



JRC SCIENTIFIC INFORMATION SYSTEMS AND DATABASES REPORT

EUROMOD Tax Compliance Adjustment (TCA) Add-on - technical note

January 2022

Alari Paulus

2022

This publication is a Scientific Information Systems and Databases report by the Joint Research Centre (JRC), the European Commission's science and knowledge service. It aims to provide evidence-based scientific support to the European policymaking process. The scientific output expressed does not imply a policy position of the European Commission. Neither the European Commission nor any person acting on behalf of the Commission is responsible for the use that might be made of this publication. For information on the methodology and quality underlying the data used in this publication for which the source is neither Eurostat nor other Commission services, users should contact the referenced source. The designations employed and the presentation of material on the maps do not imply the expression of any opinion whatsoever on the part of the European Union concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Contact information

Name: JRC-EUROMOD Team

Address: Edificio EXPO, c/ Inca Garcilaso 3, E-41092 Sevilla

Email: JRC-EUROMOD@ec.europa.eu

Tel.: +34 9544 88713

EUROMOD website: <https://euromod-web.jrc.ec.europa.eu>

EU Science Hub: <https://ec.europa.eu/jrc>

JRC128274

Seville: European Commission, 2022

© European Union, 2022



The reuse policy of the European Commission is implemented by the Commission Decision 2011/833/EU of 12 December 2011 on the reuse of Commission documents (OJ L 330, 14.12.2011, p. 39). Except otherwise noted, the reuse of this document is authorised under the Creative Commons Attribution 4.0 International (CC BY 4.0) licence (<https://creativecommons.org/licenses/by/4.0/>). This means that reuse is allowed provided appropriate credit is given and any changes are indicated. For any use or reproduction of photos or other material that is not owned by the EU, permission must be sought directly from the copyright holders.

All content © European Union, 2022

How to cite this report: Paulus, A., *EUROMOD Tax Compliance Adjustment (TCA) Add-on - technical note*, European Commission, Seville, 2022, JRC128274

Contents

- Acknowledgements5
- 1 Introduction.....5
- 2 The design and structure of the TCA Add-on.....6
 - 2.1 Conceptual design6
 - 2.2 Technical implementation.....7
- 3 Applying the TCA Add-on.....14
 - 3.1 Configuring and interpreting the Add-on.....14
 - 3.2 Kukk et al. (2019) estimates of self-employment income underreporting.....15
- References.....18
- Appendix A: Market income variables in EUROMOD19
- Appendix B: Illustrative simulations with the TCA Add-on.....22
 - Table B.1: Changes in aggregate income (scenario 2 with DAF=0.8 for employment income)22
 - Table B.2: Changes in aggregate income (scenario 2 DAF=0.5 for self-empl. income).....23
 - Table B.3 Change in aggregate income (scenario 4 with SAF=0.8 for employment income).....23
 - Table B.4 Changes in aggregate income (scenario 4 with SAF=0.5 for self-empl. income).....24
 - Table B.5 Changes in aggregate income (scenario 5 with DAF=SAF=0.8 for empl. income).....25
 - Table B.6 Changes in aggregate income (scenario 5 with DAF=SAF=0.5 for self-empl. income).....26

Acknowledgements

This document was originally prepared by the author for previous EUROMOD releases distributed by ISER-University of Essex. The JRC-EUROMOD team has only performed minor updates to adapt it to EUROMOD release I4.0+.

1 Introduction

Tax Compliance Adjustments (TCA) Add-on is a EUROMOD tool that makes it technically possible to account for varying degrees of income tax compliance of different types of households in simulations for all 27 EU countries in a highly harmonised way. The use of the TCA Add-on is highly flexible and can accommodate various needs of the user. It should be primarily seen as a technical device to sensitivity test EUROMOD core tax-benefit simulations under alternative assumptions on tax compliance, where the parameterisation of the Add-on is chosen by the user. The Add-on also includes estimates of self-employment income underreporting for 14 countries (Kukk et al., 2019), which can optionally be used.

The Add-on has been tested with EUROMOD version I4.0 (and model software 3.4.7) for 2021 policy systems and 2019 input datasets.

The technical note is an updated and revised version of Part II of the final report for the project “Assessment of tax evasion based on consumption, wealth and income using EUROMOD” (Paulus et al., 2018). The second section of the note explains the conceptual design of the Add-on, followed by a summary of the key elements of the technical implementation and a detailed presentation of the tool. The third section explains how to apply the Add-on, interpret the results and the incorporation of estimates by Kukk et al. (2019).

2 The design and structure of the TCA Add-on

2.1 Conceptual design

The **main idea** of the Add-on for tax compliance adjustments is as follows: first, taking the estimates of income misreporting as given, core market income variables available in the input dataset are adjusted to obtain the true distribution of market incomes. As EUROMOD utilises income information from the EU-SILC and these are obtained from various sources, i.e. collected through survey interviews or drawn from administrative registers, it is important to be clear about the source of data to determine what kind of adjustments for income misreporting are needed and appropriate. Depending on the nature of data, the first step is meant to account either for survey measurement errors or actual tax non-compliance behaviour. In the second step, the module allows the user to perform tax-benefit calculations under alternative tax compliance assumptions (full vs partial compliance). Taking the estimates of tax non-compliance as given, (part of) incomes on which taxes are evaded are quantified and separated from the rest. Standard tax-benefit calculations are then carried out with adjusted income variables reflecting only officially reported incomes (in line with the assumed level of compliance). Once taxes (and benefits) under partial tax compliance are calculated, non-reported incomes are added back to household income.

This approach avoids numerous changes in the core model, which would be needed if instead of adjusting main income variables separate income variables were used, as common for current TCA extensions. To provide an example: splitting total (true) employment income variable (*yem*) into reported and non-reported components (e.g. *yemre* and *yemnr*), would require providing default values and uprating factors for additional income variables, modifying relevant income lists, formulas etc in the core model. Instead, the Add-on replaces temporarily the original values of employment income with those reported for tax purposes (effectively setting *yem* equal to *yemre* in the example above) and runs the standard tax-benefit modules as they are, after which modified market income variables are reverted back to original values. It is also easier to alternate between full and partial tax compliance assumptions, compared to the existing TCA modules where two sets of income variables are used for that purpose.

Regarding adjustments for income misreporting, the Add-on provides a generic and flexible framework, which can accommodate various approaches in the income measurement and tax compliance literature with distinct key assumptions. First, there is the discrepancy method (see e.g. Fiorio and D'Amuri, 2005; Benedek and Lelkes, 2011), where it is assumed that survey incomes are reported truthfully and compared with incomes reported in administrative registers at the (semi)aggregate level to quantify non-reported incomes. Second, studies following the Pissarides-Weber (1989) line of arguments assume that income reporting in the survey corresponds to reporting for tax purposes and hence survey incomes are underreported by some population groups and/or for some income components but reflect true incomes in other cases. The Add-on can be used in conjunction with either type of estimates.

Furthermore, survey incomes may exhibit (non-random) measurement errors, which are ignored by these two strands of tax compliance literature but are of central importance for studies on survey measurement error (e.g. Bound and Krueger, 1991; Bollinger, 1998; Kapteyn and Ypma, 2007; Meijer et al., 2012). The latter in turn tend to be limited by assuming that register incomes measure true values correctly, hence ignoring tax evasion. The Add-on follows a unified framework suggested in Paulus (2015), allowing for imperfect income measurement in the survey (unrelated to income reporting for tax purposes) as well as income underreporting in administrative registers to evade taxes.

The Add-on distinguishes between two sets of adjustment factors: **data adjustment factors (DAF)** and **simulation adjustment factors (SAF)**. DAFs allow correcting for underreported ($DAF < 1$) and overreported incomes ($DAF > 1$) in the input dataset with the interpretation depending on the nature of data source, i.e. whether the input dataset contains **survey-** or **register-based income information**. SAFs allow correcting for income underreporting for tax purposes in the tax-benefit simulations. After applying DAFs, adjusted market incomes ought to correspond to true incomes and SAFs are meant to reflect the proportion of true incomes reported officially (i.e. $SAF < 1$). The discrepancy method corresponds to assuming $DAF = 1$ and $SAF < 1$ and the Pissarides-Weber approach to assuming $DAF = 1$ and $SAF = 1$ for the reference group and $DAF < 1$ and $SAF < 1$ for some incomes and/or population groups.

With this approach, various adjustments factors are incorporated (parameterised) directly in the TCA Add-on and stored there, rather than used to correct incomes for tax evasion in EUROMOD input data files. This is a preferred option as the maintenance effort for updating and/or revising the adjustment factors is lower and

alternative sets of estimates can be employed more easily. In principle, the Add-on could also be extended to allow for necessary information to be fed through (modified) input datasets.

2.2 Technical implementation

A generic EUROMOD module for tax compliance adjustments has been developed in the form of an **Add-on** (i) to achieve greater modularity and make it easier to use with different EUROMOD versions as well as (ii) provide a clear overview and summary of country-specific steps needed.

