Economics of Climate Change Cluster, BBVA Research

Measuring the CO2 Footprint of European Households: A comprehensive approach

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Household consumption, which accounts for more than half of the final demand in developed economies, is directly responsible for well over 20% of the CO2 emissions assigned by national environmental accounts. However, households' CO2 footprint is much larger than that. This note analyzes the CO2 footprint of household consumption in 10 European economies, incorporating indirect CO2 emissions through input-output analysis and detailing their structure by product. Thus, the analysis conducted makes it possible to describe patterns and to highlight relevant factors for implementing climate change mitigation policies that account for both, direct and indirect emissions.

Takeaways

- **Households total footprint, wider than direct emissions.** In order to improve the measurement, an extended households' total carbon footprint should include not only their direct CO2 emissions but also those indirect emissions embodied in the different goods and services, produced in the country or imported, that households enjoy as consumers. Regarding CO2 emissions coming from fossil fuel combustion, around 35% of household emissions are direct emissions, with the remaining 65% being indirect emissions coming from economic activities (firms) that meet the consumption demand of households.

- **Energy mixes, income, lifestyles and technological capabilities shape households footprint.** Clear differences and wide dispersions emerge when comparing the per capita CO2 footprints of european citizens - by consumption purpose, COICOP. These divergences could be related to the energy mix, together with differences in lifestyle, purchasing power and the available production technology.

- **The energy mix matters more in shelter than in mobility.** Shelter and mobility services account for about 70% of the total CO2 footprint of households. The weight of emissions linked to shelter increases in those economies with an energy mix with a low share of renewables, while its effect on the mobility footprint is less relevant given the predominance in the total vehicle fleet of combustion engines.

- **Wide dispersion of emission intensities.** Consumption pie-charts, in general, seem more homogeneous across countries than emission pie-charts, meaning that a huge part of the differences in the latter are explained by intensity disparities. However, some consumption heterogeneity can be spotted in specific countries and COICOP categories that partially explain the differences spotted in CO2 emissions.

- **Policy implications to mitigate consumption-side emissions.** Climate policies, with the aim of greening sectoral production, are imperative to reduce the footprint of households given the relevance of indirect households emissions in the total (roughly 65% of the total). Additionally, targeted policies by households' income level, considering redistribution to offset regressive impacts and behavioral nudges, might be also implemented to influence consumption decisions.

1. Introduction

Household consumption is an important contributor to CO2 emissions. Roughly 20% of global CO2 emissions are directly produced by households, mostly from fuel use for heating, cooling, cooking, and operating private vehicles (Hertwich et al., 2016a). However, and more importantly, a significant amount of emissions are also generated in the supply chains of goods and services consumed by households. These emissions are known as household indirect emissions.

In this spirit, this note compares European households' CO2 footprints with the aim of assessing the impacts of their consumption patterns. Indirect emissions are calculated with the standard approach usually implemented for footprint estimations: a top-down approach, based on environmentally extended input-output tables. However, as an extension to other previous works the note presents the total footprint of households, adding indirect and direct emissions in order to provide a fully comprehensive overview of the matter.

In general, households' CO2 emissions, both directly and indirectly generated, represent between 60% and 70% of the total emissions produced or imported by country, with the remainder coming from public, non-governmental and financial sources of final demand (Hertwich and Peters, 2009, Hertwich et al., 2016a). Thus, the behavior and consumption patterns of households are key for mitigating temperature increases and for getting closer to meeting the climate goals set in the Paris Agreement. However, as mentioned in Dubois et. al. (2019) the possible contribution and position of households in climate policies is neither well understood, nor do households receive sufficiently high priority in current climate policy strategies. The findings in this paper could be useful to understand the differences between European households' carbon footprints and to investigate how behavioral change can be useful, and therefore subject to policies, to achieve a substantial reduction in emissions.

2. From direct to total household carbon emissions

2.1 How can European households' carbon footprint be estimated?

In order to improve the measurement, households' total carbon footprint should include not only direct emissions but also those emissions embodied in the different goods and services, produced in the country or imported, that households enjoy as consumers. The emissions embodied in the production of a T-shirt, in the food eaten in a restaurant, in the home cleaning products, in the electronic products or in the manufacturing process of the car, among others, are after all the result of household consumption decisions.

Box 1.

How to calculate the indirect household carbon footprint

Environmental extended input-output (IO) modeling has been increasingly used to estimate the indirect emission component of household consumption. It would capture the total emissions generated during the production process (upstream supply chain until the product is ready to be used). **It is worth noting that IO modeling does not include the direct emissions of households, as households are not a productive sector that generates inputs for other economic activities.**

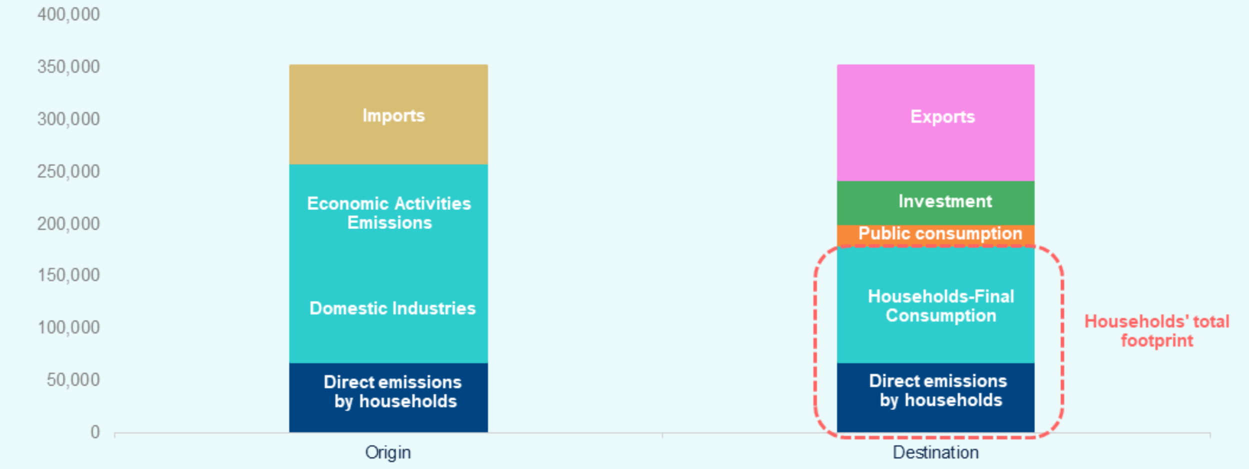
For European households, total indirect CO_2 emissions could be estimated using an Input-Output model based on Leontief coefficients[1]. The indirect household carbon footprint could be expressed as follows:

