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Economic and distributional effects of higher energy prices on households in the EU

Written by Fulvimari A., Temursho U., Vaitkeviciute A. and Weitzel M.

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Contact: A. FULVIMARI, Unit EMPL/F3

E-mail: EMPL-FAIR-TRANSITIONS@ec.europa.eu

European Commission
B-1049 Brussels

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Abstract

The increase in energy prices since mid-2021, leading to a surge in inflation overall, has severely affected households in the EU, particularly low and middle-income households. The energy-driven inflation brought acute risks of exacerbating already existing inequalities and worsening energy and transport poverty. To our knowledge, this paper is the first to analyse the impacts of recently observed price changes on (expenditure-based) energy and transport poverty and along the income distribution at EU level. It does so by using household survey micro-data in a static simulation exercise. Our analysis shows that in the absence of behavioural responses and direct income support (expenditure-based) energy and transport poverty levels would have substantially increased across the EU because of energy price changes between August 2021 and January 2023, compared to the previous 18 months. In line with the existing literature, our analysis also confirms that while residential energy expenditure is higher among low-income groups, expenditure for energy for transport fuels tends to increase along the income distribution. Increasing gas and electricity prices were the main drivers of the impact of skyrocketing energy prices for households. These price increases have also indirectly contributed to rising food prices that particularly affect lower-income households. To mitigate the effects of the increasing prices, Member States adopted a wealth of measures aimed at providing fast and tangible relief against high energy prices and costs of living, of which some have been targeted to vulnerable households but most were non-targeted in terms of budgetary impact. As price pressures have eased, Member States are phasing out support measures, also to preserve the stability of public finances. The quantitative modelling results discussed in this paper consider only those measures that have direct impact on consumer prices, such as price caps or reduction in tariffs, VAT or other consumption taxes. These measures constitute approximately 28% of the total number of measures implemented. Hence the results of this paper clearly show that the emergency measures implemented by Member States responded to an urgent need at the time to mitigate the potential and actual impacts of the energy prices spike, which would have severely exacerbated poverty and inequalities otherwise. However, by being untargeted, many measures had a regressive effect and a high cost on public finances.

Keywords: distributional analysis, energy prices, energy poverty, transport poverty, household budgets

JEL code: D10, D63, E31, Q41

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Authors

Alessia Fulvimari, European Commission, Directorate-General for Employment, Social Affairs and Inclusion.

Umed Temursho, IOpedia (Spain); Institute of Public Policy and Administration, University of Central Asia (Kyrgyz Republic).

Aiste Vaitkeviciute, European Commission, Directorate-General for Employment, Social Affairs and Inclusion.

Matthias Weitzel, European Commission, Joint Research Centre.

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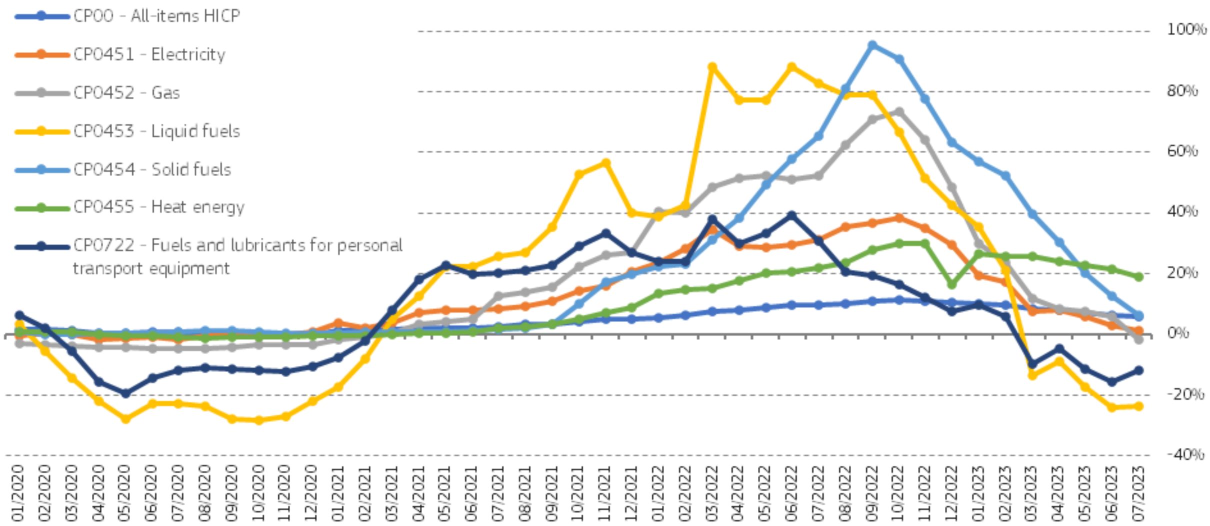
1. Introduction

Energy prices increased significantly in the second half of 2021, albeit from low levels, as a result of supply constraints and an increased global demand for energy following the recovery from the Covid-19 pandemic. This increase was much aggravated by Russia's war of aggression against Ukraine since February 2022 and the uncertainties surrounding the continuation of gas supplies and the related market turbulences, leading to a surge in inflation overall, driven mainly by energy prices (see Figure 1). These developments affected many households, with an increasing share having encountered financial difficulties facing the stark increases in energy prices. The increase in prices affected not only low-income households, but also some middle-income households, and measures to mitigate the impact of this temporary surge in energy prices became one of the main priorities for policymakers in the EU and the Member States. Since October and November 2022 electricity and gas prices have been decreasing and reached-war levels in January 2023.

Figure 1. Inflation rates by consumption categories, monthly rates (annual changes), January 2020-July 2023, EU27



Source: Eurostat, PRC_HICP_MANR.

While the recent developments and challenges were exceptional, it is important to note that energy affordability for vulnerable households was a serious policy concern already before the spike in prices registered from mid-2021, including due to the price volatility of fossil fuels and the investments required into higher energy efficiency and more reliable and cheaper renewables. The proportion of the total population unable to keep their homes adequately warm ([1]) increased by 2.4 pps in the EU27 in 2022, inverting a trend that saw this share constantly declining over the period 2015-2021. Increased energy prices affect prices for goods and services and have distributional impacts that can worsen existing inequalities and increase energy and transport poverty, if not properly addressed by policymakers. Understanding the distributional impacts of our policies and price developments and taking the necessary measures to ensure the green transition is fair and inclusive is at the core of the European Green Deal, the growth strategy of the EU. ([2])

([1]) The indicator "inability to keep one's home adequately warm" is one of the main ones used to monitor energy poverty. Section 2.2 discusses available energy poverty indicators in more detail.

([2]) On 16 June 2022 Member States unanimously adopted the Council Recommendation on ensuring a fair transition towards climate neutrality ((2022/C 243/04). The Recommendation invites Member States to adopt measures which address the

The main aim of this paper is to assess and quantify the impact of the previous spike and subsequent developments in energy prices (between August 2021 and January 2023 in the empirical analysis) on energy and transport affordability, with a special focus on low-income households. In doing so, it contributes to the urgent need for more real-time analysis of the distributional impacts of energy price hikes. To our knowledge, this is the first paper analysing the impacts of the past price changes on expenditure-based energy and transport poverty and along the income distribution at EU level, complementing Menyhert (2022) which uses similar methods and provides a more general overview on a range of poverty/deprivation indicators, including perception-based energy poverty. It does so by using household survey micro-data in a static simulation exercise. Specifically, the analysis shows the additional budget needed by households to maintain their consumption basket under observed price increases. This provides a measure of the loss of purchasing power for households at different income groups. In particular, we determine how the level of energy and transport poverty would have been affected from the price change in the absence of behavioural change by households and of changes in income support measures. (3)

The impacts of rising energy costs on households' daily life were revealed also by the Special Eurobarometer Survey (4) conducted in May-June 2022. In the survey, 93% of respondents in the EU stated that the level of energy prices for people in their country was a serious problem. 58% of them considered it as a "very serious problem". The majority of respondents were confident that they could reduce their energy consumption. The fewer financial difficulties a respondent experienced, the more likely they were to be confident they could reduce their energy use. Households with low income and high expenditure shares on energy, on the other hand, were particularly vulnerable, as they may be limited in their response options to reduce energy consumption (such as investing to improve energy efficiency).

Since the last quarter of 2022, energy inflation is decreasing again from its peak of 40.2% in March 2022 (compared to the same month of the previous year), reaching -4.4% in July 2023 in the EU. as and electricity retail prices have been decreasing since October and November 2022, respectively, driven by the steep fall in wholesale gas and electricity prices to well below pre-war levels. However, the adverse impacts of inflation are still bringing negative consequences for vulnerable households as real wages (including for minimum wage workers) are expected to continue falling in 2023 and only slightly pick-up towards the end of 2023 and in 2024 (5), and the purchasing power of low and middle-income households has strongly deteriorated in the EU (with an estimated 12% increase in their living costs on average especially regarding food and energy) (European Commission 2023a; Charalampakis et al., 2022).

employment and social aspects of climate, energy and environmental policies. The Commission proposal was accompanied by a Staff Working Document (https://ec.europa.eu/social/BlobServlet?docId=25029&langId=en) that provides an overview and discussion of the available analytical evidence underpinning the recommended policy interventions, building on the analyses presented in relevant impact assessment reports accompanying the 2030 Climate Target Plan and the various initiatives of the 'Fit for 55' package.

(3) The analysis presented in this paper has been developed under two joint projects between Directorate-General Employment, Social Affairs and Inclusion (DG EMPL) and the Joint Research Centre (JRC) of the European Commission. The two projects are: "Assessing and monitoring employment and distributional impacts of the Green Deal (GD-AMEDI)" running from 2020 to 2023; and "Assessing distributional impacts of geopolitical developments and their direct and indirect socio-economic implications, and socio-economic stress tests for future energy price scenarios (AMEDI+)" running from 2023 until 2026. The two projects combine macro-economic modelling work and micro-economic modelling approaches, with the ultimate goal of enhancing the Commission's modelling and analysis capacities for assessing and monitoring employment, social and distributional impacts of climate and energy policies as well as of energy market effects and price developments caused by Russia's war of aggression against Ukraine. For more information see https://ec.europa.eu/social/main.jsp?langId=en&catId=1588. In addition, the overview of policy measures in place in the Member States as presented in Section 4 relies on the work of the Expert Network for Analytical Support in Social Policies in the framework of an ad-hoc request on measures to tackle energy poverty and rising energy prices, undertaken in February-April 2023.

(4) Fairness perceptions of the green transition - October 2022 - Eurobarometer survey (europa.eu).

(5) European Economic Forecast, Spring 2023 (europa.eu).

The paper provides additional background on the energy and transport poverty indicators ([6]), also presented in the 2023 Country Reports, notably Annex 8 ("Fair Transition to Climate Neutrality"). It is organised as follows: Section 2 discusses the methodology and presents the expenditure-based indicators of energy and transport poverty, the data used for the calculations, and the static simulation methodology (and underlying assumptions) to assess the welfare impacts of price shocks across the income distribution. Section 3 presents the results on expenditure-based energy and transport poverty indicators (Section 3.1 and Section 3.2, respectively) and the distributional impacts (Section 3.3). Section 4 presents a brief overview of measures implemented at EU and national level and Section 5 concludes the paper.

2. Methodology

This paper assesses how increases in energy prices may have influenced energy and transport poverty in the EU. Using the EU Household Budget Survey (HBS) of EU households for the reference year of 2015 (Section 2.1), we present expenditure-based energy and transport poverty indicators that can be calculated using this dataset (Section 2.2). To assess changes in energy and transport poverty due to the past increases in energy prices, we (a) determine price changes between 2015 and pre-energy-crisis levels and "uprate" the survey data accordingly; and, (b) determine price changes between the pre-energy-crisis level and the energy crisis period (Section 2.3). We can then multiply the latter price changes with the reported expenditures to observe how much money would have been required to maintain pre-crisis consumption levels (Section 2.4). Finally, we further re-calculate the energy and transport poverty indicators using the new (counterfactual) expenditure data that we get from this multiplication of consumed quantities and price changes.

To evaluate the household-level welfare and poverty implications of the observed price changes for residential energy goods, fuels for personal transport equipment, and food, a static distributional analysis is carried out. The static analysis implies that consumption quantities remain fixed, as behavioural responses of households are not considered. Although restrictive in that it does not account for substitution effects, such analysis is still useful for understanding the potential short- to medium-term impacts of price changes (Weitzel et al., 2023). While households reduced their energy consumption, notably for gas ([7]), data is not readily available for different income groups. It needs to be recognized that often poor households do not have much scope for substitution regarding consumption of such basic goods as residential energy goods, personal transport fuels, and food.

2.1. Households Budget Survey data

The following analysis is based on the EU HBS 2015 wave, which is documented in Eurostat (2020). The EU HBS 2015 wave does not include the survey data of Austrian households. ([8]) As such, the Austrian microdata of consumption survey for 2014-2015 were obtained from

([6]) Energy poverty is a multi-dimensional concept. The indicator used focuses on an outcome of energy poverty. Further indicators are available at the Energy Poverty Advisory Hub.

([7]) Report from the Commission to the Council: "Review on the functioning of Regulation (EU) 2022/1369 on coordinated gas demand reduction", COM(2023) 173 final (https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52023DC0173)

([8]) Given the voluntary nature of an HBS, historically not all EU Member States participated or even currently participate in its "compilation".

the national statistical office of Austria (Statistik Austria) and incorporated into the EU HBS 2015 wave. ([9]) For brevity, in the current work this combined dataset is referred to as the EU-HBS-2015.

Naturally, some processing of the EU-HBS-2015 microdata is necessary to make it suitable for the purposes of this distributional analysis. This data cleaning/processing step includes such adjustments as excluding households with negative income and expenditures, checking the consistency of household weights with the actual data on the number of households in each Member State and their proportional adjustment in case of large deviations (which is the case for Czech Republic), excluding households with net income set to 0 or 1, resolving the issue of top-coding certain variables, excluding few households with significant differences between the reported aggregate expenditure and the sum of its corresponding disaggregated expenditure categories (used in the model), and estimating certain non-reported expenditures in case of related significant discrepancies between the aggregate and its corresponding reported disaggregate expenditures that are observed for the majority of households. ([10]) For further related details, see Temursho et al. (2020). Table A1 in Annex gives the summary of the number of observations, number of households and population figures per Member State in our final EU-HBS-2015 data.

2.2. Energy and transport poverty: general definitions

The concepts of energy and transport poverty are rather complex and multi-dimensional, and are affected by such drivers as high energy expenditure (in proportion to the household budget) also aggravated by high energy and fuel prices, low levels of income, low energy efficiency of buildings and appliances, geographic and climate factors, household characteristics, family health, and specific household energy and transportation needs and practices. Thus, empirically it is practically not feasible to quantify and use only one measure that captures all the relevant dimensions. As such, there are diverse indicators of energy and transport poverty that are proposed and used in the literature. ([11]) It is not feasible to summarise all the relevant dimensions in one measure.

Energy poverty, defined as “a household’s lack of access to essential energy services that underpin a decent standard of living and health, including adequate warmth, cooling, lighting, and energy to power appliances, in the relevant national context, existing social policy and other relevant policies” ([12]) is not explicitly part of the EU social monitoring framework, but it is proxied by various indicators depending on the specific need. ([13]) For example, two dimensions of the composite ”material and social deprivation” indicator directly relate to energy poverty and provide useful indicators for its monitoring: such as the “inability to keep home adequately warm” and “arrears on utility bills” (both EU-SILC based

([9]) The Austrian data is a much more extensive survey data than those of the remaining 26 individual EU countries included in the EU HBS 2015 wave.

