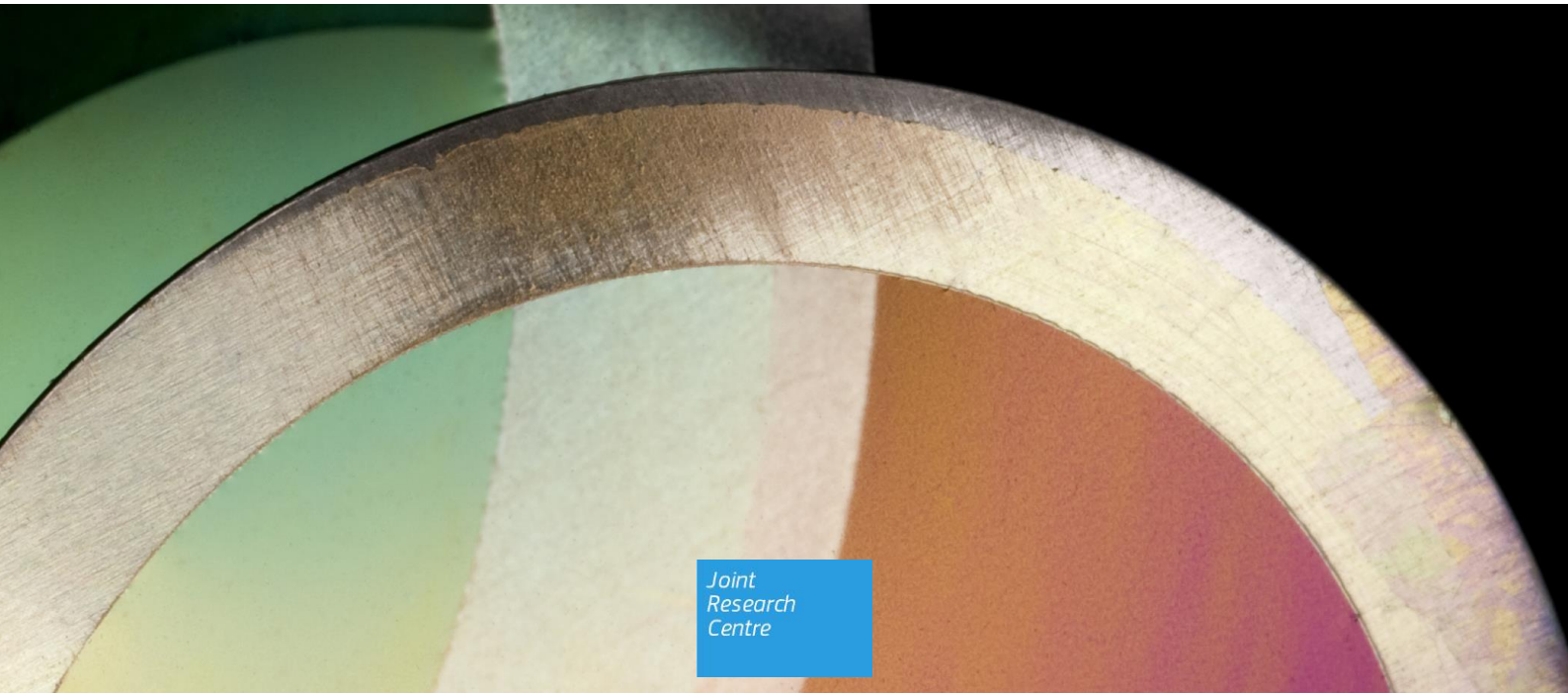

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Table of contents

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Abstract

In the aftermath of the financial and sovereign debt crisis, the need for a better understanding of the fiscal and equity implications of national tax policy reforms is greater than ever. National fiscal policies have a significant share in paving the way for economic recovery, fiscal consolidation and reducing looming inequality problems. The present work sets out a consistent framework for the in-depth country analyses of tax reforms using EUROMOD performed by the European Commission services in the context of the European Semester. Three examples of policy analysis are presented with the focus being on the provision of correct inferences alongside the typically analysed estimates and indicators.

1 Assessing tax reforms in the context of the European Semester

The present work offers a comprehensive and flexible framework for the in-depth country analyses of tax reforms provided by the Fiscal Policy Analysis Unit of the Joint Research Centre in the context of the European Semester.[1] The European Semester is the EU's annual cycle of economic and fiscal policy coordination and surveillance. Every year, the Commission undertakes detailed analyses of EU Member States' plans of fiscal, macroeconomic, and structural reforms and provides them with Country-specific Recommendations. These recommendations contribute to the Europe 2020 strategy, the EU's long-term strategy for jobs and growth, which is implemented and monitored in the context of the European Semester. The Member States align their structural reforms, fiscal policies, and measures to prevent macroeconomic imbalances with the objectives and rules agreed at the EU level.[2] The Fiscal Policy Analysis Unit contributes to this process by conducting *In-depth analysis of tax reforms using the EUROMOD microsimulation model*. The assessed tax reforms can be either hypothetical (e.g., reflecting a recommendation by the Commission) or actual (as announced in the National Reform Programmes) and feed into. The analyses feed into the Country Reports, which are the technical basis for the Country Specific Recommendation published in May.

A coherent and transparent treatment of the presented indicators and statistics will improve both the quality and the understanding of the respective notes. The work also provides the basis for a standardised reporting of standard errors and confidence intervals alongside the typically computed statistics to judge whether a policy change of interest has a significant impact in statistical terms. This requires knowledge of the underlying sample design of the input data used for simulation i.e., the sample designs of EU-SILC. Three examples of policy analysis are used to illustrate both the framework of analysis and how the sample design information may be used to provide accurate standard errors. The reforms are chosen in order to show different types of policy changes with different effects on revenue and expenditure, income distribution and poverty. The countries are chosen in a way to reflect the application of the three predominant sampling designs in EU-SILC.

The remainder of the paper is as follows. Section 2 introduces EUROMOD, the tax-benefit microsimulation model for the European Union. A standardised set of indicators for the in-depth analysis of tax reforms is proposed in section 3. Section 4 briefly describes the way in which complex sample designs affect standard errors. Section 5 provides three examples of in-depth country analyses following the

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[1] The work of the JRC Fiscal Policy Analysis Unit is presented here: https://ec.europa.eu/jrc/en/research-topic/fiscal-policy-analysis.

[2] More detailed information about the European Semester is provided here: https://ec.europa.eu/info/european-semester_en.

framework developed before. Appendix I shows the Tables with the results of the simulations for Austria, Denmark and Spain. Appendix II provides an overview of sample designs in the cross-sectional operation of EU-SILC 2012, which constitutes the current input data base of EUROMOD. A special focus is on the sampling designs of Austria, Denmark, and Spain for which examples of policy analysis are presented in Section 5. Appendix III focuses on subpopulation estimation. Appendix IV provides a Glossary with definitions of the most relevant concepts used in the policy analyses.

2 The EUROMOD microsimulation model

EUROMOD is a microsimulation model that encodes the tax-benefit systems of all EU countries, allowing researchers and analysts to assess the effects of the most relevant income taxes, social contributions and cash benefits on household disposable income. It is managed, developed and updated by the Institute for Social and Economic Research at the University of Essex in collaboration with national experts, and currently financed by DG Employment's European Union Programme for Employment and Social Innovation (EaSI).[3]

As most microsimulation models, EUROMOD applies a set of user-defined policy rules to representative micro-data of households and individuals. For all countries, it calculates income taxes, social contributions, family and housing benefits, social assistance and other income-related benefits on the basis of individual and household characteristics in the data. EUROMOD then outputs the results of the tax-benefit calculations as well as disposable income at the individual and household level. The hereby obtained micro-data are then analysed with respect to the initial policy question. EUROMOD encodes the policies and their corresponding parameters of the tax-benefit systems currently in force, and also those of recent years. Taking these systems as a benchmark, the user can change any parameter of the actual policies, and also remove them completely, create new ones or swap them between countries.

Importantly, EUROMOD captures the interaction inherent to many tax-benefit systems so that changes in one policy may affect eligibility for others. This feature is particularly relevant for the analysis of the fiscal and equity impact of tax reforms and is generally overlooked by macro-models. However, all EUROMOD simulations are carried out under a non-behavioural static framework i.e., EUROMOD does not simulate second-round effects that is, it does not estimate the behavioural response

[3] An extensive introduction to EUROMOD is provided by Figari and Sutherland (2013), which can be accessed on the EUROMOD homepage (https://www.euromod.ac.uk/). Examples of research using EUROMOD can be found in the EUROMOD Working Paper Series (https://www.iser.essex.ac.uk/research/publications/working-papers/euromod).

of individuals to a given policy change. Also, long-term policy effects are not addressed. These features are being currently being developed by the JRC.

The micro-data feeding EUROMOD are derived from the EU Statistics on Income and Living Conditions survey (EU-SILC), which is available in two versions: a cross-section and a longitudinal component. EUROMOD currently uses the cross-section version of the data. EUROMOD uses mainly information on personal and household characteristics, several types of income received by the individuals (e.g., market income, pensions or social transfers), certain expenditures (e.g., housing costs or life insurance payments), and other variables related to living conditions. Most taxes, contributions and benefits are simulated based on these variables. However, most contributory benefits (e.g., pensions as well as unemployment or disability benefits) are not simulated but taken directly from the EU-SILC data, given the lack of individual contribution histories that would be needed to simulate them.

Depending on the policy year of interest, EUROMOD uses input data from different years of EU-SILC. However, since not all EU-SILC cross-sections are available as input data, the latest available data set is used for simulation. Whenever there is no exact match between the policy year and the dataset, uprating factors are used to update monetary values to the year of the simulated tax-benefit system. Uprating factors are generally index variables taken from Eurostat or national statistical offices such as the consumer price indices, evolution of earnings and statutory adjustment rules for certain benefits. Demographic characteristics and labour market decisions of households and individuals remain unchanged.

In order to ensure macro validation, aggregates of simulated data are compared to corresponding estimates periodically provided by national tax authorities or by statistical institutes. Validation is done for both monetary and non-monetary variables as the number of households paying taxes and social security contributions or receiving different types of benefits.[4] EUROMOD results usually compare well to national estimates in terms of disposable income and revenue from personal income taxation, while estimates of social security contributions of the self-employed usually show the largest differences. One important reason for differences between simulation results and actual national aggregates is the assumption of full benefit take-up and no tax evasion, which is why simulations tend to overestimate both aggregate expenditures and revenues. For countries in which these issues are relatively more relevant and estimates currently exist, correcting factors are applied.

[4] The results of the validation exercise are included in the EUROMOD country reports, which are available at the EUROMOD homepage (https://www.euromod.ac.uk/using-euromod/country-reports). Country reports also contain background information on the tax-benefit systems, a detailed description of all simulated tax-benefit components as well as a general overview of the input data.