The general approach explained in the previous section is common for all countries, though specific technical details (e.g. variable names) may inevitably vary across countries. However, the Add-on is designed to rely on the standardised features of the core model as much as possible (e.g. existing TCA policies, *ils_udb_yyy* standard income lists) to minimise the need for country- and/or system-specific details in the Add-on. Making the Add-on as generic and harmonised as possible across countries as well as across different policy years for a given country, allows achieving wider country coverage and lowers updating and maintenance effort in the future.

The Add-on includes one template scenario (TCA) and country-specific scenarios (TCA_cc) for all 27 EU member states.¹ Among these, **Bulgaria, Greece, Italy, Lithuania** and **Romania** already feature a country-specific TCA extension in the standard version of the model (as part of their policy spines), which is switched off by the TCA Add-on. The existing TCA modules adjust self-employment income (*yse*) and, in the case of Bulgaria, Lithuania and Greece, also employment income (*yem*). The Add-on provides technical means to adjust four main components of market incomes at the individual level: employment (*yem*), self-employment (*yse*), property (*ypr*) and investment income (*yiy*).

As shown in Figure 1, these income components account for 98-100% of total market income, except in countries where pensions are mostly private (Denmark, the UK and the Netherlands). The dominant source of market income is employment income, accounting for at least 70% of market income in all countries. The only exception is Greece, which stands out for a much larger share of self-employment income (39%) than any other country, where it ranges from 2 to 20% of market income. Investment incomes are more significant (5-8% of market income) in countries where this information is drawn from administrative registers (e.g. France, Sweden, Finland, Denmark, Malta) and account for less than 4% elsewhere. Property income is the smallest among the four income components and most of the times accounts for less than 5% of market income. When interpreting these statistics, it is important to bear in mind that they are also directly affected by income reporting behaviour and components with smaller shares can reflect their higher underreporting.

By default, the Add-on assigns a single DAF and SAF for each type of income, but this is set up in a flexible way (using function BenCalc) and hence can easily be extended to allow for variation (heterogeneity) in adjustment rates across population groups.

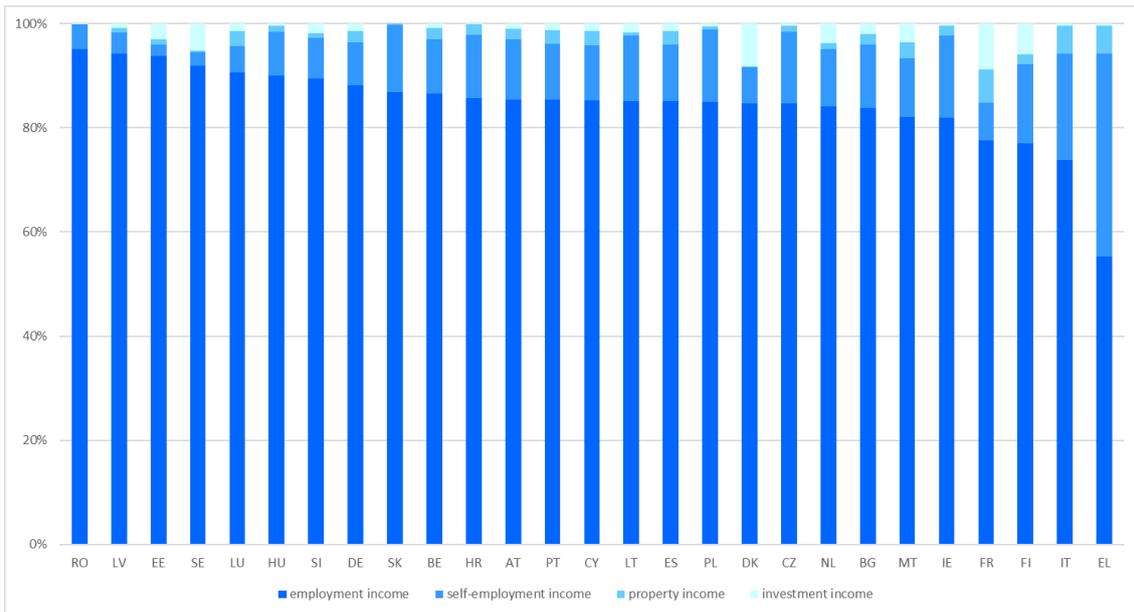
Setting up the Add-on is straightforward and only requires copying TCA\TCA.xml file to the folder \EuromodFiles\XMLParam\AddOns.

Spine

The Add-on is structured in seven modules (policies) to separate each logical step and ease navigation (see Figure 2). Note that when referring to the Add-on elements, this is explicitly stated (e.g. Add-on spine, Add-on system, Add-on policy) to distinguish it from the systems and policies in the core model.

¹ Here and elsewhere, “cc” is a generic reference to two-letter country acronyms used in EUROMOD.

Figure 1. Share of market income components, % of total market income



Notes: income concepts refer to the following standard income lists in Euromod: ils_udb_yem (employment income), ils_udb_yse (self-employment income), ils_usb_ypr (property income), ils_udb_yiy (investment income).

Source: own calculations with Euromod I4.0 (2021 baseline policies, updated 2019 data).

Figure 2. The spine of the TCA Add-on (template)

	Policy	Grp/No	TCA	Comment
1	ao_control_TCA		on	DEF: ADD-ON CONTROL
2	PREP_TCA		on	DEF: preparations for tax compliance adjustments
3	DEFINE_DAF_TCA		on	DEF: define data adjustment factors (DAF)
4	DEFINE_SAF_TCA		on	DEF: define simulation adjustment factors (SAF)
5	APPLY_DAF_TCA		on	DEF: apply data adjustments factors
6	APPLY_SAF_TCA		on	DEF: apply simulation adjustments factors
7	TOT_INCOME_TCA		on	DEF: add back non-reported income

The Add-on modules and their purposes are as follows:

- ao_control_TCA – the head (control) module of the Add-on to instruct EUROMOD, which policy systems can be run with the Add-on and where Add-on policies need to be inserted in the country policy spines.
- PREP_TCA – to carry out initial (one-off) preparations needed for main Add-on operations, such as defining intermediate variables and relevant income concepts (income lists), switching off existing TCA policies and specifying output file names.
- DEFINE_DAF_TCA – to define data adjustment factors (DAF) for input databases.
- DEFINE_SAF_TCA – to define simulation adjustment factors (SAF) for tax-benefit calculations.
- APPLY_DAF_TCA – to adjust observed market income variables for misreporting, i.e. obtain true incomes by applying DAFs.
- APPLY_SAF_TCA – to calculate and separate non-reported part of incomes for taxbenefit simulations and re-calculate aggregate income concepts.
- TOT_INCOME_TCA – to add back non-reported part of incomes and re-calculate aggregate income concepts.

Each module is explained in more detail in turn.

ao_control_TCA

The module first instructs which Add-on systems work with which country policy systems.

There is a separate Add-on system for each country (named TCA_cc). The Add-on base system (named TCA) is not used for any country but provides a template for constructing country-specific Add-on systems. Differences between the latter and the TCA system are highlighted using conditional formatting, thereby providing a clear overview of country-specific adjustments across all 27 EU countries.

Second, ao_control_TCA specifies the location for each Add-on policy in country spines. Three distinct locations are used:

- Initial operations (PREP_TCA, DEFINE_DAF_TCA, DEFINE_SAF_TCA) are carried out early in the spine, after tax unit definitions (TUdef_cc). This is to ensure that any existing TCA policy is switched off before their execution. According to the EUROMOD Modelling Conventions (EMC, section 7), most switchable policies (e.g. BTA, TCA, FYA) are located after tax unit definitions.
- Core operations (APPLY_DAF_TCA, APPLY_SAF_TCA) are carried out after negative income components have been discarded in the core model (neg_cc) and before taxbenefit calculations are performed.
- Final operations (TOT_INCOME_TCA) are carried out after tax-benefit calculations have been completed and before the output file is produced (output_std_cc.txt).
- Third, ao_control_TCA switches off existing TCA extensions. This is relevant for Bulgaria, Greece, Italy, Lithuania and Romania.