([10]) For example, in case of Germany, consumption data for “Catering services” (EUR_HE111) are reported in HBS 2015 wave but are entirely missing for “Accommodation services” (EUR_HE112). These two sub-categories make up the “Restaurants and hotels” (EUR_HE11) category. Since the differences EUR_HE11-HE112 were found to be consistently large for overwhelming majority of the households, these residuals were taken as the “Accommodation services” expenditures.

([11]) For details see e.g., Lucas et al. (2016), Thomson et al. (2017), Romero et al. (2018), Lowans et al. (2021), Gouveia et al. (2022) and Menyhert (2023), and references therein.

([12]) European Commission proposal for a Directive of the European Parliament and of the Council on “Energy efficiency (recast)” COM(2021) 558 final (Art. 2, 49, resource.html (europa.eu)) based on the European Commission Recommendation on “Energy Poverty (2020/1563).

([13]) https://ec.europa.eu/social/BlobServlet?docId=25629&langId=en

indicators). On top of these, various alternative measures focusing on households' energy expenditure patterns (EU HBS based) are also widely used in the EU.

As concerns transport poverty, this has been defined for the first time on the Regulation establishing the Social Climate Fund (SCF) ([14]), adopted on 25 April 2023, to benefit vulnerable households, micro-enterprises and transport users that are particularly affected by energy and transport poverty. In this context transport poverty has been defined for the purpose of the application of the Fund as "individuals' and households' inability or difficulty to meet the costs of private or public transport, or the lack of or limited access to transport needed for their access to essential socio-economic services and activities, taking into account the national and spatial context". In terms of indicators, data availability to measure transport poverty is more limited than for energy poverty and most of the measures used at EU level refer to households' expenditure on fuel for transports (EU HBS based).

The lack of a standard definition of transport poverty until very recently is the main reason why transport poverty is generally less studied in the literature than energy poverty. One reason could be that the share of transport (including fuel) in total expenditure is less correlated with income or total expenditure than the share of household energy. This may be because poorer households may not be able to afford a vehicle and hence may not have private expenditures for transport fuels, but other factors such as urban/rural status and commuting patterns may also play a considerable role (Vandyck et al., 2023). Different, but interrelated, aspects of transport poverty can be conceptualised as follows (Lucas et al., 2016):

- Transport affordability: the inability or lack of resources of individuals/households to afford private and/or public transportation options. In particular, "transport poverty occurs when a household is forced to consume more travel costs than it can reasonably afford, especially costs relating to motor car ownership and usage" (Gleeson and Randolph, 2002, p. 102). In developed countries, transport unaffordability can lead to social exclusion such as restricting access to other key services, such as employment, education and shopping (Litman, 2015).

- Mobility poverty: a systemic lack of transportation options, often related to a lack of transit services and/or infrastructures, especially public transport. Focusing on vulnerable segments of population (elderly, disabled people, children, part-time employees, job seekers), this is often measured by the number of trips a person/household makes during a period of time, distance of travel, and/or commuting duration (see e.g. Moore et al., 2013).

- Accessibility poverty: the difficulty of reaching certain key activities – such as employment, education, health centres, shops, etc. – within a reasonable time, ease and cost. Accessibility measures always consider location (origin/destination), opportunities people want to access, and the gap or 'separation' between people and those opportunities (Halden et al., 2000; Geurs and Ritsema van Eck, 2001). Accessibility measures often include some aspects of both affordability and mobility poverty.

- Exposure to transport externalities: a broad definition of transport poverty may (or should also) include traffic-related environmental externalities (air pollution, noise, pedestrian casualties and deaths), disamenities of transport infrastructure on lives of local communities, and disbanding and/or dislocation of communities due to building new projects. See e.g. Barter (1999).

Expenditure based energy and transport poverty are related as for both the ability to afford the purchase energy carriers could be limited. Transport poverty could even be considered

([14]) Social Climate Fund (europa.eu)

a sub-component of energy poverty, as transport related expenditure for fuels is also an energy expenditure. However, it can be useful to differentiate between residential energy and transport energy use, as these are affecting different needs, especially in times of strongly volatile prices.

2.2.1. Expenditure-based energy poverty

To measure expenditure-based energy poverty, the total residential energy budget share (REBS) needs to be calculated first. The REBS for household *h* is the sum of its budget shares over the five residential energy categories (electricity, natural gas, liquid fuels for heating like heating oil, solid fuels for heating like coal or wood, and district heating), i.e.

$$REBS_h = S_{h,Electricity} + S_{h,Gas} + S_{h,LiquidFuels} + S_{h,SolidFuels} + S_{h,Heat}, \quad (1)$$

where S_{hk} is *h*'s budget (or expenditure) share of consumption of good *k*, to be also formally defined in Section 2.3.

Table 1. Median values of residential energy budget share (REBS) by the bottom three income deciles (%)

	1st income decile	2nd income decile	3rd income decile	Average
AT	6.0	6.0	5.7	5.9
BE	8.7	8.6	8.3	8.5
BG	16.1	16.9	16.0	16.3
CY	5.9	6.0	5.3	5.7
CZ	16.8	16.5	13.8	15.7
DE	9.6	9.0	8.0	8.9
DK	8.7	10.1	9.2	9.3
EE	13.4	15.2	14.4	14.3
EL	6.6	9.7	8.7	8.4
ES	6.3	6.1	6.2	6.2
FI	2.6	2.7	2.6	2.6
FR	5.4	5.7	5.7	5.6
HR	15.4	14.9	14.4	14.9
HU	16.7	17.3	16.8	17.0
IE	7.6	9.7	7.2	8.2
LT	12.4	11.2	12.6	12.1
LU	7.1	6.4	5.6	6.4
LV	16.1	15.0	13.9	15.0
MT	3.4	3.6	3.7	3.5
NL	6.1	6.5	5.8	6.1
PL	11.8	12.8	13.2	12.6
PT	10.7	10.2	10.1	10.4
RO	10.0	12.5	13.0	11.8
SE	1.8	2.5	2.6	2.3
SI	14.3	12.6	12.0	13.0

SK	19.4	18.6	17.2	18.4
Average	10.0	10.2	9.7	10.0

Source: Own computations based on EU-HBS-2015 micro-data.
Notes: Household sample weights are taken into account in computing the household median values of REBS. Imputed rents for housing are excluded. Income data are missing for Italy in the HBS 2015 wave.

A household is considered to be energy poor if its REBS exceeds 10% (Vandyck et al., 2023). The justification of this particular REBS threshold is based on the following considerations. The REBS's 10% threshold matches with the 10% indicator, introduced by Boardman (1991), and widely used for energy poverty assessments. According to the 10% indicator, a household is considered energy poor if it has to spend 10% of its net income on adequate energy services. The 10% indicator represented the average energy expenditure of the 30% poorest households in Britain in 1988 as well as roughly twice the median share of actual energy spending for all households in the same reference year. ([15])

Table 1 presents the median values of REBS for EU Member States, accounting for the household sample weights, by the bottom three income deciles. ([16]) For the sake of completeness, the corresponding figures for all income deciles are shown in Table A2 in Annex. As follows from the figures reported in Table 1, the average median value of REBS for the poorest 30% of households in the EU in the reference year of 2015 is exactly equal to 10%. Thus, the REBS 10% threshold approximates the average median residential energy cost in the budget (i.e., total expenditure) of the poorest 30% of the EU households. For comparison, the median EU household spends 6.8% on residential energy.

It should be noted that we calculate the REBS indicator (and similarly the transport poverty indicator presented in Section 2.2.2) based on expenditure data rather than income variables. This choice is due to the EU-HBS-2015 income variables appearing to have inherent accuracy/quality issues (European Communities, 2003). ([17]) For example, potentially systematic income underreporting and/or underestimation problem can be seen from the overall household savings, defined as net income minus total expenditure that excludes imputed rents: the resulting savings are negative for a large number of households in many EU countries. This issue is clearly seen from Table A3 in the Annex, which shows the (weighted) mean household savings by income decile. In addition, in EU-HBS-2015 income data are missing for Italy. For this reason, we refrain from using the EU-HBS-2015 income variable in conjunction with other variables (e.g., generating energy expenditure ratios with income). However, we use the HBS income variable to generate income-based deciles, as systematic underreporting by a roughly identical factor, would maintain the household distribution in the country according to their reported (biased) net incomes.

Three target groups are considered when presenting estimates of energy poverty (and similarly for transport poverty): (a) all households, (b) households with equivalised total expenditure below the corresponding national median, and (c) households with equivalised

([15]) Schuessler (2014) argued that "the justification for the TRP [Ten-Percent-Rule] should rely on energy expenditure at the lowest income strata and not on the overall double median share of an entire country's energy expenditure" (p. 8).

([16]) Income deciles are based on the EU-HBS-2015 variable "monetary net income" (i.e., total monetary income from all sources minus income taxes, EUR_HH095). For Austria, the corresponding variable in HBS-AT is "estimated monthly household income" (i.e., errechnetes monatliches Haushaltseinkommen, C_HHEK), which was annualised. Member State-specific income deciles were based on income variable, expressed per adult equivalent using the modified OECD scale, which accounts for different household sizes and compositions. The modified OECD scale assigns a value of 1 to the first adult in the household, of 0.5 to the second and each subsequent person aged over 13, and of 0.3 to each child aged 13 or under.

([17]) On the limitations of income data in HBS, Eurostat (2020) states the following: "Even though efforts have been made by countries to increase income comparability between HBS and EU-SILC, one cannot expect the household income collected from HBS to be as accurate as with EU-SILC. For instance, seasonal income components or small amounts can be under-represented in the HBS" (p. 39).

total expenditure below 60% of the national median. Narrowing further down a focus on the population with below 60% of the national median equivalized total expenditure below 60% of total expenditure per adult equivalent can be referred to as an expenditure-based counterpart of the widely used at-risk-of-poverty (AROP) rate indicator that is instead based on equivalized disposable income. Formally, the proportion of “energy poor” population in country *r* in case (a) is calculated as follows:

$$EPOV_r^A = \frac{\sum_{h=1}^{N_r} weight_h^r \times size_h^r \times 1_{REBS_h^r > 10\%}}{\sum_{h=1}^{N_r} weight_h^r \times size_h^r}, \quad (2a)$$

where $weight_h^r$ and $size_h^r$ denote, respectively, the sample weight and size of household *h* in country *r*,(18) N_r is the total number of households in country *r*, and $1_{REBS_h^r > 10\%}$ is an indicator function that takes value of 1 if $REBS_h^r > 10\%$ and zero otherwise.

Similar expressions are used for the other two cases. For example, in case (b) we have:

$$EPOV_r^B = \frac{\sum_{h=1}^{N_r} weight_h^r \times size_h^r \times 1_{REBS_h^r > 10\%} \times 1_{EqvE_h^r < medianEqvE^r}}{\sum_{h=1}^{N_r} weight_h^r \times size_h^r \times 1_{EqvE_h^r < medianEqvE^r}}, \quad (2b)$$

which narrows down the computation in (2a) to households with equivalized total expenditure less than the corresponding national median, indicated by the indicator function $1_{EqvE_h^r < medianEqvE^r}$.

In view of the REBS 10% threshold, it should be noted that Table 1 shows considerable heterogeneity of the REBS median values for the 30% poorest households across some of the EU countries. As such a complementary sensitivity analysis could be carried out that is based on the country-specific REBS (average) median thresholds as reported in Table 1, which is however not further pursued in this work.(19) Finally, one could additionally argue that in policy assessments the use of changes in poverty measurement, both energy and transport poverty, as opposed to its absolute level, can be considered as a more practical and reliable application of the poverty concepts.(20)

2.2.2. Expenditure-based transport poverty

The analysis of transport poverty in this paper attempts to capture excessive or high fuel costs of private transport against the backdrop of increased energy prices, hence is related to the transport affordability concept. We focus on actual transport expenditures, as captured by the HBS data on private transport fuel budget share (PTFBS). This excludes public transport, as public transport prices overall were less affected from the energy price

(18) The corresponding variables in EU-HBS-2015 are HA10 and HB05. For the Czech Republic, the household weights (HA10) given in HBS 2015 wave were multiplied by 130 to correctly represent the actual number of Czech households (and thus population size) in 2015. In case of Malta, household size (HB05) is top-coded at 6+. These latter cases thus were all set to 6.

(19) Menyhert (2023) also uses energy expenditure share indicator (FixThreshold) as one of the five EPOV measures in the study. A much higher threshold of 30% “is selected in an arbitrary manner, in line with households’ typical energy expenditure patterns and the implied energy poverty rate” (p. 3), which results in energy poverty rate of 13% (Figure 1, p. 4). It should be mentioned that the FixThreshold indicator differs from our REBS in that Menyhert (2023) defines energy expenditure as consumption of residential energy plus fuels for private transportation (EUR_HE045+EUR_HE0722), with total expenditure (EUR_HE00) including imputed rentals for housing. In our case, only residential energy consumption is included in EPOV measure, while total expenditure excludes imputed rents.

(20) For example, on the use of transport affordability indices in evaluating the results of policy interventions, Serebrisky et al. (2009) point out that: “The use of changes in the affordability measurement, as opposed to its absolute level, seems like a much more promising avenue for the practical use of this concept” (p. 722).

shock. (21) As explained in section 2.2, transport poverty can be assessed in several dimensions, and an expenditure-based approach for transport fuel may have limitations, e.g., as mentioned, lower income households may not be able to afford an own vehicle and consequently do not have expenditures on transport fuels.

Similarly to energy poverty discussed in Section 2.2.1, a threshold-based indicator of transport poverty is used. The RAC Foundation(22) (2012) uses expenditure-based threshold indicator of transport poverty, wherein a household is defined as transport poor when more than 10% of its expenditure is spent on transport, both personal and public. Focusing on the costs related to the operation of personal transport equipment and transport services (CP072+CP073) we find the mean and median values of, respectively, 8.3% and 6.6% of total expenditures of the EU households on these two categories (Table 2). With vehicle purchases costs included (CP07 = CP071+CP072+CP073), these values increase to 10.7% and 7.6%, respectively. (23) Using a narrower focus of only energy purchases for transport fuels, where the price increase in the energy crisis was largest, we need to adjust the 10% threshold for overall transport expenditures accordingly. As about 60% of the 10% budget share threshold are spent on fuels and lubricants for personal transport equipment, this leads to a choice of a conservative fixed threshold of 6% for PTFBS in order to identify 'transport poor' households in our analysis. (24)

In particular, a household is considered transport poor if its PTFBS share exceeds 6%. The implications of this threshold choice are different from that given to the 10% threshold for energy poverty (the REBS indicator mentioned above), because transport expenditure is non-regressive in all Member States. Also, in case of PTFBS, such non-regressivity holds for all the EU countries, except for Cyprus that shows slight regressivity (25) and Italy for which income data are missing. Table 2 reports the mean and median values of budget shares of transport expenditures (CP07) and of the aggregate of its two subcategories of 'Operation of personal transport equipment' (CP072, which includes purchases of e.g. petrol and diesel fuels) plus the public transport category 'Transport services' (CP073).

