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## The redistributive impact of consumption taxation in the EU: Lessons from the post-financial crisis decade

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## JRC TECHNICAL REPORT

# The Redistributive Impact of Consumption Taxation in the EU: Lessons from the post-financial crisis decade

*JRC Working Papers on  
Taxation and Structural  
Reforms No 10/2022*

Maier Sofia and Ricci Mattia

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## **Acknowledgements**

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## **Authors**

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## **Executive summary**

- In this study, we use the Indirect Tax Tool (ITT) of EUROMOD, the microsimulation model of the EU, to simulate the tax changes that took place during the post-financial crisis decade in each Member State.
- We investigate the dynamics and the effects of consumption taxation in the broader context of the tax-benefit system. We look at evidence of tax shifts as well as at the use of targeted transfers to compensate the poorest.

## **Policy context**

- During the past decade, consumption taxes have risen in the vast majority of the EU Member States. Such increases were motivated by restoring budget balance, shifting the burden of taxation away from labour and achieving environmental targets.
- Given the fiscal consequences of the COVID-19 pandemic and renewed climate and public health ambitions, the role for consumption taxation is only likely to be heightened in the years to come. Accordingly, there is much to be learned from the past decade of increasing consumption taxation and their redistributive effects across the EU, to draw possible policy lessons.

## **Main findings**

- Our results suggest that tax policies implemented over 2010-19 resulted in increases in the tax burden for households in the EU and mostly failed in shifting the burden away from labour income. The burden of consumption taxation over household income increased by about a percentage point in the EU as a whole, while social transfers became more targeted toward the bottom of the income distribution. Increases in social transfers were typically not sufficient to compensate poorer households.
- Consumption tax hikes were driven in the first place by the taxation of transport and housing-related energy consumption. While the taxation of transport is the component that has increased the most, the highest inequality cost was driven by the taxation of housing-related energy consumption.
- At the end of the decade, in 2019, consumption taxes absorbed on average about 14% of household disposable income in the EU. Member States with the highest burden of consumption taxation tend to redistribute less. This is particularly the case of several Eastern European countries where the redistributive effect of social transfers is largely wiped out by consumption taxation.
- Across the EU, the taxation over food, alcohol, tobacco, housing and transport consumption absorbs the highest share of household budget and - with the exception of transport - is responsible for the most adverse redistributive impact.
- From a policy perspective, our results suggest that future tax reforms should be more closely assessed from a redistribution perspective. More so, in the current high inflation environment particularly affecting necessary goods such as home heating and food. Attention should be given at the role of consumption taxation in amplifying price shocks considering whether there is scope to reduce the taxation of such necessary goods without compromising environmental targets. Especially in the Member States where their share of household budget is large and these items are taxed at the standard rate of VAT.
- Finally our results suggest that while in some countries tax reforms have resulted in a shift of the tax burden away from direct taxes toward consumption taxes, in most countries this was not the case. The objectives set in the EU Green Deal should represent an opportunity to reform tax systems to contribute both to employment and EU objectives in this area.

# The Redistributive Impact of Consumption Taxation in the EU: Lessons from the post-financial crisis decade\*

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## Abstract

During the 2010-2019 decade, consumption taxes have risen in the vast majority of the EU Member States as a result of austerity measures, tax shifts as well as taxing transport and housing-related energy consumption. The redistributive impact of these policy changes remains mostly unexplored. In this paper, we provide new empirical evidence on the redistributive effect of changes in VAT and excises over this period, along with other developments in the broader tax-benefit system including tax shift reforms. Our results indicate that the consumption tax systems in the EU have become more unequalizing in most countries as a result of an increase in the tax burden and of its regressivity. While the taxation of transport is the component that has increased the most, the highest inequality impact was driven by the taxation of housing-related energy consumption. Only in a few countries these policy changes were accompanied by an increase in social transfers sufficient to compensate the poorest households.

**Keywords:** Consumption taxation, Tax shift, Austerity, Inequality, Microsimulation.

**JEL Classification:** C81, D31, H20, H22

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# 1 Introduction

During the past decade, consumption taxes have risen in the vast majority of the EU Member States. At the end of 2019, consumption taxes accounted for the second largest share of revenues (27.7%), after labour taxes (51.9%) in the EU (see: [European Commission \(2021b\)](#)). Such increases were often motivated by restoring public budget balance following the 2008/2009 crisis. Moreover, shifting the tax burden from labor to consumption was considered as a way to make the tax system more incentive-compatible<sup>1</sup> and to achieve environmental targets.<sup>2</sup> Given the fiscal consequences of the COVID-19 pandemic and renewed climate<sup>3</sup> and public health ambitions,<sup>4</sup> the role for consumption taxation in the EU is only likely to be heightened in the years to come.

Nonetheless, the use of consumption taxation does not come without trade-offs. In fact, a series of cross-country studies (among others: [O'donoghue et al., 2004](#), [Decoster et al., 2010](#) and [Thomas, 2022](#)) suggest that consumption taxation is likely to be inequality-increasing. In particular, selected groups such as poors, retired and unemployed are found to be disproportionately affected ([Decoster et al., 2010](#)). Furthermore, while virtually all components of consumption taxation are regressive (when measured against household income), some are much more regressive than others given differences in consumption patterns among income groups. On the other hand, some features of the consumption tax system might reduce its degree of regressivity. For example, the presence of reduced VAT rates results in a progressive VAT system in some countries, when measured with respect to consumption expenditure ([Thomas, 2022](#)).<sup>5</sup>

While the literature has provided numerous evidence on the effects of consumption taxation in the EU, much work remains to be done to compare its impact on household income across Member States. Indeed, since consumption taxes are not all equally regressive and tax rules vary significantly across the EU, Member States are likely to feature substantially different distributive outcomes. Also, opportunities exist in the tax-benefit system to balance equity and efficiency, for example by compensating efficient but regressive consumption taxes with targeted social transfers. However, it is not clear which EU coun-

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<sup>1</sup>This idea is supported by a large piece of literature, see among others: [Diamond and Mirrlees \(1971\)](#), [Auerbach et al. \(1983\)](#), [Bosch and van den Noord \(1990\)](#), [Laczó and Rossi \(2020\)](#) and [Nguyen et al. \(2021\)](#).

<sup>2</sup>That taxation can provide the price-induced signal needed for consumers to internalise environmental costs and promote efficiency is long-established in economics; see, in particular, the original contributions of [Pigou \(1924\)](#) and [Atkinson and Stiglitz \(1976\)](#). For a recent review of the topic, see [Cnossen \(2011\)](#).

<sup>3</sup>See: [European Commission \(2020\)](#). The 2030 Climate Target Plan has significantly stepped up the European climate ambitions requiring a substantial revision of the EU policy framework. This includes the revision of the Energy Taxation Directive, which lays down minimum excise duty rates for the taxation of energy products.

<sup>4</sup>See: [European Commission \(2021a\)](#). The EU Beating Cancer Plan sets out the EU ambitions in terms of cancer prevention, treatment and care. These include actions addressing key risk factors such as tobacco and harmful alcohol consumption. For this purpose, the EU Commission is considering reviewing the minimum excise duties levied on them.

<sup>5</sup>VAT remains regressive with respect to household income.

tries feature comparatively more regressive consumption tax systems and how successful have they been at compensating poorer households. As consumption taxes are expected to have a central role in the years to come, there is much to be learned from the past decade of increasing consumption taxation, as well as from their redistributive effects across the EU to draw possible policy lessons. This is the area where our work intends to contribute.

In this paper, we employ the Indirect Tax Tool of the EUROMOD microsimulation model (see, [Akoğuz et al., 2020](#)) to investigate the redistributive impact of the EU tax systems and of their reform. We begin by investigating the policy changes which took place between 2010 and 2019, looking at evidence of tax-shifts, as well as the extent to which increases in consumption taxation have been compensated by transfers targeted at the bottom of the income distribution. We then analyse the redistributive effects of consumption tax changes, disentangling the impact of changes in VAT, specific excises and ad-valorem excises. Finally, we analyse the characteristics of the consumption tax systems across the EU in 2019. We look at how the tax burden and its regressivity vary across countries. We investigate whether countries featuring a higher consumption tax burden also tend to feature a lower redistributive tax-benefit system.

Our results suggest that tax policies implemented over 2010-19 resulted in increases in the tax burden for households in the EU and mostly failed in shifting the burden away from labour income. The burden of consumption taxation over household income increased by about a percentage point in the EU as a whole, while social transfers became more targeted toward the bottom of the income distribution. However, increases in social transfers were typically not sufficient to compensate poorer households. Consumption tax hikes were driven in the first place by the taxation of transport and housing-related energy consumption. While the taxation of transport is the component that has increased the most, the highest inequality cost was driven by the taxation of housing-related energy consumption. Finally, we analyse the characteristics of the consumption tax systems resulting from this decade of policy changes. In 2019, consumption taxes absorbed on average about 14% of household disposable income in the EU. Member States with the highest burden of consumption taxation tend to redistribute less. This is particularly the case of several Eastern European countries where the redistributive effect of social transfers is largely, when not entirely, wiped out by consumption taxation. Across the EU, the taxation over food, alcohol, tobacco, housing and transport consumption absorb the highest share of household budget and - with the exception of transport - is responsible for the most adverse redistributive impact.

The rest of the paper is structured as follows. In Section 2, we discuss the methodology and data underpinning our analysis. We then move in Section 3, to present the results of our analysis. In Section 4, we summarize the main lessons learned from our study and offer some concluding remarks.



## 2 Methodology and Data

In this section we present the methodology and data underpinning our analysis. We begin in subsection 2.1, discussing the microsimulation model we employ to estimate household tax liabilities and cash-benefits entitlements. We then move, in subsection 2.2, to discuss how we measure the redistributive effects of the policy changes in the 2010-19 decade. Throughout the section, we discuss assumptions and limitations of our analysis.

### 2.1 The microsimulation model

For our empirical analysis we employ EUROMOD, the European Union tax-benefit microsimulation model.<sup>6</sup> EUROMOD combines country-specific coded policy rules with representative household microdata (mainly from the European Union Statistics on Income and Living Conditions, EU-SILC) to simulate tax liabilities and cash benefit entitlements. Therefore, EUROMOD simulations take into account the role played by each tax-benefit instrument, their possible interactions, and generate household disposable income (i.e. income after direct taxes and cash benefits).

For the simulation and analysis of consumption taxes, we employ the recently developed Indirect Tax Tool extension of EUROMOD<sup>7</sup> (henceforth the "ITT"). The ITT extends the scope of the EUROMOD simulations, allowing for the joint analysis of direct and indirect taxation. To simulate consumption tax liabilities, the ITT combines the underlying microdata of EUROMOD with household expenditure information for more than 200 commodity categories. These mainly come from the 2010 harmonised Eurostat Household Budget Surveys (EU-HBS), the latest available release at the time this model was developed.<sup>8</sup> To combine EU-HBS data (i.e the source dataset) with the EU-SILC data of the same year (i.e the recipient dataset), a semi-parametric procedure developed by [Akoğuz et al. \(2020\)](#) is used; a description of this procedure can be found in the appendix of this paper. Starting from the household disposable income simulated by EUROMOD, the ITT applies the consumption taxation rules in place in each country (including VAT, specific and ad-valorem excises) to simulate households' adjusted disposable income (i.e. income after direct taxes, cash benefits and consumption taxation).

EUROMOD and the ITT are validated by comparing aggregated estimates for benefits, direct and consumption taxes with official statistics, such as administrative data and national statistics. For the standard EUROMOD output,

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<sup>6</sup>See: [Sutherland and Figari \(2013\)](#) for more information.