Figure 3. ao_control_TCA module (template and Bulgarian case)

	Policy	Grp/No	TCA	TCA_BG	Comment
1	ao_control_TCA		on	on	DEF: ADD-ON CONTROL
1.1	fix AddOn_Applic		on	on	WHICH SYSTEMS APPLICABLE
1.1.1	Description		Tax Compliance Adjustments	Tax Compliance Adjustments	
1.1.2	Sys		n/a	bg_20??	can use wild symbols (? and *)
1.2	fix AddOn_Pol		on	on	ADD POLICY: preparations for tax compliance adjustments
1.2.1	Pol_Name		PREP_TCA	PREP_TCA	
1.2.2	Insert_After_Pol		TUdef_cc=	TUdef_cc=	
1.3	fix AddOn_Pol		on	on	ADD POLICY: define factors for input data adjustments
1.3.1	Pol_Name		DEFINE_DAF_TCA	DEFINE_DAF_TCA	
1.3.2	Insert_After_Pol		PREP_TCA	PREP_TCA	
1.4	fix AddOn_Pol		on	on	ADD POLICY: define factors for tax compliance adjustments in simulations
1.4.1	Pol_Name		DEFINE_SAF_TCA	DEFINE_SAF_TCA	
1.4.2	Insert_After_Pol		DEFINE_DAF_TCA	DEFINE_DAF_TCA	
1.5	fix AddOn_Pol		on	on	ADD POLICY: apply data adjustment factors
1.5.1	Pol_Name		APPLY_DAF_TCA	APPLY_DAF_TCA	
1.5.2	Insert_After_Pol		neg_cc=	neg_cc=	
1.6	fix AddOn_Pol		on	on	ADD POLICY: apply simulation adjustment factors
1.6.1	Pol_Name		APPLY_SAF_TCA	APPLY_SAF_TCA	
1.6.2	Insert_After_Pol		APPLY_DAF_TCA	APPLY_DAF_TCA	
1.7	fix AddOn_Pol		on	on	ADD POLICY: add back non-reported income
1.7.1	Pol_Name		TOT_INCOME_TCA	TOT_INCOME_TCA	
1.7.2	Insert_Before_Pol		output_std_cc=	output_std_cc=	
1.8	fix AddOn_ExtensionSwitch		n/a	on	switch off existing TCA module (BG, EL, IT, LT, RO)
1.8.1	Extension_Name		n/a	TCA	
1.8.2	Extension_Switch		n/a	off	

PREP_TCA

PREP_TCA first defines intermediate variables to store data adjustment factors (i_DAF_yyy), simulation adjustment factors (i_SAF_yyy) and non-reported incomes (i_tca_yyyrr), one for each income variable (yyy).

Second, subcomponents for each market income variable are listed using income lists (il_tca_yyy). Wherever possible, these refer in turn to the standard income lists (ils_udb_yyy) to keep country-specific elements in the Add-on to a minimum. This requires standard income lists to include detailed incomes rather than their aggregates (in accordance with EMC, section 12). While this appears to be nearly always the case for employment income (yem), selfemployment income (yse) and investment income (yiy), the same approach has often not been followed through for property income (ypr) and hence its components need to be explicitly defined in the Add-on for about half of the EU countries (see Table A.1 in Appendix A).

Finally, the output file name is changed from *cc_year_std.txt* to *cc_year_tca.txt*.

Figure 4. PREP_TCA module (template and Italian case)

	Policy	Grp/No	TCA	TCA_IT	Comment
2	PREP_TCA		on	on	DEF: preparations for tax compliance adjustments
2.1	DefVar		on	on	define intermediate variables
2.1.1	i_DAF_yem		1	1	data adjustment factors (by default set to 1): yem
2.1.2	i_DAF_yse		1	1	data adjustment factors (by default set to 1): yse
2.1.3	i_DAF_ypr		1	1	data adjustment factors (by default set to 1): ypr
2.1.4	i_DAF_yiy		1	1	data adjustment factors (by default set to 1): yiy
2.1.5	i_SAF_yem		1	1	simulation adjustment factors (by default set to 1): yem
2.1.6	i_SAF_yse		1	1	simulation adjustment factors (by default set to 1): yse
2.1.7	i_SAF_ypr		1	1	simulation adjustment factors (by default set to 1): ypr
2.1.8	i_SAF_yiy		1	1	simulation adjustment factors (by default set to 1): yiy
2.1.9	i_tca_yemnr		0	0	non-reported incomes (initially set to 0): yem
2.1.10	i_tca_ysenr		0	0	non-reported incomes (initially set to 0): yse
2.1.11	i_tca_yprnr		0	0	non-reported incomes (initially set to 0): ypr
2.1.12	i_tca_yiynr		0	0	non-reported incomes (initially set to 0): yiy
2.2	Defil		on	on	define list of components: yem
2.2.1	Name		il_tca_yem	il_tca_yem	
2.2.2	ils_udb_yem		+	+	use if includes sub-components, otherwise list sub-components here
2.3	Defil		on	on	define list of components: yse
2.3.1	Name		il_tca_yse	il_tca_yse	
2.3.2	ils_udb_yse		+	+	use if includes sub-components, otherwise list sub-components here
2.4	Defil		on	on	define list of components: yiy
2.4.1	Name		il_tca_yiy	il_tca_yiy	
2.4.2	ils_udb_yiy		+	n/a	use if includes sub-components, otherwise list sub-components here
2.4.3	yiydv		n/a	+	IT, SK: use yiy components as ils_tca_yiy=yiy
2.4.4	yiyitdp		n/a	+	
2.4.5	yiyitob		n/a	+	
2.4.6	yiyitsb		n/a	+	
2.4.7	yiy00		n/a	n/a	
2.5	Defil		on	on	define list of components: ypr
2.5.1	Name		il_tca_ypr	il_tca_ypr	
2.5.2	ils_udb_ypr		+	n/a	use if includes sub-components, otherwise list sub-components here
2.5.3	yprrt		n/a	+	BE, BG, LT, PL: currently yprrt=0, while ils_udb_ypr=ypr > 0
2.5.4	yprro		n/a	n/a	
2.5.5	yprho		n/a	n/a	
2.5.6	yprmr		n/a	+	
2.5.7	yprld		n/a	n/a	
2.6	ChangeParam		n/a	off	switch off existing TCA module (BG, EL, IT, RO)
2.7	ChangeParam		on	on	rename output file name
2.7.1	Param_Id	1	output_std_=cc=# 1.1	output_std_=cc=# 1.1	output policy > first function > first parameter, i.e. output file name
2.7.2	Param_NewVal	1	=sys=_tca	=sys=_tca	replace "std" in the output file name with "tca"

DEFINE_DAF_TCA

This is to provide data adjustment factors (DAF) for each country and input database by income components. These are meant to indicate **the ratio of observed income component in the input dataset to its true value** (both in gross terms). $0 < \text{DAF} < 1$ implies that a particular income component is underreported in the input dataset, $\text{DAF} > 1$ that it is overreported and $\text{DAF} = 1$ that it is reported accurately. By default, DAFs are set to 1, meaning that income variables in the input dataset are not adjusted for misreporting.

It is important to note that the interpretation of DAF depends on whether income information originates from survey interviews or administrative registers. In the case of survey-based income variables, DAFs ought to reflect survey measurement error, while in the case of register-based income variables, DAFs are meant to reflect tax non-compliance. The source of information varies across countries as well as EU-SILC waves (see Table 1). One group of countries (Denmark, Finland, Sweden, Slovenia and the Netherlands) have (nearly) all income components derived from administrative registers in all SILC waves, another group of countries (France, Austria, Spain, Estonia) started initially with survey-based income information in the EU-SILC and switched to register-based incomes in later waves, while the rest of EU countries have used survey-based income information in all EU-SILC waves so far. Some countries (e.g. Bulgaria, Italy, Latvia) combine both sources of information (interviews and administrative records) for a given income component but the exact source for each

individual is not documented in the EU-SILC income flag variables. In these cases, survey interview information is typically used as the primary source of information and register information as the secondary source to fill gaps and/or correct unrealistic values.

Table 1. Source of market incomes in EU-SILC

Income source	Countries
Register-base (all waves)	DK, FI, NL, SE, SI
Register-base (since ... wave)	AT (2012), EE (2014), ES (2013), FR (2008)
Survey (interview)-based	BE, CZ, DE, EL, HR, HU, IE, LU, PL, PT, RO, SK
Mixed	BG, CY, IT, LT, LV, MT

Sources: Jäntti et al. (2013), SILC National Quality Reports.

DAFs are stored as variables (rather than constants) and can hence vary between individuals. By default, they are assumed to be the same for everyone and in all datasets for a given country, but can be made individual-specific by adding further conditions to BenCalc functions using *run_cond* and *comp_cond* parameters.

Figure 5. DEFINE_DAF_TCA module (template and Estonian case)

	Policy	Grp/No	TCA	TCA_EE	Comment
3	DEFIN ⁺ DEFINE_DAF_TCA		on	on	DEF: define data adjustment factors (DAF)
3.1	BenCalc		on	on	.07101515
3.2	BenCalc		on	on	yse (default)
3.2.1	Run_Cond		IsUsedDatabase#1	IsUsedDatabase#1	may be dataset specific
3.2.2	#_DataBasename	1	*	ee_*	NB! only databases with survey-based incomes!
3.2.3	Comp_Cond	1	1	1	add more conditions to vary factors across individuals (if needed)
3.2.4	Comp_perTU	1	1	1	
3.2.5	Output_Var		i_DAF_yse	i_DAF_yse	
3.2.6	TAX_UNIT		tu_individual_=cc=	tu_individual_=cc=	
3.3	ArithOp		n/a	off	yse (Pissarides-Weber type of estimates with EU-HBS 2010)
3.4	BenCalc		on	on	ypr (default)
3.5	BenCalc		on	on	yyi (default)

DEFINE_SAF_TCA

This is to provide simulation adjustment factors (SAF) for each country by income components. SAFs reflect **the ratio of income reported for tax purposes and true income** (i.e. the share of total true income which is reported for tax purposes) and the latter is assumed to be present in the model (after applying DAFs). $0 < \text{SAF} < 1$ implies that part of income is not reported for tax purposes and associated taxes evaded. $\text{SAF} = 1$ implies there is no tax evasion associated with the particular income component. By default, SAFs are set to 1, meaning that effectively no adjustments for tax compliance will be applied in tax-benefit simulations.