The corresponding computations follow the expressions given in (2a) and (2b) for energy poverty. Formally, we use the following expression to, for example, find the proportion of transport poor households among the population with equivalized total expenditure below 60% of the national median (case c):

$$TPOV_r^C = \frac{\sum_{h=1}^{Nr} weight_h^r \times size_h^r \times 1_{PTFBS_h^r > 6\%} \times 1_{EqvE_h^r < 0.6 \times medianEqvE^r}}{\sum_{h=1}^{Nr} weight_h^r \times size_h^r \times 1_{EqvE_h^r < 0.6 \times medianEqvE^r}}, \tag{3}$$

where the indicator function $1_{PTFBS_h^r > 6\%}$ takes value of 1 if PTFBS of household *h* in country *r* is greater than 6% and zero otherwise.

(21) In addition, the public transport category 'transport service' CP073 also includes aviation which saw a stronger price increase then local public commuting and may be less suited for characterizing transport poverty.

(22) The RAC Foundation is a transport policy and research organisation which explores the economic, mobility, safety and environmental issues relating to roads and their users.

(23) Note from Table 2 that for many EU countries there is no significant difference between the budget shares for CP07 vs. its subcomponent CP072+CP073 due to a large number of zero reported expenditures on purchases of vehicles (e.g. 99.8% of Romanian households report no or zero purchases of vehicles in the EU HBS 2015 wave; the corresponding numbers are 98.7% in Bulgaria, 98.5% in Poland, 94.9% in Hungary, 94.3% in Croatia, etc.).

(24) From the EU-HBS-2015 we calculate the ratio variable putting expenditure for transport fuels in relation to total private and public transport expenditures excluding vehicle purchases, CP0722/(CP072+CP073). The average across the EU countries of the mean and median values of the ratio are 52% and 59%, respectively. The overall figures averaging over EU households are 55% and 64%.

(25) For Cyprus, the mean PTFBS values (in %) derived from HBS-2015 are 8.7, 8.2, 7.5, 8.2, 8.6, 8.8, 8.0, 7.7, 7.3 and 6.0 for the first, second, and so on up to tenth decile, respectively (Source: own computations).

Table 2. Household mean and median transport budget shares (%)

	Private and public transport expenditure share (excluding vehicle purchases) CP072+CP073		Private and public transport expenditure share (including vehicle purchases) CP07 = CP071+CP072+CP073	
	Mean	Median	Mean	Median
AT	8.0	5.9	12.4	8.2
BE	8.4	5.8	10.8	6.3
BG	6.2	4.3	6.4	4.4
CY	11.1	10.5	13.1	11.4
CZ	7.8	7.3	9.1	7.7
DE	8.2	7.0	10.5	7.8
DK	7.9	6.2	12.0	8.2
EE	5.5	1.1	8.5	2.2
EL	8.2	7.3	9.3	7.8
ES	9.5	7.0	11.7	8.1
FI	9.5	6.9	13.9	9.2
FR	7.8	5.5	12.0	7.6
HR	9.6	9.4	10.5	9.6
HU	7.7	5.4	8.4	5.6
IE	8.3	6.7	13.5	10.2
IT	9.7	8.3	11.4	8.9
LT	6.5	2.8	7.4	3.1
LU	8.0	6.4	14.6	9.3
LV	8.1	4.8	9.3	5.3
MT	8.7	7.7	11.7	8.8
NL	8.5	6.7	12.2	8.3
PL	6.9	5.3	7.2	5.4
PT	12.1	10.9	14.3	11.9
RO	4.4	1.3	4.5	1.4
SE	9.4	7.5	13.9	9.4
SI	12.3	11.6	15.8	13.3
SK	6.9	5.8	9.2	6.7
EU27	8.3	6.6	10.7	7.6

Source: Own computations based on EU-HBS-2015 micro-data.
Notes: Household sample weights are taken into account. CP07 refers to ECOICOP category ‘Transport’, which consists of three subcategories of ‘Purchase of vehicles’ (CP071), ‘Operation of personal transport equipment’ (CP072), and ‘Transport services’ (CP073).

2.3. Measuring the impact of price changes on energy and transport poverty

Consider a scenario focusing on the impacts of price changes over two consecutive 18 months periods. (26) First, the corresponding price shocks need to be defined as exogenous inputs in the evaluation exercises. Using the monthly indices (PRC_HICP_MIDX) of the Harmonised Indices of Consumer Prices (HICP) available from Eurostat, the 18-month average rate of change of the observed consumer prices of commodity *k* for the period that ends in January 2023 are obtained as follows:

$$\frac{\Delta p_k}{p_k} = \frac{\left(I_{k,Aug}^{2021}+I_{k,Sep}^{2021}+\cdots+I_{k,Jan}^{2023}\right)/18}{\left(I_{k,Feb}^{2020}+I_{k,Mar}^{2020}+\cdots+I_{k,Jul}^{2021}\right)/18} - 1, \tag{4}$$

where e.g. $I_{k,Aug}^{2021}$ denotes the HICP index of commodity *k* for August 2021 and *k* refers alternatively (depending on the specific case analysed and indicator used to measure the impact) to food (with the HBS code of EUR_HE011), electricity (EUR_HE0451), gas (EUR_HE0452), liquid fuels (EUR_HE0453), solid fuels (EUR_HE0454), heat energy (EUR_HE0455), and fuels and lubricants for personal transport equipment (EUR_HE0722). The choice of using average prices over the period of interest in defining price changes in (4) is dictated by the high volatility of prices, especially energy prices, since the start of the energy crisis in September 2021 (see e.g. Figure 1). Energy prices increased due to Russian lower (gas) deliveries, low storage levels and overall increasing uncertainty on energy markets. The period average monthly price smoothens such volatility and appropriately accounts for the months of extremely high prices, which can be easily missed if, instead, the beginning and ending months were used in the calculation of price shocks.

In the second step, one has to decide how to use the EU-HBS-2015 in building a baseline scenario, which reflects the situation prior to the energy price shock. In particular, shall the baseline scenario refer directly to the reference year of 2015 of the EU-HBS, or is it more reasonable to shift the reference year to the beginning period of each considered scenario? Depending on the aims of an evaluation, both options may be valid approaches to assess impacts. In the current setting, it is preferable to shift the reference year of the baseline according to the considered scenario. With the 18-month scenario and its price shocks defined earlier in (4), it is preferable to have the baseline (i.e., before considering the energy price shocks) poverty indicators representing the (average of the) 18-month period from February 2020 to July 2021. The first-best option, of course, would have been to directly use HBS microdata for this particular period. However, this runs into a data availability issue, as we do not have available HBS surveys for these exact dates. The last available harmonized HBS for 27 Member States at the time of this analysis was the 2015 wave. (27) Therefore, the required baseline-shifting exercise can be done by "uprating" the 2015 prices of the EU-HBS-2015 to those of the baseline period of interest. In case of the 18-months scenario, this step is formally implemented as follows:

$$(p_{hk}C_{hk}) \times \frac{p_k^{base}}{p_k} = p_k^{base}C_{hk} \ , \tag{5a}$$

where C_{hk} is household *h*'s consumption of product *k* and p_{hk} is the *h*'s purchase price of product *k*, both of which are individually not observable, but jointly captured in the EU-HBS-

(26) An 18-month period is chosen to capture the rise of energy prices starting already in 2021 and preceding the Russian invasion of Ukraine.

(27) In addition, the more recent HBS 2020 wave is difficult to use as the surveying took place between 2019 and 2021 in different member states and thus in very different stages of the Covid pandemic.

2015 as household *h*'s expenditure (in Euros) for commodity *k*, $E_{hk} = p_{hk}C_{hk}$.([28]) This method assumes no changes of the consumed quantities C_{hk}, i.e. no behavioural change, e.g. due to price changes between 2015 and the pre-crisis period. The "uprating" price index for commodity *k* in (5a) is obtained from Eurostat HICP monthly data as:

$$\frac{p_k^{base}}{p_k} = \frac{I_{k,Feb}^{2020} + I_{k,Mar}^{2020} + \cdots + I_{k,Jul}^{2021}}{18}, \tag{5b}$$

where the HICP monthly indices $I_{k,month}^{year}$ are conveniently expressed in relation to the base year of 2015, which is also the reference year of the EU-HBS-2015.

Note that in moving from the left-hand side expression in equation (5a) to its right-hand side expression, we have assumed that in each EU country all households pay the same price for product *k*, i.e., $p_{hk} = p_k$ for all *h*. This assumption is often used when working with household-level surveys. However, we take into account that prices differ across countries, but for the sake of simplicity, in the mathematical expressions presented in this work the country identifiers are suppressed, unless needed to be explicitly shown. As follows from equation (5a), inflation-uprating of the EU-HBS-2015 results in expressing the survey consumption quantities of all commodities at the corresponding average prices of the first (or starting) period of the scenario considered. These new prices, i.e., p_k^{base} for all *k*, are the baseline prices of the scenario in question.

Expenditure shares or budget shares are used in the analysis of energy and transport poverty, as already discussed in Section 2.2 above. In general, household *h*'s baseline budget share of any good *k* is straightforwardly derived from the "baseline" EU-HBS-2015 as

$$S_{hk}^{base} = \frac{p_k^{base} C_{hk}}{\sum_{j=1}^{n} p_j^{base} C_{hj}}, \tag{6}$$

where $n = 52$ is the total number of expenditure categories aggregation used in the evaluations. It is worth mentioning that imputed rentals for housing (EUR_HE042) has been excluded from the analysis as our focus is mainly on households actual expenditures, imputed rent data are not available for the Czech Republic and Malta, and "the fact that countries used different estimation methods to calculate the imputed rent for the HBS 2015 wave is likely to have seriously reduced comparability across the countries" (Eurostat, 2020, p. 36).

2.4. Calculating welfare impacts

The welfare impact of price shocks is analysed within a static framework, without considering behavioural responses of consumers and income support measures implemented by Member States since energy prices started increasing. Price measures that affect the end-user price are instead taken into account to the extent that are already reflected in the actual consumer prices. The total purchasing power loss of households in monetary terms as an absolute welfare (AW) impact of price changes on household *h* can be computed as follows:

$$AW_h = -\sum_{k=1}^{n} p_k^{base} C_{hk} \frac{\Delta p_k}{p_k^{base}} = -\sum_{k=1}^{n} C_{hk} \Delta p_k. \tag{7a}$$

([28]) We use the terms "product", "commodity" and "good" interchangeably throughout this work.

In other words, equation (7a) gives the amount of additional money income that is necessary to make the original (before price changes) consumption bundle of household *h* exactly affordable at the new prices. In this latter sense, the "compensating" income in (7a) keeps *h*'s purchasing power fixed. In fact, the welfare metric in (7a) measures the so-called Slutsky compensating variation (Slutsky, 1915), which keeps purchasing power constant in the sense of permitting households purchasing their initial bundle of goods at new set of prices. Hence, the Slutsky compensating variation is equivalent to the actual cost differences of the initial (pre-price shock) consumption bundle solely due to the price changes.([29]) See Temursho et al. (2020, pp. 42-43) for further microfoundation-based justification of using (7a) as a welfare metric, and its advantages and disadvantages in view of the neoclassical theory of rational consumer choice.

For the purpose of computing welfare impacts comparable across countries, the relative welfare (RW) impact indicator is used, which expresses AW as a proportion (or percentage) of the baseline total expenditure of households, i.e.

$$RW_h = \frac{AW_h}{\sum_{k=1}^{n} p_k^{base} C_{hk}}. \tag{7b}$$

Once the commodity-specific AW losses at the household level are computed, the new values of demand for product *k after* price shocks (implemented on one commodity or a set of goods according to a scenario of interest) are obtained as:

$$E_{hk}^{after} = p_k^{after} C_{hk} = p_k^{base} C_{hk} - AW_{kh}, \tag{8}$$

where $AW_{kh} = -p_k^{base} C_{hk} \frac{\Delta p_k}{p_k^{base}} = -C_{hk} \Delta p_k$, as follows directly from (5a).([30]) We subtract AW_{kh} in (8) because the welfare impacts are defined as losses (assuming increases in prices) with a minus sign already in (7a). Thus, in the after-price shock environment the commodities consumption bundles effectively end up having two prices:

- $E_{hj}^{after} = p_j^{after} C_{hj}$ for all goods *j* (residential energy goods, fuels for personal transport equipment, and/or food), whose price change has been simulated as given by the pre-specified price shocks, and
- $E_{hk}^{after} = E_{hk}^{base} = p_k^{base} C_{hk}$ for all the remaining goods $k \neq j$ that are not subject to price changes in the scenario under consideration.

Similarly to the baseline budget share derivation in (6), the after-price shock expenditure (budget) shares are directly calculated from E_{hk}^{after}, i.e.

$$S_{hk}^{after} = \frac{E_{hk}^{after}}{\sum_{j=1}^{n} E_{hj}^{after}},$$

from which the new values of REBS and PTFBS are readily obtained. These are used to compute the "after-price shock" energy and transport poverty, using expressions like (2a), (2b) and (3).

([29]) From micro-economic theory perspective, such amount of income compensation is more than enough to maintain the initial utility level. Hence, some authors refer to consumers' reaction to a price change with adjusted income that keeps the initially chosen consumption bundle just affordable as the "law of overcompensated demand" (Cornes, 1992). The advantage, however, is that "everything is observable" and "we do not need any information about tastes in order to perform the experiment" (Cornes, 1992, p. 99).

([30]) Note from (7a) and (8) that $AW_h = -\sum_{k=1}^{n} C_{hk} \Delta p_k = \sum_{k=1}^{n} AW_{hk}$. Hence, the total welfare impact for household *h* is straightforwardly decomposed into impacts due to the price changes of each individual commodity *k*, AW_{hk}.

3. Results

Table 3 shows the 18-month average rates of change of the observed consumer prices between August 2021 and January 2023 with the preceding 18-month period. The price changes for the seven commodities of interest are obtained according to equation (4). It follows that, on average, gas shows the largest increase in prices over the period considered, with the EU-wide (simple) average price increase of 64%, whereas food experienced the smallest relative price increase of 13%. ([31]) However, from consumers' perspective, the effect of price changes also critically depends on the size of commodities' consumption in the household budgets. Moreover, the relative price changes across the seven products are largely heterogeneous across Member States.

Table 3. Observed average price changes, 18-month average rate of change (%)

	Food	Electricity	Gas	Liquid fuels	Solid fuels	Heat energy	Fuels and lubricants for personal transport equipment
AT	9.0	14.3	76.1	96.5	49.3	29.2	49.4
BE	7.0	63.9	143.9	92.6	15.6	0.0	32.5
BG	20.4	6.3	149.2	0.0	49.6	25.5	43.1
CY	8.5	48.3	37.2	64.2	9.7	0.0	33.3
CZ	14.1	9.6	45.9	22.6	35.1	17.0	38.3
DE	12.6	16.7	39.9	76.1	42.8	20.2	39.3
DK	9.7	64.5	138.4	49.5	49.1	1.6	37.5
EE	17.6	131.5	150.4	52.8	58.1	42.6	41.2
EL	11.2	44.0	147.1	55.0	8.7	0.0	30.7
ES	10.6	53.4	20.1	86.2	0.0	0.0	31.8
FI	8.1	36.2	0.0	81.8	0.0	5.2	38.9
FR	6.4	7.4	56.0	71.0	17.0	55.9	29.3
HR	15.0	6.9	19.3	97.7	19.1	-3.4	31.5
HU	25.9	8.3	36.6	0.0	25.5	0.0	30.9
IE	5.5	48.0	60.2	96.1	27.7	0.0	32.7
IT	7.8	108.0	79.3	40.2	10.3	0.0	24.4
LT	23.9	40.8	69.7	101.2	129.6	89.6	44.8
LU	6.6	1.5	61.2	101.9	29.7	57.7	51.6
LV	19.5	39.6	103.7	0.0	60.3	49.9	46.2
MT	11.7	0.0	-0.7	0.0	0.0	0.0	-1.3
NL	8.7	131.1	116.1	0.0	0.0	25.8	28.1
PL	13.8	10.7	38.6	91.6	95.8	16.1	39.8
PT	11.1	16.3	34.0	49.0	11.5	0.0	27.9
RO	15.4	24.5	61.5	10.0	22.4	22.4	41.2
SE	9.3	48.6	6.9	48.6	29.7	2.7	42.9

([31]) The relative small price increase for food compared to energy prices as showed in Table 3, is also due to the period considered which reflects changes between August 2021 and January 2023 with the preceding 18-month period. Therefore, the peak in food prices registered in March 2023 is not taken into account in this paper.

