FAQ: simulating Consumption Taxes in EUROMOD

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Contents

From model version J0.1+ beta onwards, EUROMOD includes the possibility of simulating consumption taxes (CT), together with direct taxes and benefits.

This document has been prepared by the EUROMOD team at the JRC. For contact information and further support, check https://euromod-web.jrc.ec.europa.eu/support.

GENERAL

- **Who developed this?**

  It is the result of a collective effort of the JRC, KU Leuven, University of Essex and Praxis over 2014-2021, in several phases. After that, the JRC refined and updated it and fully incorporated to EUROMOD over 2022-2024.

- **Which taxes can be simulated?**

  EUROMOD can currently simulate the Value Added Tax (VAT) on all goods and services consumed by households, and EU harmonized excises (ad-valorem and specific) on specific consumption categories, such as energy (incl. electricity), alcohol and tobacco, but the platform allows including further consumption taxes on other products. Simulations are performed at 5-digit COICOP code level (2003 version).

- **What is the coverage?**

  It is available for the 27 EU countries for seven systems' years: 2010[1] and 2019-2024.

DATA

- **What input data is used?**

  In order to simulate taxes on households' consumption, the standard EUROMOD input data (EU-SILC-based) are matched with Household Budget Survey (HBS) data to incorporate information on household consumption patterns.[2] EUROMOD input datasets based on EU-SILC 2010 were matched with HBS 2010,[3] while datasets based on EU-SILC 2015 and 2019-2022 were matched with HBS 2015.[4] As a result, 149 new datasets were produced, with the following naming convention:

  CC_YYYY_sn_yyyy_co_mn.txt

  (e.g., SK_2022_b1_2015_03_e2.txt)

  where

  - CC = country code
  - YYYY = SILC year
  - sn = version (letter and number) of the SILC-based data
  - yyyy = HBS year (2010 or 2015)
  - co = COICOP version code (currently, 2003 for all cases, abbreviated to 03)
  - mn = version (letter and number) of the matched HBS (e = ESTAT, n = national)

  On top of the EU-SILC variables, these datasets contain shares of consumption (over disposable income) for 193 expenditure categories (for most countries, excl. AT, DE and NL, where consumption are available at different disaggregation levels). These variables are named xs?????, where ????? is the corresponding 5-digit COICOP code. The meaning of each COICOP code can be consulted in the DRD files of the matched datasets.

- **Do these datasets replace the ones based only on EU-SILC?**

  . It depends on the SILC year. In particular:

[1] 2012 for HR.

[2] The dataset includes consumption in the form of shares over income and are allocated to each household member. Original HBS expenditure data are provided at household level. To obtain absolute expenditures, consumption shares over income should be multiplied by total household (disposable) income.

[3] For DK and HR, the EUROMOD EU-SILC-based data corresponds to 2012

[4] For IT the EU-SILC-based data 2019-2022 are not available; for LU the EU-SILC-based data 2020 is not available; for SK the EU-SILC-based data 2021 is not available.

- For all EU-SILC waves up to 2022, EU-SILC-only datasets will be always available. Matched EU-SILC-HBS datasets will be additionally available for SILC years 2010, 2015 and 2019-2022. I.e., for each matched dataset (e.g., SK_2022_b1_2015_03_e2.txt), the corresponding EU-SILC-only dataset (SK_2022_b1.txt) will remain available.
- For EU-SILC waves from 2023 onwards, only matched datasets (e.g., SK_2024_b1_2015_03_e2.txt) will be produced and disseminated.

- **Can I use the matched datasets even if I don't want to simulate consumption taxes?**

  Yes, and the results are the same as when you use the EU-SILC-only datasets. Simply the shares of expenditure over income are not used in the simulation. From th stable version (J1.0+), matched datasets are the best match (default) dataset wherever available.