<sup>7</sup>See [Akoğuz et al. \(2020\)](#) for a comprehensive description of the consumption tax Tool, including the construction of the underlying micro dataset, the simulation of consumption taxes as well as the validation of the model.

<sup>8</sup>EUROSTAT harmonized 2010 HBS datasets for Austria and the Netherlands were not available and the data of Luxembourg did not contain information on income. For Austria and Luxembourg, the ITT uses national HBS data. In particular, for Luxembourg the 2013 national HBS was used as this was the first year where the income information was adequate for the imputation method. For the Netherlands, 2015 HBS dataset was employed instead.

including direct taxes and benefits, a report on the macro-validation is included in the Country Report which is produced yearly for each Member State.<sup>9</sup> For the ITT extension, macrovalidation is undertaken separately, being the ITT currently not part of the EUROMOD baseline.<sup>10</sup> For the ITT the macrovalidation is operated over consumption expenditures and consumption tax liabilities at the level 1 of COICOP consumption classification, including 12 broad consumption categories. Model validation is carried out along two main dimension. Firstly, the ITT simulated expenditures in each category are compared to their national account counterparts. Secondly, simulated consumption tax liabilities are compared to government revenue statistics.

Validation results are presented in the appendix of this paper. They indicate that simulated consumption generally falls short of expenditure data from national account, with certain categories (typically alcoholic beverages and tobacco) being systematically under-simulated. However, a closer analysis of these data (by contrasting HBS consumption data with simulated consumption) indicates a rather good performance of the imputation method with the shortfall being the responsibility of the well known under-reporting of consumption in survey. On the other hand, when comparing simulated VAT liabilities with government revenues statistics we find a generally good coverage. The validation of excises revenues cannot be meaningfully carried out due to the lack of data on the share of households liabilities in total revenues.

## 2.2 Measuring the redistributive effect of policy changes

We assess the effect of changes in tax-benefit policy on household incomes between 2010 and 2019, drawing on the decomposition framework proposed by [Bargain and Callan \(2010\)](#). In more detail, policy effects are isolated from any other changes in the population characteristics and market incomes. We refer to this as the “pure policy effect”. The main idea is that household (adjusted) disposable income at different points in time is the result of interactions between: (i) tax-benefit policies, (ii) the distribution of market incomes and (iii) household characteristics. Thus, the change in incomes between two periods can be attributed to each of these three factors. Given that EU-HBS data underpinning our simulation are only available with significant time-lag, and they are currently not available for 2019, we are not in the position to account for (ii) and (iii). Instead, we measure the pure effect of policy changes between 2010 and 2019, comparing the distribution of household income under these two policy systems (2010 and 2019), while keeping population characteristics and market incomes distribution constant (from 2010).

This approach, that responds to a data limitation in the first place, allows us to identify the effect of the policy change as distinct from the change in

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<sup>9</sup>EUROMOD Country Reports are available at: <https://euromod-web.jrc.ec.europa.eu/resources/country-reports>.

<sup>10</sup>The macrovalidation files can be found in the EUROMOD website at the page dedicated to the ITT extension: <https://euromod-web.jrc.ec.europa.eu/overview/extended-functionalitiesinline-nav-8>.

the environment in which the policy operates. Effectively, it means addressing the question of what would household income be for the population in 2010 if the system from 2019 was in place. More formally, let us denote as  $x_t$  vector of individual and household characteristics in period  $t$ ;  $y_t$  the individual and household income and  $d_t(\cdot)$  the rules of the tax-benefit system. Household adjusted disposable incomes are then given by the function  $d_t(x_t, y_t)$  where the tax-benefit rules transform market incomes taking population characteristics (including consumption preferences) as argument. Let  $I(d_t(x_t, y_t))$  be a statistic based on household adjusted disposable income. Then the effect of policy changes between 2010 and 2019 over any statistics of interest could be expressed as:

$$\Delta I = I(d_{2019}(x_{2010}, \alpha y_{2010})) - I(d_{2010}(x_{2010}, y_{2010})) \quad (1)$$

where the income data from 2010, which are expressed in monetary terms, have been adjusted by an uprating factor ( $\alpha$ ) reflecting market incomes growth over the period. As a result the policy effect calculated in our analysis will be expressed in real terms or, more precisely, relative to the growth in market incomes.

To assess the redistributive effect of taxation and transfers, we employ the standard framework based on Lorenz curves and concentration indices from the original contributions of Kakwani (1977) and Reynolds and Smolensky (1977). The total redistributive effect of a policy  $p$  ( $R_p$ ) can be decomposed into the Reymond-Smolensky ( $RS_p$ ) and the re-ranking effect ( $U_p$ ). In our study, we employ the  $RS$  indicator to assess the redistributive impact of each of the components of the tax-benefit system, including consumption taxation. The  $RS$  indicator can be in turn decomposed into the relative progressivity of the policy, i.e the Kakwani ( $K_p$ ), and the size or average impact on household budget (hereafter the “tax burden”) of the policy ( $\mu_p$ ). Namely:

$$R_p = RS_p + U_p = K_p \frac{\mu_p}{1 - \mu_p} + U_p \quad (2)$$

When assessing the redistributive impact of direct and consumption taxes together with benefits (in Section 3.1), we use as a pre-policy income concept the gross market income including pensions. On the other hand, when assessing the redistributive impact of consumption taxes alone (in Sections 3.2 and 3.3) we use household disposable income as a pre-policy income concept. Since the relevant unit of analysis in this study is the household, we account for household composition by employing the OECD-modified equivalence scale. Therefore, individuals are ranked according to their household equivalent income.

### 3 Results

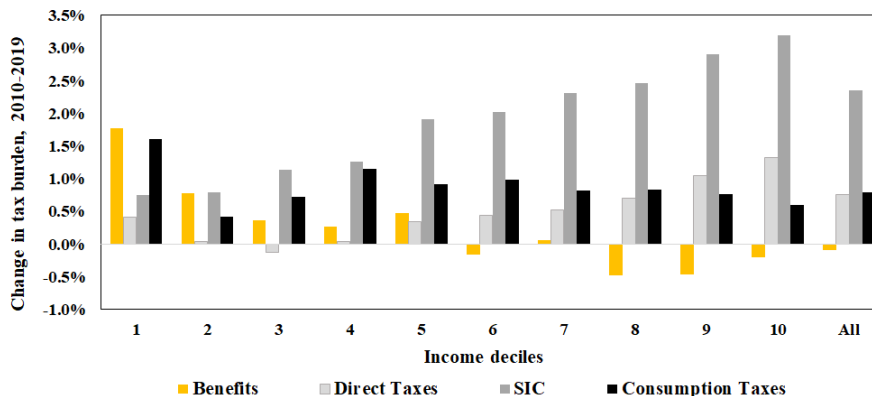
In this section we present the results of our analysis. We begin, in Section 3.1, by analysing the main fiscal developments which took place in the post-financial crisis decade. We look in particular at the fiscal trends arising as a combination of austerity measures and tax-shifts and assess whether changes in social

transfers were successful in compensating poorer households. In Section 3.2, we then zoom in the consumption tax developments which took place over this time period. We disentangle the changes by consumption tax components (VAT and excises) and by consumption categories and we study their redistributive impact. Finally, in Section 3.3, we analyse the characteristics of the consumption tax systems across the EU resulting from this decade of consumption tax developments. We assess to what extent countries with higher consumption taxation make use of other fiscal levers to promote a more equalizing tax system. We explore how the regressivity of the consumption tax system varies across Member States and move some steps in exploring its determinants.

### **3.1 The post-financial crisis decade: austerity and tax-shift**

In the post-financial crisis decade (2010-2019), a number of factors promoted a sustained increase in taxation together with a re-structuring of the tax-benefit system in many EU countries. Notably, these factors included austerity policies and a generalized consensus on the need to shift the burden of taxation away from labour income toward less distortative forms of taxation, most notably consumption taxes. In this section, we review the main policy changes occurred in this period and analyse their impact on household income. We focus in particular on the relative movements of consumption taxes: we analyse the broader fiscal outlook in which consumption tax hikes occurred and investigate to what the extent they have been compensated by increases in benefits and/or reduction of other type of taxes. For this purpose, we analyse four group policies: i) cash benefits (excluding pensions); ii) direct taxes (including taxes on capital and labour incomes); iii) social insurance contributions (contributions paid by workers only); iv) consumption taxes (including VAT, ad-valorem and specific excises). We first consider the picture for the EU-27 as a whole and then study to what extent this differs across countries.

Figure 1: Change in tax burden and benefits receipt, EU average, 2010-2019



Notes. EU-27 is calculated as unweighted average. Change in tax burden and benefits receipt is calculated with respect to market income plus pensions. Income deciles are constructed based on equivalized disposable income.

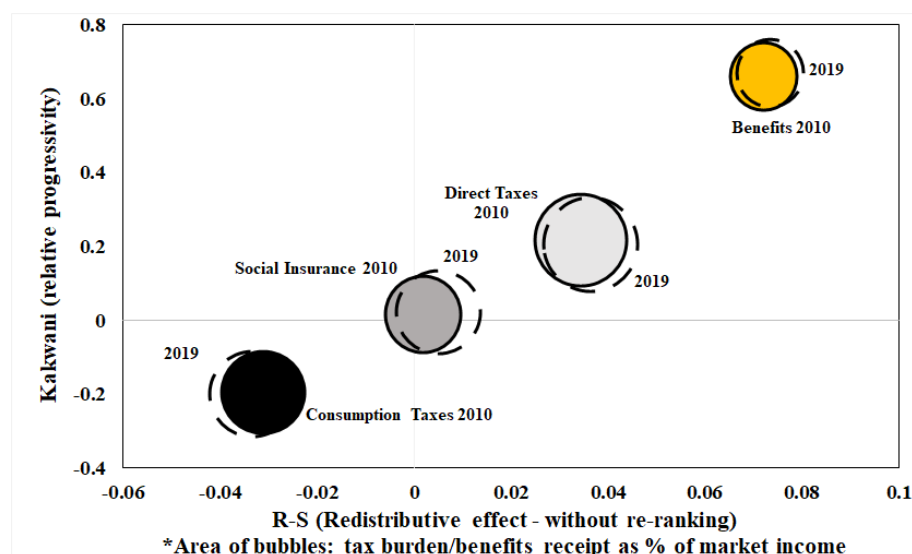
Let us begin in figure 1 to analyse the impact by income deciles of the changes in the tax-benefit system taking place during 2010-2019 in the EU-27.<sup>11</sup> There we can appreciate that the tax-benefit component featuring the largest increase is social insurance contributions, whose total burden over household income increased by 2.4% (percentage of household disposable income). This burden was shared in a progressive way. This was followed by direct and consumption taxes whose burden over household income increased by approximately the same amount, i.e slightly less than 1%. However, while direct taxes featured a broadly progressive pattern, consumption taxes displayed a regressive one. On the other hand, while cash benefits have seen an overall reduction, they became more targeted toward the less well-off. Indeed, cash benefits increased for households sitting in the first half of the income distribution, but reduced for everybody else. Nonetheless, when considering the impact of direct taxes and social insurance contributions, it results that the policy changes in the post-financial crisis decade brought, *ceteris paribus*, to an overall reduction of disposable income across the board.

The redistributive impact of these policy changes is represented in the bubble graphics in figure 2, along the horizontal axis. There we can appreciate that, with the main exception of consumption taxes, the tax and benefits changes which took place in 2010-2019 generated a positive redistributive impact. Indeed, social insurance contributions increased their positive redistributive effect both because of an increase in their burden over household income (increase in the diameter of their bubble) and because of an increase in their progressivity (their bubble shifts upwards). Direct taxes also brought to a higher redistributive impact, mostly driven by an increase in their burden. For benefits, the

<sup>11</sup>As in the rest of our analysis, the aggregate figure for the EU-27 is calculated as a simple average across the member states.

positive redistributive impact is driven by an increase in their progressivity (they became more targeted to the bottom) which more than offset the slight reduction in their level. On the other hand, for consumption taxes, the only regressive component of the tax-benefit system, the negative redistributive impact appear to be driven by an increase in their burden and, to a lower extent, by an increase in their regressivity.