SI	9.8	8.3	31.3	41.6	38.7	45.4	37.3
SK	17.1	5.7	8.1	0.0	23.7	12.3	35.1
Average	12.5	36.8	64.1	52.8	31.8	19.1	35.5

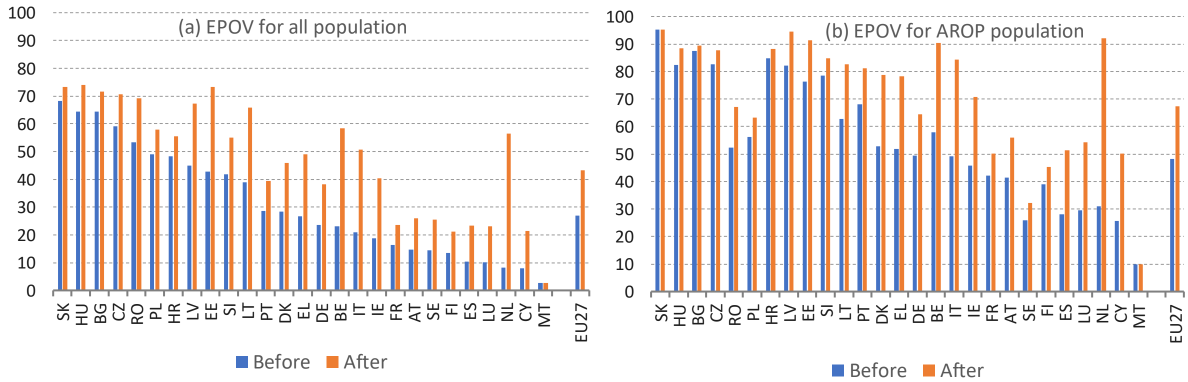
Source: Own computations based on equation using Eurostat HICP data (PRC_HICP_MIDX).
Notes: Changes between August 2021 and January 2023 with the preceding 18-month period. Zero changes for Malta are true reported zeros due to the underlying fixed prices. The same is true for Hungary in case of heat energy. Missing information in residential energy price data are all set to zero, which have no or negligible importance in household energy consumption according to the EU-HBS-2015 data. The only exception is Finland in case of solid fuels, with its mean share in total residential energy consumption of 8.7%.

3.1. Energy poverty results

The energy poverty (EPOV) results in terms of the proportion of population with REBS>10% for the entire population and the (expenditure-based) AROP population, and both before and after the residential energy price increases are illustrated in Figure 2. The corresponding numbers, including EPOV for households with equivalized total expenditure below the national medians, are reported in Table A4 in the Annex. From these findings the following general conclusions can be made.

First, as a result of energy price changes during the August 2021 to January 2023 period relative to the previous 18 months, the share of individuals living in households which spend more than 10% of their budget on energy in the EU would have increased by 16.4 pps (from 26.9% to 43.4%) for the whole EU population and by 19.1 pps (from 48.2% to 67.3%) among the (expenditure-based) AROP population. The corresponding figures in terms of the increase in the number of individuals living in households which spend more than 10% of their budget on energy in the EU total and (expenditure-based) AROP population are estimated to be about 70.7 and 12.7 million people, respectively. To be noted that this result does not take into account policy support (besides those measures already reflected in the final consumer prices, such as driven by decreases in tax rates) and behavioural responses.

Figure 2. Impact of increasing energy prices (during the August 2021-January 2023 period relative to the 18 months prior) on energy poverty for different target populations, % of population with REBS>10%



Source: Own computations based on EU-HBS-2015 micro-data and Eurostat HICP data (PRC_HICP_MIDX).
Notes: “Before” and “After” refer, respectively, to the energy poverty (EPOV) values before and after the change in residential energy prices. EPOV is measured by the proportion of persons for the whole and (expenditure-based) AROP population with REBS greater than 10%.

Second, EPOV is estimated to be higher among (expenditure-based) AROP population than for the whole population in all Member States, except for Romania. Across all EU countries, on average, the two EPOV values are different by a factor of 2.2 and 1.7 in, respectively, the baseline and after energy price hikes scenarios. This confirms the higher vulnerability of the (expenditure-based) AROP population to energy price increases.

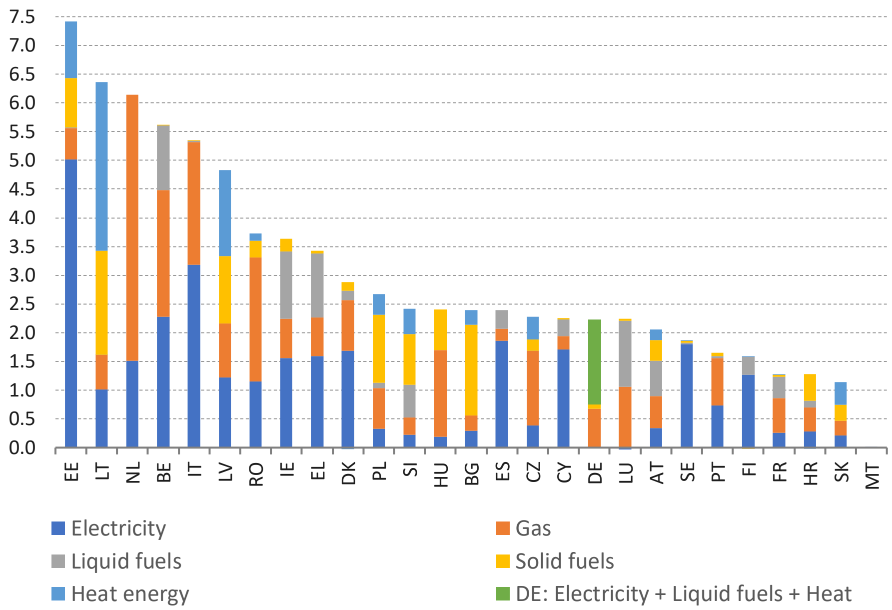
Third, considerable heterogeneity in estimated EPOV values and EPOV changes across the EU countries is found, which reflect the national differences in relative sizes of the price shocks (Table A4 in Annex) and of the consumption budget shares of residential energy goods in each country.

As follows from equations (2a) and (2b) the change in EPOV is driven by the changes in REBS shares, since the household weight and size variables are held constant as captured by the EU-HBS-2015 data. However, note that the change in REBS is captured by the binary variable $1_{REBS_h^r>10\%}$ that takes value of 1 if $REBS_h^r > 10\%$ and zero otherwise. For example, for case (a), the change in EPOV due to energy price hikes is readily derived from (2a) as:

$$\Delta EPOV_r^A = \frac{\sum_{h=1}^{N_r} weight_h^r \times size_h^r \times \left[1_{REBS_h^{r,after}>10\%} - 1_{REBS_h^{r,base}>10\%}\right]}{\sum_{h=1}^{N_r} weight_h^r \times size_h^r},$$

where $REBS_h^{r,base}$ and $REBS_h^{r,after}$ refer to the REBS shares of household *h* in country *r* before and after the energy price changes, respectively. Since the “difference” indicator function $1_{REBS_h^{r,after}>10\%} - 1_{REBS_h^{r,base}>10\%}$ in the above expression is not a continuous variable, it is not straightforward to have an exact decomposition of the change in EPOV into its drivers of changes in budget shares of each individual residential energy good.(32) Nonetheless, the changes in REBS of energy goods would shed light on their relative importance in explaining the changes in EPOV measures.

Figure 3. Percentage points change in the mean differences of residential energy budget shares due to energy price changes during the August 2021-January 2023 period relative to the 18 months prior



Source: Own computations based on EU-HBS-2015 micro-data and Eurostat HICP data (PRC_HICP_MIDX)
Notes: Since electricity, liquid fuels and heat energy data are individually missing for Germany in the HBS 2015 wave, their aggregate is used instead.

(32) One would have to use individual thresholds for each energy subcategory that need be consistent with the overall 10% REBS threshold. This is, however, a rather ad-hoc exercise, hence we choose not to implement the exact decomposition of changes in EPOV.

In particular, for each of the three household segmentation (cases (a) to (c)) considered, per each EU country we calculate the means of the differences of each category of REBS shares, i.e. the weighted means of $\left(S_{h,Electricity}^{after} - S_{h,Electricity}^{base}\right)$, $\left(S_{h,Gas}^{after} - S_{h,Gas}^{base}\right)$, $\left(S_{h,LiquidFuels}^{after} - S_{h,LiquidFuels}^{base}\right)$, $\left(S_{h,SolidFuels}^{after} - S_{h,SolidFuels}^{base}\right)$ and $\left(S_{h,Heat}^{after} - S_{h,Heat}^{base}\right)$. Figure 3 shows these results for the case of all households, while all the obtained figures for all three cases are reported in Table A5 in the Annex. Indeed, it is found that the sum of these means (making up 27 data points) is highly correlated with the changes in EPOV (reported along the column ‘After-Before’ in Table A4): the correlation coefficient was found to be 0.90 in case (a), 0.78 in case (b), and 0.73 in case (c).

From Figure 3, one observes that the largest percentage point average change in total REBS share of 7.4 pps was experienced in Estonia, which not surprisingly shows the third largest increase in EPOV of 30.5 pps (Table A4 in Annex). The decomposition of the mean differences of budget shares in Figure 3 shows that electricity was the largest source of this change, with the average increase in its budget share of 5.0 pps (see also Table A5 in Annex). Note that a change in the share of the energy budget share reflects both the corresponding pre-specified energy price shock and the relative size of consumption of the residential energy good in question vis-à-vis other energy goods and all non-energy commodities, as detailed in Section 2. Therefore, in case of Estonia, from Table 3 we find the largest price changes of 131.5% and 150.4% for, respectively, electricity and gas. Although the natural gas price increase was higher, it is the electricity consumption that contributed most to the increase in energy poverty of Estonian population due to its larger budget share as captured by the (inflation non-uprated and uprated) EU-HBS-2015 data.

The largest increase of EPOV in case (a) (48.2 pps) is observed for the Netherlands. Figure 3 and Table A5 indicate that this was mainly driven by the increase in natural gas budget share, again reflecting both the high gas price increases (116.1%) and its relative energy consumption importance for the Dutch households.

On the other extreme stands Malta with no increase in EPOV. That is because residential energy prices had not experienced any increases since the decision that the “government mandated Enemalta, the (67%) state-owned energy provider in the country, to freeze prices at their 2014 level” (Sgaravatti et al., 2021, last updated 24 March 2023). Enemalta had been compensated by the government for the losses incurred due to such energy price cap policy. For brevity, further Member State-specific results are not discussed here. The interested reader can check all the details in the corresponding tables and figures presented. ([33])

([33]) In general, one could identify EU countries with the largest relative impacts of each REBS change as follows. Ignoring the mean changes in REBS for Germany due to its incomplete data, from Table A5 we find the following 75th percentile values of the average REBS changes of the remaining 26 EU countries in case of all households: 1.67 pps for electricity, 1.03 pps for gas, 0.36 pps for liquid fuels, 0.65 pps for solid fuels, and 0.34 pps for heat energy. Countries that are assessed to experience a higher mean electricity REBS pps changes than the corresponding 75th percentile of 1.67 pps include Estonia (with the electricity average budget share change of 5.02 pps), Italy (3.18 pps), Belgium (2.27 pps), Spain (1.86 pps), Sweden (1.80 pps), Cyprus (1.71 pps) and Denmark (1.69 pps). Similarly, in case of natural gas budget share changes larger than the corresponding 75th percentile, we have Netherlands (4.64 pps), Belgium (2.21 pps), Romania (2.16 pps), Italy (2.13 pps), Hungary (1.51 pps), Czech Republic (1.30 pps) and Luxembourg (1.05 pps). The corresponding list of relatively high impacted countries in case of liquid fuels include Ireland (1.18 pps), Luxembourg (1.16 pps), Belgium (1.12 pps), Greece (1.11 pps), Austria (0.61 pps), Slovenia (0.57 pps) and France (0.37 pps). Similarly, the highest solid fuels average budget share increase is found for Lithuania (1.81 pps), Bulgaria (1.58 pps), Poland (1.17 pps), Latvia (1.17 pps), Slovenia (0.87 pps), Estonia (0.86 pps) and Hungary (0.71 pps). Finally, in terms of heat energy budget share increase, in the top list are included Lithuania (2.93 pps), Latvia (1.50 pps), Estonia (0.99 pps), Slovenia (0.44 pps), Slovakia (0.40 pps), Czech Republic (0.40 pps) and Poland (0.37 pps).

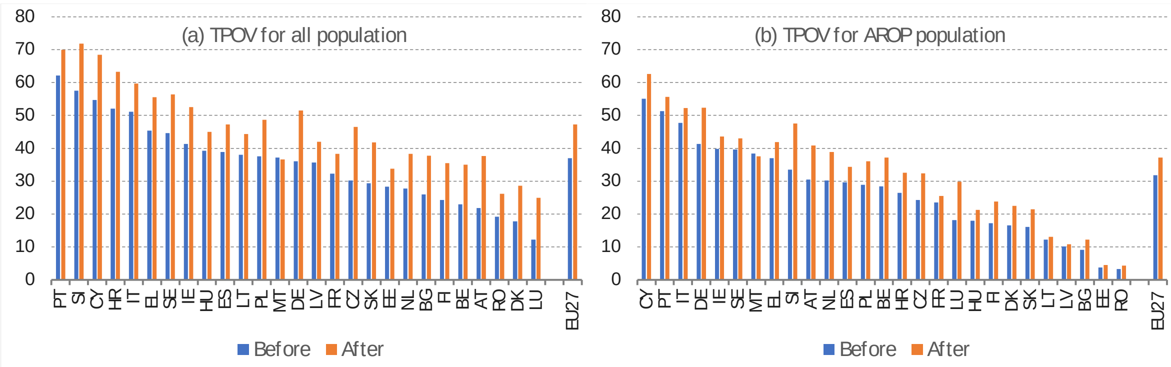
3.2. Transport poverty results

The results concerning impacts on transport poverty (TPOV) are interpreted in terms of the proportion of population with PTFBS>6% for the entire population and the (expenditure-based) AROP population, both before and after the transport fuels price increases (Figure 4). The exact values, including TPOV for households with equivalized total expenditure below the national medians, are reported in Table A6 in the Annex. From these findings the following general conclusions can be made.