3 Output of the in-depth analyses

Table 1 provides an overview of the results reported in the in-depth analyses. These assess the budgetary and distributional impact as well as poverty effects of the tax policy changes of interest.[5]

Table 1: Output tables of EUROMOD-based simulations provided by the Joint Research Centre

Category	Table	Reported variables
Budgetary impact	**1. Aggregate revenue and expenditure**	PIT Total taxes SIC employee SIC employer SIC self-employed Total SIC Pensions Means tested benefits Non-means tested benefits Total benefits
	2. Personal Income Tax	Taxable income Total allowances Tax base Gross tax liability Total tax credits Net tax liability
Distributional effects	**3. Share of taxpayers/beneficiaries**	Share of taxpayers or beneficiaries, total and by decile
	4. Shares of affected households, winners and losers	Share of households affected by the reform, total and by decile, split in winners and losers
	5. Tax liabilities/benefits	Mean annual tax liabilities or benefits, total and by decile
	6. Equivalised disposable income	Mean annual equivalised disposable income, total and by decile
	7. Implicit tax rates on labour	Implicit tax rates on labour, total and by decile
	8. Inequality and redistribution	Gini coefficients of equivalised original income and disposable income
At-risk-of-poverty indicators	**9. At-risk-of-poverty for different poverty lines**	At-risk-of-poverty rates for different poverty lines
	10. At-risk-of-poverty for different groups	At-risk-of-poverty rates for different subgroups of the population

In terms of budgetary effects EUROMOD provides estimates of the total fiscal impact of a given reform. In addition to the overall budgetary effect, the interest is in analysing how this change comes about with regard to the interactions between

[5] Definitions of all concepts referred to can be found in the Glossary in Appendix III.

different taxes and benefits and across different parts of the structure of the modified tax or benefit. These fiscal interactions are built-in in the model and shown in Table 1. It lists the revenue obtained by taxes and social security contributions and the expenditure in the form of social benefits for the baseline and the reform scenario as well as differences between them. Each category is disaggregated with regard to its relevant components. All variables are standard EUROMOD variables except the split of total taxes, which may vary across countries.

For analysing PIT reforms, Table 2 disentangles the effect of the reform for different PIT components going from gross income to final tax liability, and thereby explains how the PIT revenue is attained. Given the usual complex structure of PITs, this table helps to understand how the different parts of the tax interact among them and shape the final result.

The distributional analysis compares the baseline and the reform system with respect to key variables of interest. The comparison is generally done with respect to population deciles, which are calculated at the individual level based on equivalised household disposable income. When assessing the distributional effects of a given reform, deciles may be calculated either for each of the scenarios (flexible deciles) or by fixing the deciles at the baseline (fixed deciles). The difference between both approaches relates to the re-ranking of disposable income after the reform. Re-ranking refers to the sorting of individuals according to their equivalised disposable income before and after the reform. If deciles are flexible, decile groups in both scenarios do not necessarily contain the same individuals because of re-ranking. The reform may only affect specific individuals or specific types of income. As a consequence, individuals may move up or down across deciles such that when comparing specific deciles before and after the reform, these do not necessarily contain the same individuals. Rather, with flexible deciles one compares groups of individuals that hold the same relative position before and after the reform. Flexible deciles offer "impersonal" measures of inequality and are consistent with comparing the Gini coefficients of the baseline to the reform scenario.

In contrast to this, fixed deciles anchor the decile membership of individuals in the baseline scenario, i.e. deciles are built only for the baseline and this classification is kept for the analysis of the reform scenario. Changes within deciles must now be interpreted as changes for specific individuals, i.e., in terms of what happens to individuals that were allocated to a specific decile before the reform. In the analysis of income measures, these fixed deciles offer "personal" measures of inequality, which are consistent with comparing the Gini coefficient in the baseline scenario to the concentration coefficient in the reform scenario sorted by baseline income i.e., before re-ranking takes place.

The analyses presented below make use of fixed deciles to assess the distributional effects of reforms. The reason for this choice is twofold: (1) the interpretation of the

results is more intuitive and (2) the "impersonal" measures of redistribution are already captured by the (also offered) Gini coefficients.

Tables 3 to 7 provide analyses for deciles. Table 3 shows the shares of taxpayers or beneficiaries by decile for both the baseline and reform scenario. Taxpayers (beneficiaries) are defined as households in which the sum of individual final tax liabilities (benefits) is positive. While identifying beneficiaries is straightforward because benefits can only be positive, for taxpayers this definition keeps out tax filers with negative tax liabilities. Nevertheless, this solution is proposed because it is consistent with the idea of identifying who bears the PIT burden, and also avoids comparability problems that may arise from the large variance in the role of refundable tax credits among countries.

Table 4 shows the share of households affected by the reform and distinguishes between winners and losers. Affected households are defined as households whose disposable income changes with the reform, winners as those whose disposable income increases with the reform, and losers as those whose disposable income decreases with the reform.

Table 5 shows mean PIT liabilities at the household level in the baseline and the reform scenario as well as their difference. The means are calculated for all households with non-zero final PIT liability in the baseline and/or in the reform scenario. This means that all households with zero final tax liability before and after the reform are excluded e.g., households without any income and households for which the non-refundable tax credits zero out the outstanding liability. Although legislation largely varies across countries, these households can be broadly identified with the ones who file a PIT return.

Table 6 shows how the tax relief (or increase) shown in AT.5 translates into changes of mean equivalised disposable income. This variable is chosen because it is the standard indicator for measuring the economic well-being of households. Since in general the objective is to measure the distributional impact of a reform on the whole population, these averages are calculated for all households.

Table 7 shows the implicit tax rate on labour for each decile and for the population as a whole. The rate is calculated as total taxes and contributions paid on labour divided by total labour costs (gross salary plus employer social contributions).

Inequality and redistribution indicators are reported in Table 8. Inequality is assessed by calculating the Gini coefficient of a variable of interest at the individual level. In this case the Gini coefficients of equivalised original income and equivalised disposable income are calculated, for both the baseline and the reform scenario. This shows how the tax-benefit system affects inequality and also allows comparing the inequality-reducing effect of the baseline and the reform scenarios.

Finally, the at-risk-of-poverty analysis is based on measuring the share of individuals that fall below a pre-defined poverty line. This line is usually defined as

60% of the baseline's median equivalised disposable household income. Since this line is actually a cut-off point, the discussion above on flexible or fixed deciles applies here. Again, fixing the poverty line facilitates interpretation and avoids counterintuitive results; therefore we chose it for this section.

Table 9 shows the at-risk-of-poverty rates for three different poverty lines, defined as 40%, 50% and 60% of median equivalised disposable income at the individual level, respectively, for a better understanding of the differential effect of a tax benefit reform on the lowest levels of income. For the 60% option, Table 10 analyses the differences in at-risk-of-poverty rates between subgroups of the population, for both the baseline and the reform scenario. This is of special interest when reforms focus on a specific subpopulation group. It allows the comparison of poverty rates between scenarios for each group (intra-group comparison) and between groups in each scenario (intra-scenario comparison).

4 Standard error estimation for complex sample designs

When analysing results of simulated policy changes by means of point estimates such as totals, proportions, or means, the primary interest is in knowing whether the alternative policy actually affects a certain outcome or social indicator of interest, or not. Assessing the reliability of estimation results is standard practice in sound empirical research, and is all the more indispensable when estimation results are used for policy evaluation and making (Osier et al. 2013: 1; Goedemé 2013a: 89). For instance, a reform may have a budgetary effect that appears to be economically relevant because of its size. Yet, if the observed budgetary difference is not statistically significant given the underlying sampling design, this result is not reliable in the sense that it may be due sampling variability. The budgetary effect of Danish reform summarised below provides an example of this. The judgement of statistical significance relies on the estimation of the standard error of the observed difference between baseline and reform scenario. The accurate estimation of standard errors requires considering "the entire procedure of drawing the sample and calculating the desired statistic" i.e., sample design, weighting, imputation, and the estimator itself (Goedemé 2013a, p. 91). Almost all sample designs applied in countries participating in EU-SILC are complex in the sense that they involve stratification and clustering in at least one stage of the sampling process, as well as weighting (Goedemé 2013a, p. 90). Stratification refers to the division of the target population in homogeneous, non-overlapping groups or subpopulations (strata) prior to the sampling of units (Heeringa et al. 2010, p. 31). Stratification can be based on geography or administrative borders (regions, states), individual characteristics (age, sex), socio-economic (income, wealth), or other criteria (municipality size). In multi-stage sampling designs, different stratification criteria may be applied at different stages of the sampling process (ibid.). Clustering refers

to the sampling of units, which are groupings (clusters) of smaller elements (Eurostat 2002, p. 13). For instance, households are clusters of individuals, classrooms are clusters of students, and municipalities are clusters of dwellings.

In order to compute standard errors for complex sample designs, only the first stage of the sampling design is taken into account, because the relevant source of sampling variability is introduced with the selection of primary sampling units from the previously defined strata (Goedemé 2013a, p. 92). This approximation requires first stage sampling fractions to be small, which is generally the case (Osier et al. 2013, p. 11). The approach is referred to as the ultimate cluster approach and it finds broad application in both applied survey data analysis in general (Heeringa et al. 2010) and the analysis of EU-SILC in particular (Goedemé 2013a).

As the accurate estimation of the sampling variance requires taking into account the underlying sampling design and weighting, the latter should be made by means of a set of well-defined design variables. Unfortunately, to date, this is not the case for EU-SILC, despite some recent improvements. In order to make the best of the available information, we follow the discussion of EU-SILC sample design variables by Goedemé (2010, 2013a, 2013b), who also provides users of EU-SILC with a set of sampling design variables for all countries that corrects for both within- and between-country inconsistencies.[6] The proposed framework of analysis makes use of this information in a standardised way. Appendix II provides an overview of sample designs in EU-SILC with the focus being on the sample designs applied in Austria, Denmark and Spain.

5 Country analysis

In order to illustrate the type of results and analysis that can be provided, three hypothetical policy reforms are considered: a reform of the personal income tax schedule of Austria, the phasing-out of a child benefit introduced in Denmark in 2014, and a removal of the joint taxation scheme in Spain. The reforms are chosen in order to show different types of policy changes with different effects on revenue and expenditure, income distribution and poverty. The countries are chosen in a way to reflect the application of the three predominant sampling designs in EU-SILC: Austria applies a stratified simple random sample, Spain uses a stratified two-stage sampling procedure, and Denmark applies a simple random sampling (see Appendix II for an extensive description).

The analyses are simulated with EUROMOD Version 1.12.9 and input data derived from the cross-sectional component of the EU-SILC operation in 2012 with the

[6] Goedemé (2010, 2013a, 2013b) offers a detailed description of the principles guiding the reconstruction of the design variables. The material is available via https://timgoedeme.com.

income reference period being 2011. The baseline scenarios in the analyses of Austria and Spain use 2015 tax-benefit calculation rules and uprating factors are applied to update income components to the policy year 2015. In the analysis of Denmark, the baseline scenario is 2013, the year before the reform of the child benefit was actually implemented. For Denmark, uprating factors update incomes to 2013.