$$E_{Indirect} = EI * (I-A)^{-1} * W_{Demand\text{-}households}$$

where *EI* is the emission intensity vector (emissions generated per unit of output in each homogeneous sector or product)[2]; $(I-A)^{-1}$ is the Leontief inverse matrix, which captures the total effects that one unit of the final demand has on the output[3]; and *W* is the vector of household demand (the same procedure can be followed for the rest of components of final demand: public consumption, investment or export by product). So, the product $(I-A)^{-1} * W_{Demand\text{-}households}$ gets an output vector accounting for the inputs triggered throughout supply chains, including imports, by household's consumption.

As mentioned in Barrutiabengoa et. al. (2022), from a more general point of view, we can approach emissions as another economic factor, with origin and destination. The sum of the emissions generated directly by households, those produced by companies resident in a country and those incorporated in the imports of goods and services, are the resources (the origin) that are destined to meet the different demands (destinations); public and private consumption, investment and exports.

Figure 1. **EXAMPLE. CO2 EMISSIONS BY ACTIVITY. ORIGIN & DESTINATION** (THOUSAND TONNES).



Source: BBVA Research.

[1]: Kaihui S., Shen Q., Morteza T., Sai L., Ming X., 2019 Scale, distribution and variations of global greenhouse gas emissions driven by U.S. households.
[2]: Official data provides high granularity (two-digit level NACE classification) and eases the calculation of sectoral emission intensities.
[3]: Miller and Blair, 2009 Miller, R., Blair, P. Input-Output Analysis Foundations and Extensions.

Our own calculations are based on the latest available OECD Input-Output Tables and Environmental Extended Accounts. From 1995 to 2018, the OECD database covers 45 NACE sectors for almost all the countries, including the EU member states and the World's largest economies. To calculate the emission intensities, production-based CO2 emissions are used, which include **CO2 emissions from fossil fuel combustion to the resident industries and households[4].**

Finally, in order to translate households' sectoral emissions into products by activity (Classification of Products by Activity, CPA) and then into consumption by purpose (COICOP) categories, bridging matrices by Cai and Vandyck (2020) have been used. This step is necessary to convert 45 NACE production sectors into 35 COICOP consumption categories for households. Cai and Vandyck (2020) collected input data from Eurostat on total household consumption for 35 COICOP and 63 CPA categories, and based on these data, they constructed bridging or concordance tables for 30 European countries using recently developed matrix balancing techniques[5]. For illustrative purposes, the results of Bulgaria, Finland, France, Germany, Italy, Poland, Portugal, Spain, Sweden and The United Kingdom are shown, although the results could be replicated for the 30 countries in the Cai and Vandyck (2020) database[6].

Box 2.

How to distribute the direct household carbon footprint into COICOP categories

The Input-output method captures the emissions from cradle to gate, i.e., upstream supply chain until the product is ready to be used. However, it does not include the direct emissions from the use phase in household consumption, such as gasoline burning during car driving and on-site natural gas burning during cooking. Thus, direct emissions by COICOP category are obtain as follows:

The OECD, in its Air Emission Accounts, provides a disaggregation of households' direct emissions in transport, heating and cooking.

Transport direct emissions are added to indirect emissions in the transport COICOP category, while the direct emissions from heating and cooking are added to the shelter COICOP category.

$$EQ_{total,i} = EQ_{direct,i} + EQ_{indirect,i}$$

where $EQ_{total,i}$ are the total emissions assigned to the COICOP category i, while $EQ_{direct,i}$ and $EQ_{indirect,i}$ are, respectively, the direct and indirect CO2 emissions assigned to the COICOP category i.

[4]: Fossil fuel combustion is the largest source of carbon dioxide (CO2) emissions, accounting for about 80% of total CO2 emissions globally according to IEA. This includes CO2 emissions from the burning of coal, oil, and natural gas for electricity, transportation, and other purposes. The remaining CO2 emissions come from sources such as industrial processes, agriculture, and land use changes (e.g. steel or cement production creates CO2 as a byproduct due to the chemical reactions that occur during the production process). It is worth noting that the percentage of CO2 emissions from fossil fuel combustion may vary from one country to another, depending on the country's energy mix and its economic activities. For the analyzed countries in this note, the average is around 80%, being as low as 60% in Sweden and as high as 90% in Bulgaria.

[5]: This dataset represents bridging matrices between two different data classification systems: consumption by purpose (COICOP) and products by activity (CPA). While the former classification is used in household budget and expenditure surveys, the latter represents the industry sector dimension that is typically adopted in national accounts and input–output tables.The resulting tables enable data conversion between consumption- and production-based statistics, facilitating research that integrates macroeconomics, multi-sectoral international trade and heterogeneous agents in household-level expenditure micro-data.

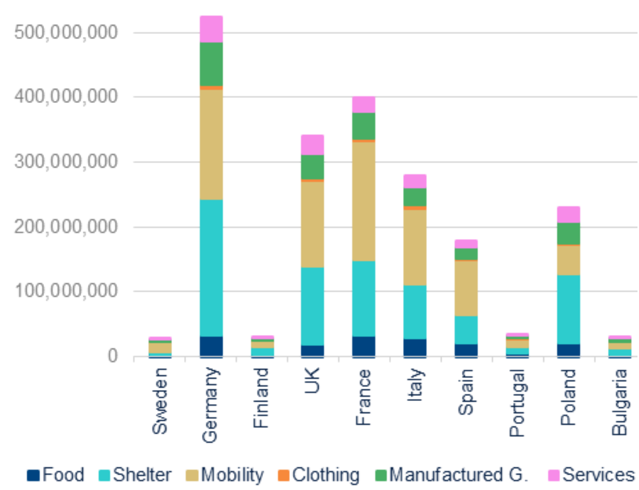
[6]: Put another way, as in other previous literature works, with the aim of analyzing the households' CO2 emissions in more detail, the Consumer Expenditure Survey-Input Output method has been used to bridge the input-output modeling and consumer expenditures (Hertwich et al., 2016b). As bridging matrices are only constructed for European countries, our work could only be focused on European countries.