Similar to DEFINE_DAF_TCA, SAFs are stored as variables using BenCalc functions to allow introducing individual variation if needed.

Figure 6. DEFINE_SAF_TCA module (template and Estonian case)

	Policy	Grp/No	TCA	TCA_EE	Comment
4	DEFIN ⁺ DEFINE_SAF_TCA		on	on	DEF: define simulation adjustment factors (SAF)
4.1	BenCalc		on	on	yem (default)
4.2	BenCalc		on	on	yse (default)
4.2.1	Run_Cond		IsUsedDatabase#1	IsUsedDatabase#1	
4.2.2	#_DataBasename	1	*	ee_*	
4.2.3	Comp_Cond	1	1	1	add more conditions to vary factors across individuals (if needed)
4.2.4	Comp_perTU	1	1	1	
4.2.5	Output_Var		i_SAF_yse	i_SAF_yse	
4.2.6	TAX_UNIT		tu_individual_=cc=	tu_individual_=cc=	
4.3	ArithOp		n/a	off	yse (Pissarides-Weber type of estimates with EU-HBS 2010)
4.4	BenCalc		on	on	ypr (default)
4.5	BenCalc		on	on	yyi (default)

APPLY_DAF_TCA

This Add-on policy applies DAFs defined earlier by income components. Specifically, **it divides each income component of il_tca_yyy by i_DAF_yyy** . It is the only step, which is completely universal to all countries and does not contain any country-specific code.

Figure 7. APPLY_DAF_TCA module (template and Estonian case)

	Policy	Grp/No	TCA	TCA_EE	Comment
5	APPLY_DAF_TCA		on	on	DEF: apply data adjustments factors
5.1	ILVarOp		on	on	adjust survey incomes to obtain true incomes: yem*
5.2	ILVarOp		on	on	adjust survey incomes to obtain true incomes: yse*
5.2.1	Operand		1 / i_DAF_yse	1 / i_DAF_yse	
5.2.2	Operation		mul	mul	
5.2.3	Operator_IL		il_tca_yse	il_tca_yse	yse components
5.3	ILVarOp		on	on	adjust survey incomes to obtain true incomes: ypr*
5.4	ILVarOp		on	on	adjust survey incomes to obtain true incomes: yiy*
5.5	ArithOp		off	off	adjust survey incomes to obtain true incomes: yse (example)
5.6	UpdateTu		off	off	UPDATE assessment units (if required)

APPLY_SAF_TCA

First, APPLY_SAF_TCA calculates part of incomes, which are not reported for tax purposes, by income component: $i_tca_yyynr = il_tca_yyy * (1 - i_SAF_yyy)$.

Second, only incomes reported for tax purposes are retained in the tax-benefit calculations. For this purpose, **all components of il_tca_yyy are multiplied with i_SAF_yyy** .

Third, aggregate income variables (yem , yse , ypr , yiy) are re-summed. Relevant country-specific information for the TCA Add-on on all 27 EU countries is summarised in Table A.2 in Appendix A.

While first two steps are universal and similarly to APPLY_DAF_TCA not expected to need any country-specific coding, the third step requires country-specific adjustments if variable names do not properly reflect their aggregation level, e.g. yem^* should be subcomponents of yem (EMC, section 3).

Figure 8. APPLY_SAF_TCA module (template and Italian case)

	Policy	Grp/No	TCA	TCA_IT	Comment
6	APPLY_SAF_TCA		on	on	DEF: apply simulation adjustments factors
6.1	ArithOp		on	on	calculate non-reported income: yem*
6.2	ArithOp		on	on	calculate non-reported income: yse*
6.2.1	Formula		$il_tca_yse * (1 - i_SAF_yse)$	$il_tca_yse * (1 - i_SAF_yse)$	
6.2.2	Output_Var		i_tca_ysenr	i_tca_ysenr	
6.2.3	TAX_UNIT		tu_individual_=cc=	tu_individual_=cc=	
6.3	ArithOp		on	on	calculate non-reported income: ypr*
6.4	ArithOp		on	on	calculate non-reported income: yiy*
6.5	ILVarOp		on	on	keep reported income (for tax purposes): yem*
6.6	ILVarOp		on	on	keep reported income (for tax purposes): yse*
6.6.1	Operand		i_SAF_yse	i_SAF_yse	
6.6.2	Operation		mul	mul	
6.6.3	Operator_IL		il_tca_yse	il_tca_yse	
6.7	ILVarOp		on	on	keep reported income (for tax purposes): ypr*
6.8	ILVarOp		on	on	keep reported income (for tax purposes): yiy*
6.9	ArithOp		n/a	n/a	re-sum aggregate variable: yem00 (SI specific)
6.10	ArithOp		on	n/a	re-sum aggregate variable: yem
6.11	ArithOp		on	n/a	re-sum aggregate variable: yse
6.11.1	Formula		il_tca_yse	n/a	IT: yse not re-summed as not used as an aggregate. SI: aggregation currently does not hold due to differential uprating.
6.11.2	Output_Var		yse	n/a	
6.11.3	TAX_UNIT		tu_individual_=cc=	n/a	
6.12	ArithOp		n/a	n/a	re-sum aggregate variable: yemse (DE specific)
6.13	ArithOp		n/a	n/a	update yemtx (LT specific)
6.14	ArithOp		n/a	n/a	update ysetx (LT specific)
6.15	ArithOp		on	on	re-sum aggregate variable: ypr
6.16	ArithOp		on	on	re-sum aggregate variable: yiy
6.17	UpdateTu		off	off	UPDATE assessment units (if required)

TOT_INCOME_TCA

The final part of the Add-on adds back incomes not reported for tax purposes. Specifically, it **adds *i_tca_yyynr* to the largest component of *il_tca_yyy***. This way country-specific elements are avoided, which would inevitably occur when needing to name specific income components.

As in APPLY_SAF_TCA, aggregate income variables (*yem*, *yse*, *ypr*, *yyi*) are also re-summed.

Figure 9. TOT_INCOME_TCA module (template and Italian case)

	Policy	Grp/No	TCA	TCA_IT	Comment
7	TOT_INCOME_TCA		on	on	DEF: add back non-reported income
7.1	fIX IVarOp		on	on	add unreported income: yem*
7.2	fIX IVarOp		on	on	add unreported income: yse*
7.2.1	Operator_IL		il_tca_yse	il_tca_yse	
7.2.2	Operation		add	add	
7.2.3	Sel_Var		max	max	to the largest component
7.2.4	Operand		i_tca_ysenr	i_tca_ysenr	
7.3	fIX IVarOp		on	on	add unreported income: ypr*
7.4	fIX IVarOp		on	on	add unreported income: yyi*
7.5	fIX ArithOp		n/a	n/a	re-sum aggregate variable: yem00 (SI specific)
7.6	fIX ArithOp		on	n/a	re-sum aggregate variable: yem
7.7	fIX ArithOp		on	n/a	re-sum aggregate variable: yse
7.7.1	Formula		il_tca_yse	n/a	IT: yse not re-summed as not used as an aggregate. SI: aggregation currently does not hold due to differential uprating.
7.7.2	Output_Var		yse	n/a	
7.7.3	TAX_UNIT		tu_individual_cc=	n/a	
7.8	fIX ArithOp		n/a	n/a	re-sum aggregate variable: yemse (DE specific)
7.9	fIX ArithOp		n/a	n/a	update yembx (LT specific)
7.10	fIX ArithOp		n/a	n/a	update ysetx (LT specific)
7.11	fIX ArithOp		on	on	re-sum aggregate variable: ypr
7.12	fIX ArithOp		on	on	re-sum aggregate variable: yyi

3 Applying the TCA Add-on

3.1 Configuring and interpreting the Add-on

To better understand how the configuration of the TCA Add-on affects model outputs, we outline and explain its main usage scenarios. Our reference point here is the model output for baseline systems with the current TCA extensions for Bulgaria, Greece, Italy, Lithuania and Romania switched off.

There are **six options** depending on whether observed market incomes in the input dataset are considered to be reported accurately (DAF=1), underreported (DAF<1) or overreported (DAF>1) and – after applying relevant corrections to arrive at true income values – whether to carry out tax-benefit calculations under the full tax compliance (SAF=1) or partial tax compliance assumption (SAF<1). Although the technical set-up is the same for survey- and register-based dataset, their interpretation differs. In the case of survey-based datasets, income under- and overreporting and corresponding adjustment factors refer to survey measurement errors in general and not necessarily to tax compliance. In the case of registerbased datasets, any misreporting is interpreted strictly for tax purposes, implying that overreporting scenarios (3 and 6) are unlikely though theoretically possible. The six possible scenarios, for a given income component, are summarised in Table 2.