Figure 2: Change in redistributive effect, regressivity, tax burden and benefits receipt, EU average, 2019-2010.



Notes. To facilitate the comparison with the other components, the Kakwani of benefits is plotted with the opposite sign (i.e. a positive value represents progressivity). The area of the bubble represents the increase in the average share of the policy over household market income plus pensions.

All in all, the picture for the EU-27 suggests that the post-financial crisis decade has featured a generalized increase in the tax burden for households across the income distribution. Such an increase begun in the aftermath of the Great Recession and was largely driven by austerity measures of tax hikes (particularly between 2010-2013), which were mostly not reversed, while tax burden edged upward until 2018 (see [European Commission, 2021b](#)). Such an additional taxation burden was shared in a broadly progressive way. However, tax hikes were generalized to the extent that the tax burden has increased across the board, including households located at the bottom of the income distribution. Interestingly, when looking at the EU as whole, no obvious pattern emerges of shifting the tax burden to consumption taxes. In fact, direct and consumption taxes have increased by the same amount - while social insurance contributions increased three times as much. Nonetheless, as we argue below, there are significant differences across countries.

Indeed, the EU-27 aggregate picture reflects some common patterns, while

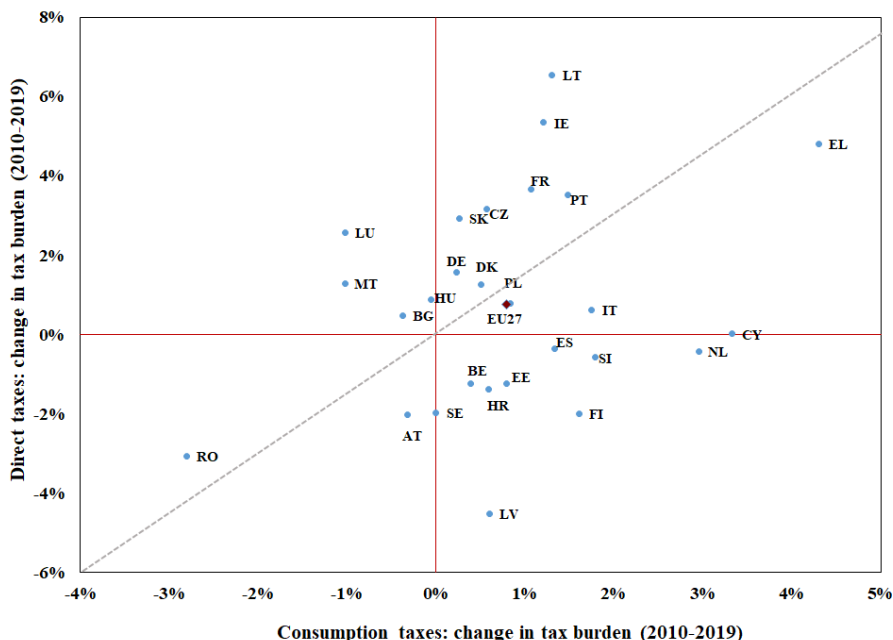
concealing some important elements of heterogeneity. This can be appreciated in the analogous figure of 1 for individual countries, which we present in the appendix B, as figure 16. As we discuss in greater detail in the next section, a common element across the EU is the increase in consumption taxation which - with the exception of a handful of countries - were raised everywhere. In parallel we observe, in the majority of Member States, benefits increasing at the bottom of the income distribution. These policy changes were largely in line with the recommendations of the EU Commission of privileging the use of less distortative forms of taxation and to accompany them with targeted transfers to compensate the loss incurred by low-income groups (see: [European Commission, 2011](#)).<sup>12</sup> However, in the majority of member states increases in social transfers at the bottom of the income distribution were not sufficient to compensate for the increases in consumption taxation.

On the other hand, the story becomes more heterogeneous when looking at the patterns for direct taxes and social insurance contributions. Indeed, in a number of countries the increase in consumption taxation was partially compensated by a parallel decrease in direct taxation. This can be appreciated in Figure 3 where we compare the change in the tax burden of direct and consumption taxation. There we can see that a tax-shift toward consumption taxation occurred in about a third of the EU countries. These are composed by a heterogeneous mix of Northern (Finland and The Netherlands), Southern (Spain), central (Belgium) and Eastern (Estonia, Slovenia, Croatia and Latvia) European countries. However, figure 3 also highlights that in about half of the Member States the burden of direct taxes grew more than the one of consumption taxes. Among those are a number of Eastern European countries (Hungary, Lithuania, Slovakia and Czech Republic) privileging the combined use of direct taxes and social insurance contributions. In some cases, a shift from direct taxation and consumption taxation to social insurance contributions was implemented, as in Romania.

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<sup>12</sup>These measures, enacted while reducing the use tax expenditure, exemptions and other loopholes, would have allowed to promote a growth-friendly tax structure, to boost fiscal revenues and to reduce compliance costs.

Figure 3: Shifting the tax burden from direct to consumption taxation?



Notes. The change in the tax burden is the difference between the tax burden over disposable income in 2019 and 2010 of each type of tax .

### 3.2 Consumption tax developments and their redistributive impact, 2010-19

In this section, we analyse the consumption tax changes which took place in the EU during the post-financial crisis decade (2010-2019) and their redistributive consequences. We begin by analysing the drivers of these consumption tax changes by comparing the dynamics of value-added taxes and excises in the various Member States. We then move to consider their redistributive implications and disentangle the role played by the taxation of different consumption categories.

#### 3.2.1 Main consumption tax developments, 2010-2019

During the post-financial crisis decade (2010-2019), consumption taxes have increased in the vast major of the EU Member States. Their tax burden over household disposable income, plotted in figure 4, increased by about a percentage point in the block as a whole. The picture, however, varies across countries. Consumption taxation burden increased in 21 Member states and reduced in the remaining 6. Largest increases were observed in Greece (4.30%), Cyprus



(3.33%), and in The Netherlands (2.95%). On the other hand, the consumption tax burden significantly reduced in Romania (−2.8%).

This generalized increase in the burden of consumption taxation was driven by specific excises in the first place. These have increased by an average of 0.56% and, with the only exception of Czechia and Bulgaria, their burden consistently increased in all Member States. Indeed, in the period 2010-2019 specific excises over alcohol, tobacco and energy have generally increased much faster than inflation in the EU<sup>13</sup>. Public health and environmental sustainability policies appear to be the main responsible for these changes.<sup>14</sup> In the case of tobacco, the EU Directive 2011/64/EU imposed a floor on total excise taxation over cigarettes, as well as upper and lower bounds in terms of the share of specific excises over its total tax burden.<sup>15</sup> As noted by [Primorac and Jeric \(2017\)](#), since then EU Member States have increasingly approached the upper limit for the share of specific excise tax in the total tax burden. In parallel, a large share of countries have reduced the ad-valorem excise component of cigarette taxation in favour of specific excises. The results of this policy are reflected in figure 4, where we can appreciate that the contribution of ad-valorem excise has mostly decreased or remained constant in the EU countries under consideration. This restructuring of the excise tax in favour of specific excises allows the system to be less dependent on manufacturers' pricing policy, consumers' preferences and down trading.

The contribution of specific excises was immediately followed by the one of VAT, whose burden has increased by an average of 0.38% over the same period. Importantly, changes in VAT drove much of the variation of consumption taxes and are the single largest source of increase and decrease in the burden of consumption taxes, i.e 3.74% in Greece and −3.22% in Romania. These changes in VAT were largely driven by fiscal consolidation policies, implemented in response to the European sovereign debt crisis and the policy recommendations from international institutions (see [OECD, 2010](#), [Bozio et al., 2015](#), [Alesina et al., 2020](#)). Importantly, by the end of 2019, increases in the rates of VAT were usually not reversed. Romania constituted the main exception implementing a cut in the standard rate of VAT from 24% to 19%, therefore fully offsetting a previous tax hikes introduced in 2009.<sup>16</sup>

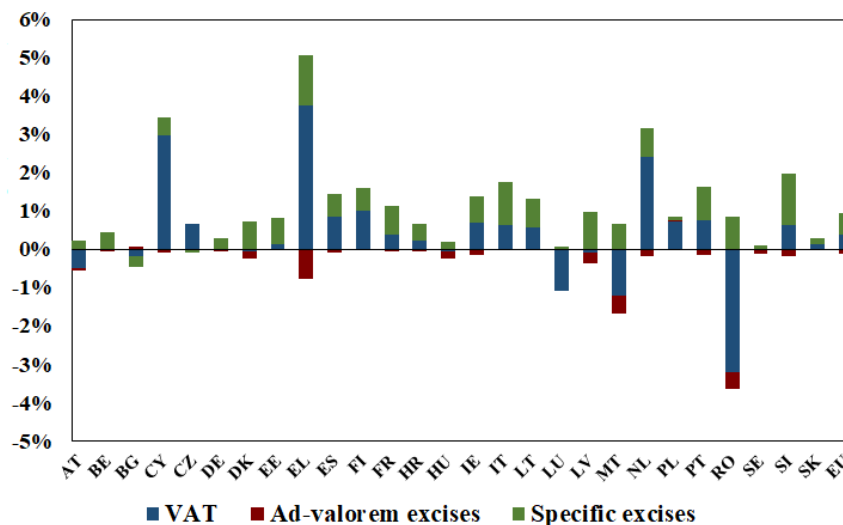
<sup>13</sup>The full list of the excises applicable on each category of goods can be found in the EUROMOD website: <https://euromod-web.jrc.ec.europa.eu/overview/extended-functionalitiesinline-nav-8>.

<sup>14</sup>There is a growing body of literature linking the consumption of tobacco and alcohol to various forms of cancer and health inequality, see for example [Kilian et al. \(2021\)](#). The World Health Organization identifies specific excises, setting a minimum price for alcohol based on its content, as one of the most effective policy tool to curb its consumption, [World Health Organization \(2020\)](#).

<sup>15</sup>From January 1, 2014 the specific excise tax on cigarettes should be neither less than 7.5% nor more than 76.5% of the total tax burden (which includes the specific and the proportional excise tax and the VAT imposed on the weighted average retail selling price). It is also stipulated that the total excise tax should not be less than EUR 90 per 1,000 cigarettes, or 60% of the weighted average retail price.

<sup>16</sup>See: 2016 Annual Report from Romania Fiscal Council.

Figure 4: Change in the tax burden of VAT and excises, 2010-2019



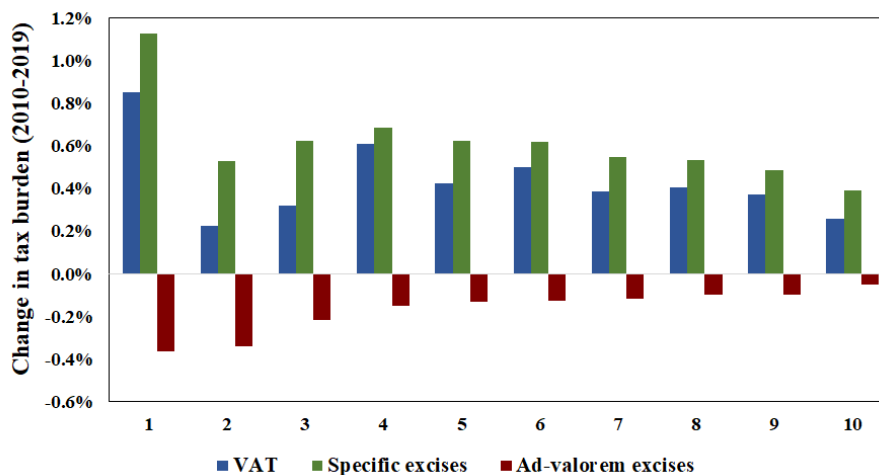
Notes. EU represents the unweighted average for the EU-27. Change in the tax burden is measured with respect households disposable income.