3. CO2 footprint of European households: level, structure and factors behind the differences

3.1 An overview of the CO2 footprint of households

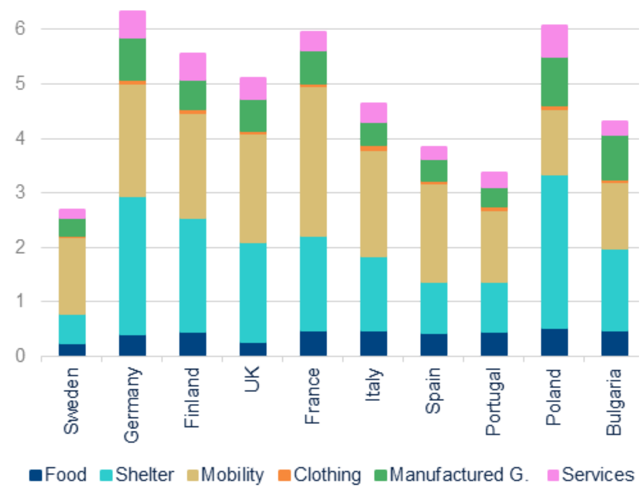
Interpreting and comparing CO2 footprint results is not a straightforward task. In this spirit, the note presents a step by step comparison of the results, with the aim of providing a more comprehensive explanation.

Figure 2. **TOTAL HOUSEHOLD CO_2 EMISSIONS BY COICOP** (TONNES CO2). 2018.[7]



Source: BBVA Research.

Figure 3. **HOUSEHOLD CO_2 EMISSIONS BY COICOP** (TONNES CO2 PER CAPITA). 2018.[8]

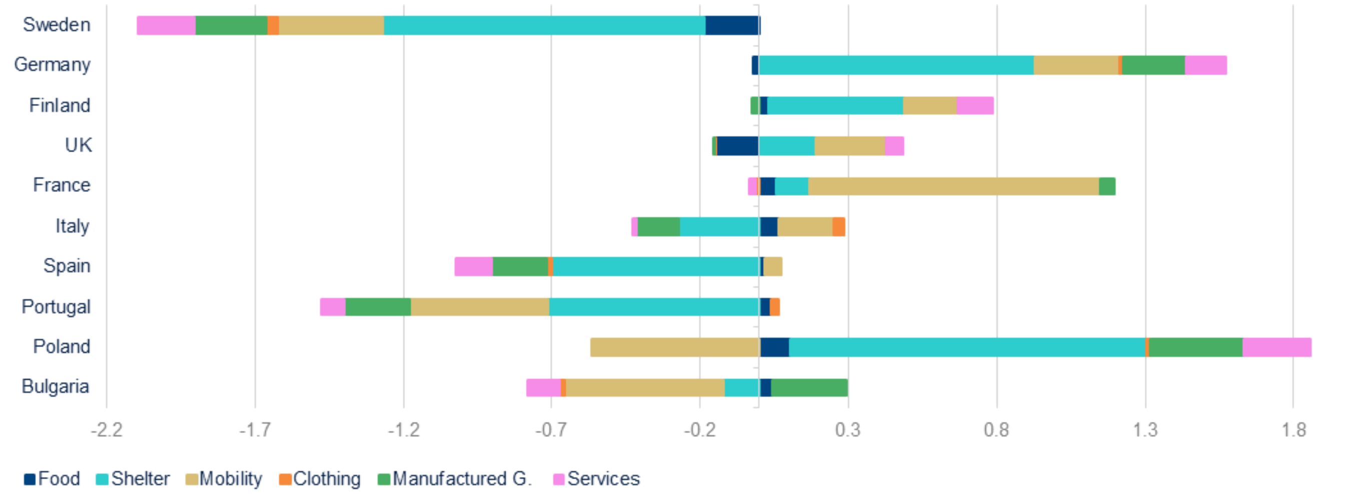


Source: BBVA Research.

Households' CO2 footprint, shaped by mobility and shelter and related to the level of income and the energy mix, among others. Figure 2 above shows the total household CO2 footprint of the analyzed countries, whereas Figure 3 rescales these emissions to per capita terms[9]. Note that while the information in Figure 2 could be important for analysis related to the total CO2 footprint of the countries, Figure 3 represents a more accurate approach, as it shows a relative picture in terms of population. From the 10 countries presented in this note, Germany has the highest household CO2 footprint per capita, followed by Poland and France. Specially significant is the difference of these countries with Sweden, or even with Portugal or Spain, the least emitting households[10] of the sample. Furthermore, it can be seen that important differences exist by COICOP category, with per capita emissions related to mobility in France being, as an example, almost twice as big as in Sweden. In this sense, Figures 4 and 5 below shed more light on it, as they illustrate the differences in the per capita household emissions by COICOP in each country with respect to the mean of each COICOP category.

7: The order of countries in the entire note follows a hierarchy of GDP per capita for the year 2018.
8: It is striking that if we remove Sweden, Poland and Bulgaria, which have the most different energy mix, there is an almost perfect positive correlation, from Germany to Portugal, between income level and per capita footprint: richer, more emissions.
9: First, one should bear in mind that representing the carbon footprint of a household through a pie-chart, as in this note, could be misleading, as it shows a percentual division, by COICOPs, of the total CO2 emissions of an average household. Thus, it is informative to consider the level of emissions first, in absolute terms.
10: Households in the context of this note represent an average citizen of each country.