Table 2. TCA configuration and expected impact on model outputs (~ = effect ambiguous)

Scenario	Correspondence of observed market incomes with true incomes	Tax compliance assumption in simulations	TCA Add-on		Effect on aggregate ...				
			DAF	SAF	gross income	taxable income	SIC and taxes	benefits	disposable income
1	Reported accurately	Full	1	1	–	–	–	–	–
2	Underreported	Full	<1	1	↑	↑	↑	↓	↑
3	Overreported	Full	>1	1	↓	↓	↓	↑	↓
4	Reported accurately	Partial	1	<1	–	↓	↓	↑	↑
5	Underreported	Partial	<1	<1	↑	~	~	~	↑
6	Overreported	Partial	>1	<1	↓	↓	↓	↑	~

To better understand how the configuration of the TCA Add-on affects model outputs, we outline and explain its main usage scenarios. Our reference point here is the model output for baseline systems with the current TCA extensions for Bulgaria, Greece, Italy, Lithuania and Romania switched off.

Scenario 1 is the default option for all input datasets with no adjustments of data variables for income misreporting and assuming full compliance in the simulations, therefore with no effect on model outputs (given our reference point). Scenario 2 considers underreported market incomes and full tax compliance, in which case the Add-on adjustments would scale gross market incomes upwards. As these income components are typically subject to social insurance contributions (SIC) and direct taxes, these are bound to increase as well at the aggregate level, whereas aggregate benefits ought to decrease due to their means-tested elements². Overall, as effective marginal tax rates on average are below 100%, disposable incomes are expected to increase. Scenario 3 reflects overreported market incomes and full tax compliance and, hence, the aggregate effects go in the opposite direction compared to those of scenario 2.

In scenario 4, observed incomes are considered accurate and simulations are carried out assuming partial tax compliance. Therefore, gross incomes are unchanged in the model output, but *taxable* income and therefore

² Note that earnings-related contributory benefits are generally not affected as the Add-on only adjusts current market incomes.

SIC/taxes are reduced, while aggregate benefits rise as it is assumed that only official incomes are taken into account for means-testing. Taxes and benefits area therefore affected similar to scenario 3.

Scenario 5 reflects underreported market incomes in the input dataset and simulations with partial tax compliance, effectively combining scenarios 2 and 4. Therefore, the only certain outcome is that the Add-on adjusts gross incomes upwards and aggregate disposable income will increase. The effects on taxable income, taxes and benefits are ambiguous and depend on the chosen values of DAF and SAF. Similarly, scenario 6 depicting overreported market incomes and tax-benefit calculations under partial tax compliance, combines scenarios 3 and 4. In this case, the effect on aggregate taxable income and taxes (both decrease) and benefits (increase) is clear, while the impact on disposable income is ambiguous.

To provide numeric examples, we have carried out some illustrative simulations with the TCA Add-on for employment and self-employment income in all 27 countries. Appendix B reports on aggregate changes by income components for scenarios 2, 4 and 5, separately for employment and self-employment income. As with Table 2, the model outputs for scenarios are compared with those for baseline systems with the current TCA extensions switched off.

Table B.1 shows results for scenario 2 with DAF=0.8 for employment income. As expected, original income, employee SIC, taxes and disposable income increase in all countries and benefits decrease (slightly). Employee SIC are unaffected only in Denmark, where these are lump sum payments. Self-employed SIC (and other SIC) either remain constant or decrease in some cases due to interactions with employee SIC, e.g. where these account towards the minimum liability of self-employment SIC. Notice that Denmark has no self-employment SIC as such but a special levy on self-employment income (labour market contribution), which is classified as a tax. The Netherlands has an integrated system of social contributions and hence employee and self-employment SIC are not separable. Table B.2 shows similar patterns for scenario 2 with DAF=0.5 for self-employment income. In this case, self-employment SIC increase except in Spain where these are lump-sum payments.

Results for scenario 4 with SAF=0.8 for employment income and SAF=0.5 for self-employment income are shown in Tables B.3 and B.4, respectively. Market incomes remain constant, taxes and SIC fall, while benefits (to a lesser extent) and disposable incomes increase in line with expectations. In some cases, self-employed SIC increase when (reported) employment income decreases due to interactions with employee SIC.

Scenario 5 combines the two previous scenarios with DAF=SAF=0.8 for employment income (Table B.5) and DAF=SAF=0.5 for self-employment income (Table B.6). Gross income and disposable income increase as would be generally expected. Taxes, SIC and benefits remain constant in this particular case because DAF=SAF but in general could change in any direction as indicated in Table 2.

3.2 Kukk et al. (2019) estimates of self-employment income underreporting

Depending on underlying assumptions, Pissarides and Weber (1989) type of estimates can be compatible with any scenario described in Section 2.1. If the PW method is applied to survey-based incomes and interpreted in terms of survey mismeasurement without making inference about tax compliance then all scenarios are feasible in the EUROMOD context, as both under- and overreporting of incomes in the input dataset would be possible. The PW results are then only used to parameterise DAFs, while SAFs need to be based on other sources of information.

If the PW results can also be interpreted in terms of tax compliance, the PW results could be used to inform both DAFs and SAFs (e.g. scenario 5). For example, by setting i_DAF_yse and i_SAF_yse to 0.6, we consider that only 60% of true self-employment income is reported in the input database and for tax-benefit simulations assume that this is also the proportion of selfemployment income reported for tax purposes. In the context of tax compliance, income overreporting is unlikely to occur however (cf. scenario 3) and the PW results cannot inform both DAFs and SAFs in scenario 6, i.e. capture simultaneously overreporting (in the survey context) and underreporting for tax purposes.

The Add-on incorporates the estimates of self-employment income underreporting obtained with the PW method for 14 countries (Kukk et al., 2019) in line with scenario 5 above.³ That is, both i_DAF_yse and i_SAF_yse

³ These are Bulgaria, Cyprus, Czechia, Estonia, Greece, Spain, Croatia, Hungary, Ireland, Lithuania, Latvia, Poland, Portugal and Romania.

are set to $1 - (\bar{k} - 1)/\bar{k} = 1/\bar{k}$ for self-employment income in EUROMOD, where \bar{k} is average underreporting factor. This is done with the following caveats.

- **Data comparability.** Estimates of income underreporting were obtained with the EUHBS 2010 for countries with survey-based income information, while EUROMOD operates with EU-SILC 2006-2019, which includes a mixture of countries with survey- and register-based income information. By utilising these estimates in EUROMOD for different policy years, we are assuming that these are valid across the two datasets and that people's tax compliance behaviour has not changed in the period of interest.
- **Sample selection.** Similar to previous studies, we have applied the PW method to a selection of relatively homogeneous households (e.g. couple households with working-age head) to ensure more stable and precise estimates, while taxes and benefits in EUROMOD are simulated for the whole population. We assume that the estimates of income underreporting are also valid for the rest of population with self-employment income.
- **Unit of analysis.** As the natural unit of analysis for consumption is household, the PW method utilises household income, while EUROMOD operates with individual incomes. We therefore assume that the same adjustment factor applies to all individuals in the same household.
- **Income concept.** The PW method is applied to net incomes and without distinguishing between income components (due to data limitations). We use these estimates to adjust gross self-employment income, which may result in underestimating related tax non-compliance.
- **Analytical and statistical uncertainty.** The PW method yields analytical bounds rather than a point estimate of income underreporting and the bounds are further subject to statistical uncertainty reflected in standard errors. We utilise the estimates of the upper bound to balance the potential bias arising from different income concepts (see previous item).
- **Static estimates.** The PW estimates do not represent a behavioural model relating tax compliance to tax-benefit policies (e.g. effective tax rates), among others, and this needs to be taken into account in simulations involving tax-benefit policy changes.

With these caveats in mind, the monetary and distributional effects of partial tax compliance related to self-employment income, based on the PW type of estimates, are presented in Table 3. Due to the small share of self-employment income in total market income, the monetary effects are modest but not insignificant – disposable incomes at the aggregate level increase from 0.45% in Estonia to 13.99% in Greece and market income from 0.5% to 23.7%. (All taxes and benefits remain constant as officially reported incomes are not affected.) On the other hand, the distributional effects in terms of income inequality (Gini), poverty headcount ratio (FGT0) and poverty gap (FGT1) measures show very small changes, going in either direction across countries. We therefore conclude that monetary and distributional effects of tax noncompliance limited to self-employment incomes are rather limited.

Due to the practical challenges for incorporating the estimates of income underreporting in the model, arising from the limitations of the Pissarides-Weber method or underlying data, the TCA Add-on should be thought of as a technical device to **sensitivity test** standard tax-benefit simulations under alternative assumptions on tax compliance rather than providing definite and conclusive adjustments for tax compliance. Substantial challenges remain in terms of providing comparative and consistent estimates of income underreporting and tax evasion by various income components and population subgroups.