- **How can I get the matched datasets?**

  On top of the conditions needed to get access to the EU-SILC-only datasets, the Research Project Proposal (RPP) you have with EUROSTAT has to mention HBS. If this is not your case, you can amend your RPP to add HBS (all the information can be found here).

MODEL

- **How are consumption taxes modelled in EUROMOD?**

  The modelling of consumption taxes is based on three components:

  - **A new policy tco_CC**, placed at the end of the spine. It contains the parameters of VAT and excises (as constants). It sets them to the desired value for the simulation and it creates a set of income lists which are subsequently used by the CT add-ons to perform the calculation of consumption taxes each household pays based on their purchases.
  - **A new Consumption Taxes table (CT table)**, accessible from the Country Tools tab. This table details the list of consumption taxes parameters (VAT, ad-valorem and specific excises, consumer prices only for goods subject to excises) for each category of goods. The CT table is country specific and it stores the baseline parameters by system-year. Information in the CT table should not be altered for policy reform simulations, as they represent the baseline tax rules. The simulation of reform and counterfactual scenarios should not be done by changing the parameters in the CT table (baseline), instead the user should simply change the assignation in the spine (i.e., overwriting the constant value in the spine).
  - **Four new add-ons**, available in the Add-ons tab and runnable from the Run dialog. These add-ons are just instrumental to perform the necessary algebra for the computation of VAT and excises, so the user does not have to open or modify them. Specifically, CT_XBASE computes consumption taxes at baseline, while the other three compute consumption taxes under the reform allowing for the following behavioural assumptions:
    - CT_XCQ computes consumption taxes reform assuming constant quantities;
    - CT_XCIS computes consumption taxes reform assuming constant shares of consumption over income;
    - CT_XCES computes consumption taxes reform assuming constant shares of expenditure over total consumption.

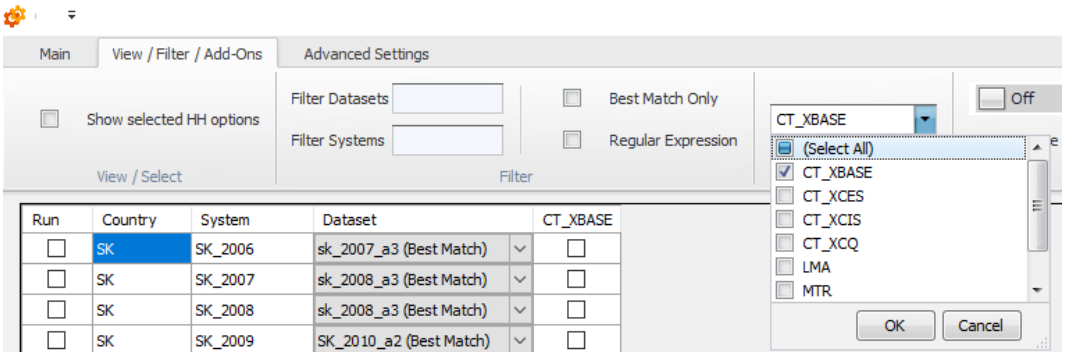
To use the reform add-ons, you need first to run the baseline. The simulations are carried out as follows:

- First, the standard EUROMOD simulations (direct taxes, social insurance contributions and benefits) are carried out. As a result, the model produces disposable income (ils_dispy) for each individual.
- Consumption expenditures are computed by multiplying the shares of expenditure over income of each COICOP code (from the input data) by the disposable income produced by EUROMOD. Please note that if you introduce changes in direct taxes, social insurance contributions or benefits, this will affect disposable income, hence consumption on each COICOP code.
- Then the corresponding VAT (il_tva) and excise liabilities (il_txa and il_txv, for ad-quantum/specific and ad-valorem excises, respectively) are computed on consumption, and a new measure, post-CT disposable income per household (ils_dispyPCT_hh), is computed as disposable income minus VAT and excises (ils_dispy - il_tva - il_txa - il_txv).[5] Total consumption taxes are save in the income list ils_taxco.