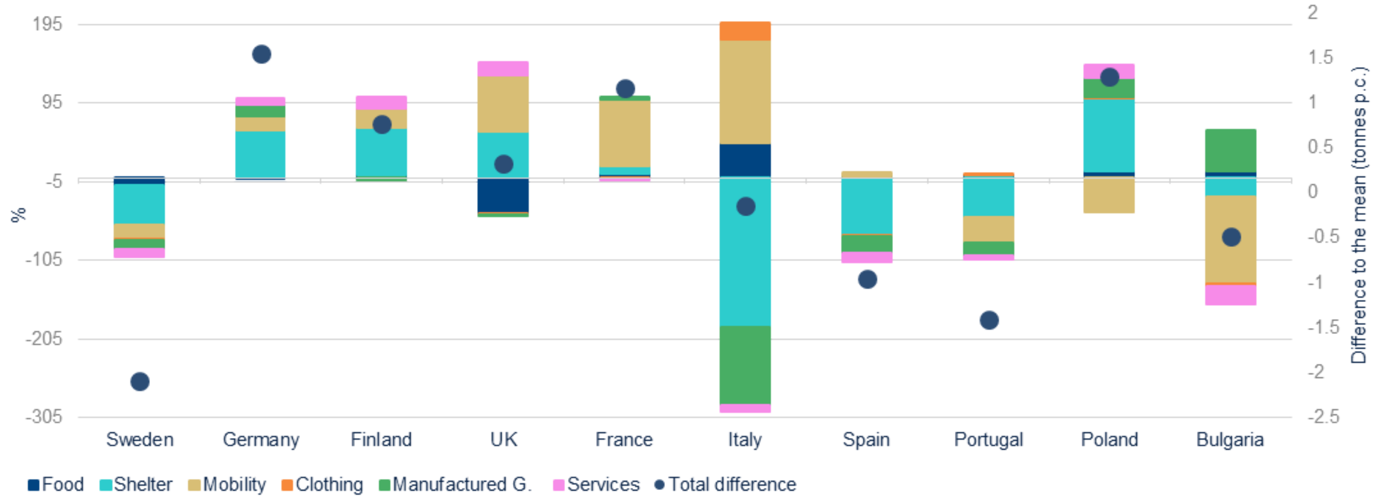
Figure 4. **HOUSEHOLD CO2 EMISSIONS BY COICOP** (TONNES CO2 PER CAPITA). DIFFERENCES WITH RESPECT TO THE MEAN OF EACH COICOP CATEGORY. 2018.



Source: BBVA Research.

Shelter, the main contributor to the existing dispersion between households' footprint across economies. Clear differences and dispersion emerge when comparing the households' CO2 footprints of each country to the average of each COICOP. As an example, it can be highlighted that in total, the Swedish household footprint is 2 tonnes per capita lower than the average, while the German carbon footprint exceeds the average by 1.5 tonnes per capita. The difference by COICOP emissions between countries could be related to the energy mix of the country, together with divergences in lifestyle, purchasing power and the available production technology (for both imports and national production).

Figure 5. **HOUSEHOLD CO_2 EMISSIONS BY COICOP** (TONNES CO2 PER CAPITA).
SHARE OF THE DIFFERENCE EXPLAINED BY COICOP (LEFT) AND TOTAL DIFFERENCE (RIGHT). 2018.



Source: BBVA Research.

In general, the greatest differences are observed at shelter and mobility COICOP categories. This could be mainly due to two reasons: First, 70% of the households' carbon footprint is explained by shelter and mobility groups, and hence, it is just logical that these two categories are the ones with a higher influence on the differences between countries. Second, shelter is the category more directly affected by the energy mix, and hence, the countries with the greenest energy mixes stand out above the rest. On the other hand, the distinctions in mobility could be related to the age or technology of the transport fleet and the mobility habits of the people.

All in all, it is interesting to note that except for Sweden, which is below the average in all the categories, the deviations from the average by COICOP category vary between countries[11]. Especially shocking are the mobility footprints of France (see Figures 4 and 5), the shelter differences between Poland, Germany and Sweden, or the differences in clothing in Italy and Portugal, clearly above the average. These discrepancies could be related with a variety of factors, such as life-styles, energy mixes or idiosyncratic factors of the country as it will be shown in the next section.

3.2 Deciphering the factors behind households' CO2 per capita emission differences

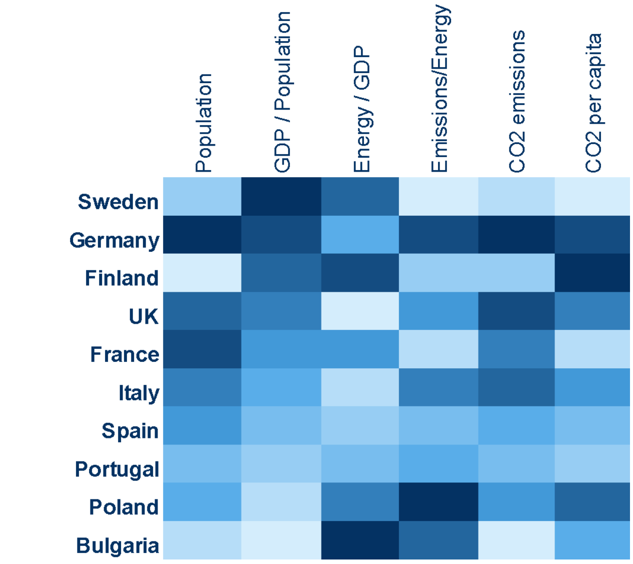
As in Kaya's economy-wide identity, household CO2 emissions depend on the number of households, their consumption, the efficiency of energy used per unit of consumption, and the emission intensity of energy consumption. Since there is no information on the indirect energy used by households as consumers, the economy-wide (territorial) Kaya identity is used as a good proxy since household emissions account for a significant amount of total territorial emissions. In this sense, Figures 6 and 7 below, in an attempt to decipher the differences between the per capita household CO2 emissions, show the Kaya's decomposition, for both territorial

[11]: All the countries have at least one category below and above the mean (mean of each COICOP across countries), with important differences also in food or manufacturing goods emissions in some countries.

and household emissions, adding other relevant variables that may help explain the identity in the second figure. A quantitative analysis of the differences is out of the scope of this note, but a brief overview of the main factors affecting households' emissions will be provided below.

