MICAT

Multiple Impacts Calculation Tool

Empirical Basis of Social Impacts Impact on Welfare

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101000132.

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E3-Modelling

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Executive Summary

Welfare and inequality are major issues for all societies and the achievement of high welfare levels across all income classes is in the core of policy making. Here we have developed an indicator that **examines the impact of energy saving measures on households' welfare**. This is derived from a partial equilibrium tool, in the sense that it examines changes in household's consumption and welfare taken as given their income levels and the prices of goods and services. National households are divided in 5 income classes; each class has different preferences and consumption patterns. The approach assumes one representative household by income class. **Households' disposable income is allocated into 4 categories of goods: energy, transport equipment, dwelling appliances, and non-energy related goods.** The module is based on the latest available statistics (base year set to 2020).

As a key methodological step, the indicator allocates total energy saving investments to each income quantile. It then calculates the net present value of investments and the net savings of energy expenditures. It further estimates the consumption of non-energy goods as the residual consumption and approximate the changes in welfare in terms of non-energy expenditures as percentage of household's income.

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Scope of MI indicator

Definition

Welfare and inequality are major issues for all societies and the achievement of high welfare levels across all income classes is in the core of policy making. Traditionally, measures and policies refer to taxes, income transfers and other policy interventions in markets to protect the most vulnerable part of the society (e.g., minimum wages).

The clean energy transition requires a deep transformation of production processes and consumption patterns. Thus, it is equally important to identify both the optimal pathways, from an aggregate perspective to a net zero world but to assess their impact on welfare and inequality. Technological progress and innovation have decreased significantly the relative cost of energy savings. Energy savings, decrease the cost of energy for e.g., heating and cooling, cooking etc. allowing households to spend more on other goods and services (hence increasing their welfare). This transformation comes at higher capital costs, as households are required to replace their energy-related equipment with more efficient one which nevertheless comes at higher costs. The relative costs and benefits are not equally distributed in the economy. Lower income households can have significantly higher gains from energy efficiency compared to higher income households.

To this end, we have developed a tool that examines the impact of energy saving measures on households' welfare. This tool is a partial equilibrium tool, in the sense that it examines changes in household's consumption and welfare taken as given their income levels and the prices of goods and services. National households are divided in five income classes; each class has different preferences and consumption patterns.

Relevance on EU, national and/or local level

The distributional impacts, and in particular the welfare metrics are a key indicator for the socioeconomic impact assessment of clean energy policies both at the EU and at the national level. Compared with aggregate measures of economic performance, such as GDP and employment, the results can help in the identification of optimal pathways. The indicator could also be relevant at a local level, if data availability allows.

Impact pathway figure

The methodology adopted to perform the assessment of the welfare indicator of the different measures is composed from the following steps:

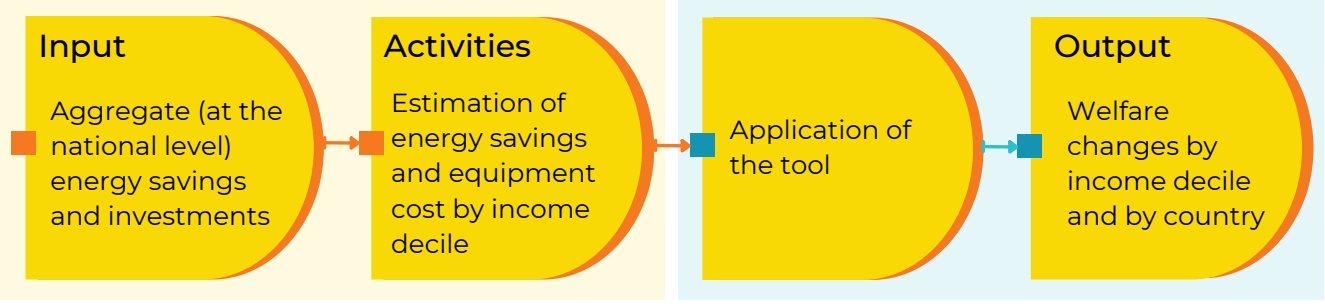

Figure 1: Quantification steps for the estimation of the welfare indicator

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Overlaps with other MI indicators and potential risk of double-counting

No risk of overlaps or double-counting with other multiple impact indicators as most are not available on income quantile level.

Quantification method

Description

The tool, as previously mentioned, focuses on households taken as given the level of income and prices in the economy. The module assumes one representative household by income class. Households' disposable income is allocated into 4 categories of goods: energy, transport equipment, dwelling appliances, and non-energy related goods. The module is based on the latest available statistics (base year set to 2020).