Table 3. Monetary and distributive effects of partial tax compliance using the PW estimates

	Total change		Baseline values				Absolute change			
	Market income (MI)	Disposable income (DPI)	Gini (MI)	Gini (DPI)	FGT0	FGT1	Gini (MI)	Gini (DPI)	FGT0	FGT1
BG	1.13%	0.87%	0.534	0.416	0.229	0.069	0.001	0.002	0.001	0.001
CY	1.12%	0.97%	0.450	0.338	0.165	0.027	0.000	-0.001	-0.006	-0.002
CZ	5.20%	4.79%	0.433	0.267	0.098	0.020	0.003	0.008	-0.012	-0.002
EE	0.50%	0.45%	0.445	0.312	0.193	0.044	0.000	-0.001	-0.001	0.000
EL	23.70%	13.99%	0.531	0.335	0.177	0.049	0.032	0.046	-0.026	-0.080
ES	2.00%	1.78%	0.512	0.359	0.206	0.064	0.000	0.001	0.010	0.030
HR	2.70%	2.00%	0.476	0.332	0.187	0.057	0.000	0.002	-0.006	-0.002
HU	3.40%	3.72%	0.464	0.322	0.224	0.086	0.002	0.004	-0.014	-0.006
IE	8.02%	8.47%	0.519	0.386	0.198	0.045	0.011	0.016	-0.009	-0.002
LT	5.37%	6.11%	0.502	0.378	0.197	0.055	0.004	0.009	-0.013	-0.003
LV	2.61%	2.63%	0.488	0.369	0.209	0.061	-0.001	0.001	-0.008	-0.003
PL	3.49%	3.34%	0.468	0.300	0.153	0.041	0.000	0.003	-0.013	-0.004
PT	1.89%	1.75%	0.522	0.372	0.170	0.042	0.003	0.004	-0.004	-0.001
RO	1.59%	1.56%	0.530	0.388	0.233	0.081	-0.008	-0.006	-0.018	-0.007

Source: own calculations with EUROMOD I4.0 (2021 baseline policies, updated 2019 data).

References

- Benedek, D., and Lelkes, O. (2011). "The distributional implications of income under-reporting in Hungary", *Fiscal Studies*, 32(4), 539-560.
- Bollinger, C. B. (1998). "Measurement error in the Current Population Survey: A nonparametric look.", *Journal of Labor Economics*, 16 (3), 576-594.
- Bound, J., and Krueger, A. B. (1991). "The extent of measurement error in longitudinal earnings data: Do two wrongs make aright?", *Journal of Labor Economics*, 9 (1), 1-24.
- EUROMOD (2018). "EUROMOD Modelling Conventions", EUROMOD Technical Note Series EMTN/1.1.
- Fiorio, C. V., and D'Amuri, F. (2005). "Workers' tax evasion in Italy", *Giornale degli Economisti e Annali di Economia*, 64(2/3), 241-264.
- Jäntti, M., Törmälehto, V.-M., and Marlier, E. (eds) (2013). "The use of registers in the context of EU-SILC: challenges and opportunities", *Statistical working papers*, Eurostat.
- Kapteyn, A., and Ypma, J. (2007). "Measurement Error and Misclassification: A Comparison of Survey and Administrative Data", *Journal of Labor Economics*, 25, 513-551.
- Kukk, M., Paulus, A., and Staehr, K. (2019). "Cheating in Europe: underreporting of selfemployment income in comparative perspective", *International Tax and Public Finance*. doi: [10.1007/s10797-019-09562-9](https://doi.org/10.1007/s10797-019-09562-9)
- Meijer, E., Rohwedder, S., and Wansbeek, T. (2012). "Measurement error in earnings data: Using a mixture model approach to combine survey and register data", *Journal of Business & Economic Statistics*, 30(2), 191-201.
- Paulus, A. (2015). "Tax evasion and measurement error: An econometric analysis of survey data linked with tax records", *ISER Working Paper*, 2015-10, University of Essex.
- Paulus, A., Kukk, M., and Staehr, K. (2018). "Assessment of tax evasion based on consumption, wealth and income using EUROMOD: final report", *Praxis Centre for Policy Studies*.
- Pissarides, C. A., and Weber, G. (1989). "An expenditure-based estimate of Britain's black economy", *Journal of Public Economics*, 39(1), 17-32.

Appendix A: Market income variables in EUROMOD

Table A.1: EUROMOD standard income lists for market income components

Country	ils_udb_yem	ils_udb_yse	ils_udb_yiy	ils_udb_ypr
AT	yem, yemot, yot01	yse	yiy	ypr
BE	yem	yse	yiy	ypr
BG	yemtx, yemn	ysetx, ysenr	yiy	ypr
CY	yem, bml	yse	yiy	ypr
CZ	yem	yse	yiy	ypr
DE	yem	yse	yiy	ypr
DK	yem	yse	yiy	ypr
EE	yem00, yemabtx, yemabnt	ysena, ysera, yseag, ysebs,	yiyit, yiyot, yiydv	yprrt, yprro,
EL	yemre, yemn	ysere, ysenr	yiy	ypr
ES	yem	yse	yiy	yprrt
FI	yem	yse00, yse01	yiytx00, yiytx01,	ypr
FR	yem00, yemxp	yse	yiy	ypr
HR	yem, yst	ysenr00, ysenr01, ysere00,	yiy	ypr
HU	yem	yse	yiy	ypr
IE	yem	yse	yiy	ypr
IT	yem, yemtj, yemxp, yempv,	yse, ysenr_s, yseil, yseib	yiy	ypr
LT	yem	yse	yiy	ypr
LU	yem	yse	yiy	ypr
LV	yem	yse	yiytx, yiynt	ypr
MT	yem00, yemls	yse	yiy	ypr
NL	yem, bcbma01, bcbma02	yse	yiy	ypr
PL	yempj, yemtj	yseag, ysebs	yiy	ypr
PT	yem	yse	yiy	ypr
RO	yem	yse	yiy	ypr
SE	yem	yse	yiy	ypr
SI	yemtx, yemnt, yemst, yemaj	yse00, ysest, yseaj	yiy	ypr
SK	yemwg, yemtj, yemaj,	yse	yiy	ypr

Table A.2: Uprating of market income components in EUROMOD

Country	yem*	yse*	yy*	ypr*
AT	yem, yemot, yot01	yse	yy	ypr
BE	yem	yse	yy	ypr, (yprrt)
BG	yem=yemtx+yemnr	yse=ysetx+ysenr	yy	ypr, (yprrt, yprld)
CY	yem	yse	yy	ypr
CZ	yem	yse	yy	ypr
DE	yem	yse	yy	ypr
DK	yem	yse	yy	ypr
EE	yem=yem00+yemabnt+yemabtx	yse=ysera+yseana+yseag+ysebs+yseil+yseab	yy=yyit+yyot+yydv	ypr=yprrt+yprro+yprho
EL	yem > yemre + yemnr	yse > ysere + ysenr	yy	ypr
ES	yem	yse	yy	ypr=yprrt
FI	yem	yse=yse00+yse01	yy, yytx00, yytx01, yynt	ypr
FR	yem, yem00, yemxp	yse	yy	ypr, yprrt
HR	yem, yst	yse, ysenr00, ysenr01, ysere00, ysere01	yy	ypr
HU	yem	yse	yy	ypr=yprrt
IE	yem	yse	yy	ypr
IT	yem, yemtj, yemxp, yempv, yemnt	yse > yseev, ysenr	yy=yydv+yyitdp+yyitob+yyitsb	ypr, yprrt, yprmr
LT	yem, yemtx	yse, ysetx	yy	ypr, (yprrt)
LU	yem	yse	yy	ypr
LV	yem	yse	yy=yytx+yynt	ypr
MT	yem=yem00+yemls	yse	yy	ypr
NL	yem	yse	yy	ypr=yprrt
PL	yem, yempj, yemtj	yse=yseag+ysebs	yy	ypr, (yprrt)
PT	yem	yse	yy	ypr
RO	yem	yse	yy	ypr
SE	yem	yse	yy	ypr
SI	yem, yem00, yemtx, yemnt, yemst, yemaj	yse, yse00, ysest, yseaj	yy	ypr
SK	yem, yemwg, yemtj, yemaj, yemot, yemab, (yemcs)	yse	yy, yy00, yydv	ypr

Appendix B: Illustrative simulations with the TCA Add-on

Table B.1: Changes in aggregate income (scenario 2 with DAF=0.8 for employment income)