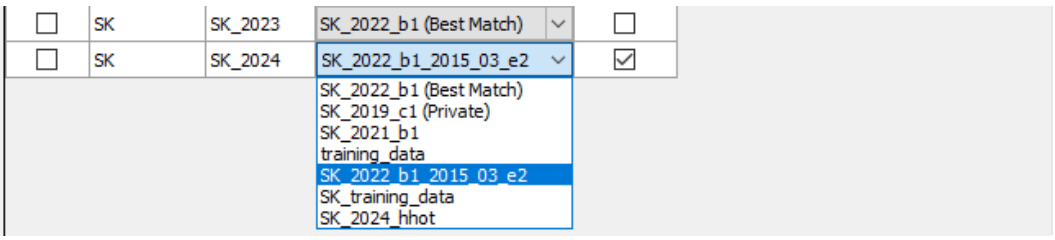
- **How do I run the baseline with consumption taxes?**

  You have to:

  - Open the Run dialog.
  - Make the CT_XBASE add-on column visible by selecting it in the dropdown menu available in the tab "View / Filter / Add-Ons".



  - For the systems you want to run, tick the CT_XBASE column and select a matched dataset from the dropdown list in the Dataset column. Matched datasets are only available for systems where parameters for consumption taxes simulation are available (2010 and 2019-2022). The CT_XBASE add-on will run correctly only if using the matched dataset.



  - Click on Run.

[5] Note that expenditures and consumption taxes are all measured at household level, hence post-consumption disposable income is also measured at household level.

The run produces four datasets:

- CC_yyyy_xbase_std.txt: an extended standard output, including the results from the baseline simulations on direct taxes, social contribution, benefits and consumption taxes;
- CC_yyyy_tco_cq.txt: an auxiliary file storing the consumption quantities[6] for the constant quantity reform scenario/add-on;
- CC_yyyy_tco_ces.txt: an auxiliary file storing total expenditures and savings (used as an input for the constant shares of expenditure over total consumption reform scenario/add-on);
- CC_yyyy_tco_fclb.txt: an auxiliary file storing the calibration factors at baseline (used as an input for all simulated reform scenarios to ensure consistency of calibration between baseline and reforms.

- **How do I model reforms?**

  As in the standard use of EUROMOD, you have to create first a new reform system, as a copy of a baseline system (e.g., SK_2024_reform based on SK_2024). Then, given that consumption taxes calculation are harmonised at EU-level, usual reforms will just consist of parametrical changes of VAT rates and excises and its allocation to different items. In particular:

  - If you want to **change the values of an existing standard (or reduced) rate of VAT for all goods and services to which the rate applies**, you have to do it in the first function of the tco_CC policy in the spine. In the baseline system, these rates are just set to the values stored as constants in the CT table and represent the actual tax rules in place in each country and year. These are named as follows: $tco_base_t_std for standard, $tco_base_t_red* for reduced rates and $tco_base_t_zero for zero rate. To simulate a reform, modify the assignation of these parameters in the spine of the reform system that has been created. E.g., replacing $tco_base_t_std by 0.25.

33	tco_sk		off	off	TAX: Commodities
33.1	fx DefConst		on	on	Parameters
33.1.1	$tco_t_std	1	$tco_base_t_std	0.25	vat - standard rate
33.1.2	$tco_t_red1	2	$tco_base_t_red1	$tco_base_t_red1	vat - reduced rate 1
33.1.3	$tco_t_red2	13	n/a	n/a	vat - reduced rate 2
33.1.4	$tco_t_zero	3	$tco_base_t_zero	$tco_base_t_zero	vat - 0% rate and exempted
33.1.5	$tco_theta1	4	20%	20%	Theta- Tax incidence parameter level 1
33.1.6	$tco_theta2	5	50%	50%	Theta- Tax incidence parameter level 2
33.1.7	$tco_theta3	6	80%	80%	Theta- Tax incidence parameter level 3
33.1.8	$tco_theta0	7	100%	100%	Theta=1
33.1.9	$tco_theta_flag	12	0	0	TIP: switch – set equal 1 to activate tax incidence pass through (TIP) calculations