5.1 Austria: A simple PIT reform

Personal income tax in Austria is levied progressively on an individual basis. Until 2016, the income tax schedule consisted of four brackets.[7] The tax base includes income from dependent labour, self-employment and pensions, as well as rental income.[8] We consider the case where the government wants to shift part of the tax burden from lower to higher income earners and it decides to do so by increasing the basic tax free allowance from currently 11,000 EUR to 12,000 EUR. The relief is partly financed by increasing the top tax rate from currently 50.0% to 55.0%.[9]

Table 2 summarises the PIT schedule in the baseline and the reform scenario, all else being equal.

Table 2: Simple reform of the PIT schedule, Austria

Baseline		Reform	
Taxable income	Marginal tax rate, %	Taxable income	Marginal tax rate, %
0 - 11,000	00.00	0 - 12,000	00.00
11,000 - 25,000	36.50	12,000 - 25,000	36.50
25,000 - 60,000	43.21	25,000 - 60,000	43.21
60,000	50.00	60,000	55.00

Notes. The tax brackets refer to annual taxable income in euro. Source: Art. 33 Austrian Income Tax Act for 2016.

Given the opposed effects of the two changes, the revenue impact of the reform is theoretically unknown, but given the usual right-skewed distribution of income the revenue-reducing effect of the change in the tax allowance should exceed the revenue-raising effect of the top rate increase. In contrast, the positive

[7] The income tax system underwent major changes that came into force as of January 2016. The new tax schedule consists of seven brackets. It squeezes the existing brackets and assigns lower rates with respect to the previous system. For both lower and higher incomes an entirely new tax bracket has been introduced.

[8] The current EUROMOD coding of the PIT tax base for Austria does not include rental income, because the underlying data are not sufficiently reliable.

[9] For simplicity, the reform is not designed to be budget neutral as this introduces complexities in the estimation of standard errors which are beyond the scope of this paper.

redistributional effect of the reform amongst taxpayers is clear because in relative terms higher income earners benefit less from the increase of the basic tax-free allowance than lower income earners. In addition to this, the increase of the top tax rate affects only high income earners.[10] Regarding poverty, we also know in advance that if we fix the poverty line in the baseline poverty will not increase (disposable income of the poor can only increase or remain constant).

Budgetary impact

Table AT.1 shows the budgetary effect of the reform, and shows how it affects the budget through two channels, via PIT (directly) and via means-tested benefits (indirectly). The PIT revenue reduction of approximately 1 million euro is due to the combined effect of the increase of both the tax free allowance and the top tax rate. The revenue reduction caused by the increased allowance outweighs the revenue increase caused by the higher top rate so that the net effect on the budget is negative. The reduction in social benefits is due to interactions between the tax and the benefit system. Some individuals lose eligibility for certain means-tested benefits because their disposable income after reform is higher than before the reform. In the present case, the eligibility for the unemployment assistance and the social assistance of Vienna is affected by the increase of the basic tax free allowance. Both the change in PIT and in social benefits is statistically significant but the confidence interval for the benefit reduction is quite large.

Table AT.2 disentangles the effect of the reform for different PIT components going from gross income to final tax liability, and thereby explains how the PIT revenue is attained. The significant decrease of the final tax liability is mostly driven by the reduction of the gross tax liability, which is a result of the changes in the tax schedule. However, the more favourable tax schedule also reduces the amount of deducted tax credits in the order of magnitude of EUR 77.75 million. The reason is that non-refundable tax credits can reduce gross tax liabilities at most to zero. Finally, the broadening of the zero-tax bracket also causes a slight decrease in total allowances (here a child allowance) that can be only applied by those taxpayers with positive taxable base.

Distributional effects

Table AT.3 shows the shares of taxpayers by decile for both the baseline and reform scenario. As of the fourth decile, the share of taxpayers is higher than 90%. In the first decile, 14% of the households have a positive final tax liability as the definition excludes households that do not file tax returns at all or that have non-positive liabilities after deducting tax credits. It is noticeable that the figures do not reach

[10] However, the lowest income households are not taxpayers and are not affected by any of the changes. This fact may decrease to some extent the redistributive effect of the reform. .

100% even in the top deciles. The reason is that some households receive types of income that are not taxed under PIT, like investment income (which is modelled as a separate tax in EUROMOD) or monetary transfers from other households. The increase of the tax free area decreases the share of taxpayers significantly up to the third decile. As of the fourth decile, the difference in taxpayers is not statistically different from zero.

Table AT.4 shows the share of households affected by the reform and distinguishes between winners and losers. The share of affected households increases across deciles because of the cumulative nature of the tax schedule. This is also why the share of winners exceeds the share of losers. The share of losers is largest in the tenth decile where the effect of the increased tax rate exceeds the relief from the increased tax free allowance. In lower deciles, net losers are households for which the increased tax free allowance results into a reduction of means-tested benefits.

Table AT.5 shows mean PIT liabilities at the household level in the baseline and the reform scenario as well as their difference. Average PIT liabilities increase across deciles, for both the baseline and reform scenario. For all deciles but the tenth the reform decreases the tax liability on average, being this reduction statistically significant. In the last decile, the higher top rate has a stronger effect than the increased tax free allowance such that the final tax liability increases on average by EUR 501. Overall, the tax relief is centred at lower income deciles, which is shown by the percentage differences at the rightmost column of AT.5.

Table AT.6 shows how the tax relief shown in AT.5 translates into changes of mean equivalised disposable income. As the average reduction in tax liabilities increases across all deciles apart from the tenth (AT.5), the average increase in equivalised disposable income increases across deciles but the tenth one. Although the percentaged tax relief is higher for lower deciles (AT.5), the percentaged change in equivalised disposable income is lower for lower deciles. The reason is that changes in PIT liabilities in those deciles are high in relative terms but small in absolute terms, so they do not have a high impact on disposable incomes, which are much higher in absolute terms.

Table AT.7 shows the implicit tax rate on labour for each decile and for the population as a whole. The rate increases across deciles both for the baseline and the reform scenario. The reform reduces the rate for all deciles but the top one, where the increase in the top rate has the strongest effect. All changes are significant, but the confidence intervals are narrower for reductions than for the increase.

Table AT.8 analyses inequality and redistribution. The comparison shows that both the baseline and the reform scenario roughly halve inequality from 0.5 to 0.26. The difference of Gini coefficients in the baseline and the reform scenario reveals that redistribution increases significantly through the reform.

At-risk-of-poverty indicators

Table AT.9 shows the at-risk-of-poverty rates for three different poverty lines (40%, 50% and 60% of median equivalised disposable income at the individual level). The rates vary from 1.25% to 13.28% in the baseline scenario, and the corresponding poverty lines from EUR 744.53 to EUR 1,116.80. Focusing on the 60% measure, before the reform 13.28% of the individuals had an equivalised disposable income below the poverty line of EUR 1,116.80. If the poverty line is reduced to 50% and 40% of the median, the effect of the reform on the risk of being poor decreases.

At-risk-of-poverty rates are also provided for different types of households, for both the baseline and the reform scenario. Table AT.10 shows that the reform has significant impact only on households with two adults (their rates decrease), while the rest of the groups show no significant changes (the confidence intervals include the zero) or no changes at all.

5.2 Denmark: Phase out of child family grant

Denmark has a child family grant (Børnefamilieydelse) that provides parents with quarterly amounts for each child they have.[11] The amount depends on the age group of the child and is adjusted annually according to the development of the consumer price index and consolidation requirements. Until 2013, all parents were entitled to the benefit. As of 2014, the benefit was made subject to an income test with a 2% phase out for taxable incomes falling in the top tax bracket. More precisely, for incomes above DKK 712,600, the benefit is reduced by DKK 0.02 for each additional DKK of income. For both married and unmarried couples, the income of the mother is used for the income test, irrespectively of whether she earns the income above the threshold or her spouse. If both parents' income exceed the threshold, the phase out is applied to the joint income above the threshold (Peterson et al. 2016, p. 15). For example, if a mother has one child and an annual taxable income of DKK 894,000 the amount of the child benefit equals zero. Table 3 compares the baseline and the reform scenario.

Table 3: Phase out of the child family grant, Denmark

Age group	Baseline	Reform
0-2 years	17,196	17,616
3-6 years	13,608	13,944
7-17 years	10,716	10,980
Phase-out	No	2% if inc. over DKK

Source: Ministry of Finance, Denmark.

[11] Lovbekendtgørelse Nr. 964 of 19 October 2011, http://www.skm.dk/skattetal/beregning/skatteberegning/boerne-og-ungeydelse-i-2016-og-2017, last access: 13 June 2016.

In order to isolate the effect of the reform, we use a copy of the 2013 tax-benefit system as reform scenario and implement only the reform of the child family grant as shown above, keeping all other taxes and benefits constant. The overall budgetary effect of the reform is not known a priori because the annual adjustment and the phase out work in opposite directions. The redistributive effect of the reform depends on how children are distributed across income levels. For instance, if children were uniformly distributed across incomes, the reform would have a redistributive effect i.e., reduce relative inequality because of the reduced amount for parents with higher incomes. The simulation results for Denmark are presented in Appendix I, Tables DK.1-DK.8. Finally, the at-risk-of-poverty rate should decrease, because poorer people are receiving higher benefits after the reform and they are not affected by the phase-out.

Budgetary impact

Table DK.1 shows that the reform has a direct budgetary effect. The total expenditure for non-means tested benefits increases by about 62.7 million DKK, although this difference is not significant at the 5% level. There are no indirect budgetary effects of the reform, which arise in the presence of interactions between the policy of interest and other taxes or benefits.

Distributional effects

Table DK.2 compares the share of households receiving the child family grant by deciles of equivalised disposable income in the baseline and the reform scenario. Before the reform, 22.75% of all households receive the benefit, with the share being highest in the sixth and seventh decile. As the phase out may reduce the benefit to zero given a sufficiently high taxable income of the mother, the number of beneficiaries decreases with the reform. Although overall this reduction is small (0.27 percentage points), it is entirely due to a decrease of recipients in the tenth decile (almost 3 percentage points) and both results are sigificant at the 5% level.[12]

The way in which households are affected by the reform is shown more precisely in Table DK.3. All beneficiaries in the baseline scenario are affected by the reform (22.75%), although in different ways. Households falling in the first, second, fourth, and fifth decile are affected by the annual adjustment only i.e., they receive a slightly higher benefit than in the baseline scenario. The remaining households are affected either by the annual adjustment only or by both the adjustment and the phase out. The net effect determines whether they are winners or losers of the reform. For instance, out of 20.46% of affected households receiving the benefit in the tenth decile, roughly half (10.34%) are net losers i.e., they face a reduction of

[12] Note that, the table does not identify families for which the benefit amount is reduced due to the phase out (see DK.3 for this case), but it shows those that entirely lose eligibility for the benefit given the income test.

the benefit because the effect of the phase out exceeds the one of the annual adjustment.[13] As shown in Table DK.2, only in the tenth decile some households do entirely lose eligibility for the benefit in the presence of the phase out.