Figure 5, show the impact of these consumption tax changes across the distribution of household disposable income, for the EU as a whole.<sup>17</sup> Generally speaking, the results show that while changes in VAT and specific excises resulted in a negative impact over household income, changes in ad-valorem excises instead had a positive impact. This can be explained by the fact that ad-valorem excises have generally decreased over this period of time, as a number of European countries progressively shifted the burden of tobacco taxation to specific excises.

From a distributive point of view, it can be appreciated that the reduction of ad-valorem excises across the EU was generally progressive (it benefited more households at the bottom of the income distribution), whereas the increase in specific excises was regressive. Similarly, the impact of VAT changes - while less obviously regressive - has affected households more significantly in the first part of the income distribution. The order of magnitude of these changes appears overall modest and generally well below 1%. However, as we show in the next section, the large degree of heterogeneity across and within countries in terms of consumption patterns and consumption tax policies means that the impact on household income has varied significantly.

<sup>17</sup>The EU-27 aggregate is calculated as simple average of the impact in each Member State considered in our analysis.

Figure 5: Change in the tax burden across the income distribution, EU average, 2010-2019

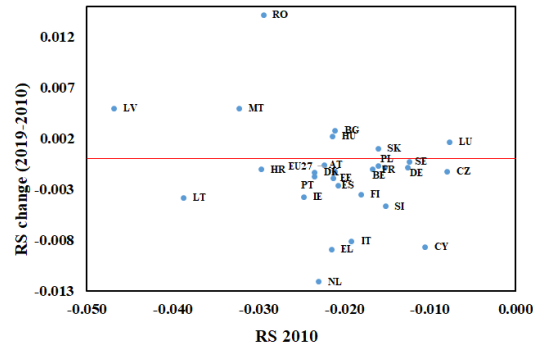


Notes. EU represents the unweighted average for the EU-27. Change in the tax burden is measured with respect households disposable income.

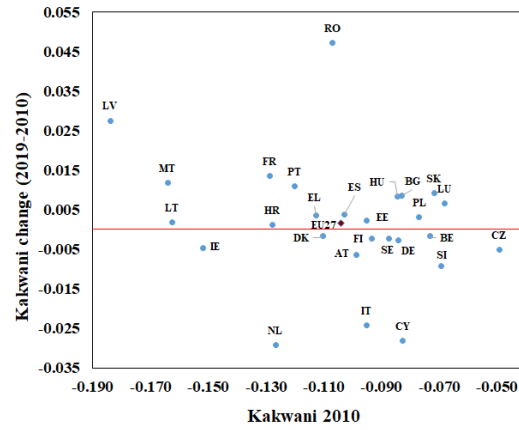
### 3.2.2 The redistributive impact of consumption taxes changes, 2010 - 2019

In this section, we analyse the redistributive impact of the consumption tax developments discussed in the previous section. We do so by looking into the changes in the regressivity and in the burden (as defined in Section 2) of consumption taxation. For each EU country, we therefore explore the evolution of three indicators over 2010-2019: i) the 'Reynolds-Smolensky' (measuring the redistributive effect without re-ranking), ii) the Kakwani (measuring the degree of regressivity/progressivity) and iii) the tax burden (measuring the consumption tax payments over disposable income ratio). These indicators are displayed in figure 6, where the horizontal axis reports the value of each of these indicators in 2010, and the vertical axis reports their change over the 2010-2019 decade.

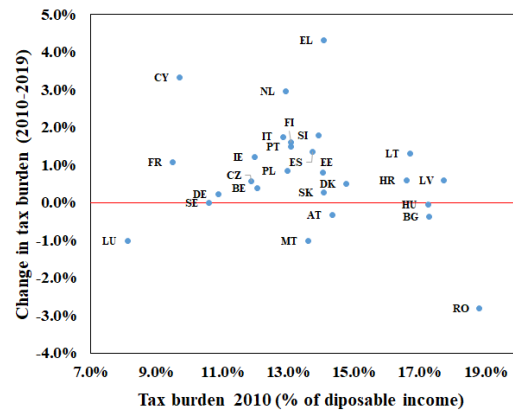
Figure 6: Decomposing the redistributive effect of consumption taxes, 2019-2010



(a) Redistributive effect (Reynolds-Smolensky Index)



(b) Regressivity (Kakwani Index)



(c) Tax burden (% of disposable income)

Beginning with 6a, which displays the Reynolds-Smolensky index, we can appreciate that consumption taxation has become more unequalizing during the post-financial crisis decade in the great majority of EU countries (i.e. 20 out of 27). Such a negative redistributive effect was driven by a generalised increase in the consumption tax burden which, in some countries, was further accompanied by an increase in their degree of regressivity. Exceptions are represented by Romania, Slovakia, Bulgaria, Malta, Latvia, Luxembourg and Hungary, where a positive redistributive impact was produced by a reduction of consumption taxation (partially counteracted by an increase of its regressivity).

Let us therefore move to consider the change in the burden of consumption taxation over household income. Looking at figure 6c, it is apparent that - with the only exception of the countries above mentioned - the burden of consumption taxation has increased in the whole of the EU during the 2010 - 2019 decade. Given that consumption taxation is regressive in all countries (see the negative value of the Kakwani index in the x-axis in figure 6b), an increase in its burden inevitably produces a negative redistributive effect.

Looking at the change in the Kakwani index between 2010 and 2019 in figure 6b, we can appreciate that such a negative redistributive effect was reinforced by an increase in regressivity of consumption taxation in about half of the Member States where it increased. This effect was most significant in the Netherlands and in Cyprus, the two countries that featured the largest increase in both the consumption tax burden and its regressivity. Consumption taxes in Italy also experienced a significant increase in regressivity, whereas in Greece -where consumption taxation burden saw the largest increase- the regressivity of these taxes was reduced.

To further explore the evolution of the regressivity of these consumption tax development, we plot in figure 17 (Appendix), the impact of the increase in consumption taxes over household income across the distribution for each Member State. Looking at the figure it is apparent that changes in consumption taxation have generally affected households belonging to the first decile of the income distribution disproportionately. In Italy, an increase of the tax burden of consumption taxes of about 1.8% translated into a nearly 9% increase for the first decile (about 5 times as much). Similarly, in Cyprus and the Netherlands an increase in the tax burden of about 3% translated into a nearly 7% increase for the first decile (more than twice as much). At the opposite, countries which have reduced the burden of consumption taxation, had households in the first decile as the main winners. This is for example the case in Romania, where an overall reduction of 2.8% of the consumption tax burden translated into more than 10% disposable income gain for the first decile.

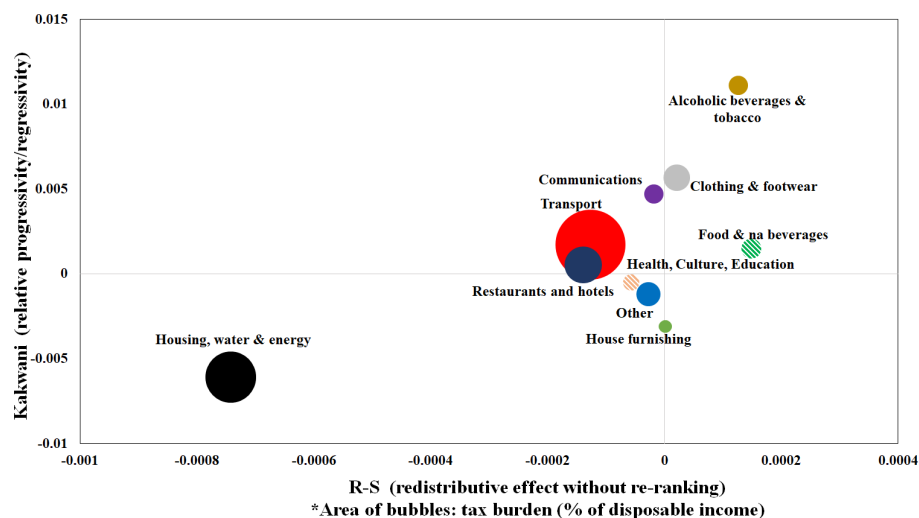
Finally, we breakdown the redistributive effect of changes in consumption taxation by the aggregate consumption categories in COICOP level 1 (we pool together health, education and culture therefore featuring 10 categories).<sup>18</sup> We begin by considering the picture for the EU as whole in Figure 7, which is analo-

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<sup>18</sup>These categories were pooled together to avoid the zero-expenditure problem that makes the inequality indicators we use not well defined.

gous to the bubble graphics in Figure 2. However, because of the larger number of elements to be represented, instead of reporting the levels in 2010 and in 2019, we directly report their difference. Accordingly, a bubble located to the left of the zero indicates that the taxation over the consumption category it represents has become more unequalizing; on the other hand, a bubble located to the bottom of the zero indicates an increase in its regressivity. The size of the bubble represents the increase in the tax burden with dashed-filled bubbles representing a reduction. We can therefore immediately identify the consumption categories which have experienced the largest increase in the burden of consumption taxation. These are transport and housing, water & energy. These are indeed the consumption categories whose rate of taxation has increased the most (see figure 18 in the Appendix) and rather consistently across Member States.<sup>19</sup> Housing, water & energy has also experienced the largest increase in regressivity therefore featuring the largest negative redistributive effect. On the other hand, food & non-alcoholic beverages together with health, education and culture are the only consumption categories experiencing an overall reduction of their tax burden.

Figure 7: Change in redistributive effect, regressivity and tax burden by consumption categories, EU average, 2010-2019.



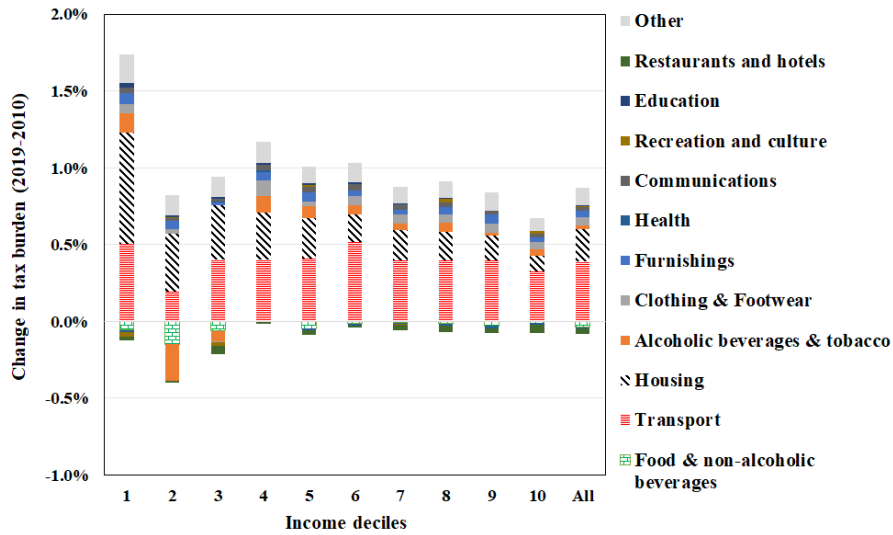
Notes. The area of the bubble represents the increase in the tax burden during 2010-2019. Dashed-filled bubbles indicate a reduction in the tax burden.