  - If you want to **change the rate of VAT applied to specific items (single or multiple consumption goods or services)**, you have to do it in the second function of the tco_CC policy in the spine where VAT rates are assigned to each specific item. The parameter needs to be changed in the reform system column that you have created. E.g., if rice is

[6] Consumption quantities represent physical quantities only for goods subject to excises. For other goods for which consumer price is not available and producer price is assumed to be equal one, consumption quantities are normalized (i.e., multiplied by the actual producer price). See footnote at page 77 here for more details.

taxed at the standard VAT rate and you want to tax it at the first reduced rate, you have to change $tco_t_std to $tco_t_red1.

33.2	fx DefConst		on	on	Parameters: vat rates (all goods)
33.2.1	Run_Cond		GetDataCOICOPVersion=2003	GetDataCOICOPVersion=2003	
33.2.2	$tco_t_01111		$tco_t_std	$tco_t_red1	01111 : 01 Food and nonalcoholic beverages - 1 Food - 1 Bread and cereals - 1 Rice
33.2.3	$tco_t_01112		$tco_t_red1	$tco_t_red1	01112 : 01 Food and nonalcoholic beverages - 1 Food - 1 Bread and cereals - 2 Bread
33.2.4	$tco_t_01113		$tco_t_std	$tco_t_std	01113 : 01 Food and nonalcoholic beverages - 1 Food - 1 Bread and cereals - 3 Pasta products

- If you want to **change specific excises**, you have to do it in the fourth function of the tco_CC policy. In the baseline system, specific excises are set to their values stored as constants in the Consumption Taxes table (i.e, $tco_base_a_[COICOP code]) and they are assigned to parameters $tco_a_[COICOP code] used for the simulation. In the reform system column, to change a specific excise on, e.g., cigarettes in SK from 91.3 EUR to 100 EUR per 1,000 pieces, you have to replace $tco_base_a_02211 (91.3 in the Consumption Taxes table) with "100" in the spine. It is important to be careful about the unit measure of reference (i.e., EUR per 1,000 pieces or EUR per Kg, etc.).

33.4	fx DefConst		on	on	Parameters: specific excises (excise goods)
33.4.1	$tco_a_02111	1	$tco_base_a_02111	$tco_base_a_02111	excise - specific - 02111 Ethyl alcohol (per 100 l of pure alcohol)
33.4.2	$tco_a_02121	2	$tco_base_a_02121	$tco_base_a_02121	excise - specific - 02121 Wine (per 100 l)
33.4.3	$tco_a_02122	3	$tco_base_a_02122	$tco_base_a_02122	excise - specific - 02122 Sparkling wine (per 100 l)
33.4.4	$tco_a_02131	4	$tco_base_a_02131	$tco_base_a_02131	excise - specific - 02131 Beer (per 100 L per Plato of finished product)
33.4.5	$tco_a_02211	5	$tco_base_a_02211	100	excise - specific - 02211 Cigarettes (per 1000 pieces)
33.4.6	$tco_a_02212	6	$tco_base_a_02212	$tco_base_a_02212	excise - specific - 02212 Cigars (per 1000 pieces)

- If you want to **change ad-valorem excises**, you have to do it in the fifth function of the tco_CC policy. It works exactly as the fourth function, but the relevant constants are named $tco_base_v_[COICOP code]. The parameter has to be changed in a reform system column.

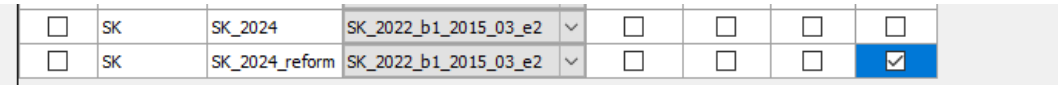
Note that by default all scenarios assume a full pass-through of consumption taxes, meaning that any proportional change in consumption tax rate would be fully reflected in the consumer price.