Table DK.4 shows the average amount of the child family grant in the baseline and the reform scenario as well as the difference between both for all households that receive the grant in the baseline scenario. As a result, the population of recipients referred to in the reform scenario includes not only households whose benefit is reduced due to the phase out, but also those households that lose it entirely and hence have a benefit amount equal to zero. In all deciles but the tenth, the benefit amount increases on average with the difference being statistically significant. In the tenth decile, the difference in means is negative and significant. Overall, the reform has a positive net effect on the amounts received but this effect is insignificant.

Table DK.5 reports the mean equivalised disposable income before and after the reform for the entire population i.e., regardless of the eligibility for the child family grant.[14] Overall, the difference in mean equivalised disposable income (DKK 12.53) is statistically insignificant, which is in line with the result for the budgetary effect, and the overall change in the amount received. However, the differences are significant in all deciles. In the tenth decile, the average loss in the amount of the benefit received (DKK -4,064 in Table DK.4) corresponds to an annual decrease in equivalised disposable income in the order of magnitude of DKK 388.54 in this decile.

By confronting the Gini coefficients of equivalised original income and disposable income in a given scenario, Table DK.6 shows the degree to which the tax-benefit system reduces inequality. Both the baseline and the reform system reduce inequality significantly by about 0.21 points. The difference in Gini coefficients of equivalised disposable income in both scenarios is also significant: the combined effect of the annual adjustment and the introduction of the phase out reduces inequality in equivalised disposable income by about 0.0004 points.

At-risk-of-poverty indicators

Table DK.7 shows the at-risk-of poverty rates for poverty lines fixed at 40%, 50%, and 60% of the median equivalised disposable income in the baseline scenario, respectively. For all three measures, identical results are obtained for both scenarios. Hence, in aggregate terms, the reform does not affect the risk of being

[13] It seems counterintuitive that a household in the third decile faces a net negative effect, while households in the fourth and fifth deciles may not. The reason is that the income test considers the income of the mother only, while deciles are based on equivalised disposable income, which may contain negative income components of the spouse.

[14] However, changes in equivalised disposable income are the result of this reform only, as all other policies are held constant.

poor. This may seem counterintuitive given that poor households with children are better off with the reform (due to the adjusted benefit amount) and poor households without children are not affected. However, the average increase of the benefit is small (Table DK.4 reports an average increase in the first decile of DKK 552.47 annually, which correspond to EUR 74.19) such that the change in equivalised disposable income is not sufficient to make any household 'jump' over the poverty line.

For the 60% poverty line, Table DK.8 shows the differences in at-risk-of-poverty rates for children and adults. Again, for both subgroups, the reform does not affect at-risk-of-poverty rates. However, in both scenarios, the poverty rate of children is significantly smaller than of adults, which is the result of this and other child benefits: if all available child benefits were switched off, the difference in at-risk-of-poverty rates would not be significant anymore i.e., children would be as affected by poverty as adults.

5.3 Spain: Removal of joint taxation

The Spanish personal income tax system offers married couples the possibility to submit their tax returns either individually or jointly. Under joint taxation, both incomes (there is no income splitting) as well as personal and family allowances are pooled. This means that under joint taxation allowances take account of the personal and family circumstances of both spouses (dependent children, parents, disabilities), while under individual taxation every taxpayer applies only half of the child allowances plus the allowances corresponding to his or her personal situation. Under joint taxation, an additional allowance of EUR 3,400 is granted.[15] As a consequence, joint taxation is preferable for couples in which one of the spouses earns no or a low income, so that the reduction in the tax liability caused by the higher allowance overcompensates for the increase caused by the application of the progressive schedule to the pooled income.[16] Table 4 summarises the baseline and the reform scenario.

[15] The remaining rules are common to both types of taxation, except some minor differences whose effect is negligible in our simulation.

[16] For the simulation, we use 2015 tax-benefit rules as the baseline scenario, which implies that married couples choose the most convenient option i.e., EUROMOD calculates both options and selects the one where the tax liability is lower. In the reform scenario, we drop the option of joint taxation by assigning the tax liability of the individual option to all taxpayers.

Table 4: Removal of joint taxation, Spain

	Baseline		Reform	
Type of taxation	Individual	Joint	Individual	Joint
Taxable income	Individual	Pooled	Individual	n/a
Personal and family allowances	Characteristics and individual circumstances	Characteristics and circumstances of the spouses	Characteristics and individual circumstances	n/a
Joint taxation allowance	n/a	EUR 3,400	n/a	n/a
Applied to	unmarried taxpayers, married taxpayers opting for individual taxation[a]	married taxpayers opting for joint taxation[b]	all taxpayers	n/a

Source: Art. 82 Law 35/2006, of November 28, 2006, Spain. a. Disabilities, dependent parents, half of the dependent children allowance. b. Disabilities, dependent parents, dependent children allowance.

The expected effects of the reform are as follows. Government revenue is expected to increase because married couples that opted for joint taxation before the reform will face higher tax liabilities afterwards whereas other taxpayers remain unaffected. Consequently, if this change is economically relevant, anchored poverty will increase, because the disposable income for those couples decreases. The redistributive effect of the reform depends on how couples that opted for joint taxation are distributed across income levels. If these couples are located at the lower end of the income distribution, the reform is likely to reduce redistribution i.e., increase inequality in disposable income.

Budgetary impact

According to Table ES.1 the reform increases government revenues by about EUR 6.6 million with the upper range of the confidence interval being roughly EUR 7 million and the change being statistically significant. The removal of joint taxation has an effect through the eligibility for means tested benefits because the income test for several regional benefits regards the PIT tax base net of allowances. The reform reduces the amount of these allowances for one-earner couples because after the reform only the earner files a return so she loses the allowances corresponding to her spouse, which were pooled together when filing a joint return. The effect of the reform on single PIT components is shown in Table ES.2. The increase in the final tax liability is mainly driven by the increase in the initial (gross)

tax liability, caused mainly by the removal of the joint taxation allowance of EUR 3,400. Unlike the Austrian reform previously considered, the tax schedule itself is not changed. The remaining increase in the tax liability is due to lower personal and family tax credits, which are calculated by applying the tax schedule to the new lower personal and family allowances.

Distributional effects

ES.3 compares shares of taxpayers by deciles of equivalised disposable household income in the baseline and the reform scenario. Overall, the share of taxpayers increases by more than 8 percentage points (in the range of 8.08 and 9.36) with the increase being most pronounced between the third and the sixth decile. Before the reform, there were taxpayers that did not pay PIT because the joint taxation allowance and/or the personal and family tax credits reduced their tax liabilities to zero. When applying individual taxation, the lower allowances and tax credits result in positive tax liabilities for many of them.

Table ES.4 shows the share of households being affected by the reform as well as shares of winners and losers. As the reform aims at removing tax reliefs for married couples, there are no winners by definition. Losers are mostly allocated in the middle deciles, because they used the joint taxation scheme more frequently. The effect is lower in the upper deciles because there are fewer one-earner couples for whom joint taxation was the preferred option.

Table ES.5 shows mean PIT liabilities before and after the reform at the household level, calculated for all households with non-zero final PIT liabilities. The new liabilities are on average more than EUR 558 higher than in the baseline scenario, and they are higher for all deciles since nobody pays less after the reform. The highest relative increase can be found in the third decile, where the mean baseline liability was positive but very small. Table ES.6 confronts mean equivalised disposable income before and after the reform.

In line with previous results, average disposable income significantly decreases for all deciles, with the increase being highest in the middle deciles. The implicit tax rates on labour for workers by deciles are reported in Table ES.7. As expected, the implicit tax rate increases in all deciles, with the change being most pronounced in the middle deciles. Although both the analysed population and the monetary concepts in Tables ES.5 and ES.7 are different, the results are correlated because most adult individuals in the sample are workers and most of their income is labour income.

Table ES.8 compares the Gini coefficient of equivalised original income to the equivalised disposable income in both the baseline and the reform scenario. Both scenarios are redistributive. The reform increases inequality by 0.0027 points with the difference being statistically significant. This result is consistent with the relative changes observed in Table ES.6 from the third decile onwards.

At-risk-of-poverty indicators

Tables ES.9 and ES.10 analyse the effect of the reform on poverty. The risk of being poor increases after the removal of joint taxation for all three poverty lines considered. However, the increase is small and insignificant when a relatively narrow definition (poverty line fixed at 40% of median equivalised disposable income) is applied. This compares well with the results of Table ES.4 that shows that only a small share of households is affected in the first two deciles. The last table assesses the at-risk-of-poverty rates of households in which there is at least one married couple and those in which no person is married.[17] By construction, the at-risk-of-poverty rate of singles does not change, while the at-risk-of-poverty rate of married couples increases significantly by about one percentage point after the removal of joint taxation.

6 Conclusions

The present work develops a comprehensive framework for the in-depth analyses of tax reforms using EUROMOD. The need to assess the outcomes of tax-benefit reforms in a consistent way translates into ten standard tables which summarise the budgetary impact, the distributional effects and the at-risk-of-poverty indicators. Accurate standard errors and confidence intervals are provided for all the results, taking account of the underlying sample design of EU-SILC for the country of interest.

Three tax-benefit reforms have been simulated to illustrate the various types of results and analyses that can be provided, while the three countries (Austria, Denmark and Spain) were chosen to reflect the application of the three predominant sampling designs in EU-SILC. The selected standard tables allow assessing each of the reforms in a comprehensive way, offering not only point estimates for each variable but also standard errors and confidence intervals, which are necessary to judge the reliability of results.

[17] The distinction is based on socio-economic information in the data and does not mean the type of taxation opted for i.e., individual or joint.

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Appendix I: Simulation results

Table AT.1. Aggregate revenue and expenditure (thousand EUR)

	Baseline	Reform	Difference				
	Total	Total	Total	Standard error	95% confidence interval		% of baseline
					Lower bound	Upper bound	
PIT	30,761,834	29,714,849	-1,046,985	46,206	-1,137,564	-956,405	-3.40
Capital income tax	604,298	604,298	0	-	-	-	0.00
Total taxes	**31,366,126**	**30,319,147**	**-1,046,978**	**46,206**	**-1,137,558**	**-956,399**	**-3.34**
SIC employee	21,337,056	21,337,056	0	-	-	-	0.00
SIC employer	25,779,158	25,779,158	0	-	-	-	0.00
SIC self-employed	4,440,460	4,440,460	0	-	-	-	0.00
Total SIC	**51,556,674**	**51,556,674**	**0**	**-**	**-**	**-**	**0.00**
Pensions	44,516,840	44,516,840	0	-	-	-	0.00
Means tested benefits	4,526,113	4,517,219	-8,894	1,484	-11,804	-5,984	-0.20
Non-means tested benefits	9,099,074	9,099,074	0	-	-	-	0.00
Total benefits	**58,142,036**	**58,133,142**	**-8,894**	**1,484**	**-11,804**	**-5,984**	**-0.02**
Net budgetary effect	**24,780,764**	**23,742,680**	**-1,038,084**	**46,211**	**-1,128,674**	**-947,495**	**-4.19**

Table AT.2. PIT structure (thousand EUR)