To analyse the impact of higher energy saving investments on the welfare of each income class, the following steps are taken:

The first step consists of allocating total energy saving investments to each income quantile. To do so the indicator takes as input the national-level energy savings (by type of measure) of the economy and the national energy saving investment expenditure. These two inputs are then split by income quantile, based on coefficients taken from the PRIMES energy system model and the literature. This adjustment reflects the concept of marginal abatement costs; higher income households are assumed to own higher efficiency equipment relative to the poorer households, hence the cost of equipment for additional energy savings is higher for them.

Combining the net present value of energy savings and equipment spending we use an index to calculate the share of each income group to total national energy savings. For energy savings we assume a time-horizon of 10 years (i.e., we assume that the lifetime of the equipment is equal to 10 years and thus during this period energy consumption is lower compared to a reference case) while for equipment, the costs are repaid within 5 years period.

$$NPV_{iq}^{en} = \frac{ENSAVE_{iq,t}}{(1 + df_{iq})^t} \quad (1)$$

$$NPV_{iq}^{eq} = \frac{EQCOST_{iq,t}}{(1 + df_{iq})^t} \quad (2)$$

where:

NPV_{iq}^{en} : net present value of energy savings by income quantile

$ENSAVE_{iq,t}$: energy savings expressed in monetary terms (€) by income quantile, split according to country-specific coefficients

df_{iq} : discount factor by income quantile

NPV_{iq}^{eq} : net present value of equipment by income quantile

$EQCOST_{iq,t}$: annualised cost of energy-efficient equipment expressed in monetary terms (€) by income quantile, split according to country-specific coefficients

The discount factor is a compound interest rate which is a function of national interest rate and of the social time preference by income quantile. The latter denotes the willingness of households to sacrifice part of their present consumption for higher future consumption levels, is lower for low-income households and higher for the richer quantiles. It is calculated as a function of the propensity to consume [1].

[1] Data are based on Eurostat's ICW_SR_10 dataset

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The index as well as the allocation of energy efficiency investments are given by the following formulas:

$$RLNPV_{iq} = \frac{NPV_{iq}^{en}}{NPV_{iq}^{eq}} \quad (3)$$

$$EFEXSHR_{iq} = \frac{efexshr_{iq}^{0} \bullet RLNPV_{iq}^{\varepsilon}}{\sum_{iq} efexshr_{iq}^{0} \bullet RLNPV_{iq}^{\varepsilon}} \quad (4)$$

where:

$RLNPV_{iq}$: *is a benefit to cost index by income quantile*

$EFEXSHR_{iq}$: *share of energy efficiency investment expenditure by income quantile*

$efexshr_{iq}^{0}$: *parameter reflecting status of energy efficiency expenditures by income quantile*

ε : *adjustment factor*

Once the expenditures on equipment and the related energy savings are calculate we adjust the consumption of the relative categories of our datasets. Hence, we have:

$$C_{ener,id} = C_{ener,id}^{0} - EFEXSHR_{id} \bullet ENSAVE\_TOT \quad (5)$$

$$C_{equip,iq} = C_{equip,iq}^{0} - EFEXSHR_{iq} \bullet ENCOST\_TOT \quad (6)$$

where:

$C_{ener,id}$: energy expenditures by income quantile

$C_{equip,iq}$: equipment expenditures (transport or household appliances) by income quantile

$ENSAVE\_TOT$: total energy savings expressed in monetary terms

$ENCOST\_TOT$: total equipment expenditures

The consumption of non-energy goods is the residual consumption:

$$C_{nener,iq} = INC_{iq} - \sum_{ener} C_{ener,iq} - \sum_{ener} C_{equip,iq} \quad (7)$$

Methodological challenges

Energy spendings by income decile and energy carrier are not provided by Eurostat. Furthermore, no index on the stock of equipment by decile is available to our knowledge. This would facilitate the calculation of required spendings on equipment by income group and would allow for a more refined approach regarding the allocation of energy efficiency investments among income deciles.

Data requirements

In terms of data requirements, the model is based on the following inputs:

1. Coefficients to allocate national-level energy savings and associated investment expenditure to the different income classes, i.e. quantiles (PRIMES model and literature)
2. Household income by quantile (Eurostat)
3. Household consumption by income quantile (Eurostat[2])
4. Savings by income decile (Eurostat's database[3])

[2] Dataset code: HBS_STR_T223
[3] Dataset code: ICW_SR_10, TEC00131, NASA_10_NF_TR, ILC_DI01, HBS_EXP_T133

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Impact factor/functional relationship

We approximate the changes in welfare by income quantile (WC_{iq}) in terms of non-energy expenditures as percentage of household's income according to the following formula:) in terms of non-energy expenditures as percentage of household's income according to the following formula:

$$WC_{iq} = \frac{C^{0}_{nener,id} - C_{nener,iq}}{INC_{iq}} \quad (8)$$

Monetization

Monetisation can be approached via the welfare metric that captures the changes in non-energy expenditures (as percentage of income).

Aggregation

The indicator cannot be directly aggregated with other indicators.