Country	Market income	Benefits	Employer SIC	Employee SIC	Self-empl. SIC	Other SIC	Taxes	Disp. income
AT	21.2%	-0.4%	20.8%	21.1%	-1.3%	0.0%	38.4%	10.6%
BE	21.6%	-0.2%	28.6%	26.9%	0.0%	n/a	32.2%	9.5%
BG	20.9%	-0.3%	19.5%	19.5%	0.0%	n/a	22.7%	16.5%
CY	21.4%	-1.4%	21.8%	21.8%	0.0%	0.0%	44.6%	13.7%
CZ	20.6%	-0.7%	24.6%	24.3%	-0.1%	n/a	41.5%	14.0%
DE	22.1%	-0.6%	12.9%	17.2%	0.0%	-0.2%	36.2%	13.2%
DK	19.5%	-1.2%	0.0%	0.0%	n/a	n/a	19.9%	12.8%
EE	23.6%	-0.1%	24.4%	25.0%	-1.5%	n/a	33.4%	15.8%
EL	14.2%	-0.7%	24.1%	24.3%	0.0%	0.0%	16.6%	8.2%
ES	21.2%	-0.4%	17.0%	17.0%	0.0%	0.0%	36.5%	12.2%
FI	21.3%	-0.8%	24.7%	24.9%	0.0%	n/a	27.9%	10.6%
FR	19.6%	-1.4%	29.3%	23.9%	0.0%	n/a	22.0%	11.4%
HR	21.6%	-0.7%	0.0%	0.0%	0.0%	0.0%	1.0%	20.0%
HU	22.2%	0.0%	25.0%	25.6%	0.1%	n/a	20.3%	15.8%
IE	20.7%	-1.1%	25.7%	31.0%	0.0%	n/a	34.1%	11.4%
IT	12.9%	-0.2%	21.6%	19.8%	0.0%	n/a	21.2%	5.3%
LT	21.4%	-0.1%	24.0%	24.3%	0.0%	0.0%	30.3%	13.6%
LU	22.9%	-0.9%	19.7%	17.8%	0.0%	-12.0%	32.7%	12.0%
LV	23.5%	-0.1%	24.3%	23.3%	0.0%	n/a	31.4%	16.1%
MT	20.9%	-0.9%	10.8%	11.3%	0.0%	n/a	43.5%	14.4%
NL	18.4%	-1.3%	16.2%	14.4%	n/a	-0.2%	43.7%	11.3%
PL	21.3%	-0.2%	23.0%	22.9%	-2.2%	n/a	22.0%	14.2%
PT	21.5%	-0.5%	25.0%	25.0%	-0.4%	n/a	32.1%	11.7%
RO	23.7%	-0.1%	25.0%	25.0%	0.0%	n/a	23.0%	15.6%
SE	22.4%	-0.4%	27.0%	14.2%	-1.9%	n/a	30.4%	12.6%
SI	21.8%	-0.9%	23.7%	23.7%	0.0%	0.4%	35.7%	12.9%
SK	20.8%	-0.3%	25.0%	25.5%	0.0%	0.0%	41.9%	14.4%

Source: own calculation with EUROMOD I4.0 (2021 baseline policies, uprated 2019 data).

Table B.2: Changes in aggregate income (scenario 2 DAF=0.5 for self-empl. income)

Country	Market income	Benefits	Employer SIC	Employee SIC	Self-empl. SIC	Other SIC	Taxes	Disp. income
AT	11.9%	-0.2%	0.0%	0.0%	50.5%	0.0%	24.3%	5.8%
BE	10.7%	-0.1%	0.0%	0.1%	55.8%	n/a	16.7%	4.9%
BG	11.4%	-0.2%	0.0%	0.0%	67.5%	n/a	8.1%	8.7%
CY	10.1%	-0.6%	0.0%	0.0%	46.7%	0.0%	20.9%	6.6%
CZ	16.5%	-0.4%	0.0%	0.0%	88.0%	n/a	36.0%	9.6%
DE	7.9%	-0.1%	0.0%	0.0%	49.4%	-0.1%	16.5%	4.5%
DK	5.8%	-0.3%	0.0%	0.0%	n/a	n/a	6.5%	3.5%
EE	1.5%	0.0%	0.0%	0.0%	55.7%	n/a	1.7%	1.0%
EL	38.1%	-0.7%	0.0%	0.0%	2.9%	0.0%	78.2%	22.1%
ES	10.6%	-0.3%	0.0%	0.0%	0.0%	0.0%	20.5%	6.1%
FI	6.1%	-0.1%	0.0%	0.0%	117.2%	n/a	6.0%	3.2%
FR	7.4%	-0.2%	0.0%	0.0%	75.4%	n/a	9.2%	3.4%
HR	11.4%	-0.3%	0.6%	0.0%	7.6%	0.0%	21.6%	9.5%
HU	9.8%	0.0%	0.0%	0.0%	88.1%	n/a	7.9%	6.7%
IE	14.9%	-0.5%	0.0%	0.0%	88.1%	n/a	27.2%	7.8%
IT	21.7%	0.0%	0.0%	0.0%	59.8%	n/a	33.1%	8.7%
LT	12.0%	-0.1%	0.0%	0.0%	69.4%	0.0%	8.7%	10.5%
LU	4.4%	-0.1%	0.0%	0.0%	59.6%	-0.9%	6.6%	2.2%
LV	3.5%	0.0%	0.0%	0.0%	83.9%	n/a	4.3%	2.3%
MT	11.1%	-0.4%	0.0%	0.0%	28.2%	n/a	24.7%	7.5%
NL	11.2%	-1.0%	0.0%	5.6%	n/a	2.8%	25.3%	7.2%
PL	14.0%	-0.1%	0.0%	0.0%	3.1%	n/a	13.3%	11.0%
PT	10.0%	-0.3%	0.0%	0.0%	74.6%	n/a	13.9%	5.9%
RO	4.8%	-0.2%	0.0%	0.0%	155.1%	n/a	5.7%	4.2%
SE	2.4%	-0.1%	0.0%	0.0%	121.9%	n/a	3.5%	1.0%
SI	7.7%	-1.0%	0.0%	0.0%	41.2%	0.1%	14.9%	4.6%
SK	16.2%	-0.4%	0.0%	0.0%	83.7%	0.2%	38.0%	6.2%

Source: own calculation with EUROMOD I4.0 (2021 baseline policies, uprated 2019 data).

Table B.3 Change in aggregate income (scenario 4 with SAF=0.8 for employment income)

Country	Market income	Benefits	Employer SIC	Employee SIC	Self-empl. SIC	Other SIC	Taxes	Disp. income
AT	0.0%	0.5%	-18.5%	-19.8%	1.0%	0.0%	-27.2%	7.8%
BE	0.0%	0.3%	-24.1%	-24.1%	0.0%	n/a	-24.5%	10.6%
BG	0.0%	0.4%	-17.2%	-17.2%	0.0%	n/a	-18.0%	3.0%
CY	0.0%	1.4%	-18.6%	-18.7%	0.0%	0.0%	-28.8%	3.7%
CZ	0.0%	1.2%	-19.9%	-19.2%	0.0%	n/a	-30.5%	3.9%
DE	0.0%	0.9%	-14.2%	-16.9%	0.0%	0.5%	-25.7%	8.4%

DK	0.0%	1.7%	0.0%	0.0%	n/a	n/a	-14.9%	9.5%
EE	0.0%	0.2%	-19.1%	-20.0%	1.7%	n/a	-26.6%	4.4%
EL	0.0%	0.7%	-19.7%	-19.8%	0.0%	0.0%	-10.8%	3.7%
ES	0.0%	0.4%	-14.4%	-14.4%	0.0%	0.0%	-25.4%	4.7%
FI	0.0%	0.9%	-19.8%	-19.9%	0.0%	n/a	-20.6%	7.8%
FR	0.0%	1.8%	-23.3%	-19.6%	0.0%	n/a	-15.0%	5.0%
HR	0.0%	0.6%	0.0%	0.0%	0.0%	0.0%	0.3%	0.2%
HU	0.0%	0.0%	-20.0%	-20.7%	-0.1%	n/a	-16.2%	6.7%
IE	0.0%	1.3%	-20.7%	-25.3%	0.0%	n/a	-25.4%	8.0%
IT	-4.4%	0.7%	-17.6%	-16.2%	0.0%	n/a	-15.5%	1.4%
LT	0.0%	0.3%	-16.0%	-19.7%	0.0%	0.0%	-24.0%	8.7%
LU	0.0%	1.4%	-17.9%	-15.8%	0.0%	19.0%	-24.2%	8.5%
LV	0.0%	0.1%	-19.7%	-19.3%	0.0%	n/a	-24.4%	5.9%
MT	0.0%	1.3%	-12.4%	-13.6%	0.0%	n/a	-31.2%	4.6%
NL	0.1%	2.2%	-16.5%	-14.6%	n/a	0.2%	-28.9%	7.7%
PL	0.0%	0.2%	-19.2%	-19.2%	1.9%	n/a	-16.4%	4.8%
PT	0.0%	0.7%	-20.0%	-20.0%	0.6%	n/a	-22.8%	6.1%
RO	0.0%	0.2%	-20.0%	-20.0%	0.0%	n/a	-19.8%	9.2%
SE	0.0%	0.6%	-21.2%	-15.4%	2.4%	n/a	-20.1%	6.9%
SI	0.1%	1.2%	-18.9%	-18.9%	0.0%	-0.1%	-27.2%	7.7%
SK	0.0%	0.5%	-20.0%	-20.8%	0.0%	-0.2%	-31.6%	5.1%

Source: own calculation with EUROMOD I4.0 (2021 baseline policies, uprated 2019 data).