	Baseline	Reform	Difference				
	Total	Total	Total	Standard error	95% confidence interval		% of baseline
					Lower bound	Upper bound	
Gross income	**184,092,085**	**184,092,085**	**0**	-	-	-	**0.00**
Deductions and allowances	-48,905,853	-48,899,271	6,581	1,117	4,391	8,772	-0.01
Taxable income	**135,186,232**	**135,192,813**	**6,581**	**1,117**	**4,391**	**8,772**	**0.00**
Gross tax liability	**31,549,761**	**30,425,024**	**-1,124,737**	**46,380**	**-1,215,657**	**-1,033,816**	**-3.56**
Tax credits	-1,807,423	-1,729,672	77,751	3,594	70,706	84,796	-4.30
Net tax liability	**29,742,337**	**28,695,352**	**-1,046,986**	**46,206**	**-1,137,565**	**-956,406**	**-3.52**
Tax on special payments	1,019,497	1,019,497	0	-	-	-	0.00
Final tax liability	**30,761,834**	**29,714,849**	**-1,046,985**	**46,206**	**-1,137,564**	**-956,405**	**-3.40**

Table AT.3. Share of taxpayers (%)

Decile	Baseline	Reform	Difference			
	Share	Share	Share	Standard error	95% confidence interval	
					Lower bound	Upper bound
1	13.90	12.31	-1.58	0.48	-2.53	-0.64
2	49.38	45.54	-3.84	0.76	-5.33	-2.34
3	82.48	80.68	-1.80	0.61	-3.00	-0.60
4	91.84	91.16	-0.67	0.35	-1.35	0.01
5	95.56	95.48	-0.08	0.08	-0.23	0.08
6	98.26	98.26	0.00	-	-	-
7	98.72	98.60	-0.11	0.11	-0.33	0.11
8	99.37	99.37	0.00	-	-	-
9	99.26	99.10	-0.16	0.16	-0.48	0.16
10	99.17	99.17	0.00	-	-	-
All	**81.41**	**80.55**	**-0.87**	**0.12**	**-1.11**	**-0.63**

Note: Taxpayers are defined as households in which the sum of all final PIT liabilities is positive.

Table AT.4. Shares of affected households, winners and losers (%)

Decile	Affected	Winners		Losers	
	Share	Share	95% confidence interval	Share	95% confidence interval
1	12.14	12.14	(9.20, 15.87)	0.00	-
2	49.19	49.19	(45.03, 53.35)	0.00	-
3	82.05	82.05	(78.53, 85.10)	0.00	-
4	91.45	91.45	(88.70, 93.57)	0.00	-
5	95.62	95.52	(93.49, 96.93)	0.11	(.01, .75)
6	98.16	98.07	(96.64, 98.91)	0.08	(.01, .59)
7	98.95	98.24	(96.58, 99.10)	0.71	(.23, 2.22)
8	99.21	98.30	(96.96, 99.05)	0.91	(.43, 1.91)
9	99.34	95.27	(93.24, 96.71)	4.07	(2.74, 6.00)
10	98.30	61.95	(57.94, 65.80)	36.36	(32.55, 40.34)
All	**81.04**	**76.82**	**(75.65, 77.94)**	**4.22**	**(3.73, 4.77)**

Note: Affected households are those whose equivalised disposable income changes with the reform; they are defined as winners if it increases and losers if it decreases. Only changes above 1 EUR/month are considered.

Table AT.5. Mean annual final PIT liability (EUR)

Decile	Baseline	Reform	Difference				
	Mean	Mean	Mean	Standard error	95% confidence interval		% of baseline
					Lower bound	Upper bound	
1	93.30	-3.70	-97.01	10.91	-118.39	-75.62	-103.97
2	1,200.86	943.85	-257.01	8.60	-273.86	-240.16	-21.40
3	2,287.92	1,941.19	-346.73	6.51	-359.50	-333.96	-15.15
4	3,668.60	3,266.82	-401.78	9.29	-419.99	-383.58	-10.95
5	4,842.45	4,408.94	-433.50	7.94	-449.06	-417.94	-8.95
6	6,131.57	5,657.60	-473.98	9.30	-492.20	-455.75	-7.73
7	8,306.85	7,799.98	-506.87	13.06	-532.48	-481.26	-6.10
8	10,593.44	10,022.01	-571.43	12.48	-595.90	-546.97	-5.39
9	14,908.76	14,362.55	-546.21	18.98	-583.42	-509.00	-3.66
10	33,904.29	34,407.75	503.46	112.72	282.48	724.43	1.48
All	**9,444.91**	**9,123.45**	**-321.46**	**13.84**	**-348.60**	**-294.32**	**-3.40**

Note: Mean values are calculated for households with non-zero final PIT liabilities in the baseline and/or in the reform scenarios

Table AT.6. Mean annual equivalised disposable income (EUR)

Decile	Baseline	Reform	Difference				
	Mean	Mean	Mean	Standard error	95% confidence interval		% of baseline
					Lower bound	Upper bound	
1	10,636.81	10,658.34	21.53	2.85	15.94	27.12	0.20
2	13,967.75	14,073.34	105.59	5.15	95.49	115.69	0.76
3	16,535.89	16,742.24	206.35	5.48	195.62	217.09	1.25
4	18,821.86	19,063.10	241.24	5.06	231.33	251.16	1.28
5	21,144.19	21,418.05	273.85	4.78	264.49	283.21	1.30
6	23,671.59	23,977.53	305.94	4.19	297.72	314.15	1.29
7	26,471.12	26,799.18	328.06	5.75	316.78	339.34	1.24
8	29,883.32	30,237.94	354.62	4.54	345.72	363.53	1.19
9	35,269.14	35,625.11	355.97	7.94	340.40	371.53	1.01
10	56,116.83	55,825.60	-291.24	69.90	-428.27	-154.21	-0.52
All	**25,082.87**	**25,268.80**	**185.93**	**7.58**	**171.06**	**200.79**	**0.74**

Note: Mean values are calculated for all households

Table AT.7. Implicit tax rates on labour (%)

Decile	Baseline	Reform	Difference			
	Rate	Rate	Rate	Standard error	95% confidence interval	
					Lower bound	Upper bound
1	32.26	31.76	-0.49	0.06	-0.60	-0.38
2	37.55	36.71	-0.83	0.03	-0.90	-0.77
3	39.85	38.99	-0.85	0.02	-0.90	-0.81
4	41.78	40.96	-0.82	0.02	-0.86	-0.78
5	42.86	42.06	-0.80	0.02	-0.83	-0.76
6	43.07	42.28	-0.79	0.01	-0.82	-0.76
7	45.03	44.31	-0.72	0.01	-0.75	-0.69
8	45.23	44.55	-0.68	0.01	-0.71	-0.66
9	46.46	45.89	-0.57	0.02	-0.61	-0.54
10	47.91	48.25	0.35	0.08	0.18	0.51
All	**44.87**	**44.43**	**-0.44**	**0.03**	**-0.50**	**-0.38**

Note: ITRs are calculated for each decile taking into account the subgroup of individuals with positive labour income

Table AT.8. Inequality and redistribution

	Baseline	Reform	Difference			
	Value	Value	Value	Standard error	95% confidence interval	
					Lower bound	Upper bound
Gini eq. original income (A)	0.499115	0.499115	0.000000	-	-	-
Gini eq. disposable income (B)	0.261875	0.259686	-0.002190	0.000246	-0.002672	-0.001708
Redistribution index (A) - (B)	0.237240	0.239429	0.002190	0.000246	0.001708	0.002672

Table AT.9. At-risk-of poverty rates (%) for different fixed poverty lines

Poverty line	Baseline	Reform	Difference			
	Mean	Mean	Mean	Standard error	95% confidence interval	
					Lower bound	Upper bound
40% of the median (EUR 8,934.38)	1.25	1.25	0.00	-	-	-
50% of the median (EUR 11,167.98)	6.61	6.50	-0.10	0.04	-0.18	-0.03
60% of the median (EUR 13,401.58)	13.28	12.93	-0.35	0.08	-0.52	-0.19

Note: Poverty line (EUR) is based on median equivalised annual disposable income.

Table AT.10. At-risk-of poverty rates (%) for different types of household

Household type	Baseline	Reform	Difference			
	Mean	Mean	Mean	Standard error	95% confidence interval	
					Lower bound	Upper bound
One adult <65, no children	24.15	24.11	-0.04	0.04	-0.12	0.04
One adult ≥65, no children	12.43	12.43	0.00	-	-	-
Single person with children	29.89	29.09	-0.79	0.79	-2.34	0.75
Two adults <65, no children	13.06	12.21	-0.85	0.33	-1.49	-0.21
Two adults, at least one ≥65, no children	9.07	8.48	-0.59	0.24	-1.07	-0.11
Two adults with children	13.49	12.94	-0.55	0.23	-1.00	-0.11
Three or more adults, no children	6.65	6.65	0.00	-	-	-
Three or more adults with children	13.28	13.28	0.00	-	-	-

Notes: Poverty line is EUR 13,401.58 (60% of median equivalised annual disposable income). Children are defined as persons below 18 years old.

Table DK.1. Aggregate revenue and expenditure (thousand DKK)

	Baseline	Reform	Difference				
	Total	Total	Total	Standard error	95% confidence interval		% of baseline
					Lower bound	Upper bound	
PIT	58,804,890	58,804,890	0	-	-	-	0.00
Capital income tax	19,391,106	19,391,106	0	-	-	-	0.00
Total taxes	**366,824,754**	**366,824,754**	**0**	**-**	**-**	**-**	**0.00**
SIC employee	88,750,439	88,750,439	0	-	-	-	0.00
SIC employer	5,330,860	5,330,860	0	-	-	-	0.00
SIC self-employed	5,751,215	5,751,215	0	-	-	-	0.00
Total SIC	**99,832,513**	**99,832,513**	**0**	**-**	**-**	**-**	**0.00**
Pensions	213,082,411	213,082,411	0	-	-	-	0.00
Means tested benefits	42,029,863	42,029,863	0	-	-	-	0.00
Non-means tested benefits	71,461,587	71,524,345	62,758	42,424	-20,410	145,926	0.09
Total benefits	**326,573,906**	**326,636,664**	**62,758**	**42,424**	**-20,410**	**145,926**	**0.02**
Net budgetary effect	**140,083,361**	**140,020,603**	**-62,758**	**42,424**	**-145,926**	**20,410**	**-0.04**

Table DK.2. Share of beneficiaries (%)

Decile	Baseline	Reform	Difference			
	Share	Share	Share	Standard error	95% confidence interval	
					Lower bound	Upper bound
1	10.92	10.92	0.00	-	-	-
2	16.01	16.01	0.00	-	-	-
3	18.96	18.96	0.00	-	-	-
4	21.88	21.88	0.00	-	-	-
5	28.99	28.99	0.00	-	-	-
6	33.03	33.03	0.00	-	-	-
7	34.09	34.09	0.00	-	-	-
8	27.72	27.72	0.00	-	-	-
9	25.76	25.76	0.00	-	-	-
10	20.56	17.64	-2.92	0.71	-4.31	-1.52
All	**22.75**	**22.49**	**-0.27**	**0.07**	**-0.40**	**-0.14**

Note: Taxpayers are defined as households with positive benefits

Table DK.3. Shares of affected households, winners and losers (%)

Decile	Affected	Winners		Losers	
	Share	Share	95% confidence interval	Share	95% confidence interval
1	10.92	10.92	(7.75, 15.16)	0.00	-
2	16.01	16.01	(12.40, 20.44)	0.00	-
3	18.96	18.85	(15.06, 23.32)	0.11	(.02, .80)
4	21.88	21.88	(18.25, 26.00)	0.00	-
5	28.99	28.99	(24.77, 33.61)	0.00	-
6	33.03	32.75	(28.44, 37.37)	0.29	(.10, .79)
7	34.09	34.01	(29.80, 38.49)	0.08	(.01, .59)
8	27.72	26.68	(23.09, 30.61)	1.04	(.51, 2.10)
9	25.76	22.82	(19.65, 26.34)	2.93	(1.95, 4.39)
10	20.46	10.12	(8.03, 12.67)	10.34	(8.23, 12.91)
All	**22.75**	**21.40**	**(20.15, 22.71)**	**1.34**	**(1.11, 1.63)**

Note: Affected households are those whose equivalised disposable income changes with the reform; they are defined as winners if it increases and losers if it decreases. Only changes above 1 DKK/month are considered.