In figure 8, we then analyse the impact of the changes in the taxation of the

<sup>19</sup>The taxation rates over tobacco and alcoholic beverages have also increased by the same magnitude of housing, water & energy in the EU. However their changes were more scattered across Member States. Therefore, the taxation burden has not increased as much since Member States where the taxation increased are not the ones where the share of expenditure is the largest.

various consumption categories on households across the income distribution. Consistently with the previous figure, we can immediately appreciate the predominant role of transport (the red-dashed bar) and housing, water & energy (the black-dashed bar) taxation. On average, first decile EU households have experienced an increase in the taxation burden of these two consumption categories corresponding to more than 1% of their disposable income. However, while the impact of transport taxation was quite uniform across the distribution, the taxation of housing, water & energy affected the bottom of the distribution about three times as much as the top, on average.

Figure 8: Change in the tax burden by consumption categories, 2010-2019

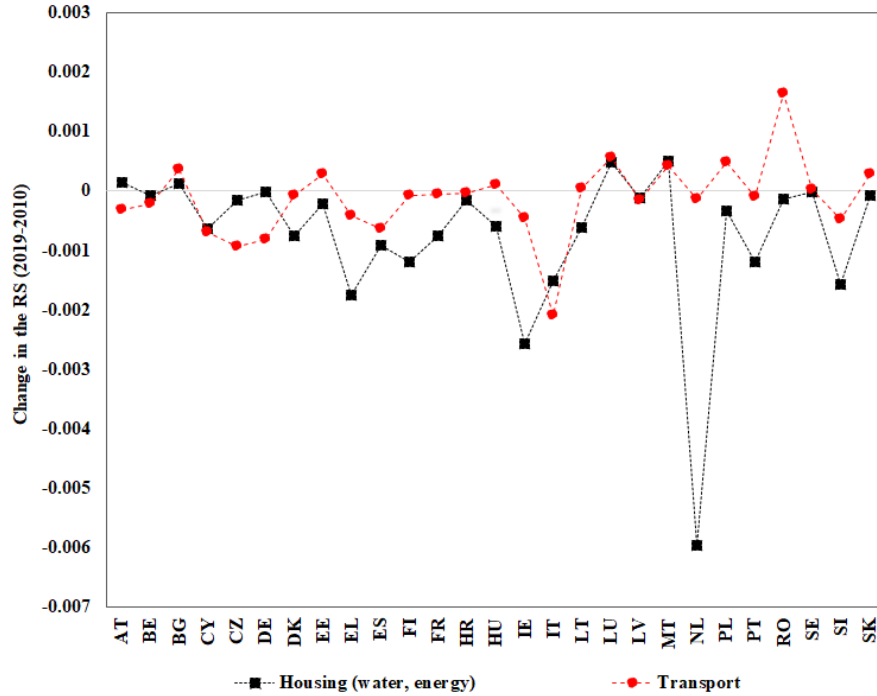


Notes. 'EU' represents the unweighted average for the EU-27. Change in the tax burden is measured with respect households disposable income.

To what extent are these EU average patterns representative of the various Member States? To address this question, we analyse the change in the redistributive effect of the consumption categories which have experienced the largest increase in terms of the tax burden, namely transport and housing, water & energy. This is plotted in figure 9. There we can appreciate that the increase in the unequalizing effect of taxation on housing, water & energy has been quite generalized across the 27 Member States of the EU. Still, we observe significant heterogeneity across countries in terms of magnitude. On the other hand, the picture for the change in the redistributive effect of transport taxation is quite different. Firstly, this is generally smaller than housing. Secondly, in a number of Eastern European countries (including Romania, Poland, Estonia, Bulgaria, Hungary and Slovakia) increases in transport taxation were actually inequality-reducing. This is consistent with the findings of the related literature on the topic (see Amores et al., 2022), which documents how in most Eastern

European countries the taxation of transport consumption is typically non regressive. This is likely to be explained by a lower vehicle ownership in the first half of the income distribution compared to higher income EU Member States.

Figure 9: Redistributive effect of housing and transport consumption taxation by Member State, change 2010-2019

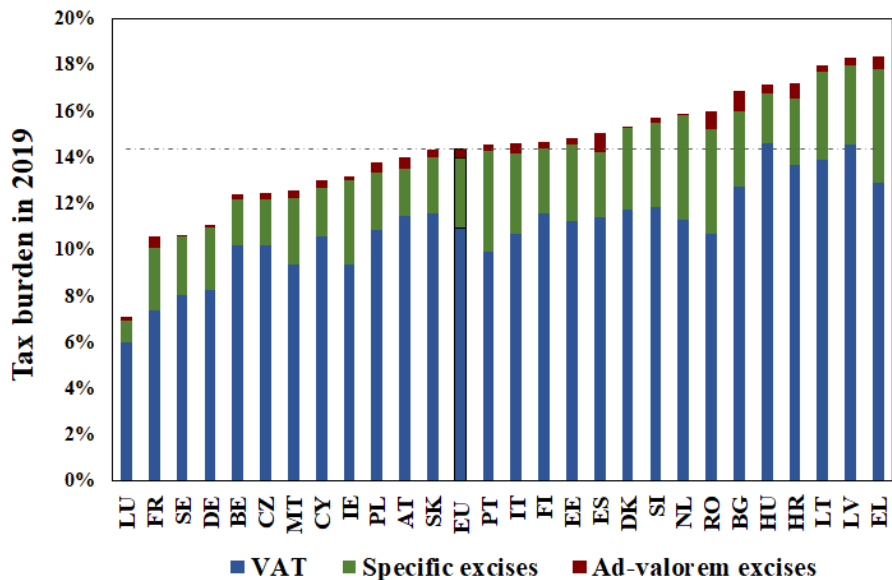


### 3.3 Consumption tax systems in the EU at the end of the decade

We now turn to investigate the characteristics of the EU consumption tax systems in 2019, resulting from the decade of policy developments just described. We look at how the burden of consumption taxation varies across the EU and ask to what extent countries with heavier consumption taxation make use of other fiscal levers to promote a more equalizing tax-benefit system. We then analyse which are the most unequalizing taxes by consumption categories.



Figure 10: The burden of consumption taxation, 2019



Notes. 'EU' represents the unweighted average for the EU-27. The tax burden is measured with respect households disposable income.

Consumption taxes absorbed about 14% of household income on average in the EU in 2019 (see Figure 10). However, the figure varies significantly across countries. The tax burden is typically larger in Eastern European countries, with Latvia, Lithuania and Greece featuring the largest burden measuring about 18% of household income. At the other extreme, Luxembourg features the lowest burden, at about 7% of household income. VAT represents on average 75% of the total consumption tax burden over households, ranging from 67% in Romania to 85% in Hungary. On the other hand, specific excises account on average for about 21%, ranging from 13% in Hungary to 30% in Portugal. The residual and smallest component is ad-valorem excises, ranging from a minimum of 0.02% in Sweden to maximum of 1.5% in Spain.

We analyze whether countries with the highest tax burden are also those displaying the most regressive consumption tax system. In Figure 11 we can appreciate that, among the countries featuring a higher burden of consumption taxation (right quadrant), half of them also feature a higher regressivity (bottom-right quadrant). Among those, stand the cases of Latvia and Lithuania ranking highest both in regressivity and tax burden.

We therefore ask whether countries featuring a higher burden of consumption taxation tend to redistribute less. This effectively means investigating to what extent countries uses their tax-benefit levers to compensate for the use of efficient but unequalizing consumption taxes. For this purpose, we plot in figure

Figure 11: Tax burden and regressivity of consumption taxation, 2019

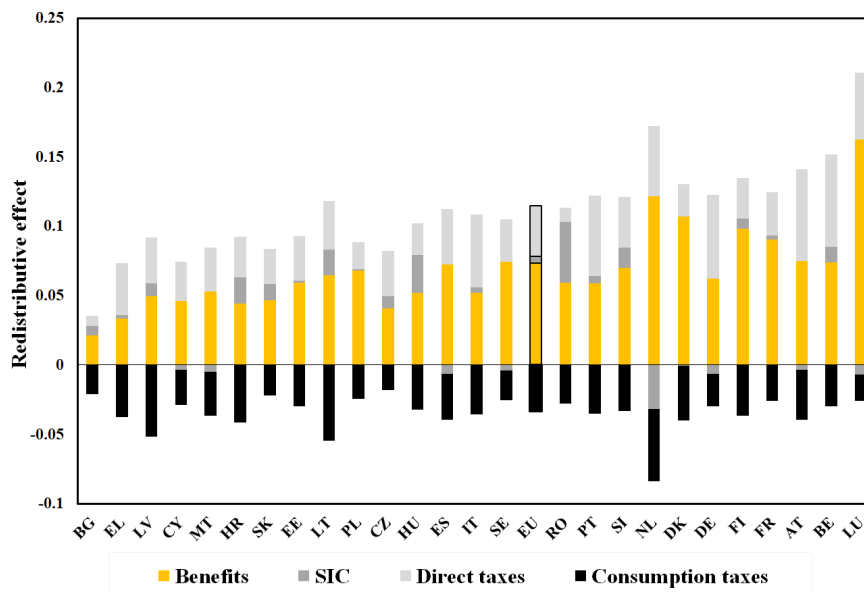


Notes. The tax burden in the horizontal axis is measured with respect to household disposable income. The regressivity in the vertical axes is measured through the Kakwani index (a negative value indicates that the tax is regressive).

12 the total redistributive effect of the tax-benefit system in the EU countries<sup>20</sup> (ordered left to right from the least redistributive to the most redistributive). There it appears that countries with the highest burden of consumption taxation redistribute far less than the EU average. Indeed, in Greece, Latvia, Croatia, Bulgaria and Lithuania the total redistributive effect of the tax-benefit system appears low compared to the rest of the EU. In these countries the redistributive effect of social transfers is largely, when not entirely, wiped out by consumption taxation, while direct taxes and social insurance contribution do little to close the gap. At the other extreme, Luxembourg is again the country with the highest level of redistribution featuring the most redistributive social benefits system accompanied by a low negative redistributive effect of consumption taxation.

<sup>20</sup>We exclude Ireland from the picture for the reason that, differently from the other Member States, the pension components is mostly included in the benefits category meaning that their contribution is not comparable.

Figure 12: Decomposition of the redistributive effect of tax-benefit components, 2019



Notes. EU represents the unweighted average for the EU-27. Pre-policy income concept: market income with pensions.

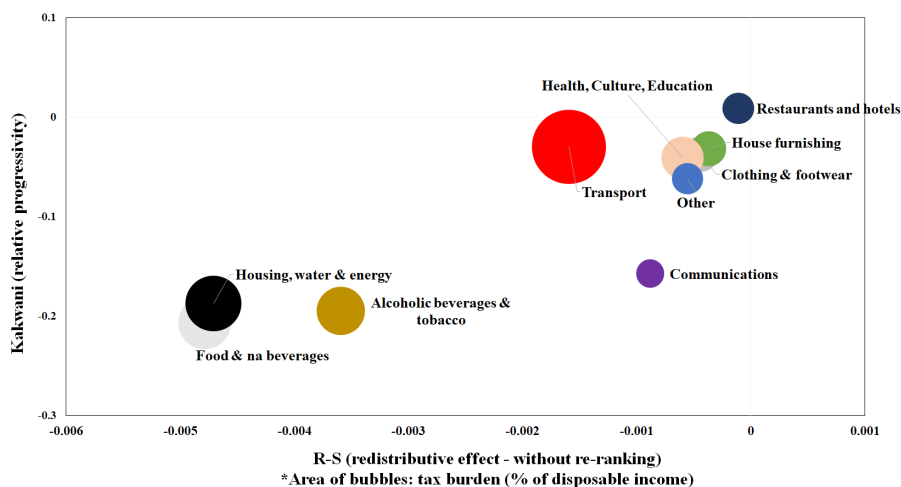
However, important exceptions exist. For example, the Netherlands have experienced in the 2010-2019 decade a significant increase in the burden and regressivity of consumption taxes, as discussed in section 3.2. As a result, in 2019 the Netherlands features a higher-than-average burden of consumption taxes and one of the strongest redistributive effect.<sup>21</sup> However, thanks to highly redistributive social transfers, the Netherlands present a tax-benefit system among the most equalizing of the EU. A similar case is represented by Denmark which also features a consumption tax system with higher than average burden and regressivity (driven by a large uniform rate of VAT, set at 25% in 2019). As in the case of the Netherlands, highly redistributive social transfers allow Denmark to present one of the most equalizing tax-benefit system of the EU.