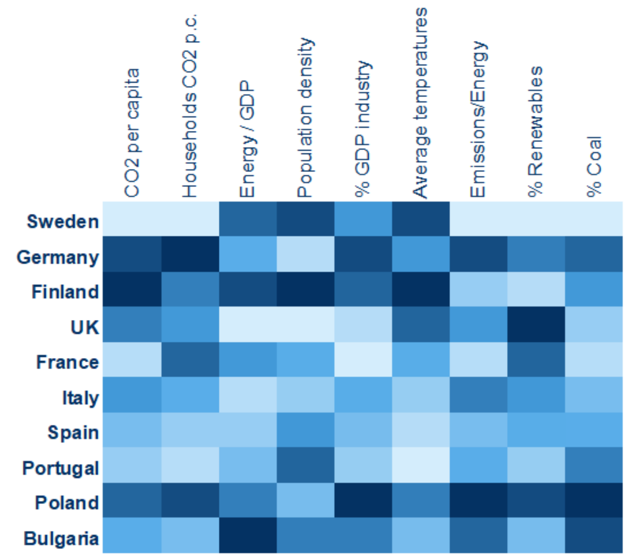
$$Kaya's\ decomposition:\ CO2 = Population\ *\ GDP/Population\ *\ Energy\ cons./GDP\ *\ CO2/Energy\ cons.$$

Figure 6. **TERRITORIALITY PRODUCED CO2 PER CAPITA.** EMISSIONS BREAKDOWN BY KAYA'S FACTORS. 2018.



Source: BBVA Research.

Figure 7. **CO2 PER CAPITA (TERRITORIALITY PRODUCED AND CONSUMED BY HOUSEHOLDS).** EMISSIONS BREAKDOWN BY VARIABLES. 2018.



Source: BBVA Research.

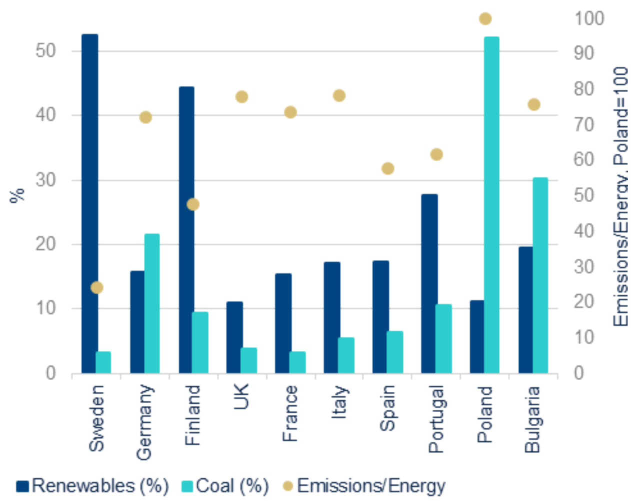
The heat-maps above show that the consumption footprint of German citizens is not the largest by accident. With the dark-blue color representing the worst-performing country in each category in terms of the variable's influence on CO2 emissions, it seems that their large footprint is mainly driven by a high purchasing power and a higher than the average emission and energy intensity factors that lead to a significant energy consumption, and hence, to high carbon emissions. This can be better understood if we take a look at Figure 7, which shows that the share of renewable energy in Germany is below the sample median while its coal share lies among the highest. On the other hand, Swedish households, which also have a high GDP per capita and an energy consumption even greater than that of Germany (partly driven by lower temperatures) have a much lower CO2 per capita emissions, helped by a clean energy mix. Sweden has the highest share of renewables among EU countries (53% of energy consumption in 2018), followed by Finland (almost 44%). Put another way, a clean energy mix or low emission intensity enables Swedish citizens to consume high energy inputs without emitting large amounts of CO2. On the contrary, Poland, which has a much lower GDP per capita, is penalized by its high emissions intensity. The case of Finland is also interesting as it shows a high renewable, coal and energy consumption, being the worst ranked country in terms of territorial CO2 per capita emissions. However, its ranking changes when the analysis is shifted to households' CO2 per capita emissions, indicating the relevance of consumption habits in the footprint of citizens[12].

[12]: Household demand is proportionally lower in comparison to the rest of the final demand components in Finland than in Germany, for example.

As a general note, it can be said that to reduce global emissions it is imperative to 'decarbonize' the energy mix, that is, to shift energy systems from fossil fuels to low-carbon sources of energy. The relationship between emission intensity and the energy mix is shown in Figure 8 below.

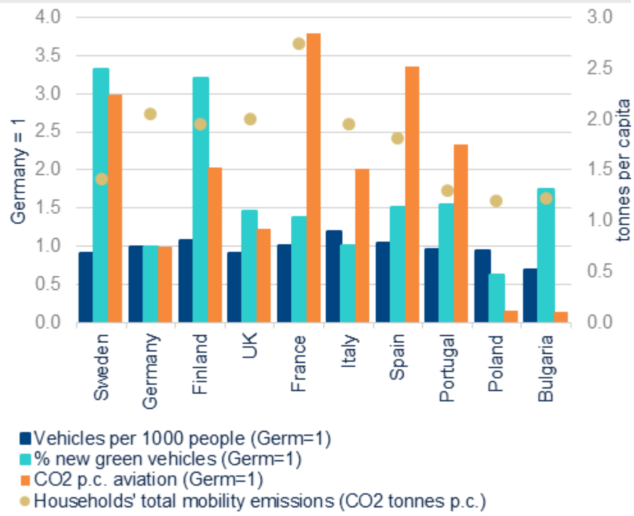
Nevertheless, mobility emissions are not closely related to the domestic energy mix[13] and, as it has been mentioned at the beginning of the note, are also an important determinant of the differences (i.e. France or Germany). In this respect, a more in-depth analysis is needed in order to understand the drivers, but a quick assessment points out life habits, intensity differences driven by technology and purchasing power gaps between countries as three of the main elements behind the differences. As it can be seen in Figure 9, aviation emissions are higher in France or Spain than in Bulgaria or the UK, a fact that could be related to purchasing power, habits (e.g. households may have a higher propensity to flight, even for shorter distances in France) or technological differences. However, in order to meticulously decipher mobility footprints, more information will be needed (e.g. statistics related to the fuel intensity of the average vehicles or details related to the use of these vehicles by households in each country). As an example, in Germany, the average distance covered per day by each person is almost 20 km, the highest of Europe, being traveling to work the main reason in one third of the cases according to Eurostat (see here and here for more information).

Figure 8. **ENERGY MIX.** RENEWABLE AND COAL SHARE (%) AND ENERGY INTENSITY. 2018.[14]



Source: BBVA Research.