- **How to run the simulation of a reform?**

  Simulating a reform scenario requires two **sequential** steps:

  - First, you have to **run the baseline system with the CT_XBASE add-on** (i.e., SK_2024 in our case) with the matched dataset (SK_2022_b1_2015_03_e2 in our case). The baseline run produces the above-described auxiliary files containing information on consumed quantities and current savings which are needed to simulate the reforms
  - After that (not simultaneously!), you can **run the reform system**, again with the matched dataset, **with any of the other three add-ons (CT_XCES, CT_XCIS, CT_XCQ)**; you have to

make them visible in the run window like you did with CT_XBASE before. This produces an output file with a suffix indicating which add-on has been used to produce the data, and hence the behavioural assumption used. In our example, we run system SK_2024_reform with constant quantities (CT_XCQ), so we get the following output file: SK_2024_reform_cq_std.txt.

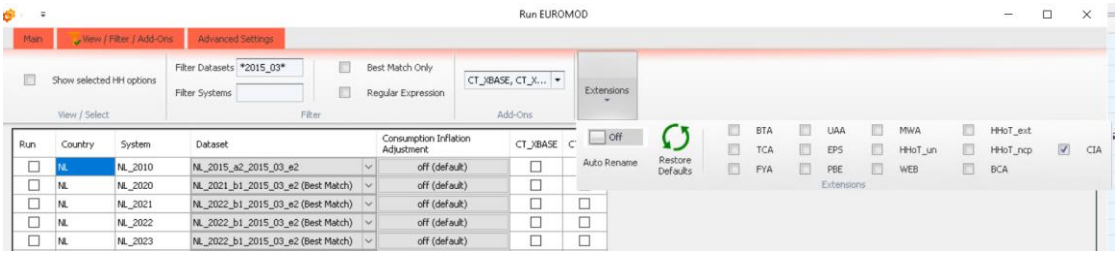


- **How to account for rising inflation effects?**

From version J1.0+, it is possible to adjust expenditures for inflation changes. This is done within the add-ons by inflating the shares of consumption over income by HICP indices for each COICOP between t and t-1, after correcting for disposable income growth for the same period (see Annex on Modelling inflation in the CT framework for the theoretical explanation).

In order to activate this part of the model, the user should activate the Consumption Inflation Adjustment (CIA) extension by:

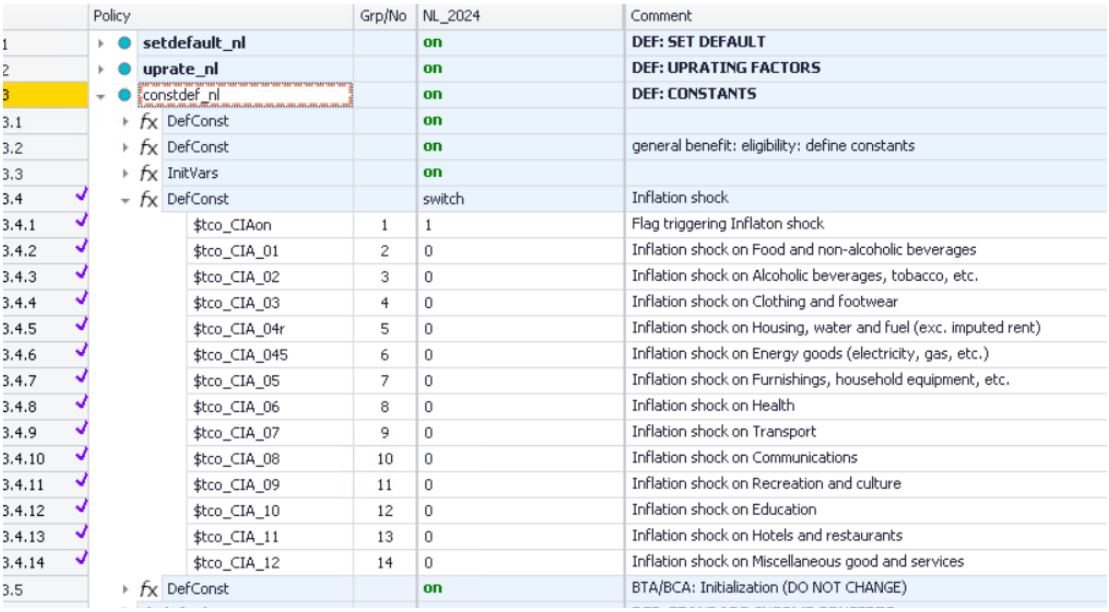
- Go to run EUROMOD tab View/Filter/Add-ons
- Expand the menu Extensions and tick CIA: this will visualise the column Consumption Inflation Adjustment
- The extension is set to OFF by default. Set it to ON by clicking on the cell related to relevant system-data combination.