First, as a result of transport fuel price changes during the August 2021 to January 2023 period relative to the 18 months prior, in the absence of policy support (except for those policies already reflected in the final consumer prices, such as decreases in tax rates) and behavioural responses, in the EU the share of individuals living in households which spend more than 6% of their budget on fuels for private transportation would have increased by 10.3 pps (from 37.0% to 47.2%) for the whole EU population and by 5.3 pps (from 31.8% to 37.1%) among the (expenditure-based) AROP population. The corresponding figures in terms of the increases in the number of individuals living in households which spend more than 6% of their budget on transport fuel in the EU total and (expenditure-based) AROP population are estimated to be around 44.2 and 3.5 million people, respectively.

Second, in most Member States, TPOV levels are estimated to be lower among (expenditure-based) AROP population than for the whole population. In addition, the impacts in terms of increases in TPOV are found to be smaller among AROP population than for the entire population. Across all EU countries, excluding Malta due to its negative fuel price shock (Table 3) ([34]), on average, the changes in TPOV among the (expenditure-based) AROP population were half the corresponding impacts for the whole population. These differences may be explained by low car ownership rates and/or low travel demand of the households at the bottom end of the (expenditure/income) distribution.

Figure 4. Impact of increasing transport fuel prices (during the August 2021-January 2023 period relative to the 18 months prior) on transport poverty for different target populations, % of population with PTFBS>6%



Source: Own computations based on EU-HBS-2015 micro-data and Eurostat HICP data (PRC_HICP_MIDX).
Notes: “Before” and “After” refer, respectively, to the transport poverty (TPOV) values before and after the change in private transport fuels prices. TPOV is measured by the proportion of persons for the entire and (expenditure-based) AROP population with PTFBS greater than 6%.

Third, considerable heterogeneity in estimated TPOV values and TPOV changes across the EU countries are found, which capture the heterogeneity in relative sizes of the transport fuels price shocks (Table 3) and of the personal transport fuel expenditure shares in each country. This heterogeneity across Member States is driven by the overall cost of transport

([34]) As explained in Section 3.1 all energy prices, including fuel prices, were frozen in Malta.

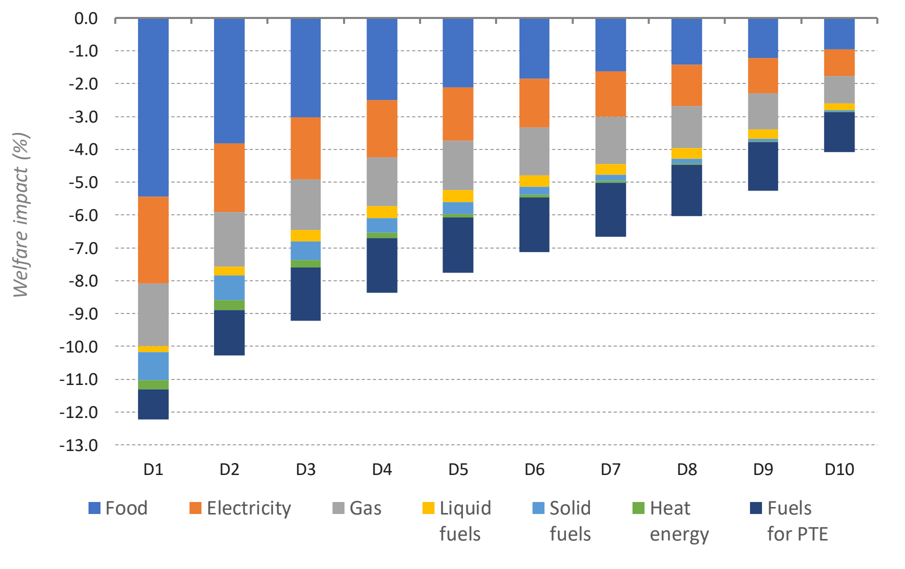
(e.g., through excise and other taxes on vehicle fuels), geographical features that require more or less private transport and availability, accessibility and affordability of public transport which is not taken into account in this paper. Vandyck et al (2023) therefore conclude that "(spatial) interactions between the choice of residence, travel time and mode choice" would also need to be considered for a more complete assessment of transport poverty.

Since we did not consider finer level of fuel prices (i.e., those for diesel, petrol and other fuels for personal transport equipment), a further decomposition of TPOV results driven by the prices of transport fuel types is not possible.

3.3. Distributional impacts

As detailed in Section 2.3, as a welfare metric in the current static framework we use the notion of Slutsky compensating variation, which keeps purchasing power constant in the sense of permitting households purchasing their initial bundle of goods at new set of prices. Hence, the Slutsky compensating variation is fully determined by the cost differences of the initial consumption bundle solely due to the price changes. Figure 5 illustrates the EU-wide household mean welfare impacts as a percentage of baseline total expenditures (see equation (7b)) due to the price changes of seven commodities shown in Table 3. The exact numbers, also including the relative welfare decomposition by population density, are reported in Table A7 in the Annex.

Figure 5. EU-wide distributional impacts of price changes (during the August 2021-January 2023 period relative to the 18 months prior)



Source: Own computations based on EU-HBS-2015 micro-data and Eurostat HICP data (PRC_HICP_MIDX).
Notes: The welfare metric used is (negative) Slutsky compensating variation expressed as a percent of total expenditures, thus shows the average loss of purchasing power of households due to higher prices. Deciles (D1, D2, …, D10) are based on total expenditure, excluding imputed rentals for housing. Price changes for other consumption categories are not considered. "Fuels for PTE" refers to fuels used for the operation of private transport equipment.

The average welfare loss for all EU households due to the considered price changes of food, residential energy and transport fuels is estimated to be 7.6% of households' baseline total expenditures (Table A7 in Annex). However, the impacts were regressive as illustrated in Figure 5. For instance, the poorest EU households were estimated to lose 12.2% of their purchasing power, whereas the corresponding number for the top decile was only 4.1%.

Figure 5 also shows the sources of the EU households' purchasing power losses by decile. Although food price changes were generally lower than those of energy and transport fuels (Table 3), it was the food price increases that individually contributed most (i.e., 45%) to the total welfare loss of the households in the first decile. For the households at the top of the distribution, food prices still contributed 23% to their mean purchasing power loss. This heterogeneity reflects the relative importance of food in households' budget. In general, the decomposition of welfare impacts in Figure 5 and Table A7 reflects the relative size of price shocks and of the budget share of each consumption category in question.([35])

We estimate an average relative total welfare loss of 9.1% for households living in sparsely populated areas (with less than 100 inhabitants per square km) due to all the considered price changes (Table A7). The corresponding loss for households living in densely populated areas (with at least 500 inhabitants per squared km) was 6.5%. This difference is partly explained due to higher transport fuel costs as households living in sparse areas are more dependent in their everyday life on personal transportation than people living in cities. In addition, households living in sparse areas, on average, spend more (relative to their total expenditures) on liquid and solid fuels than urban households (Table A7).

The EU-wide impact overview in Figure 5 naturally hides a lot of heterogeneity stemming from the Member State-level results. In what follows, we discuss residential energy and transport fuels related impacts. The corresponding mean relative welfare impacts by expenditure decile are shown in Figure 6.

Figure 6(a) confirms that the energy price increases had (strongly) regressive impacts in all EU countries, except for Poland standing out with its progressive results and Romania and Bulgaria with their U-shape distributional impacts. A closer look into the Polish case reveals that this progressivity was driven by the price increases of solid fuels, whose consumption has strong progressive pattern (see Figure A1 in the Annex). The importance of this pattern showing up in total residential energy consumption was due to solid fuels size in households' budget: the share of solid fuels in mean expenditure in EU-HBS-2015 was 2.3% in Poland, which was much larger than in many other Member States (e.g., the EU-wide mean solid fuels budget share was only 0.7%). Figure A1 in Annex also shows that it is the *inverse* U-pattern of expenditure share of natural gas consumption([36]) and its size (average share of 4.6% in HBS-2015) in Romania that explains the U-shape of the relative welfare impacts in the country. In Bulgaria, the increased prices for solid fuels drove the welfare results (average of 3.9% in HBS-2015), but here the poorer half of the population was more affected than the richer half due to higher expenditure shares for solid fuels (Figure A1).

Overall, in terms of relative size of energy price impacts, Estonia stands out in Figure 6(a) for the very large regressive impacts (i.e., a relatively very high burden falling on lower income groups). This was driven by the increase in electricity prices (131.5%, Table 3, see also Figure A1), which was the largest (average) price increase among all Member States. The only comparable electricity price increase of 131.1% was observed for the Netherlands, and, to the lesser extent, for Italy (108.0%). In general, we reiterate that the relative size of the welfare impacts shown in Figure 6 are explained by the relative sizes of the simulated observed country-specific price shocks (which are assumed to be the same for all households in each country) and of the expenditure shares of residential energy goods

([35]) This follows from equations (7a), (7b) and (6), which together imply the following alternative formulation of the relative welfare impacts:

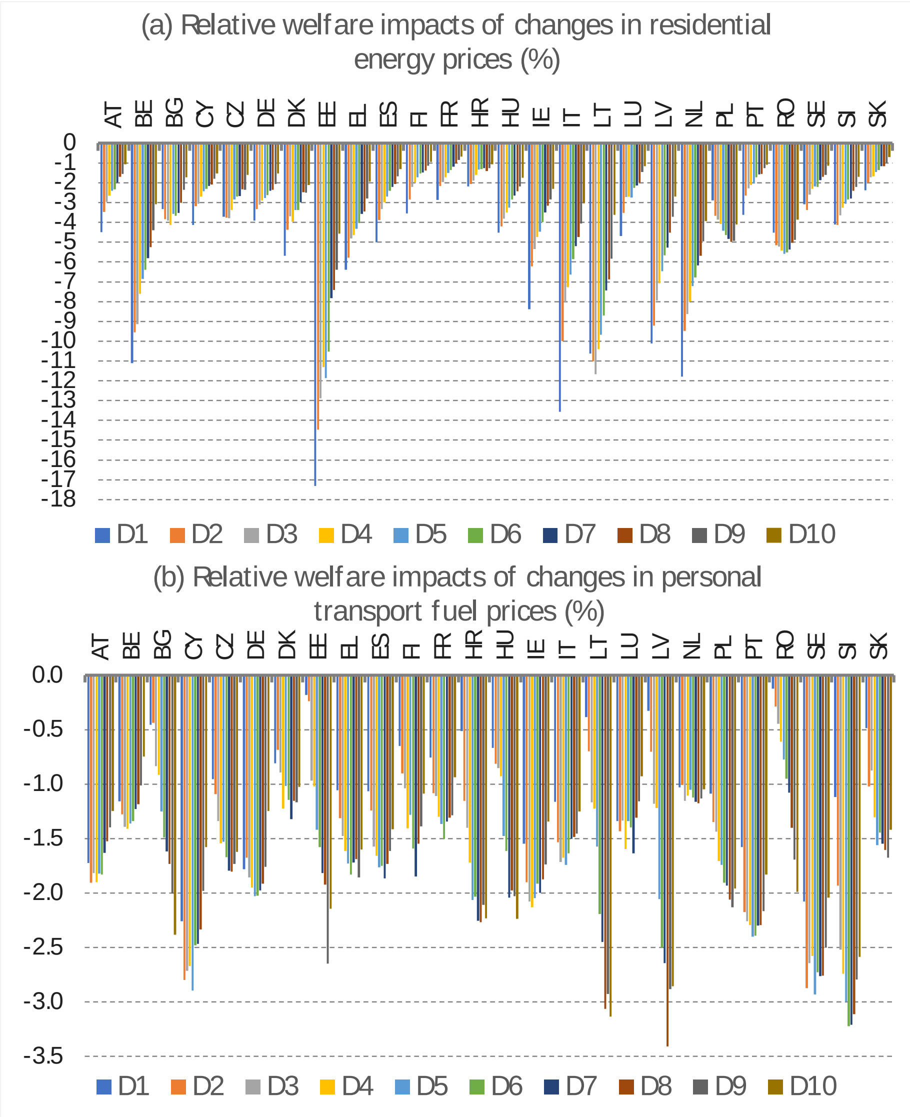
$$RW_h = \frac{AW_h}{\sum_{j=1}^{n} p_j^{base} C_{hj}} = \frac{-\sum_{k=1}^{n} C_{hk}\Delta p_k}{\sum_{j=1}^{n} p_j^{base} C_{hj}} = -\sum_{k=1}^{n} \frac{p_j^{base} C_{hk}}{\sum_{j=1}^{n} p_j^{base} C_{hj}} \times \frac{\Delta p_k}{p_k^{base}} = -\sum_{k=1}^{n} S_{hk}^{base} \frac{\Delta p_k}{p_k^{base}}.$$

([36]) Note that since the relative welfare impacts in Figure 6 are expressed with a negative sign, the shapes seen in this graph from the reader perspective are driven by the corresponding inverse shapes of the expenditure shares.

(which differ across Member States and by household affluence level for the same energy commodity).

In Figure 6(b), the country-specific distributional impacts due to the changes in transport fuel prices are shown. Here, per country the shape of the impacts exactly reveals (when inverted) the pattern of expenditure shares for personal transport fuels by expenditure decile in the country concerned. For detailed discussion of the latter issue, see Temursho et al. (2020, Section 2.5.2 and Figure 23).

Figure 6. Country-specific distributional impacts of energy and transport fuel price changes (during the August 2021-January 2023 period relative to the 18 months prior)



Source: Own computations based on EU-HBS-2015 micro-data and Eurostat HICP data (PRC_HICP_MIDX).
Notes: The welfare metric used is (negative) Slutsky compensating variation expressed as a percent of total expenditures, thus shows the average loss of purchasing power of households due to higher prices. Malta is excluded due to (dominantly) zero or negative price changes. Deciles (D1, D2, …, D10) are based on total expenditure, excluding imputed rentals for housing.

For completeness purposes, in Figure A2 in Annex the country-specific results due to increases in food prices are shown. Again, since we are considering only one (aggregate) commodity, the overall pattern of impacts by expenditure decile exactly captures the (inverse) pattern of food budget shares. The latter are found to be strictly decreasing in households' affluence level in each country, which is in line with Engel's Law (1857). ([37]) Note, however, that such relation is not necessary observed across countries since the size of impacts is additionally affected by the food price changes. Thus, the largest relative welfare loss (in absolute value) is found for Lithuania because, apart from the size of food expenditure shares, the observed food average price increase of 23.9% (Table 3) was the second largest price increase (after Hungary).

4. Policy measures at EU and national level

The quantitative assessments of energy price shocks presented in this paper implicitly consider only those policies that affect the end-user energy prices. These policies include changes in VAT or tax rates, general price changes or policies which directly or indirectly affect the household energy prices and bills, such as the "Iberian measures"([38]) for electricity consumption. Such measures account for 26 % of the total number of measures undertaken by Member States to alleviate the social effects of price shocks (Figure A3 in Annex). The analysis of policy measures presented in this section is based on the counting of policy measures conducted by the European Social Policy Analysis Network (ESPAN). The presented evidence complements similar completed or ongoing exercises and studies([39]). It is important to note that this methodology is different from the one used to account for policy measures adopted by Member States in the context of the European Semester, whereby the share of measures is estimated based on their budgetary impact, measured as a share of GDP allocated to those policies. ([40])

The EU ([41]) and its Member States launched several actions to anticipate and counteract the negative economic and social consequences of the energy crisis. At the EU level, the Communication of 13 October 2021 on Tackling rising energy prices ([42]), presented a toolbox for action that can help the EU and its Member States address the immediate impacts of price increases and strengthen resilience against future shocks. The REPowerEU Plan of 18 May 2022([43]) set out measures to phase out the Union's

([37]) Engel's law is an economic relationship according to which as family income increases, the percentage spent on food decreases, even though the total amount of food expenditure increases. Expenditure on housing and clothing remains proportionally the same, and that spent on education, health and recreation rises. The Engel's law was proposed by the statistician Ernst Engel in 1857 and although it was proposed more than 150 years ago, it is still relevant.