Figure 9. **CO2 PER CAPITA - MOBILITY.** EMISSIONS BREAKDOWN BY VARIABLES OF INTEREST. 2018.



Source: BBVA Research.

3.3 The CO2 footprint of households: pie-charts by COICOP category

The total CO2 footprint of each country is shown in the outer circle of Figure 10. A general conclusion is that almost 70% of households' CO2 emissions have their origins in mobility and shelter, with the share of mobility being slightly higher in every country. Specifically, 60% of the mobility emissions are direct emissions, while the remaining

13: Given the dominance, in general, of internal combustion engines, as far as cars are concerned.
14: Renewables (%): Renewable energy consumption, including solar, wind, hydro, biofuels and geothermal, is the share of renewables energy in total final energy consumption. World Bank.

40% are indirect emissions from fuels and public transport. On the contrary, 35% of the emissions related to shelter are direct emissions linked to heating and cooking.

Indirect emissions have a higher weight on households' footprints than the direct ones. In total, around 35% of household emissions are direct emissions, with the remaining 65% being indirect emissions coming from economic activities (firms) - emissions used in the production, transportation and sales of products and services -. It is also worth noting that countries with a higher share of renewable energy have a higher than the average weight on mobility due to a lower weight on shelter, and on the other hand, countries with a high coal share (the highest emission intensive fuel) have, generally, a high share in shelter emissions. Energy-intensive industrialized countries also show a higher share on manufacturing goods, while Mediterranean countries have a higher share on food.[15]

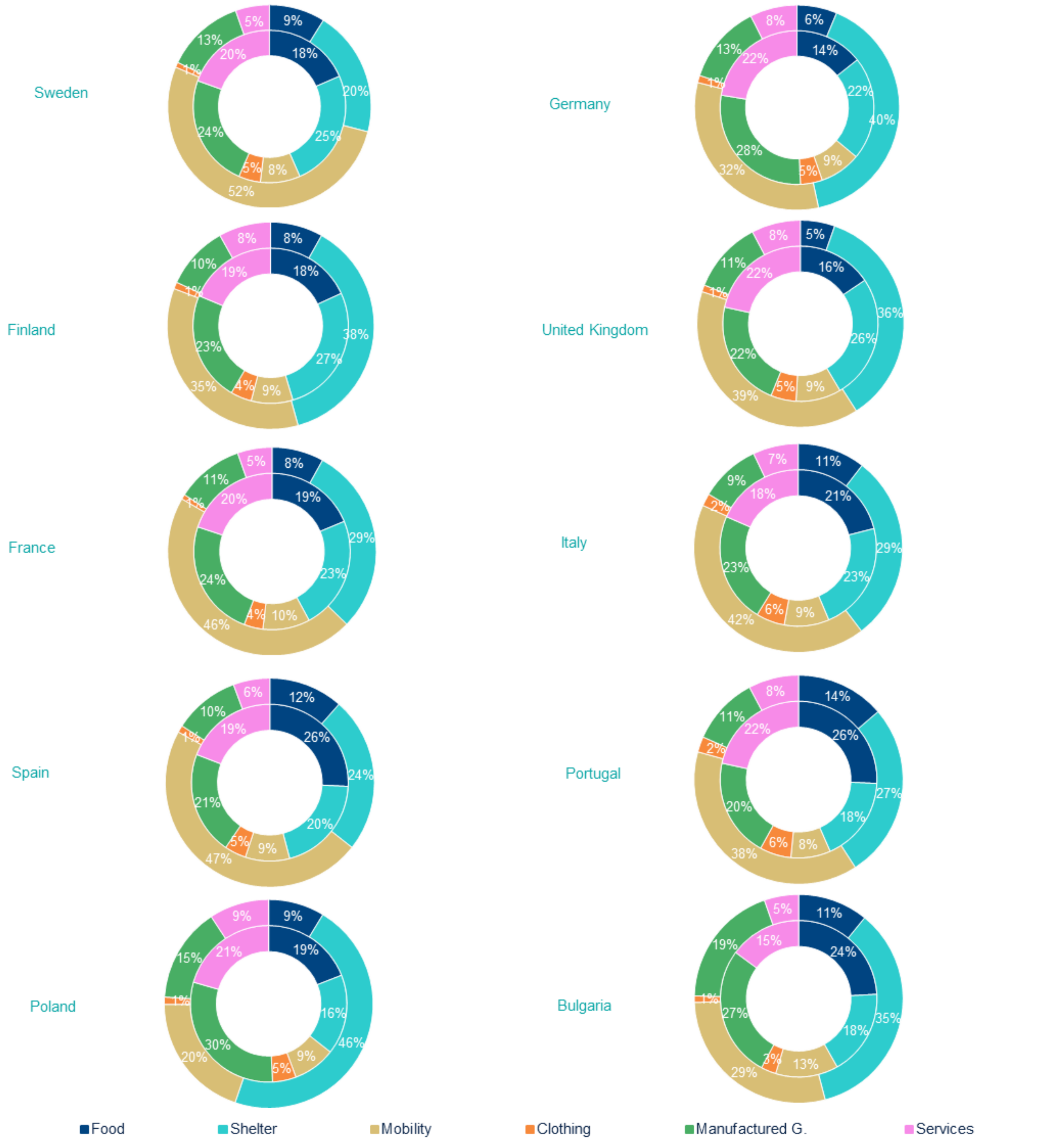
The energy mix mainly shapes the structure of emissions due to its impact on heating. All in all, CO2 footprint pie-charts could be classified in two main groups. The first group is composed of the countries with a mobility share that is, at least, 10% higher than the shelter category. This group includes Spain, France, Portugal, Italy and the main exponent, Sweden. A common characteristic of these countries is their high aviation mobility footprint and, at the same time, their higher than the average share of clean energy (renewables and nuclear). In short, their energy mix enables them to reduce their shelter per capita emissions in comparison to the mobility ones.[16]

The second group is composed of countries with shelter emission shares that are higher or similar to the mobility ones, including Finland, United Kingdom, Germany, Bulgaria and the main exponent, Poland. Again, the main distinctive characteristic of this group is that their energy mix is browner than the average (with coal having an important role) or, at least, their high energy intensity is not fully compensated by a high share of renewable energy (which determines emission intensities). These countries, due to the fuel inputs used or their lower than the average technological capacity, also have a comparatively higher share of emissions in manufacturing goods (e.g. Bulgaria and Poland).