To conclude this discussion on the main features of the consumption tax

<sup>21</sup>Also, note that the Netherlands is the Member States featuring the largest negative redistributive effect of social insurance contributions (while in most Member States this policy has a positive redistributive effect). The reason is that social insurance contributions in the Netherlands feature a flat cash payment (everybody older than 18 years old is compelled to pay) with an additional part proportional on earnings which, however, is subject to an upper limit. Altogether this results in a regressive policy. For more detail on the social insurance contribution in the Netherlands, see the EUROMOD country report at: [https://euromod-web.jrc.ec.europa.eu/sites/default/files/2022-01/Y12C\\_R\\_N\\_L\\_Final.pdf](https://euromod-web.jrc.ec.europa.eu/sites/default/files/2022-01/Y12C_R_N_L_Final.pdf).

systems and their inequality-effects across the EU, we look into the redistributive effect of consumption taxes by product categories. Figure 13 decomposes the redistributive effect (horizontal axis) into regressivity (vertical axis) and tax burden (size of the bubble) for the EU as a whole. There we can clearly observe the contribution of the taxation of three consumption categories in driving their regressivity and their negative redistributive effect, these are: (1) “food and non-alcoholic beverages”, (2) “alcoholic beverages and tobacco” and (3) “housing, water and energy”. The taxation over the first consumption category is not only the most regressive one but also the most unequalizing. Housing, water and energy is almost as unequalizing despite being slightly less regressive than alcohol and tobacco (this is due to a size effect, i.e. its average tax burden on household income is larger than the one of alcohol and tobacco).

Figure 13: Redistributive effect, regressivity and tax burden of consumption taxes by consumption categories, EU average, 2019



Notes. The size (diameter) of the bubble represents the burden of consumption taxation over a certain product category in 2019.

To explore the redistributive effect of taxing different categories of consumption across countries, we plot in Figure 14 the redistributive effect of consumption taxation (panel 14a) together with its regressivity (panel 14b) and the tax burden (panel 14c) by consumption categories, for each Member State. Countries are ranked from left to right according to the redistributive effect of indirect taxation; accordingly, we have on one extreme Lithuania displaying the highest negative effect of consumption taxation and on the other Luxembourg, displaying the lowest. In virtually all countries, the taxation of housing, water & energy together with food & non-alcoholic beverages and tobacco & alcohol are the most regressive components of the consumption tax system, although their relative regressivity varies significantly. In several Eastern European countries,

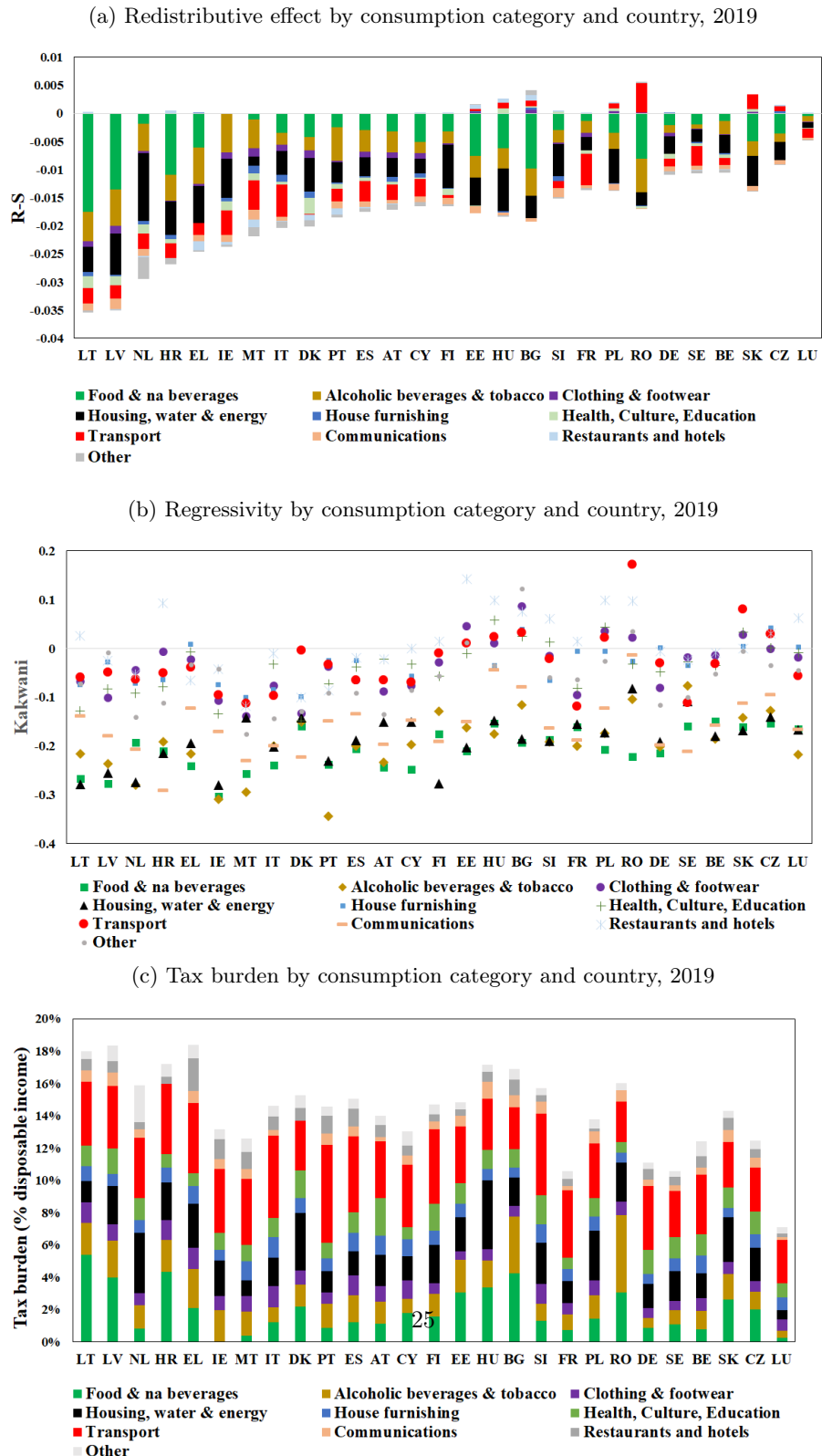
the taxation of food consumption is both the most regressive and unequalizing, given its high share in the household budget. Elsewhere is the taxation housing, water and energy and transport consumption that drives the highest inequality impact. Across the EU, the taxation of transport often constitutes the largest share of the taxation burden over consumption. However, it is often little regressive or even progressive in lower-income Member States; hence a less unequalising effect in these countries. On the contrary, the taxation of transport is the most, or the second highest, unequalizing component of consumption taxation in a number of higher-income EU Member States (including Austria, Belgium, Germany, Spain, France, Ireland, Italy, Luxembourg, Portugal and Malta).

In the current historical circumstances of spiralling energy prices and, though to a lower extent, of food prices (see HCPI figures published by ESTAT for 2022<sup>22</sup>), this points toward the importance of monitoring the redistributive consequences of the taxation of these items, given that - by its very nature - VAT amplifies those price shocks. Even more so in consideration of the low price elasticities of the various necessary goods such as home heating and certain food items which enter these categories. While European Green Deal initiatives, such as the Revision of the Energy Taxation directive, aim at using the tax lever over energy products to steer households toward more sustainable forms of consumption, targeted transfers might be used to shelter the poorest. Also, in the case of less environmental harmful food products there could be the scope to consider reducing their rate of taxation, especially in the Member States where their share on household budget is among the highest and these items are taxed at the standard rate of VAT (e.g. in Estonia, Lithuania and Bulgaria).

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<sup>22</sup>See: <https://ec.europa.eu/eurostat/web/hicp/data/database>.

Figure 14: Redistributive effect and regressivity by product category and country - 2019



## 4 Conclusions

In this paper, we investigate the redistributive impact of the tax changes which took place during the post-financial crisis decade and the resulting features of the consumption tax systems in the EU at the end of this period. We focus on the pure effect of policy changes, comparing the distribution of household income under 2010 and 2019 policies, while keeping population characteristics and market incomes distribution constant. For this purpose, we use micro-data from EU-SILC and EU-HBS and the recent extension of the EU tax-benefit microsimulation model EUROMOD, the consumption tax Tool (ITT).

We find that in the EU the post-financial crisis decade has seen a generalized increase in the tax burden for households across the income distribution. Such an additional tax burden was shared in a broadly progressive way across income groups. At the same time, all type of households - including those at the bottom of the distribution - have seen their disposable income being lowered. A common element across the EU is the increase in consumption taxation which occurred virtually everywhere, while cash benefits become more targeted toward the bottom of the income distribution. However, increases in cash benefits were typically not sufficient to compensate poorer households for the increases in consumption taxation. Moreover, in about a third of the EU countries, we find evidence of a shift from direct to consumption taxation. These include a heterogeneous mix of northern (Finland and The Netherlands), southern (Spain), central (Belgium) and eastern (Estonia, Slovenia, Croatia and Latvia) European countries. However, in about half the EU Member States direct taxes grew more than consumption taxes. This trend was mostly driven by a number of Eastern European countries (Hungary, Lithuania, Slovakia, Czech Republic) privileging the combined use of direct taxes and social insurance contributions.

We therefore analyse the nature and the effect of consumption tax hikes, disentangling the impact of changes in VAT, specific excises and ad-valorem excises. Our results suggest that the burden of consumption taxation over disposable income increased by about a percentage point in the EU as a whole. Largest increases were observed in Greece (4.30%), Cyprus (3.33%) and in The Netherlands (2.95%). This increase in consumption taxation was driven by specific excises in the first place, whose burden increased in nearly all Member States. Taxing energy, tobacco and alcohol were driving this trend. On the other hand, the restructuring of the excise taxes over tobacco in favour of specific excises, means that ad-valorem excises have mostly decreased or remained constant in the EU countries. The contribution of specific excises was immediately followed by the one of VAT. Increases in VAT were mostly driven by fiscal consolidation policies, implemented in response to the European sovereign debt crisis. However, by the end of 2019, increases in the rates of VAT were generally not reversed. Importantly, a higher consumption tax burden was often accompanied by an increase in its degree of regressivity. This effect was the most significant in the Netherlands and in Cyprus, the two countries that featured the largest increase in the tax burden and its regressivity. In these countries an increase in the mean tax burden of consumption taxes of about 3% translated

into a nearly 7% increase for the first decile.