([38]) The Spanish and Portuguese measures aim at reducing the wholesale electricity prices by lowering the input costs of fossil fuel-fired power stations, https://ec.europa.eu/commission/presscorner/detail/en/ip_22_3550

([39]) Several mapping exercises of national policy measures aimed at cushioning increasing energy prices have been conducted since mid-2021. For example it is worth mentioning the EU inventory of energy emergency measures produced by the EU Agency for the Cooperation of Energy Regulators (ACER) which is based on information provided by Member States, as well as on publicly available information, validated by National regulators and complemented accordingly (ACER's inventory of 400+ energy emergency measures seeks to aid policy makers going forward | www.acer.europa.eu). Another relevant source is the mapping done by Bruegel (National fiscal policy responses to the energy crisis: National fiscal policy responses to the energy crisis) which quantifies that since the start of the energy crisis 646 billion have been allocated in the EU to shield consumers from the rising energy costs. Eurofound's EU PolicyWatch also maps measures related to the energy crisis (EU PolicyWatch | Eurofound (europa.eu)). Other useful references are: two OECD policy briefs "Income support for working-age individuals and their families" (2022a) and "How inflation challenges pensions" (2022b), the IMF Working Paper "Surging Energy Prices in Europe in the Aftermath of the War: How to Support the Vulnerable and Speed up the Transition away from Fossil Fuels" (2022) and related shorter and more updated article "Helping Europe's households" (2022), and the thematic focus in the Employment and Social Developments in Europe Quarterly Review on "Impact of rising prices on households" (2022).

([40]) The Commission monitors fiscal policy measures to reduce the impact of energy price increases on households and firms and presents an updated estimate of their budgetary costs. The Commission assesses the budgetary impacts of 'energy measures' adopted to address the crisis, which primarily focus on price and income measures targeting households and small businesses, whereby targeting is defined as selective application of the measure, based primarily on a means-test.

([41]) EU action to address the energy crisis (europa.eu)

([42]) COM(2021) 660 final.

([43]) COM(2022) 230 final.

dependence on fossil fuels from Russia by saving energy, diversifying energy supplies and accelerating the green transition. The Council Regulation of 6 October 2022 on an emergency intervention to address high energy prices([44]) extended the toolbox and introduced common measures to collect and redistribute the energy sector's surplus revenues, such as a solidarity contribution from fuel energy producers and a cap on profits from inframarginal technologies. The latter were expected to generate revenues for Member States to finance measures supporting final electricity customers, including households and businesses that are increasingly at risk of not being able to pay their energy bills. Thus, these measures can help mitigate increasing inequalities and the risk of poverty and social exclusion. Moreover, according to the complementary Council Regulation of 19 December 2022([45]), relevant measures taken by Member States to save gas should strictly be limited to non-essential consumption and by no means reduce the basic use by protected customers nor limit their ability to heat their homes adequately.

Yet, with the persisting energy crisis and inflation, the Council Recommendation on the economic policy of the euro area ([46]) emphasised the importance of more targeted rather than broad-based measures that ensure price signals and reduce budgetary costs, followed by public investments bolstering energy security and green transition. The Commission's Communication on the European Semester Spring Package 2023 ([47]) and the Eurogroup statement of October 2022 ([48]) also highlighted the importance of exceptional, temporary and targeted measures that focus on the most vulnerable households and companies. According to the Spring Economic Forecast ([49]), household disposable incomes are expected to increase, and energy prices are expected to fall in 2024, allowing to reduce the cost of support measures or even to phase them out, which is recommended in the Fiscal policy guidance for 2024, ([50]) as in the long-run structural changes rather than price measures are crucial.

In this context, the EU Member States introduced a wide range of exceptional measures, in addition to policies that were already in place. Such support measures vary greatly across countries, in view of differences in tax-benefit systems, political preferences, available fiscal space, administrative capacity and existing wider social protection measures. Overall, the measures implemented fall into one of the three main categories (Figure A3 in Annex). The first category regards measures directly improving the affordability of energy and hence directly tackling energy poverty (blue and orange bars in Figure A3 in Annex). These include specific income-support allowances to face high energy prices such as the so-called "heating allowances" (18%); caps on energy prices or reduction in energy tariffs (16%); and VAT or other tax reductions on energy consumption (10%). The second category of measures regards support measures to ensure access to a certain (minimum) level of residential energy, such as measures against energy disconnection and in-kind supply of a minimum quota of energy. This second category, however, includes a much smaller number of measures (7%) (grey bars in Figure A3 in Annex). Finally, the third category includes all measures to cushion the impact of high inflation in general (48% of all measures) and therefore indirectly combat energy poverty (yellow bars in Figure A3 in Annex). In most cases, this third group of measures regards various forms of indexation of social benefits.

([44]) Council Regulation (EU) 2022/1854.

([45]) EUR-Lex - 32022R2576 - EN - EUR-Lex (europa.eu)

([46]) COM(2022) 782 final

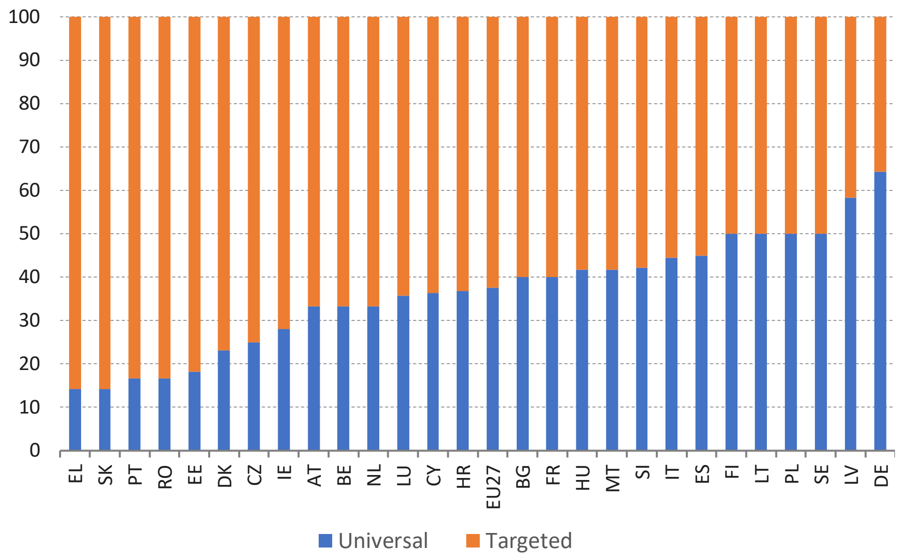
([47]) COM(2023) 600 final

([48]) Eurogroup statement on the fiscal policy response to high energy prices and inflationary pressures - Consilium (europa.eu)

[49]) Spring 2023 Economic Forecast: an improved outlook amid persistent challenges (europa.eu)

([50]) COM(2023) 141 final

Figure 7. Universal and targeted measures in Member States (%)



Source: Compiled based on the policy mapping conducted by the European Social Policy Analysis Network (2023).

The Commission's assessment based on budgetary impacts found that the majority of temporary price and income measures were non-targeted in 2023. The ESPAN policy mapping, which in addition to price and income measures considers broader social policies that were adjusted to respond to the energy crisis and which consider the number of measures (but not their corresponding budget), shows that approximately 62% of measures were targeted (Figure 7). Most targeted measures are among those aimed at cushioning the impact of the inflation. The universal measures primarily include caps on energy prices, energy tariffs or reduction of VAT and other consumption taxes. Targeted measures were often aimed at specific income groups, social benefit recipients, or specific groups, such as people with debts or unable to pay their electricity bills. Many targeted measures were closely linked to the various social benefits, such as minimum income and social assistance, unemployment, family or housing benefits, and, thus, were de facto means-tested (or at least to include an income-based criterion). Many Member States provided targeted support to older persons, students, families with children, especially large families, and persons with disabilities. A few Member States also developed separate support measures based on the level of energy use and the type of energy source.

Most Member States used a mix of temporary and permanent measures to address the energy crisis (Figure A4 in Annex). Temporary measures are defined as those that were in place between July 2022 and February 2023 with specified start and end dates (although some might be renewed afterwards). Permanent measures, with or without amendments, refer to those in place before and during the period covered and with no specified end date. Measures aimed at directly reducing energy prices through universal cash allowances, reduction in VAT or other taxes were temporary. According to Commission's estimates, in 2023, the budgetary costs of temporary price and income measures in the EU constituted 1.15 % of GDP, with the variation among the Member States ranging from 0.09% to 2 %. In terms of measures taken to cushion inflation in general, those related to wage indexation or increase, tended to be permanent but were modified or increased to better correspond to the impacts of the crisis, while allowances linked to wages or social security, temporary. The majority of targeted or universal cash allowances were introduced either as one off or offered some support to households in the winter months.

EU-level fiscal policy coordination is key to provide an anchor of stability, support investments in a fair transition, strengthen resilience and allow buffers to be built to cope with future shocks. In March 2023, the Commission published fiscal policy guidance for 2024 ([51]), containing the main orientations for 2024, focusing on the need to improve debt sustainability (after the Covid-19 pandemic, the energy crisis and the consequent three years of sizeable fiscal support) and to support monetary policy to reduce inflation. As the EU economy has recovered from the economic shock of both the Covid-19 crisis and the effects of Russia's war against Ukraine, the general escape clause ([52]) will be deactivated at the end of 2023. The fiscal policy guidance invites Member States to pursue a medium-term fiscal strategy of gradual and sustainable consolidation, combined with investments and reforms conducive to higher sustainable growth, in order to achieve a prudent medium-term fiscal position. On that basis, the 2023 European Semester Spring Package ([53]), emphasizes the need for ambitious action to address the economic and social challenges exposed by the recent crises, thus securing long-term prosperity, competitiveness, fairness and resilience. This is reflected in the chapeau Communication on the Spring Package, the Country Reports and Country Specific Recommendations (CSRs) addressed to the Member States. The Spring Package includes fiscal recommendations for all Member States, also emphasising that the remaining emergency energy support measures in force should be wound down as soon as possible in 2023 and 2024.Should renewed energy price increases necessitate new or continued support measures, such support measures should be targeted at protecting vulnerable households and firms, be based on distributional impact considerations and be part of fiscally sustainable policies, while preserving incentives for energy saving, where relevant.

5. Conclusions

The analysis presented in this paper responds to the need for real-time distributional analysis brought by the recent geopolitical developments, including the energy price hikes and increasing volatility since 2021, and notably since the start of the Russian invasion of Ukraine. As such, it brings added value to the still scarce and scattered evidence on distributional impacts of energy price changes, particularly on energy and transport poverty.

Energy price shocks affected many households in the EU across different income levels. While energy affordability for vulnerable households had been a longstanding problem in the EU already before the energy crisis, the spikes in prices between August 2021 and January 2023 and their comparatively high and persistent levels also affected middle-income households. Increasing gas and electricity prices were the main drivers of the spike in energy prices for households. These price increases have also indirectly contributed to rising food prices that particularly affected lower-income households. The effects of energy price shocks were not uniform across Member States due to differences in their energy pricing structures, use of different fuels, climatic conditions, and policy choices made to stabilise prices, among other factors.

As a result of energy price changes between August 2021 and January 2023 (compared to the previous 18 months), energy and transport poverty levels would have substantially increased across the EU if it were not for the policy interventions. When it comes to energy poverty, the share of households which spend more than 10% of their budget on energy in

([52]) The general escape clause of the Stability and Growth Pact is meant to provide a temporary deviation from the budgetary requirements that normally apply in the event of a severe economic downturn

([52]) The general escape clause of the Stability and Growth Pact is meant to provide a temporary deviation from the budgetary requirements that normally apply in the event of a severe economic downturn

([53]) [Spring Package (europa.eu)]

the EU would have increased by 16.4 pps for the general EU population and by 19.1 pps for the (expenditure-based) AROP population. In the same context, the share of households which spend more than 6% of their budget on transport fuels in the EU would have increased by 10.3 pps for the general EU population and by 5.3 pps for the (expenditure-based) AROP population. In line with the literature in this field (Lucas et al., 2016), the analysis also shows that while the (expenditure-based) AROP population is generally more vulnerable to energy price increases than the whole population, the opposite is true for transport price increases. This confirms that residential energy expenditure is regressive, but energy for transport fuels is non-regressive. A possible explanation relates to the low car ownership rates and/or low travel demand of the households with the lowest incomes.

The results of this paper suggest that the distributional impacts of energy price spikes would have been significant. While our analysis does not assess the effectiveness of policies implemented by Member States, it helps understanding the urgent need under which these policies were designed and implemented considering the significant impact of the energy crisis on households and businesses. Future research could expand such now-casting analysis to alternative indicators that capture other dimension of energy and in particular transport poverty. This assessment is static and does not allow for adjustment of households' behaviour. While this is a reasonable approach given the short-term nature of the shock, a dynamic approach could provide additional information. This would however require estimating a demand system, which is still work in progress under the AMEDI+ project. Such an approach would allow for a more detailed discussion also of the relationship between energy and transport poverty, e.g., on whether energy and transport poverty act as complements or substitutes due to households shifts in expenditures.

With the intention to mitigate the effects of the increasing prices, Member States have adopted a wealth of measures aimed at providing fast and tangible relief against high energy prices and costs of living while targeting support to people, households, and business in need, to the extent possible. Most of the measures were not sufficiently targeted and may have played a regressive role. ([54]) The quantitative modelling results discussed in this paper do not capture all policy responses put in place to mitigate the effects of increasing prices on households. The analysis takes into account only those universal measures that have direct impact on consumer prices, such as price caps or reduction in tariffs, VAT or other consumption taxes. These measures constitute approximately 26% of measures of overall measures taken by Member States (blue bars in Figure A3 in Annex). The extent to which other policy measures, e.g., protection from disconnection or general social protection measures, along with those targeting consumer prices, helped mitigate the effects of energy price shocks on households will be further explored in the future, also in the context of the AMEDI+ project of the European Commission (see footnote 3).

The analysis in this paper has shed light on how high distributional impacts resulting of high energy prices would have been without policy interventions. Considering the nature of measures, which were primarily untargeted, many measures had a regressive effect and a high cost on public finances. As price pressures have eased, Member States are phasing out support measures (starting with the least targeted ones), which contributes to preserving the stability of public finances. In case of future energy price increases, it is advisable that governments target vulnerable households more effectively, ensure that measures are both cost efficient and preserve the price signal and incentives to reduce consumption, in particular for high income groups, thereby also contributing to reduce energy price inflation. Developing mechanisms at the national level that would enable better targeting of measures in a similar situation would ensure a more efficient and fiscally sustainable crisis response.

([54]) COM(2023) 600 final.