Note that simulation of inflation (prices) shocks assumes constant quantities (CQ), hence CIA extension by construction only works with CT_XBASE and the CT_XCQ add-ons. This is in line with EUROMOD static modelling which represents a "morning-after" response where households ability to immediately adapt their consumption following a sudden price shock is limited.

Also note that in order to simulate the impact of inflation correctly, one should add to the input data the percentage change in disposable income (name it *ydsyc_a*) for each household between time t-1 and t.

Switching ON the inflation simulation applies annual inflation rates by product category (source EUROSTAT, DG ECFIN forecast for the total inflation of the latest quarter of last year). These values are stored within the CT table as $tco_base_upr_[COICOP]. Running this scenario and comparing the output to the baseline without inflation provides an estimation of the impact of the inflation. The user can also simulate different inflation scenarios at COICOP level 1 (2 digits) categories by modifying the value listed in policy ConstDef_cc, function "Inflation shock". For example, what if annual inflation for food was 5% instead of the officially recorded? Typing 5% for food and non-alcoholic beverages below, multiplies the expenditures of foods and non-alcoholic beverages by 1.05.



	Policy	Grp/No	NL_2024	Comment
1	setdefault_nl		on	DEF: SET DEFAULT
2	uprate_nl		on	DEF: UPRATING FACTORS
3	constdef_nl		on	DEF: CONSTANTS
3.1	DefConst		on	
3.2	DefConst		on	general benefit: eligibility: define constants
3.3	InitVars		on	
3.4	DefConst		switch	Inflation shock
3.4.1	$tco_CIAon	1	1	Flag triggering Inflaton shock
3.4.2	$tco_CIA_01	2	0	Inflation shock on Food and non-alcoholic beverages
3.4.3	$tco_CIA_02	3	0	Inflation shock on Alcoholic beverages, tobacco, etc.
3.4.4	$tco_CIA_03	4	0	Inflation shock on Clothing and footwear
3.4.5	$tco_CIA_04r	5	0	Inflation shock on Housing, water and fuel (exc. imputed rent)
3.4.6	$tco_CIA_045	6	0	Inflation shock on Energy goods (electricity, gas, etc.)
3.4.7	$tco_CIA_05	7	0	Inflation shock on Furnishings, household equipment, etc.
3.4.8	$tco_CIA_06	8	0	Inflation shock on Health
3.4.9	$tco_CIA_07	9	0	Inflation shock on Transport
3.4.10	$tco_CIA_08	10	0	Inflation shock on Communications
3.4.11	$tco_CIA_09	11	0	Inflation shock on Recreation and culture
3.4.12	$tco_CIA_10	12	0	Inflation shock on Education
3.4.13	$tco_CIA_11	13	0	Inflation shock on Hotels and restaurants
3.4.14	$tco_CIA_12	14	0	Inflation shock on Miscellaneous good and services
3.5	DefConst		on	BTA/BCA: Initialization (DO NOT CHANGE)