Table DK.4. Mean annual child benefit (DKK)

Decile	Baseline	Reform	Difference				
	Mean	Mean	Mean	Standard error	95% confidence interval		% of baseline
					Lower bound	Upper bound	
1	22,441.49	22,993.96	552.47	37.25	479.44	625.50	2.46
2	22,160.41	22,705.80	545.39	38.36	470.19	620.58	2.46
3	21,420.45	21,941.91	521.45	26.44	469.62	573.29	2.43
4	22,227.52	22,770.47	542.95	26.24	491.50	594.39	2.44
5	21,850.67	22,387.60	536.93	18.91	499.86	574.01	2.46
6	21,592.77	22,100.98	508.21	19.21	470.55	545.87	2.35
7	20,755.70	21,262.68	506.99	16.06	475.51	538.46	2.44
8	20,790.18	21,178.90	388.72	51.54	287.69	489.75	1.87
9	18,934.65	19,109.80	175.16	72.87	32.30	318.01	0.93
10	19,150.27	15,086.31	-4,063.96	640.60	-5,319.80	-2,808.12	-21.22
All	**21,115.17**	**21,211.69**	**96.53**	**65.06**	**-31.01**	**224.07**	**0.46**

Note: Mean values are calculated for households with positive child benefits in the baseline

Table DK.5. Mean annual equivalised disposable income (DKK)

Decile	Baseline	Reform	Difference				
	Mean	Mean	Mean	Standard error	95% confidence interval		% of baseline
					Lower bound	Upper bound	
1	68,736.16	68,765.58	29.42	5.32	18.99	39.85	0.04
2	129,770.71	129,813.39	42.68	5.67	31.56	53.80	0.03
3	151,933.05	151,982.91	49.86	6.13	37.84	61.88	0.03
4	169,875.44	169,932.00	56.56	5.34	46.09	67.04	0.03
5	190,492.43	190,566.92	74.49	6.41	61.93	87.05	0.04
6	210,143.91	210,224.60	80.69	6.39	68.16	93.22	0.04
7	231,612.05	231,694.14	82.09	5.87	70.57	93.61	0.04
8	258,417.77	258,471.40	53.63	7.77	38.41	68.86	0.02
9	297,952.36	297,978.44	26.08	8.55	9.32	42.85	0.01
10	462,654.52	462,265.98	-388.54	71.41	-528.53	-248.55	-0.08
All	**205,775.84**	**205,788.37**	**12.53**	**6.99**	**-1.18**	**26.24**	**0.01**

Note: Mean values are calculated for all households

Table DK.6. Inequality and redistribution

	Baseline	Reform	Difference			
	Value	Value	Value	Standard error	95% confidence interval	
					Lower bound	Upper bound
Gini eq. original income (A)	0.466061	0.466061	0.000000	-	-	-
Gini eq. disposable income (B)	0.259108	0.258729	-0.000379	0.000042	-0.000460	-0.000297
Redistribution index (A) - (B)	0.206953	0.207332	0.000379	0.000042	0.000297	0.000460

Table DK.7. At-risk-of poverty rates (%) for different fixed poverty lines

Poverty line	Baseline	Reform	Difference			
	Mean	Mean	Mean	Standard error	95% confidence interval	
					Lower bound	Upper bound
40% of the median (DKK 80,160.53)	3.52	3.52	0.00	-	-	-
50% of the median (DKK 100,200.67)	6.66	6.66	0.00	-	-	-
60% of the median (DKK 120,240.80)	11.33	11.33	0.00	-	-	-

Note: Poverty line (EUR) is based on median equivalised annual disposable income.

Table DK.8. At-risk-of poverty rates (%) for adults and children

Household type	Baseline	Reform	Difference			
	Rate	Rate	Rate	Standard error	95% confidence interval	
					Lower bound	Upper bound
Adults	12.04	12.04	0.00	-	-	-
Children	8.71	8.71	0.00	-	-	-

Note: Poverty line is EUR 120,240.80 (60% of median equivalised annual disposable income)

Table ES.1. Aggregate revenue and expenditure (thousand EUR)

	Baseline	Reform	Difference				
					95% confidence interval		
	Total	Total	Total	Standard error	Lower bound	Upper bound	% of baseline
PIT	46,143,328	52,802,951	6,659,623	171,612	6,323,064	6,996,182	14.43
Capital income tax	354,812	354,812	0	-	-	-	0.00
Total taxes	**48,425,684**	**55,085,304**	**6,659,620**	**171,612**	**6,323,061**	**6,996,178**	**13.75**
SIC employee	20,161,802	20,161,802	0	-	-	-	0.00
SIC employer	90,807,448	90,807,448	0	-	-	-	0.00
SIC self-employed	6,499,469	6,499,469	0	-	-	-	0.00
Total SIC	**117,468,718**	**117,468,718**	**0**	**-**	**-**	**-**	**0.00**
Pensions	104,227,314	104,227,314	0	-	-	-	0.00
Means tested benefits	21,520,425	21,519,332	-1,093	1,663	-4,354	2,167	-0.01
Non-means tested benefits	16,753,521	16,753,521	0	-	-	-	0.00
Total benefits	**142,501,280**	**142,500,187**	**-1,093**	**1,663**	**-4,354**	**2,167**	**0.00**
Net budgetary effect	**23,393,122**	**30,053,835**	**6,660,713**	**171,616**	**6,324,147**	**6,997,280**	**28.47**

Table ES.2. PIT structure (thousand EUR)

	Baseline	Reform	Difference				
					95% confidence interval		
	Total	Total	Total	Standard error	Lower bound	Upper bound	% of baseline
Gross income	**465,280,622**	**465,280,622**	**0**	**-**	**-**	**-**	**0.00**
Earned income allowance*	121,519,098	130,615,380	9,096,282	377,084	8,356,758	9,835,806	7.49
Pension allowance*	1,908,885	1,387,869	-521,017	93,363	-704,117	-337,916	-27.29
Joint taxation allowance*	35,810,960	0	-35,810,960	462,641	-36,718,276	-34,903,644	-100.00
Tax base	**342,297,295**	**351,574,569**	**9,277,274**	**331,745**	**8,626,668**	**9,927,881**	**2.71**
Gross income tax	**82,778,394**	**84,993,753**	**2,215,359**	**88,968**	**2,040,879**	**2,389,840**	**2.68**
Personal and family tax credits*	45,820,910	42,257,245	-3,563,665	102,407	-3,764,503	-3,362,828	-7.78
Mortgage tax credit*	2,381,267	2,269,136	-112,131	18,541	-148,493	-75,769	-4.71
Rental tax credit*	430,305	442,601	12,296	9,721	-6,768	31,359	2.86
Total non refundable tax credits*	48,632,467	44,968,945	-3,663,522	105,290	-3,870,014	-3,457,031	-7.53
Net tax liability	**48,070,875**	**54,730,498**	**6,659,623**	**171,612**	**6,323,064**	**6,996,182**	**13.85**
Working mother tax credit	1,036,484	1,036,484	0	-	-	-	0.00
Large families tax credit	891,064	891,064	0	-	-	-	0.00
Final tax liability	**46,143,328**	**52,802,951**	**6,659,623**	**171,612**	**6,323,064**	**6,996,182**	**14.43**

Note: * indicates potential amounts. The applied amounts are lower due to insufficient taxable income (for allowances) or insufficient gross tax liability (for tax credits).

Table ES.3. Share of taxpayers (%)

Decile	Baseline	Reform	Difference			
	Share	Share	Share	Standard error	95% confidence interval	
					Lower bound	Upper bound
1	0.04	0.84	0.80	0.26	0.29	1.31
2	3.68	11.78	8.10	1.26	5.63	10.58
3	9.31	26.87	17.56	1.25	15.11	20.02
4	23.26	49.51	26.25	1.53	23.25	29.25
5	39.67	59.05	19.38	1.50	16.44	22.33
6	68.13	78.71	10.58	1.00	8.62	12.53
7	87.54	91.89	4.35	0.63	3.12	5.58
8	98.00	98.41	0.42	0.19	0.04	0.79
9	98.70	99.02	0.31	0.17	-0.01	0.64
10	99.70	99.74	0.04	0.04	-0.04	0.13
All	**53.45**	**62.17**	**8.72**	**0.33**	**8.08**	**9.36**

Note: Taxpayers are defined as households in which the sum of all final PIT liabilities is positive.

Table ES.4. Shares of affected households, winners and losers (%)

Decile	Affected	Winners		Losers	
	Share	Share	95% confidence interval	Share	95% confidence interval
1	0.80	0.00	0.00	0.80	(.42, 1.51)
2	9.25	0.00	0.00	9.25	(7.01, 12.11)
3	20.83	0.00	0.00	20.83	(18.24, 23.69)
4	36.08	0.00	0.00	36.08	(32.87, 39.41)
5	41.41	0.00	0.00	41.41	(38.07, 44.83)
6	40.43	0.00	0.00	40.43	(36.97, 43.98)
7	39.09	0.00	0.00	39.09	(35.66, 42.63)
8	30.51	0.00	0.00	30.51	(27.54, 33.64)
9	22.87	0.00	0.00	22.87	(20.28, 25.68)
10	12.29	0.00	0.00	12.29	(10.24, 14.67)
All	**25.40**	**0.00**	**0.00**	**25.40**	**(24.42, 26.40)**

Note: Affected households are those whose equivalised disposable income changes with the reform; they are defined as winners if it increases and losers if it decreases. Only changes above 1 EUR/month are considered.