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Annex

Table A1. Summary of (the size of) the EU-HBS-2015 used in microsimulations

Country	Number of observations	Number of households	Population
AT	7,162	3,804,688	8,469,536
BE	6,131	4,817,068	11,148,486
BG	2,965	2,946,251	6,991,500
CY	2,872	312,521	843,640
CZ	2,907	4,377,206	9,733,531
DE	52,107	38,243,533	76,496,903
DK	2,083	2,505,886	5,280,420
EE	3,278	562,090	1,248,308
EL	6,080	4,090,904	10,585,469
ES	21,912	18,141,759	45,517,386
FI	3,667	2,673,803	5,413,675
FR	16,682	29,153,652	65,103,585
HR	2,026	1,469,746	4,244,865
HU	7,155	4,119,192	9,634,780
IE	6,829	1,699,539	4,636,510
IT	15,011	25,786,900	60,439,270
LT	3,439	1,342,118	2,884,168
LU	3,166	222,761	538,708
LV	3,836	826,456	1,957,426
MT	3,691	164,814	421,971
NL	13,649	7,266,991	15,821,737
PL	36,337	13,282,328	37,004,437
PT	11,398	4,104,709	10,374,821
RO	30,548	7,455,136	19,828,840
SE	2,643	3,822,885	8,062,752
SI	3,748	780,926	2,024,796
SK	4,781	1,851,217	5,425,410
EU27	276,103	185,825,081	430,132,932

Source: Own computations-based EU-HBS-2015 micro-data.
Notes: Household sample weights and/or household size are taken into account in computing the number of households and population figures.

Table A2. Median values of REBS by income deciles (%), EU-HBS-2015

	1st income decile	2nd income decile	3rd income decile	4th income decile	5th income decile	6th income decile	7th income decile	8th income decile	9th income decile	10th income decile
AT	6.0	6.0	5.7	5.6	5.7	5.1	5.1	4.5	4.4	3.8
BE	8.7	8.6	8.3	7.8	7.0	6.4	6.1	5.5	5.4	4.9
BG	16.1	16.9	16	15.1	13.9	12.3	11.8	11.6	9.2	7.3
CY	5.9	6.0	5.3	4.6	5.0	4.2	4.4	3.8	3.8	3.7
CZ	16.8	16.5	13.8	14.5	13.1	11.3	10.4	10.3	9.4	8.5
DE	9.6	9.0	8.0	7.7	6.9	6.7	6.3	5.9	5.3	4.5
DK	8.7	10.1	9.2	8.1	7.9	7.4	7.0	7.0	7.4	6.4
EE	13.4	15.2	14.4	12	11	9.1	8.7	7.7	7.3	5.3
EL	6.6	9.7	8.7	8.8	8.4	8.8	7.1	6.4	5.8	5.1
ES	6.3	6.1	6.2	6.4	5.3	5.0	5.0	4.5	4.1	4.2
FI	2.6	2.7	2.6	2.8	3.5	3.9	3.5	3.2	3.2	3.4
FR	5.4	5.7	5.7	5.7	5.5	5.0	5.1	4.4	4.5	4.1
HR	15.4	14.9	14.4	11.9	11.2	11.3	9.6	9.3	8.7	7.1
HU	16.7	17.3	16.8	16.1	14.7	14.2	12.7	11.8	10.8	8.5
IE	7.6	9.7	7.2	7.2	6.5	5.9	5.8	5.1	4.7	4.7
LT	12.4	11.2	12.6	12.5	11.7	11.2	10.4	9.5	9.5	7.1
LU	7.1	6.4	5.6	4.7	4.8	4.0	4.3	4.0	3.8	3.5
LV	16.1	15	13.9	12.6	11.8	10.7	10	10.1	7.6	6.3
MT	3.4	3.6	3.7	3.0	3.2	2.7	2.6	2.3	2.0	2.0
NL	6.1	6.5	5.8	5.8	5.3	5.4	5.3	5.2	5.0	4.6
PL	11.8	12.8	13.2	13.1	12.4	11.9	11.4	10.1	9.2	7.7
PT	10.7	10.2	10.1	9.1	8.1	8.0	7.3	6.9	5.8	5.3
RO	10.0	12.5	13	12.7	12.5	12.0	12.2	10.7	10.3	8.4
SE	1.8	2.5	2.6	2.3	2.8	2.7	2.8	3.4	3.0	2.9
SI	14.3	12.6	12.0	10.8	10.9	9.7	8.5	8.4	7.6	7.6
SK	19.4	18.6	17.2	16.8	15.3	14.1	12.6	12.4	10.9	9.3
Average	10.0	10.2	9.7	9.1	8.6	8.0	7.5	7.1	6.5	5.6

Source: Own computations-based EU-HBS-2015 micro-data.
Notes: Household sample weights are taken into account in computing the household median values of REBS. Imputed rents for housing are excluded. Income data are missing for Italy in the HBS 2015 wave.

Table A3. Household mean savings by income decile (Euros), EU HBS-2015

Country	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
AT	-8,159	-4,519	-487	954	4,598	6,046	8,367	10,101	18,439	31,584
BE	-2,195	-1,373	19	834	1,918	3,944	5,328	7,972	11,554	29,731
BG	-234	52	160	211	459	276	532	839	642	2,361
CY	-3,885	-2,254	-2,025	-2,682	-1,781	-859	1,980	2,219	6,997	21,413
CZ	243	751	1,727	2,121	2,521	2,922	3,574	4,555	5,490	9,837
DE	-1,853	-161	975	2,294	4,112	5,826	8,638	12,062	16,329	33,831
DK	-2,935	1,736	2,949	6,753	11,286	20,188	23,252	29,269	37,418	72,098
EE	-1,369	-89	496	492	698	1,702	2,370	4,029	5,588	11,924
EL	-7,854	-4,213	-2,644	-1,326	-1,338	-138	-661	865	2,187	10,614
ES	-5,339	-3,839	-2,097	-1,162	-1,443	211	1,029	2,139	5,028	15,320
FI	-3,367	845	2,335	2,732	3,800	6,587	8,366	9,664	14,458	35,749
FR	-5,020	271	2,111	3,689	5,831	7,774	10,821	13,727	20,847	45,833
HR	-2,674	-2,339	-977	-1,391	-85	506	813	1,751	3,361	9,376
HU	-804	173	194	529	760	1,089	1,272	1,671	2,600	7,101
IE	-7,290	-377	3,599	6,133	9,838	11,025	16,660	20,636	26,040	53,866
LT	-1,740	-1,049	-1,142	-961	-528	-615	-95	486	1,347	3,898
LU	-123	3,696	7,047	7,731	8,606	10,050	13,775	17,251	30,060	70,208
LV	-1,571	-410	-748	-448	-626	-451	-144	411	1,134	3,795
MT	-5,818	-3,006	-744	-786	520	1,417	6,215	6,484	10,837	27,495
NL	-9,191	-2,709	-1,200	1,143	3,304	6,137	9,139	13,138	17,915	41,713
PL	-977	163	723	1,181	1,691	2,281	2,842	3,736	4,793	10,678
PT	-4,907	-2,875	-1,714	-672	-402	912	2,025	3,073	5,950	20,111
RO	-844	-481	-295	-89	87	358	710	1,050	1,659	3,647
SE	-6,591	657	2,160	6,204	9,919	10,255	14,198	15,764	24,920	45,145
SI	-5,196	-1,688	-1,173	1,130	2,317	4,336	5,391	7,450	9,405	20,685
SK	-206	959	1,559	1,971	3,014	3,528	4,186	5,653	6,786	10,389

Source: Own computations-based EU-HBS-2015 micro-data.
Notes: Household sample weights are taken into account in computing the mean household savings, defined as monetary net income minus total expenditure, excluding imputed rents for housing. Income data are missing for Italy in the HBS 2015 wave.

Table A4. Proportion of population (%) with residential energy budget share greater than 10% before and after the energy price changes (August 2021-January 2023 period relative to the 18 months prior)

Country	(a) All households (HHs)			(b) HHs with EqvTotExp < Median			© HHs with EqvTotExp < 60% of Median		
	Before	After	After – Before	Before	After	After – Before	Before	After	After – Before
AT	14.8	26.0	11.3	24.8	40.1	15.4	41.4	55.9	14.6
BE	23.2	58.3	35.2	38.5	78.0	39.5	57.9	90.4	32.5
BG	64.4	71.7	7.3	82.8	86.1	3.3	87.5	89.5	2.0
CY	8.0	21.4	13.4	13.7	33.2	19.5	25.8	50.3	24.5
CZ	59.2	70.8	11.5	76.6	85.3	8.7	82.7	87.7	5.0
DE	23.6	38.2	14.7	33.8	52.7	18.9	49.4	64.3	14.9
DK	28.4	45.9	17.5	34.9	55.6	20.7	52.8	78.8	26.0
EE	42.8	73.3	30.5	66.6	90.5	23.9	76.3	91.4	15.2
EL	26.7	49.0	22.2	39.7	65.8	26.2	51.9	78.3	26.5
ES	10.4	23.4	13.0	17.8	36.5	18.7	28.0	51.4	23.4
FI	13.5	21.1	7.6	22.6	32.0	9.4	38.9	45.2	6.3
FR	16.5	23.6	7.1	27.0	36.5	9.6	42.1	50.2	8.1
HR	48.4	55.5	7.1	69.0	74.8	5.8	84.8	88.3	3.4
HU	64.5	74.0	9.5	81.2	88.0	6.8	82.4	88.4	5.9
IE	18.8	40.5	21.7	31.4	58.1	26.6	45.9	70.8	24.9
IT	20.8	50.8	30.0	32.6	69.2	36.6	49.1	84.4	35.3
LT	39.0	65.9	27.0	55.0	80.7	25.7	62.8	82.7	19.9
LU	10.2	23.1	12.8	17.5	36.8	19.4	29.5	54.3	24.8
LV	45.1	67.4	22.3	68.8	88.3	19.5	82.0	94.6	12.5
MT	2.6	2.6	-0.1	4.7	4.6	-0.1	9.8	9.8	0.0
NL	8.2	56.4	48.2	14.0	76.9	62.9	30.9	92.2	61.2
PL	49.1	57.9	8.7	57.2	65.2	8.0	56.2	63.2	7.1
PT	28.7	39.5	10.8	44.9	59.8	14.8	68.0	81.1	13.1
RO	53.2	69.3	16.0	56.5	72.0	15.5	52.4	67.2	14.7
SE	14.5	25.5	11.0	23.3	34.5	11.2	26.0	32.1	6.1
SI	41.7	55.1	13.4	61.6	73.6	12.0	78.4	84.8	6.4
SK	68.3	73.3	5.0	86.1	88.9	2.8	95.3	95.3	0.0
EU27	26.9	43.4	16.4	37.5	57.4	19.9	48.2	67.3	19.1

Source: Own computations-based EU-HBS-2015 micro-data and Eurostat HICP data (PRC_HICP_MIDX).
Notes: The reported proportions (in %) are given relatively to the number of persons of the corresponding segment of population. These segments are defined as: (a) all households in our sample of the EU-HBS-2015, (b) households with equivalized total expenditure below the national (equivalized) median, and (c) households with equivalized total expenditure below 60% of the national (equivalized) median. Total expenditure excludes imputed rentals for housing. “Before” and “After” refer, respectively, to the energy poverty values before and after the change in residential energy prices.

Table A5. Percentage points of mean differences in budget shares of residential energy goods due to energy price changes during the August 2021-January 2023 period relative to the 18 months prior

	(a) All households						(b) HHs with EqvTotExp < Median						© HHs with EqvTotExp < 60% of Median					
	Elec	Gas	LiqF	SolF	Heat	Resid	Elec	Gas	LiqF	SolF	Heat	Resid	Elec	Gas	LiqF	SolF	Heat	Resid
AT	0.34	0.56	0.61	0.37	0.18		0.42	0.68	0.76	0.50	0.22		0.50	0.85	0.85	0.67	0.24	
BE	2.27	2.21	1.12	0.02			2.89	2.71	1.30	0.03			3.53	3.01	1.30	0.03		
BG	0.29	0.27	0.00	1.58	0.25		0.34	0.24	0.00	1.92	0.17		0.44	0.13	0.00	1.76	0.11	
CY	1.71	0.23	0.29	0.02			2.10	0.35	0.22	0.02			2.48	0.50	0.15	0.02		
CZ	0.39	1.30	0.00	0.19	0.40		0.43	1.50	0.00	0.22	0.46		0.57	1.07	0.00	0.35	0.48	
DE		0.67		0.08		1.48		0.79		0.09		1.73		0.88		0.11		2.03
DK	1.69	0.88	0.16	0.15	-0.03		2.06	1.00	0.22	0.16	-0.05		2.83	1.15	0.56	0.17	-0.09	
EE	5.02	0.55	0.01	0.86	0.99		6.09	0.59	0.01	1.08	1.24		6.72	0.69		1.22	1.24	
EL	1.59	0.67	1.11	0.06	0.00		2.03	0.83	1.18	0.07	0.00		2.46	1.00	1.13	0.07		
ES	1.86	0.21	0.32	0.00			2.43	0.24	0.35	0.00			3.02	0.24	0.36	-0.01		
FI	1.27	0.00	0.31	-0.02	0.01		1.56	0.00	0.43	-0.03	0.00		2.07	0.00	0.57	-0.05	0.00	
FR	0.26	0.60	0.37	0.04	0.00		0.31	0.78	0.49	0.05	0.00		0.36	0.98	0.55	0.06	0.00	
HR	0.28	0.41	0.12	0.46	-0.02		0.33	0.41	0.04	0.68	-0.02		0.38	0.24		1.05	-0.02	
HU	0.19	1.51	0.00	0.71	-0.01		0.20	1.69	0.00	0.98	-0.01		0.19	1.68	0.00	1.27	-0.01	
IE	1.55	0.69	1.18	0.22			1.95	0.80	1.47	0.28			2.40	0.85	1.76	0.37		
IT	3.18	2.13	0.03	0.01	0.00		4.21	2.53	0.03	0.00	0.00		5.38	2.78	0.04	-0.02	0.00	
LT	1.01	0.61	0.00	1.81	2.93		1.21	0.73	0.00	2.62	2.97		1.44	0.93		3.20	1.79	
LU	-0.04	1.05	1.16	0.03			-0.07	1.34	1.46	0.05			-0.12	1.61	1.87	0.04		
LV	1.22	0.95	0.00	1.17	1.50		1.43	1.12	0.00	1.65	1.80		1.55	1.37	0.00	2.36	1.58	
MT	0.00	0.00	0.00	0.00	0.00		0.00	-0.01		0.00			0.00	-0.01				
NL	1.51	4.64	0.00	0.00			1.80	5.62	0.00	0.00			2.34	6.93	0.00	0.00		
PL	0.33	0.71	0.10	1.17	0.37		0.42	0.79	0.05	0.92	0.38		0.49	0.82	0.01	0.57	0.27	
PT	0.73	0.82	0.04	0.05	0.00		0.92	1.10	0.02	0.04	0.00		1.10	1.40	0.01	0.03		
RO	1.15	2.16		0.29	0.13		1.34	2.17		0.24	0.06		1.45	1.91		0.13	0.01	
SE	1.80		0.02	0.04	0.00		2.15		0.02	0.05	0.00		2.35		0.04	0.09	-0.01	
SI	0.22	0.31	0.57	0.87	0.44		0.26	0.29	0.61	1.13	0.54		0.31	0.23	0.48	1.33	0.72	
SK	0.21	0.25	0.00	0.28	0.40		0.25	0.29	0.00	0.38	0.46		0.29	0.33	0.00	0.73	0.37	

Source: Own computations-based EU-HBS-2015 micro-data and Eurostat HICP data (PRC_HICP_MIDX).
Notes: Elec, LiqF, SolF and Heat refer, respectively, to electricity, liquid fuels, solid fuels, and heat energy. Resid. (for residual) is the aggregate of electricity, liquid fuels, and heat energy, not reported separately in case of Germany.