RESULTS

- **What does the output file contain?**

  The output file contains:

  - The standard EUROMOD output variables, i.e., uprated input variables and simulated variables and income lists for direct taxes, social insurance contributions and benefits.
  - EUROMOD output variables related to consumption taxes:
    - Consumption as income share (xs?????) at 5-digit COICOP category;
    - Consumption expenditure at 5-digits COICOP category (x?????) and aggregated at 2-digit COICOP (il_x??);
    - Simulated consumption taxes: VAT (tva?????), ad-valorem excise (txv?????) and specific excise (txa?????) liabilities by 5-digit COICOP category, as well as aggregate consumption tax liabilities at 2-digit COICOP (il_tva??, il_txa?? and il_txv??);
    - Simulated consumption quantities[7] (xx?????);
    - Expenditures and tax liabilities adjusted by National Account at 5-digits and 2-digits COICOP (x?????_na, tva?????_na, txa?????_na, txv?????_na, il_x??_na, il_tva??_na, il_txa??_na and il_txv??_na);
    - Total consumption taxes paid by each household (ils_taxco), assigned to the household head: VAT non-adjusted (il_tva) and adjusted (il_tva_na) by National Accounts, and excises non-adjusted (il_tx = il_txa + il_txv) and adjusted (il_tx_na = il_txv_na + il_txa_na) by National Accounts.
    - Post-Consumption household disposable income ils_dispyPCT_hh.

[7] Simulated quantities are expressed in units in which specific excises are levied only for items subject to excises for which EUROMOD knows the consumer price paid (i.e., quantities = expenditures / consumer price, hence xx????? = x????? / $tco_q_?????). Note that for items on which excises are not levied, producer price is assumed to be equal 1, hence consumer price is 1+VAT. In this case xx????? are measured in monetary terms at producer prices. For more details on this, see section 7.1.1 here.

- **How can I analyse the results?**

  Like when running EUROMOD with EU-SILC-only data, there are several ways of analysing your results:

  - **Statistics Presenter** (Applications → EUROMOD Statistics). From software version 3.7.4 onwards, the standard options of the Statistics Presenter (Default, Baseline-reform, Multiple systems) offer indicators of simulations produced including consumption taxes, if simulated. The tool recognises the output file and produces results according to the simulations found. When consumption taxes are simulated, the main variable for distributional analysis is post-CT disposable income, which is the result of deducting consumption taxes from the disposable household income computed by EUROMOD.
  - **In-depth Analysis** (Applications → EUROMOD Statistics). The tool can be used with any EUROMOD output file, including or not simulations of consumption taxes. The default values of the tables follow the standard simulations without consumption taxes, but the tool is fully customisable and can produce indicators based on any variable included in the output.
  - **Macrovalidation** (Applications → Macrovalidation). When the output file contains simulated consumption taxes, the macrovalidation tool offers two additional tabs that compare the results of the simulations with external statistics: one with the results obtained in the simulation (non-calibrated) and the other with those results calibrated to match national accounts (calibrated). External statistics are stored in Country tools → External statistics.
  - **External software**. Since EUROMOD produces tab-separated text files as output, you can also use any statistical software (R, Python, Stata, Excel, etc.) to analyse the results.

ANNEX: Modelling inflation in EUROMOD

- **General Framework**

Before starting the discussion on how to model inflation, is worth just reminding how consumption expenditure is calculated in the CT tool. The CT input data contain information on household income shares of consumption and the CT simulations use the household disposable income produced by EUROMOD. Let **Y** be the household disposable income and, **α**, the consumption share of income.[8] Consumption expenditure, **E**, is therefore calculated by the CT tool as follows:

$$\alpha * Y = E = P * C$$

Where **C** is the consumed quantity and **P** its price. Note that, when simulating successive years with the CT using the same input data, consumption expenditure grows at the same rate as household disposable income. Therefore, when modelling inflation we need to mind double counting as well as to account for its real impact on consumer, namely the erosion of purchasing power of household income. We discuss how to do this below.