Table ES.5. Mean annual PIT final liability (EUR)

Decile	Baseline	Reform	Difference				
	Mean	Mean	Mean	Standard error	95% confidence interval		% of baseline
					Lower bound	Upper bound	
1	-962.82	-914.75	48.07	20.07	8.70	87.44	4.99
2	-374.38	-106.73	267.65	32.99	202.95	332.35	71.49
3	21.93	624.35	602.43	39.24	525.47	679.38	2,747.38
4	285.35	1,060.53	775.17	35.79	704.99	845.36	271.66
5	647.20	1,611.54	964.34	40.63	884.66	1,044.01	149.00
6	1,169.87	1,925.72	755.85	40.89	675.65	836.05	64.61
7	1,895.71	2,504.12	608.41	32.06	545.53	671.29	32.09
8	3,237.62	3,720.48	482.86	31.19	421.69	544.02	14.91
9	5,404.02	5,812.62	408.60	28.01	353.68	463.53	7.56
10	13,162.11	13,452.75	290.64	34.00	223.97	357.31	2.21
All	**3,866.99**	**4,425.10**	**558.10**	**13.03**	**532.55**	**583.65**	**14.43**

Note: Mean values are calculated for households with non-zero final PIT liabilities in the baseline and/or in the reform scenarios

Table ES.6. Mean annual equivalised disposable income (EUR)

Decile	Baseline	Reform	Difference				
	Mean	Mean	Mean	Standard error	95% confidence interval		% of baseline
					Lower bound	Upper bound	#DIV/0!
1	2,380.65	2,379.14	-1.51	0.63	-2.74	-0.28	-0.06
2	6,372.86	6,348.42	-24.44	3.37	-31.05	-17.83	-0.38
3	8,313.73	8,219.25	-94.47	7.60	-109.38	-79.57	-1.14
4	9,814.83	9,596.52	-218.31	11.57	-241.00	-195.62	-2.22
5	11,566.30	11,247.45	-318.85	16.27	-350.77	-286.94	-2.76
6	13,400.05	13,068.69	-331.36	17.76	-366.19	-296.54	-2.47
7	15,536.00	15,223.84	-312.16	16.66	-344.83	-279.50	-2.01
8	18,009.37	17,754.60	-254.76	16.28	-286.69	-222.84	-1.41
9	21,720.20	21,499.83	-220.38	15.29	-250.37	-190.39	-1.01
10	31,515.40	31,362.01	-153.39	16.94	-186.61	-120.17	-0.49
All	**14,018.70**	**13,825.14**	**-193.55**	**4.78**	**-202.94**	**-184.17**	**-1.38**

Note: Mean values are calculated for all households

Table ES.7. Implicit tax rates on labour (%)

Decile	Baseline	Reform	Difference			
	Rate	Rate	Rate	Standard error	95% confidence interval	
					Lower bound	Upper bound
1	29.56	29.56	0.00	0.00	0.00	0.00
2	28.17	28.65	0.49	0.09	0.32	0.65
3	28.41	30.26	1.85	0.16	1.54	2.16
4	29.09	31.52	2.43	0.14	2.15	2.70
5	29.83	32.58	2.75	0.16	2.44	3.05
6	31.58	33.52	1.94	0.13	1.68	2.20
7	33.59	34.82	1.23	0.10	1.04	1.42
8	35.32	36.08	0.76	0.07	0.62	0.89
9	37.32	37.74	0.42	0.05	0.32	0.52
10	40.70	40.92	0.22	0.04	0.14	0.30
All	**35.42**	**36.37**	**0.96**	**0.03**	**0.89**	**1.02**

Note: ITRs are calculated for each decile taking into account the subgroup of individuals with positive labour income

Table ES.8. Inequality and redistribution

	Baseline	Reform	Difference			
	Value	Value	Value	Standard error	95% confidence interval	
					Lower bound	Upper bound
Gini eq. original income (A)	0.526837	0.526837	0.000000	-	-	-
Gini eq. disposable income (B)	0.318701	0.321393	0.002692	0.000179	0.002342	0.003042
Redistribution index (A) - (B)	0.208136	0.205444	-0.002692	0.000179	-0.003042	-0.002342

Table ES.9. At-risk-of poverty rates (%) for different fixed poverty lines

Poverty line	Baseline	Reform	Difference			
	Rate	Rate	Rate	Standard error	95% confidence interva	
					Lower bound	Upp bou
40% of the median (EUR 4,982.69)	10.09	10.11	0.03	0.02	-0.01	0.(
50% of the median (EUR 6,228.37)	14.52	14.76	0.24	0.06	0.12	0.3
60% of the median (EUR 7,474.04)	21.84	22.50	0.66	0.10	0.47	0.8

Note: Poverty line (EUR) is based on median equivalised annual disposable income.

Table ES.10. At-risk-of poverty rates (%) for households with and without married couples

Household type	Baseline	Reform	Difference			
	Rate	Rate	Rate	Standard error	95% confidence interval	
					Lower bound	Upper bound
No married couples	22.50	22.50	0.00	-	-	-
Married couples	21.60	22.51	0.91	0.13	0.65	1.17

Note: Poverty line is EUR 7,474.04 (60% of median equivalised annual disposable income). Married couples refer to households in which there is at least one married couple, and no married couples refer to those in which no person is married.

Appendix II: Sampling designs in EU-SILC 2012

The European Union Statistics on Income and Living Conditions (EU-SILC) is the major survey data set for comparative research on income equality and social inclusion in the European Union. A variety of social indicators used to monitor EU objectives for social protection and inclusion is based on EU-SILC e.g., the Europe 2020 headline target to reduce the number of people in or at risk of poverty and social exclusion by 20 million until 2020 (Eurostat 2015; European Commission 2015; Goedemé 2013a). As input database for EUROMOD, EU-SILC is of direct relevance for the in-depth country analyses of tax reforms prepared in the run-up to the country specific recommendations.

EU-SILC offers both comparable cross-sectional and longitudinal micro-data on in- come, poverty, social exclusion, housing, labour, education, and health for each of the 28 EU member states as well as Iceland, Norway, Switzerland, and Turkey. The cross- sectional user data base (UDB) of the 2012 operation, which forms the basis of the EUROMOD input data used for this analysis, includes 31 countries (except Turkey).[18]

The objective of cross-country data comparability is not pursued by means of a common questionnaire but rather by a common framework regulation (EC 1177/2003) and several implementing regulations (in particular EC 1980, 1981, 1982, 1983/2003) aimed at realising output harmonisation ex ante i.e., before the data collection.[19] The com- mon framework defines statistical concepts (e.g., household income), classifications (e.g., employment status), harmonised lists of permanent variables, and sets out requirements for imputation and weighting procedures as well as recommendations for the survey de- sign. Lists of temporary variables are set up by additional regulations on an annual basis.[20] The framework regulation EC 1177/2003 prescribes that "data shall be based on nationally representative probability samples" of predefined minimum effective sizes. Regulation EC 1982/2003 specifies that "the target population in EU-SILC shall be all private households and their current members residing in the territory of the Member State at the time of data collection. Persons living in collective households and in institutions are generally excluded from the target population." As for the selection of the sample, the regulation further defines the frame population as "all private households and all persons aged 16 and over within the household" irrespectively of their language, nationality or legal residence status. The sampling design is required to "ensure that every individual and household in the target population is assigned a known and non-zero probability of selection."

Besides the framework provisions, countries have considerable leeway in the choice of a specific design, leading to a variety of sampling designs in practice. Table 5 provides an overview of sampling designs used in the EU-SILC operation in 2012.

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[18] The following discussion is limited to the cross-sectional component of EU-SILC and countries covered by EUROMOD. The longitudinal component of EU-SILC is based on a four-year rotational design in the majority of countries. This implies that there are four representative sub-samples of similar size one of which is replaced every year by a newly drawn sample. As a result, the cross-sectional component of EU-SILC 2012 is composed of sub-samples drawn in the years 2009-2012. See also the Eurostat online publication EU statistics on income and living conditions (EU-SILC) methodology, Chaper 3 on Sampling as a reference.

[19] http://ec.europa.eu/eurostat/web/income-and-living-conditions/overview.

[20] See http://ec.europa.eu/eurostat/web/income-and-living-conditions/legislation for a complete documentation of the EU-SILC framework legislation.

Table 5: EU-SILC sample designs by country, 2010-2013

Sampling design	Country
Without stratification	
Simple random sampling	DK, MT
Systematic sampling	SE
With stratification	
Stratified simple random sampling	AT, DE, CY, LT, LU, SK
Stratified and systematic sampling	EE
Stratified two-stage sampling	HR, IT, LV, NL, PT, SI
Stratified multi-stage sampling	CZ, ES, PL, RO, IE, FR, UK, BE, BG, EL
Stratified two-phase sampling	FI, HU

Source: Berger et al. (n.d.) as referred to by Goedemé and Zardo Trindade (2016, p. 2). Countries not modelled in EUROMOD are not regarded.

The choice of the sampling design reflects country-specific considerations aimed at ensuring the quality of the data and estimates as well as cost efficiency. The majority of countries apply stratification and multi-stage sampling. Only Austria, Cyprus, Germany, Lithuania, Luxembourg, and Slovakia apply stratified simple random sampling. Denmark and Malta apply simple random sampling, and Sweden applies systematic sampling. In accordance with the sampling design, the sampling unit can be either a dwelling unit or address, a household or the individual. If the sampling unit is a dwelling unit in which more than one household resides, the dwelling unit is a cluster of households, while selected households are clusters of individuals.[21]

As discussed in Section 3, the accurate estimation of the sampling variance requires taking into account the underlying sampling design and weighting. A complete documentation of the latter should be made available to the researcher by means of a set of well-defined design variables (Heeringa et al. 2010, pp. 9-12). Unfortunately, in the UDB of EU-SILC 2012, important design variables are missing for the majority of countries. For all countries the original stratification variable (DB050) is unavailable for reasons of data protection, and for several countries, primary sampling units (DB060) are not uniquely identified (Goedemé 2013a, p. 97). The recognition of this flaw is not new, though (Iacovou et al. 2012). In his extensive cross-country analysis of sampling designs in EU-SILC 2008, Goedemé (2013a) compares the standard errors obtained when using the complete design information available to Eurostat to those obtained when using the incomplete design information available in the UDB. More precisely, he assesses the effect of different degrees of accuracy in the design variables on the standard errors of the indicators defining the poverty reduction target. However, before doing so, the design variables offered in the UDB are carefully examined in order to correct for both within- and between-country inconsistencies. Goedemé (2013b) provides a detailed description of the principles guiding the reconstruction of the design variables. Summarising his main findings, taking into account the corrected albeit incomplete sampling design information provided in the UDB leads to standard errors that compare well to those obtained by using the full design information. When variables are analysed at the level of household members (e.g., equivalised disposable income), standard errors should be clustered at the household level instead of assuming a random

[21] Eurostat online publication EU statistics on income and living conditions (EU-SILC) methodology, Section 3.2 on Sampling and Section 3.2.2 on Sampling Unit.

sampling of individuals. However, when first stage clustering involves higher levels than the household (e.g., municipalities, census blocks, etc.) this should be accounted for in the definition of the primary sampling units. To illustrate the problem of lacking design variables in the UDB, the sampling designs of Austria, Denmark and Spain are described more closely in the following. Furthermore, based on the insights offered by Goedemé (2013a) and Goedemé and Zardo Trindade (2016) as well as the updated syntax to reconstruct design variables for the EU-SILC operation in 2012, it is shown how the available information can be used in the estimation of policy effects using EUROMOD.[22] In what follows, the sample designs of Austria, Denmark and Spain are discussed more in detail.