Table A6. Proportion of population (%) with personal transport fuels budget share greater than 6% before and after the transport fuel price changes (August 2021-January 2023 period relative to the 18 months prior)

Country	(a) All households (HHs)			(b) HHs with EqvTotExp < Median			© HHs with EqvTotExp < 60% of Median		
	Before	After	After – Before	Before	After	After – Before	Before	After	After – Before
AT	21.8	37.6	15.8	28.2	43.4	15.2	30.5	40.8	10.4
BE	22.9	35.1	12.2	29.5	42.7	13.2	28.4	37.1	8.8
BG	26.0	37.8	11.8	15.3	21.9	6.6	9.1	12.2	3.2
CY	54.7	68.5	13.8	62.7	73.0	10.3	55.1	62.7	7.5
CZ	30.2	46.5	16.4	29.5	44.1	14.6	24.2	32.4	8.1
DE	36.0	51.5	15.5	41.4	55.1	13.7	41.4	52.3	11.0
DK	17.8	28.6	10.8	18.8	29.7	10.9	16.5	22.5	6.0
EE	28.3	33.8	5.5	14.9	17.8	2.9	3.8	4.4	0.7
EL	45.4	55.6	10.2	44.4	52.3	8.0	37.0	41.9	4.9
ES	38.9	47.3	8.4	37.0	43.8	6.7	29.6	34.4	4.8
FI	24.2	35.5	11.3	22.3	30.7	8.5	17.2	23.8	6.6
FR	32.3	38.3	6.0	30.8	33.8	3.0	23.5	25.5	2.0
HR	52.0	63.3	11.3	45.8	55.4	9.6	26.4	32.5	6.1
HU	39.3	45.0	5.7	26.3	30.6	4.4	17.9	21.3	3.4
IE	41.3	52.5	11.2	44.5	53.3	8.8	39.9	43.6	3.7
IT	51.1	59.7	8.6	54.7	60.9	6.2	47.8	52.3	4.5
LT	38.0	44.4	6.3	23.6	27.1	3.5	12.2	13.0	0.8
LU	12.2	24.9	12.7	16.3	30.1	13.8	18.2	29.8	11.6
LV	35.7	42.0	6.3	21.3	25.0	3.6	10.1	10.8	0.6
MT	37.2	36.6	-0.5	42.8	42.3	-0.5	38.4	37.6	-0.8
NL	27.7	38.3	10.6	29.9	40.1	10.1	30.2	38.9	8.7
PL	37.6	48.6	11.0	34.6	43.8	9.1	28.9	36.0	7.1
PT	62.1	70.0	7.8	60.5	66.9	6.4	51.4	55.7	4.3
RO	19.2	26.2	7.0	10.5	13.3	2.7	3.2	4.3	1.0
SE	44.6	56.4	11.8	49.1	56.7	7.5	39.6	43.0	3.4
SI	57.6	71.9	14.3	53.0	67.2	14.2	33.5	47.5	14.0
SK	29.3	41.8	12.4	26.9	37.4	10.5	16.1	21.4	5.3
EU27	37.0	47.2	10.3	37.0	45.1	8.1	31.8	37.1	5.3

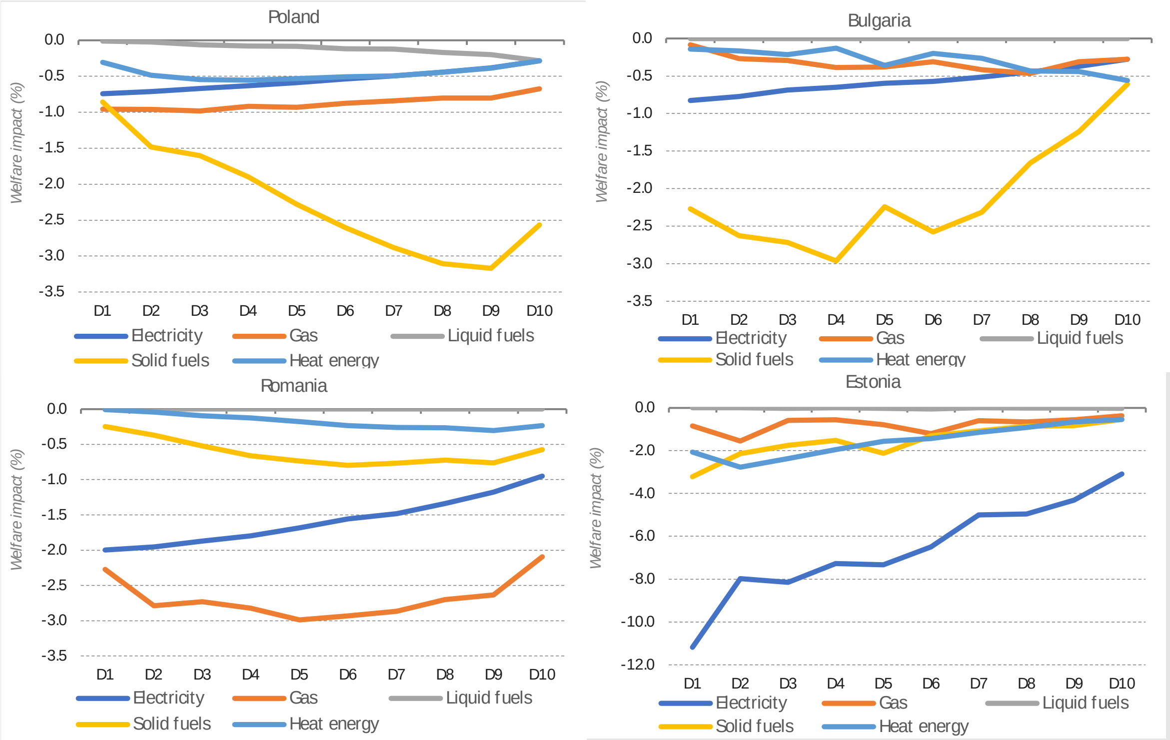
Source: Own computations-based EU-HBS-2015 micro-data and Eurostat HICP data (PRC_HICP_MIDX).
Notes: The reported proportions (in %) are given relatively to the number of persons of the corresponding segment of population. These segments are defined as: (a) all households in our sample of the EU-HBS-2015, (b) households with equivalized total expenditure below the national (equivalized) median, and (c) households with equivalized total expenditure below 60% of the national (equivalized) median. Total expenditure excludes imputed rentals for housing. “Before” and “After” refer, respectively, to the energy poverty values before and after the change in residential energy prices.

Table A7. EU-wide mean relative welfare impacts by expenditure decile and population density (%)

	EU26 (excluding DE)								EU27
	Food	Electricity	Gas	Liquid fuels	Solid fuels	Heat energy	Fuels for PTE	Total impact	Total impact
D1	-5.5	-2.6	-1.9	-0.2	-0.9	-0.3	-0.9	-12.2	-12.2
D2	-3.8	-2.1	-1.7	-0.3	-0.7	-0.3	-1.4	-10.3	-10.2
D3	-3.0	-1.9	-1.6	-0.3	-0.6	-0.2	-1.6	-9.2	-9.1
D4	-2.5	-1.8	-1.5	-0.4	-0.4	-0.2	-1.7	-8.4	-8.2
D5	-2.1	-1.6	-1.5	-0.4	-0.4	-0.1	-1.7	-7.8	-7.6
D6	-1.8	-1.5	-1.5	-0.3	-0.2	-0.1	-1.7	-7.1	-7.1
D7	-1.6	-1.4	-1.4	-0.3	-0.2	0.0	-1.6	-6.7	-6.6
D8	-1.4	-1.3	-1.3	-0.3	-0.1	0.0	-1.6	-6.0	-6.1
D9	-1.2	-1.1	-1.1	-0.3	-0.1	0.0	-1.5	-5.3	-5.3
D10	-1.0	-0.8	-0.8	-0.2	0.0	0.0	-1.2	-4.1	-4.1
Dense	-2.3	-1.4	-1.4	-0.1	-0.1	-0.2	-1.2	-6.8	-6.5
Intermediate	-2.4	-2.0	-1.9	-0.3	-0.3	-0.1	-1.5	-8.5	-8.2
Sparse	-3.1	-1.6	-1.1	-0.5	-0.9	-0.1	-1.8	-9.2	-9.1
All households	-2.5	-1.7	-1.4	-0.3	-0.4	-0.1	-1.5	-8.0	-7.6

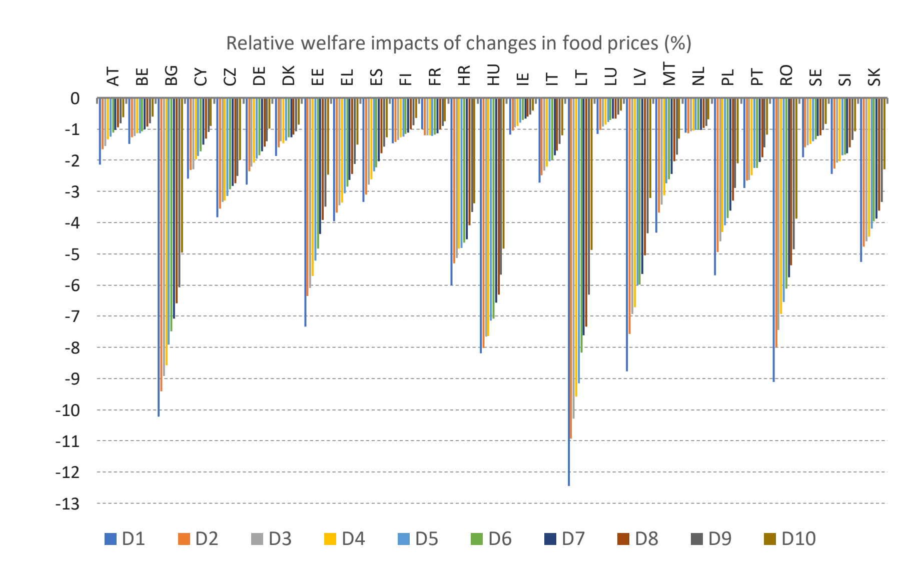
Source: Own computations-based EU-HBS-2015 micro-data and Eurostat HICP data (PRC_HICP_MIDX).
Notes: The welfare metric used is (negative) Slutsky compensating variation expressed as a percent of (baseline) total expenditures. The decomposition into mean impacts of separate commodity price effects is given for EU26, since EU-HBS-2015 does not report expenditures for electricity, liquid fuels, and heat energy in case of Germany. Population density levels are: dense – at least 500 inhabitants/km2, intermediate – between 100 and 499 inhabitants/km2, and sparse – less than 100 inhabitants/km2.

Figure A1. Mean relative welfare impacts of energy price changes for selected countries (%)



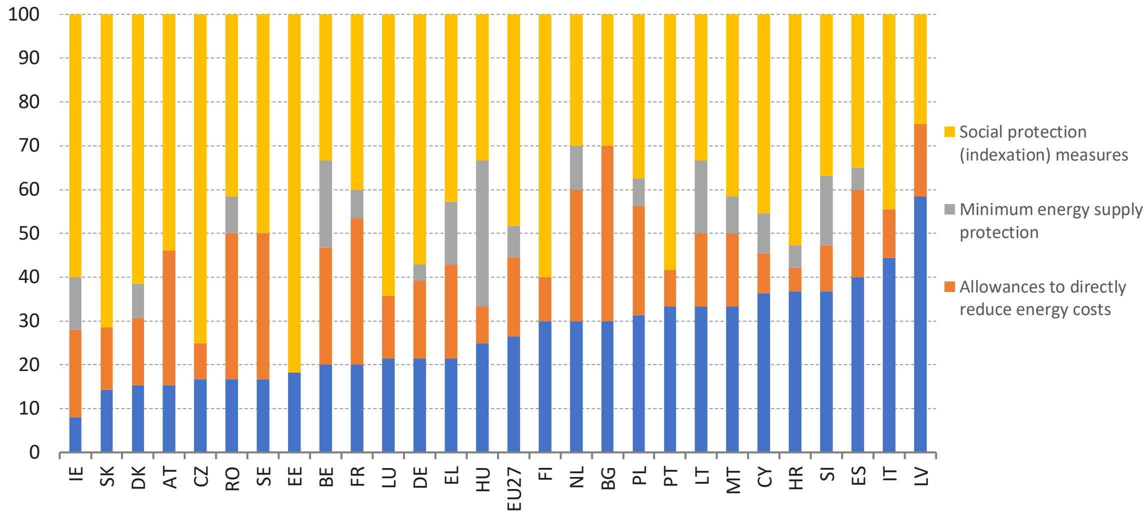
Source: Own computations-based EU-HBS-2015 micro-data and Eurostat HICP data (PRC_HICP_MIDX).
Note: The welfare metric used is (negative) Slutsky compensating variation expressed as a percent of total expenditures. Deciles (D1, D2, …, D10) are based on total expenditure, excluding imputed rentals for housing.

Figure A2. Country-specific distributional impacts of food price increases (during the August 2021-January 2023 period relative to the 18 months prior)



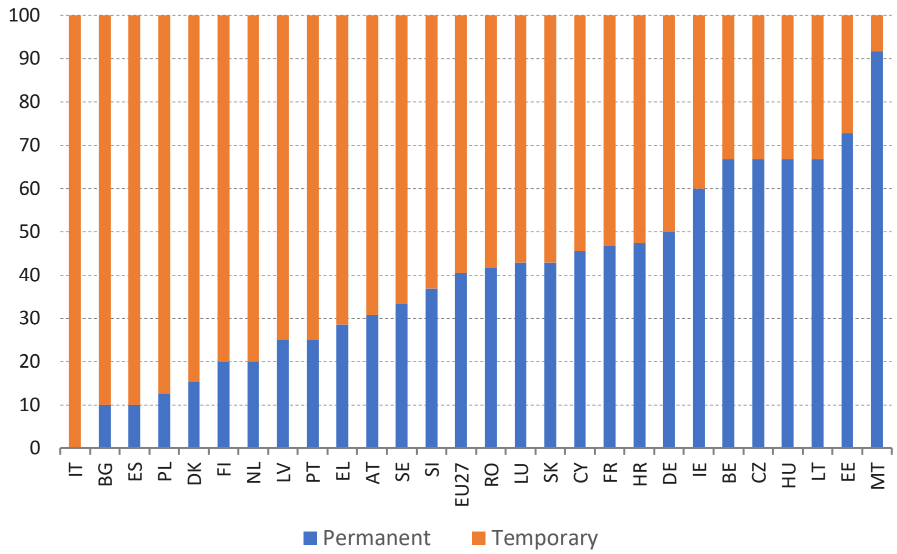
Source: Own computations-based EU-HBS-2015 micro-data and Eurostat HICP data (PRC_HICP_MIDX).
Note: The welfare metric used is (negative) Slutsky compensating variation expressed as a percent of total expenditures, thus shows the average loss of purchasing power of households due to higher food prices. Deciles (D1, D2, …, D10) are based on total expenditure, excluding imputed rentals for housing.

Figure A3. Measures used to mitigate energy poverty in Member States, by type (%)



Source: Compiled based on the policy mapping conducted by the European Social Policy Analysis Network (2023).

Figure A4. Share of temporary and permanent measures in Member States (%)



Source: Compiled based on the policy mapping conducted by the European Social Policy Analysis Network (2023).

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