But, do these differences emerge from emission intensity variations among countries or do lifestyles and per capita consumption divergences, proxy by consumption pie-charts, also have an influence? The inner circle of Figure 10 below shows that both factors are relevant. As it can be seen in this figure, the share of food, services, manufactured goods and clothing is significantly higher in the consumption basket than in the emission one. This is mainly explained by the significant difference between the share of mobility in consumption and emissions, much higher in the latter due to the high ratio (total emissions by unit of final demand) of transport in comparison to other COICOP categories. This is a common feature in all the analyzed countries. Furthermore, it can be stated that **the consumption pie-charts, in general, seem more homogeneous across countries than the emission pie-charts, meaning that a huge part of the differences in the latter is explained by intensity disparities.** However, on a good note, some heterogeneity can be spotted in specific countries and COICOPs that partially explain the differences spotted in CO2 emissions. As an example, both the UK and Finland have a higher than the average consumption share on shelter, which, ceteris paribus, would be upwardly pushing the share of shelter in the emission basket. The same happens with Bulgaria and France in the case of mobility, with Italy and Portugal in clothing, or with Bulgaria, Poland and Germany in manufactured goods. A quantitative decomposition of these differences would be an interesting exercise to perform in the future.

[15]: Note that as long as we are not measuring the CO2 footprint of the households, the food share is probably lower than what it would have been if the GHG footprint was measured.
[16]: At the moment, the differences in the emission intensity of the vehicles are quite low, but important divergences may emerge in the future if electric vehicles continue with their current trend, increasing the relevance of the energy mix also in the mobility footprint.

Figure 10. **TOTAL CO2 EMISSIONS IN HOUSEHOLDS FINAL CONSUMPTION* AND HOUSEHOLDS CONSUMPTION BASKET**.** (%). BY COICOP CATEGORY. 2018.

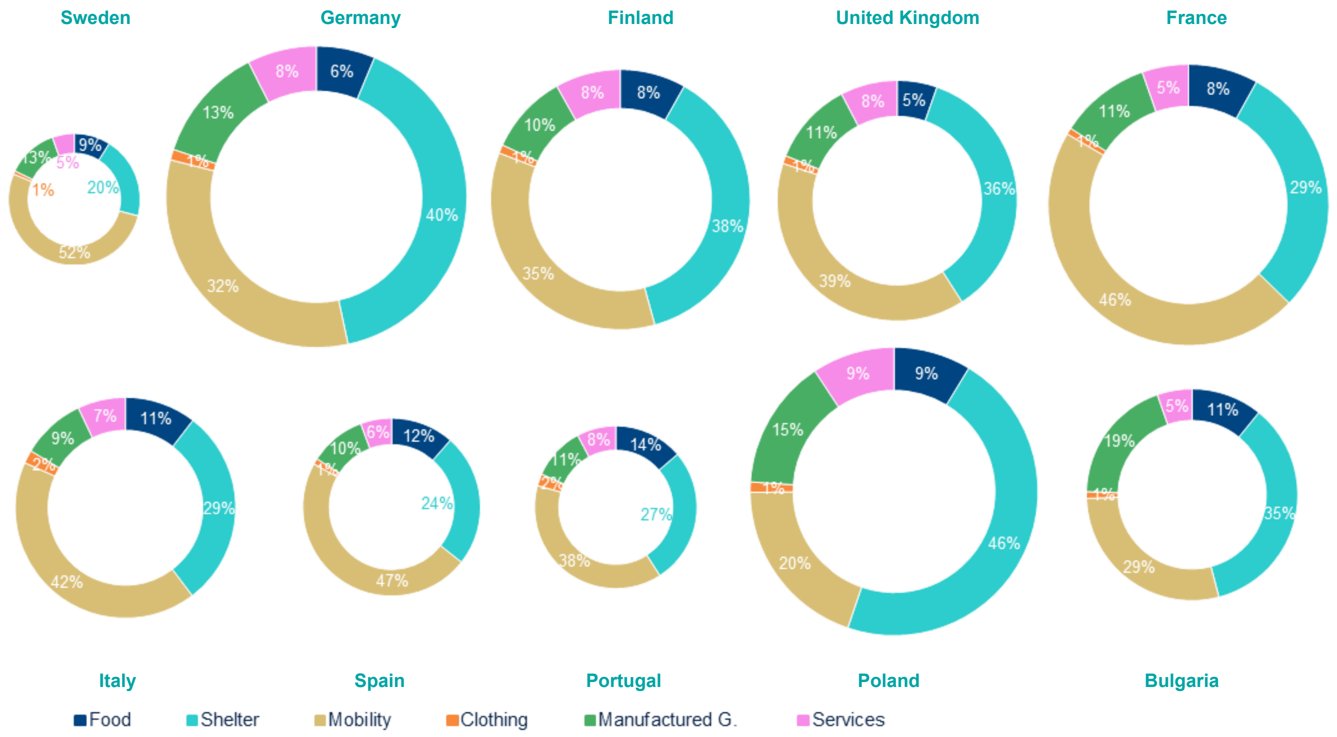


*: Outer circle: CO2 footprint of households; **:Inner circle: Consumption basket. The sum of the percentages does not add up to 100% because of rounding.
Source: BBVA Research.

Nonetheless, the pie-charts only show a percentage distribution of emissions by COICOP. Thus, by escalating the pie-charts to per capita terms, Figure 11 emerges, illustrating the big differences that exist between the households' per capita CO_2 footprints even at a European level. Germany, Poland and France are the countries with the highest households' per capita footprints, being the first two penalized by high shelter emissions and the latter by a soaring mobility footprint. An intermediate batch follows these countries, composed of Finland, The United Kingdom and Italy. Finally, Bulgaria, Portugal, Spain and Sweden are the countries with the lowest total per capita emissions.