Austria applies a stratified simple random sample. Stratification is based on 206 geographical units, which are disjoint sub-divisions of the nine Austrian states. For instance, Lower Austria is divided into 30 and Burgenland into 13 of these units (Statistik Austria 2015, p. 13). Within the strata, sampling units are directly randomly selected. The primary sampling units are dwellings units listed in the central residence register, a constantly updated population register administered by the Ministry of Interior. The sampling frame is all accommodation units in which at least one person aged 16 years or older has her main residence (Statistik Austria 2015, p. 11). If more than one household lives in a selected dwelling, this should be accounted for in the estimation of the sampling variance i.e., by clustering at the dwelling level. However, current data do not enable clustering at the dwelling level so that clustering at the household level is taken into account. As proxy for the unavailable original stratum information, we switch to the state of residence at the moment of the interview. However, the hereby obtained nine strata fall clearly below the number of original strata.

In Denmark, a simple random sample of individuals is drawn from the Central Population Register and the household is defined as the household the selected person belongs to. The sampling frame consists of all individuals aged 13 or above living in households where the selected person is aged 16 or above at the beginning of the survey year (Statistics Denmark 2012, p. 7). The primary sampling unit is the household, which is why the sampling design is taken into account by clustering at the household level. For the three countries in which simple random sampling without stratification is applied, there is no loss of sampling design information and standard errors can be estimated with the information offered by the UDB (Goedemé 2013a, p. 102).

In Spain, a stratified two-stage sampling procedure is applied. For each of the 17 Autonomous Communities and the two Autonomous Cities, census blocks are stratified into seven groups according to the size of the municipality they belong to. Theoretically, this results in 133 strata, although in practice the number of strata is smaller because not all Autonomous Communities have municipalities falling in each of the seven predefined groups. Then, within each stratum, census blocks are selected with a probability proportional to their number of dwellings. At the second stage, dwelling units are drawn with equal probabilities from the previously sampled census blocks and all households residing in a selected dwelling are interviewed. As for the case of Austria, since the primary strata information is unavailable, the Autonomous Community of residence at

[22] The updated syntax used to reconstruct design variables from the UDB of EU-SILC are available at https://timGoedemé.com/. Goedemé and Zardo Trindade (2016) discuss the updating procedure in detail.

the time of the interview is taken as proxy. Census blocks are the primary sampling units used for the cluster specification.

In order to allow for a standardised account of the sampling design in the analysis of EUROMOD output data, the corrected design variables for all EUROMOD countries are saved in a separate data set, which is called by the do-file conducting the in-depth country analyses. The documentation of the syntax for conducting the below analyses is provided by the authors upon request.

Appendix III: Analysis of subpopulations

Depending on the policy goals as well as the scope of analysis, disentangling policy effects for different subgroups of the survey population is desirable. EU-SILC offers various predefined classifications, which are also incorporated in the EUROMOD input data. Table 6 lists the most relevant classifications that frequently arise in practice. However, the analysis of subpopulations has implications for the computation of point estimates and standard errors. Heeringa et al. (2010, pp. 111-116) give a brief and intuitive introduction and West et al. (2008) provide a detailed discussion.

Before analysing subpopulations, a look at the distribution of the subpopulation of interest over the specified design variables i.e., strata-cluster combinations should be taken. This helps detecting cases of asymmetrically distributed subpopulations, which can cause standard errors to be seriously biased (Heeringa et al. 2010, pp. 111-113). This will be less of a problem for big subpopulations such as male and female individuals but probably more so for very specific subpopulations e.g., farmers belonging to a certain age group. In order to correctly account for the sampling design in the estimation of subpopulations in Stata, the *svy* command is used either with the *subpop()* or the *over()* option, depending on how the subpopulation indicator is defined. The first option is used in the case of a single binary indicator variable while the second is used in the case of one or several categorical indicator variables. The commands may also be combined to compute statistics for different categories of a part of a subpopulation e.g., mean benefit amount received by deciles of equivalised disposable income for the subpopulation of benefit recipients. The underlying idea of subpopulation estimation is not to restrict the sample in the spirit of the *if* or *in* options but rather to assess the sampling variability of the survey subpopulations.

Table 6: Predefined subpopulations in EUROMOD

Subpopulation	EUROMOD variable	Possible values
Gender	dgn	0 female
		1 male
Age[a]	dag	0-14 years
		15-24 years
		25-49 years
		50-64 years
		65-79 years
		80 or more years
Disability	ddi	0 not disabled
		1 disabled
		-1 not applicable
Marital status	dms	1 single
		2 married
		3 separated
		4 divorced
		5 widowed
Current education status	dec	0 not in education
		1 pre-primary
		2 primary
		3 lower secondary
		4 upper secondary
		5 post secondary
		6 tertiary
Highest education status	deh	0 not completed Primary
		1 primary
		2 lower Secondary
		3 upper Secondary
		4 post secondary
		5 tertiary
Economic status	les	0 pre-school
		1 farmer
		2 employer or self-employed
		3 employee
		4 pensioner
		5 unemployed
		6 student
		7 inactive
		8 sick or disabled
		9 other
		10 family worker

continued on next page

Table 6: Predefined subpopulations in EUROMOD (cont.)

Subpopulation	EUROMOD variable	Possible values
Household		A1 single person A1_LT65 one adult younger than 65 years A1_GE65 one adult 65 years or over A1_DCH single person with dependent children A1F single female A1M single male A2 two adults A2_2LT65 two adults younger than 65 years A2_GE1_GE65 two adults, at least one aged 65 years or over A2_1DCH two adults with one dependent child A2_2DCH two adults with two dependent children A2_GE3DCH two adults with three or more dependent children A_GE3 three or more adults A_GE3_DCH three or more adults with dependent children HH_NDCH households without dependent children HH_DCH households with dependent children

[a] Age group classification as in EUROSTAT statistics, table Population by age group (tps00010). See http://ec.europa.eu/eurostat/en/web/products-datasets/-/TPS00010.

[b] Household type classification defined by EUROSTAT, Table Distribution of population by household type and income group (ilc_lvps02). Several groups are not mutually exclusive. See http://ec.europa.eu/eurostat/en/web/products-datasets/-/ILC_LVPS02.

Appendix IV: Glossary

At-risk-of-poverty rate

According to Eurostat, the at-risk-of-poverty rate is defined as the "share of people with an equivalised disposable income (after social transfer) below the at-risk-of-poverty threshold, which is set at 60% of the national median equivalised disposable income after social transfers".[23] This indicator has to be interpreted with caution, since "it does not measure wealth or poverty, but low income in comparison to other residents in that country, which does not necessarily imply a low standard of living".[24] For our analyses, we use the specific concept of equivalised disposable income defined below.

Deciles

Income decile groups are defined as groups of individuals with equal population size sorted by their equivalised disposable income. In Eurostat terms, (1) equivalised disposable income is attributed to each member of the household; (2) the individual data are sorted according to equivalised disposable income; (3) nine cut-point values of disposable income are identified, dividing the survey population into ten groups each of which represents 10% of the target population.[25] This means that the first decile represents 10% of the population with the lowest income i.e., an income smaller or equal to the first cut-off value, and the tenth decile represents 10% of the population with the highest income i.e., an income greater than the ninth cut-off value.

Disposable income

In general, disposable income refers to the income that is available to an individual or household after paying direct taxes and social security contributions. Accoridngly, in the EUROMOD framework, is defined as the sum of original (market) income and benefits received minus taxes and contributions paid.

Disposable income = Original income + Benefits − Taxes
− Employee social security contributions
− Self-employed social security contributions

Equivalised disposable income

It is defined as the total disposable income of a household adjusted for the household composition by taking economies of scale into account. In Eurostat wording, it is the "total income of a household, after tax and other deductions, that is available for spending or saving, divided by the number of household members converted into equalised adults; household members are equalised or made equivalent by weighting each according to their age, using the so-called modified OECD equivalence scale".[26] This scale assigns a weight of 1 to the household head, 0.5 to other adults (14 year-old or

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[23] http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:At-risk-of-poverty_rate.
[24] Ibid.
[25] http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Income_quintile_group.
[26] http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Equivalised_disposable_income

older) and 0.3 to children (younger than 14). The result of the calculation is attributed to every member of the household.

Gini coefficient

According to Eurostat, the "Gini coefficient measures the extent to which the distribution of income within a country deviates from a perfectly equal distribution. A coefficient of 0 expresses perfect equality where everyone has the same income, while a coefficient of 100 expresses full inequality where only one person has all the income".[27] The Gini coefficient is a relative measure of inequality, which means that (1) the degree of inequality remains constant if we increase or reduce all incomes by the same proportion; (2) the degree of inequality increases if we increase the income of the rich by a higher proportion than that of the poor, (3) the degree of inequality decreases if we increase the income of the poor by a higher proportion than that of the rich. Gini coefficients in the above analyses are computed on the basis of equivalised disposable income.

Implicit tax rate on labour

The implicit tax rate on labour measures the effective average tax burden on employed labour income. As an aggregate measure for the economy, it is defined as the "sum of all direct and indirect taxes and employees' and employers' social contributions levied on employed labour income divided by the total compensation of employees working in the economic territory increased by taxes on wage bill and payroll".[28] At the individual level or for groups of individuals (e.g., deciles) it is calculated as the sum of all taxes and contributions paid on labour (in general PIT and SSC), divided by the total labour cost (basically gross wages plus employers' SSC[29]) for the same individual or group. In EUROMOD, all components of the implicit tax rate are precisely defined except the PIT on labour, because the PIT base usually includes also other types of income e.g., self-employment income. Since the PIT liability is a unique value and cannot be directly split, a proxy for the part corresponding to labour income has to be calculated. To avoid country-specific complexities we calculate it as the total PIT liability multiplied by the share of gross labour income over total gross taxable income i.e., before allowances are deducted.[30]

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[27] http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Gini_coefficient.

[28] http://ec.europa.eu/eurostat/en/web/products-datasets/-/TEC00119.

[29] http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Labour_cost.

[30] In terms of EUROMOD variables, the ITR for a group *h* formed by *i* individuals is:

$$ITR_h = \frac{Taxes\ on\ labour_h}{Total\ labour\ costs_h} = \frac{\sum_{i=1}^{h}\left(\frac{yem_i}{GTI_i} * PIT_i + il\_sicee_i + il\_sicer_i\right)}{\sum_{i=1}^{h}(yem_i + \ il\_sicer_i)}$$
$$= \frac{\sum_{i=1}^{h}\left(\frac{yem_i}{GTI_i} * PIT_i + il\_sicee_i + il\_sicer_i\right)}{\sum_{i=1}^{h}(yem_i + \ il\_sicer_i)}$$

where GTI is gross taxable income i.e., the sum of the gross components of taxable income before applying deductions and allowances; PIT is the Personal Income Tax liability.

List of tables

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