Table B.4 Changes in aggregate income (scenario 4 with SAF=0.5 for self-empl. income)

Country	Market income	Benefits	Employer SIC	Employee SIC	Self-empl. SIC	Other SIC	Taxes	Disp. income
AT	0.0%	0.4%	0.0%	0.0%	-40.2%	0.0%	-9.4%	2.8%
BE	0.0%	0.2%	0.0%	-0.1%	-41.5%	n/a	-6.6%	3.0%
BG	0.0%	0.1%	0.0%	0.0%	-44.5%	n/a	-3.7%	1.4%
CY	0.0%	1.0%	0.0%	0.0%	-44.9%	0.0%	-3.6%	1.2%
CZ	0.0%	0.7%	0.0%	0.0%	-35.1%	n/a	-13.7%	2.3%
DE	0.0%	0.2%	0.0%	0.0%	-33.5%	0.1%	-7.2%	1.9%
DK	0.0%	0.2%	0.0%	0.0%	n/a	n/a	-3.0%	1.9%
EE	0.0%	0.1%	0.0%	0.0%	-30.7%	n/a	-0.8%	0.2%
EL	0.0%	1.0%	0.0%	0.0%	-7.5%	0.0%	-30.1%	5.6%
ES	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	-7.4%	1.3%
FI	0.0%	0.1%	0.0%	0.0%	-56.4%	n/a	-2.5%	1.2%
FR	0.0%	0.1%	0.0%	0.0%	-45.1%	n/a	-3.5%	1.6%
HR	0.0%	0.3%	-0.3%	0.0%	-3.8%	0.0%	-7.1%	0.5%
HU	0.0%	0.0%	0.0%	0.0%	-30.8%	n/a	-4.0%	1.6%

IE	0.0%	0.5%	0.0%	0.0%	-44.3%	n/a	-11.7%	3.5%
IT	-4.4%	0.6%	0.0%	0.0%	-45.7%	n/a	-13.9%	2.2%
LT	0.0%	0.1%	0.0%	0.0%	-43.8%	0.0%	-4.1%	1.7%
LU	0.0%	0.2%	0.0%	0.0%	-43.6%	1.9%	-2.8%	1.2%
LV	0.0%	0.1%	0.0%	0.0%	-53.3%	n/a	-1.8%	0.6%
MT	0.0%	1.3%	0.0%	0.0%	-22.6%	n/a	-8.2%	1.5%
NL	0.0%	1.4%	0.0%	-3.6%	n/a	-2.7%	-8.4%	2.5%
PL	0.0%	0.1%	0.0%	0.0%	-15.8%	n/a	-5.8%	1.4%
PT	0.0%	0.3%	0.0%	0.0%	-44.7%	n/a	-5.8%	1.6%
RO	0.0%	0.2%	0.0%	0.0%	-86.8%	n/a	-2.8%	0.7%
SE	0.0%	0.1%	0.0%	0.0%	-54.5%	n/a	-1.3%	0.6%
SI	0.0%	1.3%	0.0%	0.0%	-14.7%	0.0%	-5.5%	1.5%
SK	0.0%	0.8%	0.0%	0.0%	-40.0%	-2.5%	-10.7%	4.4%

Source: own calculation with EUROMOD I4.0 (2021 baseline policies, uprated 2019 data).

Table B.5 Changes in aggregate income (scenario 5 with DAF=SAF=0.8 for empl. income)

Country	Market income	Benefits	Employer SIC	Employee SIC	Self-empl. SIC	Other SIC	Taxes	Disp. income
AT	21.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	20.6%
BE	21.6%	0.0%	0.0%	0.0%	0.0%	n/a	0.0%	22.8%
BG	20.9%	0.0%	0.0%	0.0%	0.0%	n/a	0.0%	20.0%
CY	21.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	18.7%
CZ	20.6%	0.0%	0.0%	0.0%	0.0%	n/a	0.0%	18.9%
DE	22.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	23.8%
DK	19.5%	0.0%	0.0%	0.0%	n/a	n/a	0.0%	25.1%
EE	23.6%	0.0%	0.0%	0.0%	0.0%	n/a	0.0%	21.3%
EL	14.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	13.2%
ES	21.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	18.7%
FI	21.3%	0.0%	0.0%	0.0%	0.0%	n/a	0.0%	20.8%
FR	19.6%	0.0%	0.0%	0.0%	0.0%	n/a	0.0%	17.8%
HR	21.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	20.3%
HU	22.2%	0.0%	0.0%	0.0%	0.0%	n/a	0.0%	24.1%
IE	20.7%	0.0%	0.0%	0.0%	0.0%	n/a	0.0%	21.9%
IT	12.9%	0.2%	0.0%	0.0%	0.0%	n/a	-0.1%	12.4%
LT	21.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	24.4%
LU	22.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	22.7%
LV	23.5%	0.0%	0.0%	0.0%	0.0%	n/a	0.0%	23.5%
MT	20.9%	0.0%	0.0%	0.0%	0.0%	n/a	0.0%	20.1%
NL	18.5%	0.0%	0.0%	0.0%	n/a	0.0%	0.0%	21.4%
PL	21.3%	0.0%	0.0%	0.0%	0.0%	n/a	0.0%	20.4%

PT	21.5%	0.0%	0.0%	0.0%	0.0%	n/a	0.0%	19.8%
RO	23.7%	0.0%	0.0%	0.0%	0.0%	n/a	0.0%	27.0%
SE	22.4%	0.0%	0.0%	0.0%	0.0%	n/a	0.0%	22.3%
SI	21.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	22.6%
SK	20.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	20.9%

Source: own calculation with EUROMOD I4.0 (2021 baseline policies, uprated 2019 data).

Table B.6 Changes in aggregate income (scenario 5 with DAF=SAF=0.5 for self-empl. income)

Country	Market income	Benefits	Employer SIC	Employee SIC	Self-empl. SIC	Other SIC	Taxes	Disp. income
AT	11.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	11.6%
BE	10.7%	0.0%	0.0%	0.0%	0.0%	n/a	0.0%	11.3%
BG	11.4%	0.0%	0.0%	0.0%	0.0%	n/a	0.0%	11.0%
CY	10.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	8.8%
CZ	16.5%	0.0%	0.0%	0.0%	0.0%	n/a	0.0%	15.2%
DE	7.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	8.5%
DK	5.8%	0.0%	0.0%	0.0%	n/a	n/a	0.0%	7.4%
EE	1.5%	0.0%	0.0%	0.0%	0.0%	n/a	0.0%	1.4%
EL	38.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	35.4%
ES	10.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	9.4%
FI	6.1%	0.0%	0.0%	0.0%	0.0%	n/a	0.0%	6.0%
FR	7.4%	0.0%	0.0%	0.0%	0.0%	n/a	0.0%	6.7%
HR	11.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	10.7%
HU	9.8%	0.0%	0.0%	0.0%	0.0%	n/a	0.0%	10.6%
IE	14.9%	0.0%	0.0%	0.0%	0.0%	n/a	0.0%	15.7%
IT	21.7%	0.2%	0.0%	0.0%	0.0%	n/a	-0.1%	20.8%
LT	12.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	13.6%
LU	4.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.4%
LV	3.5%	0.0%	0.0%	0.0%	0.0%	n/a	0.0%	3.5%
MT	11.1%	0.0%	0.0%	0.0%	0.0%	n/a	0.0%	10.7%
NL	11.2%	0.0%	0.0%	0.0%	n/a	0.0%	0.0%	12.9%
PL	14.0%	0.0%	0.0%	0.0%	0.0%	n/a	0.0%	13.3%
PT	10.0%	0.0%	0.0%	0.0%	0.0%	n/a	0.0%	9.2%
RO	4.8%	0.0%	0.0%	0.0%	0.0%	n/a	0.0%	5.4%
SE	2.4%	0.0%	0.0%	0.0%	0.0%	n/a	0.0%	2.4%
SI	7.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	8.0%
SK	16.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	16.3%

Source: own calculation with EUROMOD I4.0 (2021 baseline policies, uprated 2019 data).

GETTING IN TOUCH WITH THE EU

In person

All over the European Union there are hundreds of Europe Direct information centres. You can find the address of the centre nearest you at: https://europa.eu/european-union/contact_en

On the phone or by email

Europe Direct is a service that answers your questions about the European Union. You can contact this service:

- by freephone: 00 800 6 7 8 9 10 11 (certain operators may charge for these calls),
- at the following standard number: +32 22999696, or
- by electronic mail via: https://europa.eu/european-union/contact_en

FINDING INFORMATION ABOUT THE EU

Online

Information about the European Union in all the official languages of the EU is available on the Europa website at: https://europa.eu/european-union/index_en

EU publications

You can download or order free and priced EU publications from EU Bookshop at: <https://publications.europa.eu/en/publications>. Multiple copies of free publications may be obtained by contacting Europe Direct or your local information centre (see https://europa.eu/european-union/contact_en).

The European Commission's science and knowledge service

Joint Research Centre

JRC Mission

As the science and knowledge service of the European Commission, the Joint Research Centre's mission is to support EU policies with independent evidence throughout the whole policy cycle.



EU Science Hub

ec.europa.eu/jrc



@EU_ScienceHub



EU Science Hub - Joint Research Centre



EU Science, Research and Innovation



EU Science Hub