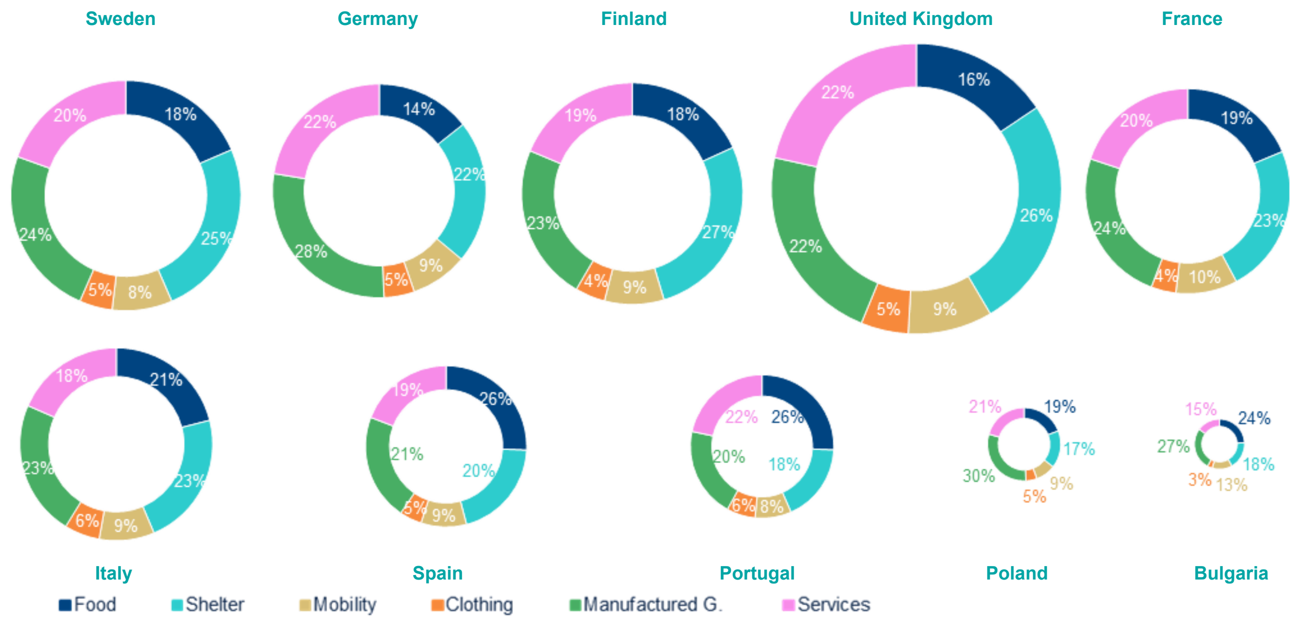
In some countries, such as Bulgaria, low consumption per capita is one of the main drivers of the results, while in Sweden, Portugal and Spain, apart from the consumption per capita differences that exist, which may provoke differences in consumption patterns, a high share of renewables or, at least, a lower than the average energy intensity, reduces emissions in comparison to other countries in the sample. This could be clearly seen by comparing Figure 11 and 12 below. For example, more than driven by technological comparative advantages, it could be said that households' emissions per capita in Poland and Bulgaria are contained due to their low consumption per capita. The overall intensity of Sweden is clearly the lowest (with its consumption per capita being one of the highest and emissions per capita the lowest), no big differences exist between the intensity multipliers in Italy, Spain or Portugal, and finally, the UK's intensity is lower than the one in Germany or France.

Figure 11. **TOTAL EMISSIONS IN HOUSEHOLDS FINAL CONSUMPTION** (%) BY COICOP CATEGORY. 2018. SIZE ADJUSTED TO PER CAPITA EMISSIONS.



Source: BBVA Research.
The sum of the percentages does not add up to 100% because of rounding.

Figure 12. **HOUSEHOLDS FINAL CONSUMPTION** (%) BY COICOP CATEGORY. 2018.
SIZE ADJUSTED TO PER CAPITA CONSUMPTION.



Source: BBVA Research.
The sum of the percentages does not add up to 100% because of rounding.

4. Conclusions

The results shown in the note illustrate that **significant disparities exist in the carbon footprint of European households, both within COICOP categories at national level and across countries.** The differences are related with a variety of factors including idiosyncratic characteristics, technology, consumption habits and the emission intensities of the energy mix. That is, consumption habits have an influence on the carbon footprint of citizens, and hence**, there is room to acquire more sustainable consumption patterns or behavioral changes**, and hence, reduce emissions.

However, most of the disparities in the carbon footprints, both in level and structure, are related with the different emission intensities across countries, and consequently, it seems reasonable to focus the mitigation efforts on the production-side of the problem, reducing technological differences and investing in green energy and sustainable transport alternatives. Furthermore, it has to be noted that a variety of countries, although they do not have an tremendous impact in terms of emissions due to their low consumption per capita, show worrisome emission footprints, being proportionally much higher than their consumption footprint. Thus, technological advances are key in these countries in order to witness a sustainable increase in consumption that does not translate into important increases in emissions. This is a conclusion that can be translated to other developing countries outside Europe. Put another way, **technological transfers are key in order to tackle a global externality problem that does not provide the same incentives to act in every country** given their different framework for climate mitigation.

In short, the most important takeaways of the note are the following: An extended households' total carbon footprint should include not only direct emissions but also those indirect emissions embodied in the different goods and services, produced in the country or imported, that households enjoy as consumers. The calculations made suggest that, in total, around 35% of household CO2 emissions from fossil fuel combustion are direct emissions, with the remaining 65% being indirect emissions coming from economic activities (firms), noting the importance of accounting for both. It has also been shown that clear differences and dispersion emerge when comparing the per capita CO2 footprints of European citizens - by consumption purpose, COICOP -. In general, the greatest differences are observed at the shelter and mobility COICOP categories. Additionally, it has to be taken into account that almost 70% of households' CO2 emissions are related to the mobility and shelter categories, with the share of mobility being slightly higher in every country, which clearly manifests that the greatest efforts need to be focused in these two categories. Countries with a high share of renewable energy have a higher weight on mobility due to a lower weight on shelter. On the other hand, countries with a high coal share (the highest emission intensive fuel) have, generally, a high share of shelter emissions. Finally, one should bear in mind that consumption pie-charts, in general, seem more homogeneous across countries than the emission pie-charts, meaning that a huge part of the differences in the latter is explained by emission intensity disparities.

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