- **Modelling inflation**

Let us know introduce inflation occurring at a rate, **π**. If household disposable income and consumption prices were growing at the same rate, then nothing would change in real terms:

$$\frac{P * (1 + \boldsymbol{\pi}) * C}{Y * (1 + \boldsymbol{\pi})} = \frac{P * C}{Y} = \alpha$$

Otherwise stated, when disposable income and consumption prices grow at the same rates, then the consumption share of income, saving share of income and consumed quantity all remain constant.[9] Note that in such a scenario inflation does not affect household welfare: since prices and income grow at the same rates, nothing changes in real terms. I.e., consumption goods will come with new price tags and people will have more money to spend. In practice, household will be able to afford no more no less than the same consumption basket they were buying before. Note that, if that were the situation in the real world, there would be no ground for concerns about inflation hitting households.

The issue is that, in the real world, price inflation and disposable growth do not typically occur at the same rate for a number of reasons. The most prominent are:

1. **Wage indexing is lagged**, **infrequent and incomplete** such that workers receive wage adjustments based on past inflation and not on current inflation. Also, workers do not receive a wage adjustment in every period (depending on the country and job, the wage adjustment might take place only every few years). Moreover, people typically see their wages to increase by only a fraction of the inflation rate.

2. **Benefits and taxes are also indexed in an imperfect way** again this is because the adjustment of amounts and income bands is lagged and incomplete.

In our notation above, this means that disposable income at the denominator grows at a different (and typically lower) rate than the numerator. Let's call this rate μ, then:

[8] The formalization above can straightforwardly be extended to multiple consumption goods. However, since this extension does not alter the conclusions while complicating the notation, we show with one good only.

[9] Of course, we are excluding here the possibility that consumers change tastes or they are affected by monetary illusion etc. since these are not modelled in EUROMOD.

$$\frac{P * (1 + \boldsymbol{\pi}) * C}{Y * (1 + \mu)} \neq \frac{P * (1 + \boldsymbol{\pi}) * C}{Y * (1 + \boldsymbol{\pi})} = \alpha$$

Under the assumption that household do not change their consumed quantities from one period to the other, we can account for the difference between price inflation and disposable income growth by adjusting the consumption share of income. In more detail, the consumption share of income is re-calculated as follows:

$$\frac{P * (1 + \boldsymbol{\pi}) * C}{Y * (1 + \mu)} = \alpha * \frac{(1 + \boldsymbol{\pi})}{(1 + \mu)}$$

As a consequence, savings will adjust to meet the budget constraint, i.e.:

$$Y - \frac{P * (1 + \boldsymbol{\pi}) * C}{Y * (1 + \mu)} = 1 - \alpha * \frac{(1 + \boldsymbol{\pi})}{(1 + \mu)}$$

Note that whenever wage growth is lower than price inflation, i.e., $\mu < \boldsymbol{\pi}$, the consumption share of income increases and the share of saving reduces.

Finally, it should be noted that in the CT tool we have a large number of households whose disposable income growth occurs at a different rate. Similarly, we have various goods/good categories whose price growth also occurs at a different rate. Accounting for this, we can define the post-inflation income share of consumption of good *j* for household *i,* $\boldsymbol{\alpha_{ii}^{infl}}$

$$\alpha_{ji}^{infl} = \alpha_{ji} * \frac{(1 + \boldsymbol{\pi_j})}{(1 + \mu_i)}$$

Where $\boldsymbol{\pi_j}$ is the rate of inflation specific to good/good categories *j* and $\mu_i$is the disposable income growth specific to household i.[10]

[10] Disposable income growth can be just calculated as the ratio between baseline simulated disposable income, i.e., ils_dispy, in the year of the analysis and in the previous one.