Finally, we analysed the characteristics of the consumption tax systems across the EU resulting from these policy changes, at the end of the decade. We find that consumption taxes absorbed on average about 14% of household disposable income in the EU in 2019. However there are significant differences across countries. Latvia, Lithuania and Greece feature the largest tax burden measuring about 18% of household income. At the other extreme, Luxembourg features the lowest tax burden at about 7% of household income. We find that countries with the highest burden of consumption taxation tend to redistribute less within their tax-benefit system. This is particularly the case of several Eastern European countries where the redistributive effect of social transfers is largely, when not entirely, wiped out by consumption taxation (while direct taxes and social insurance contributions do little to close the gap). In virtually all countries the taxation of housing, water & energy together with food & non-alcoholic beverages and tobacco & alcohol are the most regressive components of the consumption tax system. In several Eastern European countries the taxation of food consumption is both the most regressive and unequalizing, given its high share in household budget. Elsewhere is the taxation housing, water and energy and transport consumption that drives the highest inequality impact.

From a policy perspective, our results suggest that future tax reforms should be more closely assessed from a redistribution perspective especially in the current high inflation environment given that VAT tend to amplify the effects of price shocks. This is especially true when considering the low price elasticities of the various necessary goods such as home heating and certain food items which enter these categories. Targeted transfers might be used to shelter the poorest without compromising price-incentives to switch away from more polluting energy sources. Also, in the case of less environmental harmful food products there could be the scope to consider reducing their rate of taxation, especially in the Member States where their share of household budget is large and these items are taxed at the standard rate of VAT. Finally our results suggest that while in some countries tax reforms have resulted in a shift of the tax burden away from direct taxes toward consumption taxes, in most countries tax system tend to be highly distortative. The objectives set in the EU Green Deal should represent an opportunity to reform tax systems to contribute both to employment and EU objectives in this area.



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## A Imputation method and validation

### A.1 Imputation method

In this section we outline the imputation method used to combine the SILC and the HBS data alongside with its advantages and its limitations. This method effectively underpins the creation of the EUROMOD-ITT dataset, which combines household demographic, income and labour market information with consumption data. Since the sample of interviewed household in SILC and HBS is not the same, no exact correspondence can be established among households in these two surveys. Therefore, combining SILC and HBS data requires to use an imputation method that matches any household in SILC which their closest peer in HBS.<sup>23</sup>

For this purpose, we adopt the semi-parametric procedure developed by [Akoğuz et al. \(2020\)](#). This combines the estimation of Engel curve (employed in previous studies, such as [Decoster et al., 2010](#)) with matching techniques. In the following we provide a step-by-step description of this procedure and discuss its main advantages and limitations.

1. A household  $h$ 's expenditure on a good  $i$  in the source dataset (the HBS, indexed by 's'), denoted by  $e_{shi}$ , is converted into a share,  $w_{shi}$ , of disposable income,  $y_{sh}$ :

$$w_{shi} = \frac{e_{shi}}{y_{sh}}, \quad i \in N \quad (3)$$

where  $N$  is the set of indices of goods at the most detailed level in the HBS.

2. These income shares of expenditures on detailed goods are aggregated under broader categories.<sup>24</sup> We index these categories by  $X = A, B, \dots$ . Thus, the income share of expenditure category  $X$ ,  $W_{shX}$ , is defined as:

$$W_{shX} \equiv \sum_{i \in N_X} w_{shi}. \quad (4)$$

3. Income shares of consumption for aggregated categories,  $W_{shX}$  are regressed against a relevant set of covariates common to both the source (ie. HBS) and the recipient dataset (ie. SILC). Though there is not a structural interpretation to the regression model, the selection of covariates is

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<sup>23</sup>In the case of Italy, the situation is further complicated since net household income is missing in the 2010 HBS data. To address this issue, before inputting HBS to SILC, income data are imputed to HBS through a third survey, i.e the 2010 Survey on Household Income and Wealth (SHIW). For more details, see [Akoğuz et al. \(2020\)](#).

<sup>24</sup>These categories should be big enough to reduce the infrequent expenditure problem but small enough to allow household characteristics to explain differences in allocations of income across these goods.

very much inspired by the specification of Engel curves.<sup>25</sup> Note that, aggregated categories  $X = A, B, \dots$  may still contain a significant number of zero observations. At this level of aggregation, these are considered to be true zeros<sup>26</sup>. To account for zero expenditures a two-steps regression is performed.

- (a) The probability that a household exhibits positive expenditures on commodity aggregate  $X$  is modelled by a probit model, using the common variables in the source and recipient dataset as explanatory variables. Formally:

$$Pr(W_{shX} > 0) = 1 - \phi\left(-\gamma'_X x_{sh}\right) = \phi\left(-\gamma'_X x_{sh}\right) \quad (5)$$

where  $\phi(\cdot)$  denotes the standard normal distribution function,  $x_{sh}$  is the vector of explanatory variables for household  $h$  in the source dataset  $s$ , and the vector  $\gamma_X$  contains parameters to be estimated.

- (b) Next, an ordinary continuous regression model is formulated for assessing the relation of positive income shares of broad expenditure categories with the common variables:

$$W_{shX} = \beta'_X X_{sh} + \epsilon_h X, \quad W_{shX} > 0. \quad (6)$$

4. Using the estimated models, values are fitted for the income shares of expenditures on the broad categories  $X = A, B, \dots$ , for all households in both the source and the recipient datasets, indexed by  $s$ ,

$$W_{dhX} = \phi\left(-\hat{\gamma}'_X x_{dh}\right) \hat{\beta}'_X X_{dh}, \quad d = s, r. \quad (7)$$

5. Denoting a vector of fitted shares retained as input for the distance by  $W_{dh} \equiv (W_{dhA}, W_{dhB}, \dots)$ , where  $d = s, r$  and using the Mahalanobis distance metric, the distance between a household  $h$  in the source data, and a household  $g$  in the recipient data is defined as:

$$dist(h, g) = dist(W_{rg}, W_{sh}) = \sqrt{\left(\widehat{W}_{rg} - \widehat{W}_{sh}\right)' \Sigma^{-1} \left(\widehat{W}_{rg} - \widehat{W}_{sh}\right)} \quad (8)$$

where  $\Sigma$  here stands for the variance covariance matrix of the vector  $\widehat{W}$ , using data from both source and recipient.

<sup>25</sup>More specifically, a third degree polynomial in the log of incomes, and a rich set of household composition characteristics were included, containing detailed information on the number of household members in different socio-demographic groups, such as gender, labour market status, and age. A list of all potential covariates can be found in Appendix ....

<sup>26</sup>Which is to say not a consequence of the infrequent expenditures problem

6. A match for household  $g$  in the recipient dataset is defined as the household  $h$  in the source dataset that has the smallest distance to household  $g$ . Where the distance is measured in terms of equation 8.
7. For each match  $(h, g)$ , income shares of expenditures at the most detailed level of good disaggregation  $i \in N$  for the recipient household  $g$ , are obtained from the corresponding values of the source household  $h$ :

$$w_{r gi} = w_{sh i}. \tag{9}$$

Two key advantages are worth remarking about this imputation method. Firstly, by matching observed consumption shares rather than fitting them based on a regression (as in the standard Engel Curve approach), this method can successfully impute expenditures data at the highest available level of disaggregation (which, using HBS data, is COICOP level 4 classifying consumption in about 200 good-types). This in turn underpins one of the key advantages of the new EUROMOD-ITT over its predecessor (see [De Agostini et al., 2017](#)), which only modeled household consumption at the level of 12 broad categories (i.e. COICOP level 1) and it was based on the Engel Curve method. Indeed, thanks to this higher level of disaggregation, the new EUROMOD-ITT ensures a far more precise assessment of consumption patterns and of tax liabilities across households, resulting in a distributional analysis which is more accurate and broader in scope (e.g it allows analysing the impact of the consumption taxation over specific products such as cigars and beers). Secondly, the regression model exploits information on the relation between household characteristics (namely, the explanatory variables in the regression) and expenditures (dependent variables) in the dataset, which is neglected in other widely used imputation methods, such as the Hot Deck Matching. Effectively, this means that the distance between households in both dataset is measured based on household characteristics (e.g age, income, education etc) which are implicitly weighted in the distance function according to their ability to explain household consumption on different good categories.

However, this imputation method also comes with some limitations. Firstly, fitted values are obtained by means of a regression model that takes the logarithm of income as input. This means this approach makes only sense for households with a sufficiently high and positive income. Expenditure behaviour of agents with negative or extremely small positive income, do not fit into this model.<sup>27</sup> Furthermore, it can only make reasonable predictions on expenditures on sufficiently aggregated, broad categories, so that only such aggregates enter into the distance function. Therefore, it does not guarantee that matched households will bear very similar characteristics. In fact, there might well be two households with different sets of characteristics both featuring a similar levels of expenditure on several broad categories. Therefore these two household

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<sup>27</sup>Indeed, the concept of an income share in terms of which our model is specified, makes not much sense in case of negative incomes, it is not defined in case of zero incomes, and may yield extreme values in case of incomes close to zero.

might be matched, while we would not expect them to necessarily present similar expenditure behaviour, when it comes to allocating their budget on specific commodities within these broad category.

## A.2 Validation results

As discussed in section 2.1, we validate our model along two main dimensions. Firstly, the ITT simulated expenditures are compared to their national account counterparts. Secondly, simulated consumption tax liabilities are compared to government revenue statistics. We report here the validation results. Validation at a higher level of disaggregation can be found in the EUROMOD website.<sup>28</sup>

In Figure 15, we present the total simulated consumption expenditure as a share of household consumption expenditure recorded in the National Account of each Member State (for the baseline year 2010). On average, simulated consumption expenditure is 70% of its National Account counterpart, ranging from 51% in Croatia to 86% in Denmark. The comparison between the ITT simulated consumption data and the HBS consumption data (see detailed statistics in the EUROMOD website) indicates that such a short-fall is not due to the imputation method, but rather by the well know consumption under-reporting in survey. This is more prominent for certain consumption categories, particularly tobacco and alcohol.

We then contrast simulated VAT liabilities with official government revenue statistics, in table 1. However, these figures cannot be immediately compared for the reason that the latter include VAT liabilities from the business sector and public administration on top of the household VAT liabilities. We therefore use administrative data from government VAT statements to estimate the household shares of VAT liabilities and report these in the same table. Overall, we find a very good fit when we compare the simulated household VAT liabilities with the share of VAT revenues associated with private consumption. Given the under-estimation of household consumption, this suggests that simulated VAT are probably over-estimated in some countries, which is expected given the assumption of no tax evasion.

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<sup>28</sup>See: <https://euromod-web.jrc.ec.europa.eu/overview/extended-functionalitiesinline-nav-8>

Figure 15: Simulated consumption expenditure Vs National Account (2010)

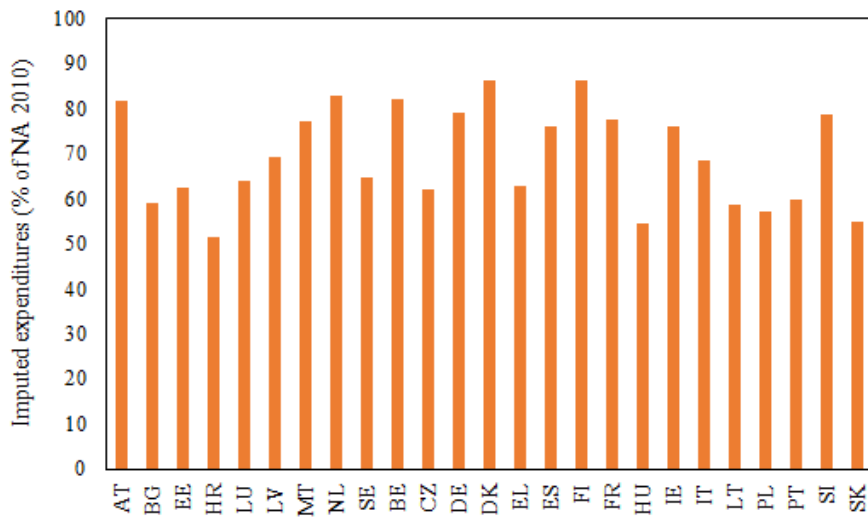


Table 1: Simulated VAT Vs government revenues statistics (2010)

	<b>Total VAT revenues</b>	<b>Share of HH VAT</b>	<b>Simulated VAT</b>	<b>Validation ratio</b>
<b>AT</b>	22,682	<b>69%</b>	15,607	99%
<b>BG</b>	6,452	<b>67%</b>	4,314	100%
<b>EE</b>	19,675	<b>64%</b>	10,438	83%
<b>HR</b>	37,623	<b>81%</b>	16,733	55%
<b>LU</b>	2,608	<b>62%</b>	618	38%
<b>LV</b>	850	<b>71%</b>	738	122%
<b>MT</b>	477	<b>74%</b>	328	93%
<b>NL</b>	41,840	<b>55%</b>	24,067	105%
<b>SE</b>	322,603	<b>54%</b>	115,530	66%
<b>BE</b>	25,628	<b>60%</b>	15,043	97%
<b>CY</b>	1,597	<b>67%</b>	784	73%
<b>CZ</b>	263,457	<b>62%</b>	137,638	84%
<b>DE</b>	180,213	<b>65%</b>	102,927	88%
<b>DK</b>	171,583	<b>65%</b>	95,979	86%
<b>EL</b>	15,958	<b>78%</b>	8,944	72%
<b>ES</b>	55,318	<b>64%</b>	46,164	130%
<b>FI</b>	15,533	<b>58%</b>	9,098	100%
<b>FR</b>	135,578	<b>61%</b>	68,634	84%
<b>HU</b>	2,325,608	<b>67%</b>	1,260,350	80%
<b>IE</b>	10,067	<b>54%</b>	5,726	105%
<b>IT</b>	97,042	<b>72%</b>	69,884	100%
<b>LT</b>	2,180	<b>71%</b>	1,523	98%
<b>PL</b>	109,717	<b>66%</b>	55,403	76%
<b>PT</b>	13,527	<b>84%</b>	6,987	61%
<b>RO</b>	39,990	<b>46%</b>	20,027	109%
<b>SI</b>	2,926	<b>54%</b>	1,869	117%
<b>SK</b>	4,182	<b>54%</b>	2,695	118%

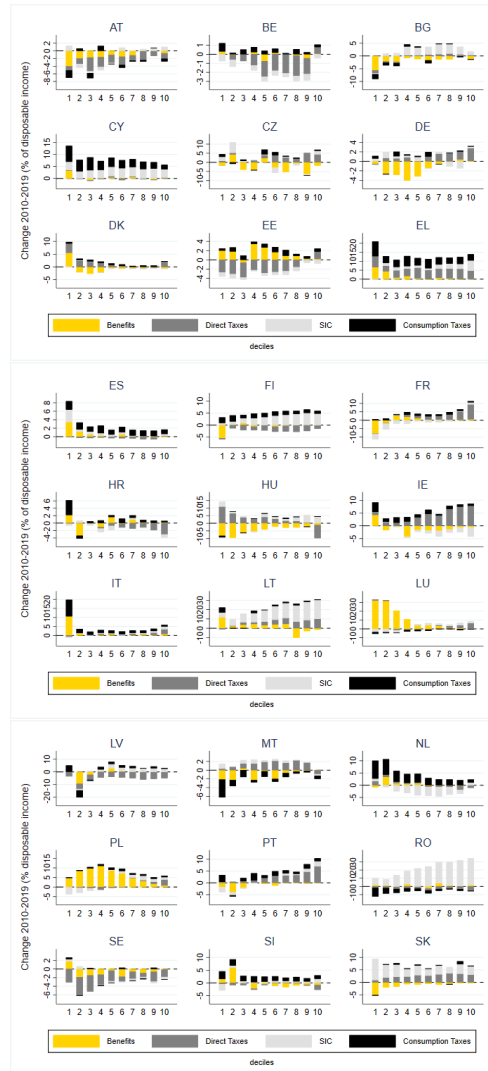
Notes. Simulated and actual VAT revenues are expressed in millions of national currency.



## B Further results

### B.1 Tax and benefits changes by country, 2010-19

Figure 16: Impact by decile of tax/benefits changes, 2019-2010



### B.2 Consumption tax changes by country, 2010-19

Figure 17: Impact by decile of consumption tax changes, 2019-2010

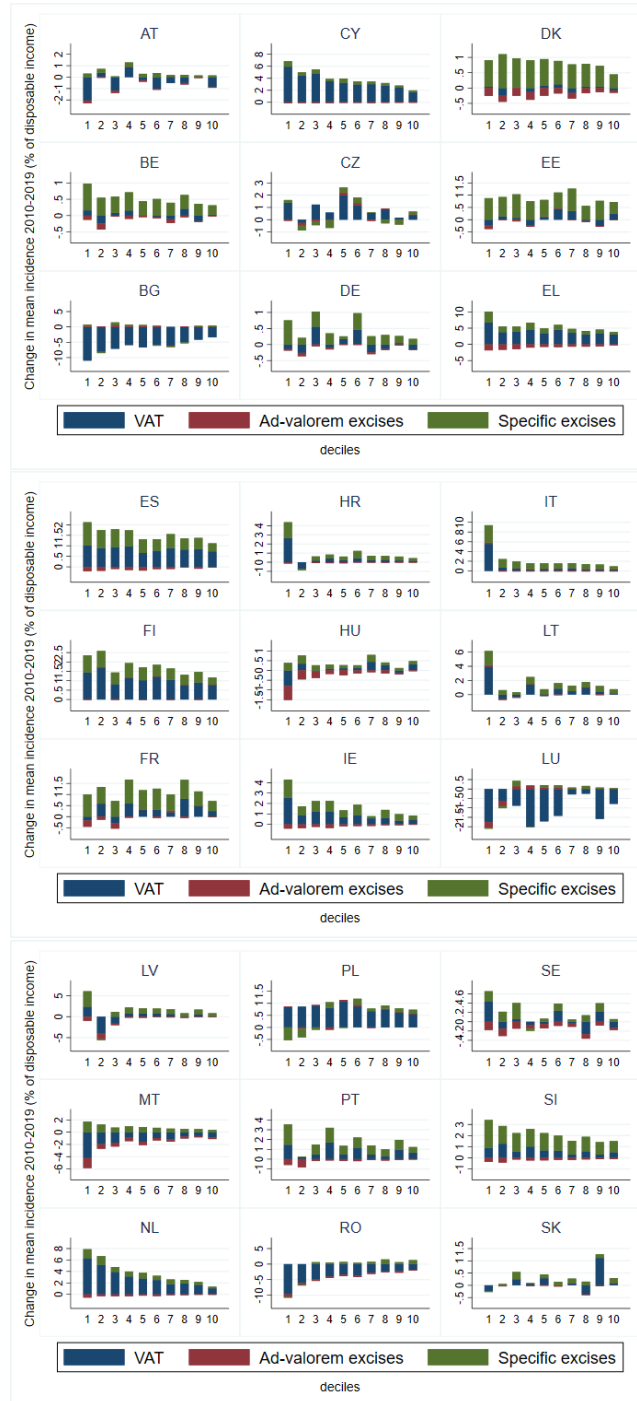


Figure 18: Change in implicit tax rate by consumption categories, 2010 - 2019

	Food & na beverages	Alcoholic beverages & tobacco	Cloathing & footwear	Housing, water & energy	House furnishing	Health, culture, education	Transport	Communications	Restaurants & hotels	Others
AT	0.00%	3.00%	0.00%	-0.55%	0.00%	-0.46%	0.74%	0.00%	-3.74%	-0.07%
BE	0.00%	6.81%	0.00%	0.09%	0.00%	0.00%	1.44%	0.00%	0.00%	0.00%
BG	0.00%	-3.35%	0.00%	-0.11%	0.00%	-0.20%	-0.43%	0.00%	-0.38%	0.37%
CY	13.63%	5.91%	2.92%	1.35%	2.92%	0.46%	4.26%	2.88%	0.00%	2.09%
CZ	3.95%	-1.50%	0.69%	0.55%	0.69%	0.78%	3.75%	0.67%	-1.40%	0.30%
DE	0.01%	-3.21%	0.00%	0.08%	0.00%	-0.21%	2.19%	0.00%	-2.46%	-0.08%
DK	0.00%	0.79%	0.00%	2.06%	0.00%	-0.02%	1.28%	0.00%	0.00%	-0.03%
EE	0.00%	17.91%	0.00%	-0.01%	0.00%	0.01%	2.01%	0.37%	0.00%	0.06%
EL	3.34%	2.97%	3.74%	5.51%	3.45%	1.14%	6.94%	3.37%	10.29%	1.98%
ES	-2.88%	2.50%	3.56%	3.46%	3.56%	1.02%	5.52%	3.53%	-4.06%	2.42%
FI	1.57%	7.57%	1.32%	4.51%	1.32%	0.73%	2.28%	1.29%	0.32%	1.08%
FR	0.01%	-2.27%	0.28%	3.78%	0.28%	0.06%	3.06%	0.02%	2.19%	0.08%
HR	0.72%	3.53%	0.00%	0.78%	0.00%	0.04%	1.92%	0.00%	0.00%	-0.02%
HU	-1.96%	-5.78%	1.26%	1.44%	1.26%	-0.22%	3.20%	1.26%	0.72%	0.57%
IE	0.00%	2.35%	1.33%	7.10%	1.52%	-1.26%	3.63%	1.34%	1.34%	-0.56%
IT	0.00%	2.92%	1.37%	2.50%	1.37%	0.27%	6.52%	1.27%	-1.99%	0.69%
LT	0.00%	1.18%	0.00%	0.74%	0.00%	4.15%	6.85%	0.02%	-0.01%	-0.01%
LU	0.01%	1.32%	-0.01%	-2.42%	0.18%	-2.61%	0.56%	-5.64%	-10.13%	0.55%
LV	-1.70%	4.30%	0.00%	2.63%	0.00%	-0.06%	5.62%	0.00%	-0.53%	5.08%
MT	0.00%	2.65%	0.06%	-2.03%	0.00%	-4.24%	1.19%	0.00%	-0.41%	0.08%
NL	-1.27%	6.05%	1.34%	9.27%	-0.07%	3.45%	1.78%	3.22%	-7.71%	13.66%
PL	1.62%	-6.69%	0.67%	0.32%	0.67%	0.44%	2.79%	0.67%	0.87%	0.46%
PT	0.81%	-4.84%	2.03%	2.06%	2.03%	0.51%	5.29%	2.02%	0.79%	-0.03%
RO	-7.71%	-5.00%	0.00%	0.16%	0.00%	-0.34%	9.36%	0.00%	-6.97%	0.08%
SE	0.00%	8.78%	0.00%	0.09%	0.00%	-0.02%	-0.91%	0.00%	0.00%	0.00%
SI	0.84%	3.14%	1.36%	4.94%	1.55%	0.27%	5.04%	1.37%	-4.81%	0.38%
SK	-1.75%	-2.17%	0.70%	0.63%	0.70%	1.93%	3.21%	0.69%	0.70%	0.58%
EU	0.34%	1.81%	0.84%	1.81%	0.79%	0.21%	3.30%	0.68%	-1.01%	1.10%

Notes. The implicit tax rate is calculated as the ratio between the consumption taxes and the consumption expenditure over a certain good category. The EU figure is calculated as simple average between Member States. Conditional formatting is applied such that larger positive changes are highlighted in darker green and larger negative changes are highlighted in darker red.

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