Generational Carbon Accounts

Decomposing the carbon footprint by age to assess the impact of age and generation on carbon emissions

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Abstract

There is no broad scientific consensus on the impact of population dynamics such as population ageing on greenhouse gas emissions and consequently on global warming, due, in particular, to the lack of studies considering the decomposition of the carbon footprint over the long term. This project thus proposes a methodology for constructing age-specific carbon accounts. First, by estimating a household consumption model, I decompose a households consumption microdata by types of goods and by households members. Successively with Input-Output data, I estimate the carbon footprint of each category of goods and services by age group and subsequently derive a decomposition of the carbon footprint of a given country by type of goods. The method proposed is highly flexible and can therefore be applied widely. Preliminary results are provided for France, Japan, South Korea and Mexico. Moreover, this project provides early estimates of pseudo-panels of French carbon footprint from household consumption, spanning from 1979 to 2011.

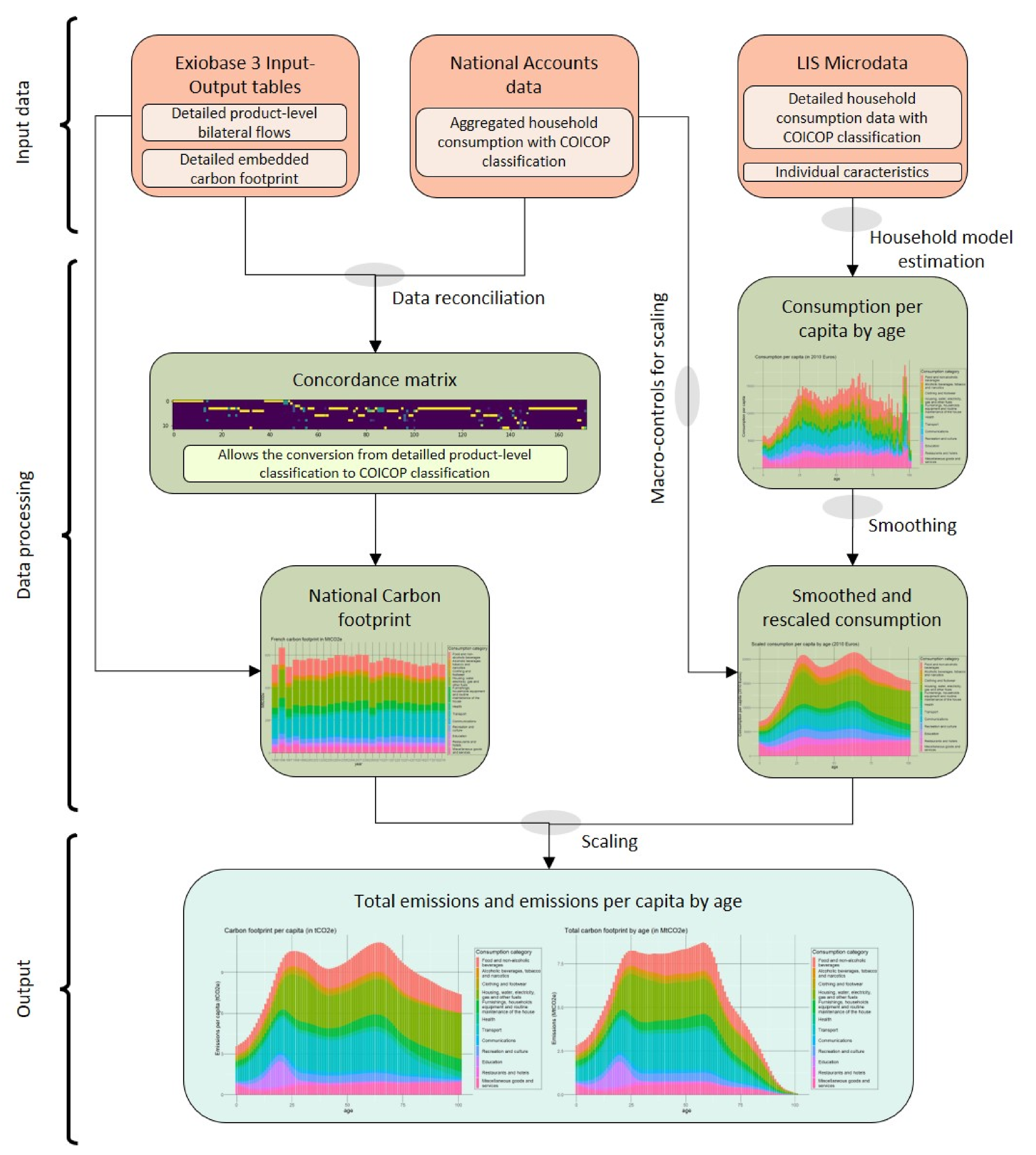


Figure 1. Proposed method to decompose the carbon footprint

Introduction

It seems logical that the structure of the population should have an impact on greenhouse gas emissions, as consumption needs and preferences change over the course of a lifetime. Moreover, each generation is also characterised by variable consumption practices related to an economic and technological context. However, there is no consensus on the influence of the structure and dynamics of the population on greenhouse gas emissions (*1*). Indeed, there is no study to date that takes into account all the consumption poles over the long term and clearly highlights the importance of the demographic process: either there is a lack of temporal depth (*2*), or not all emissions are considered (*3*), or all the emissions of a household are attributed to its head (*4*).

To address these challenges, I propose a two-step method. First, decompose the carbon footprint by age group for country c at time t as follows:

$$E_{c,t} = \sum_{age} Pop_{c,t,age} \sum_i \theta_i C_{t,age,i}$$

Where $Pop_{c,t,age}$ corresponds to the population by age group. And I estimate θ_i the consumption of good i carbon intensity and $C_{t,age,i}$ the consumption of good i by age group.

Then, based on these numerous carbon footprint profiles by age group, the various effects that contribute to this result are distinguished: technological effects linked to the variable carbon intensity of consumption, life cycle effects, generational effects and period effects (*5*, *6*).

The rest of this poster introduces the method used to construct the carbon footprint by age group and highlights its flexibility and therefore its very general application framework. It then presents some initial elements on the long-term dynamics of the carbon footprint by age group.

Methods and data

The method I follow is displayed on Figure 1. To carry it out, I mainly use two data sources: The EXIOBASE database, which allows me to determine the emissions of consumption by taking into account imported as well as final use emissions (*7*); and the data from the Luxembourg Income Study (LIS), which gives me access to repeated cross-sections of micro-data on consumption for several countries (*8*). The decomposition of consumption per capita is then made possible by estimating a model derived from a collective household model (*9*–*11*) in which the sharing rule is determined according to the convention of the National Transfer Accounts (NTAs) (*12*). Specifically, to determine the budget share in good j of individual i within household h, I estimate the following tobit model:

$$w^h = \frac{1}{\sum_i \eta(age^i)} \left(\sum_{c^\alpha} \alpha^c \sum_i \eta(age^i) c^i + \sum_{c^\beta} \beta^c \sum_i \eta(age^i) c^i \left(\ln(y^{h,i}) - \ln(\tilde{y}) \right) + \sum_{c^\gamma} \gamma^c \sum_i \eta(age^i) c^i \left(\ln(y^{h,i}) - \ln(\tilde{y}) \right)^2 \right)$$

with $y^{h,i} = \frac{\eta(age^i)}{\sum_i \eta(age^i)} y^h$

Once the model has been estimated, it is possible to allocate consumption within a household, and to draw an age profile for each type of good. This profile is smoothed by applying the method recommended by the NTAs.

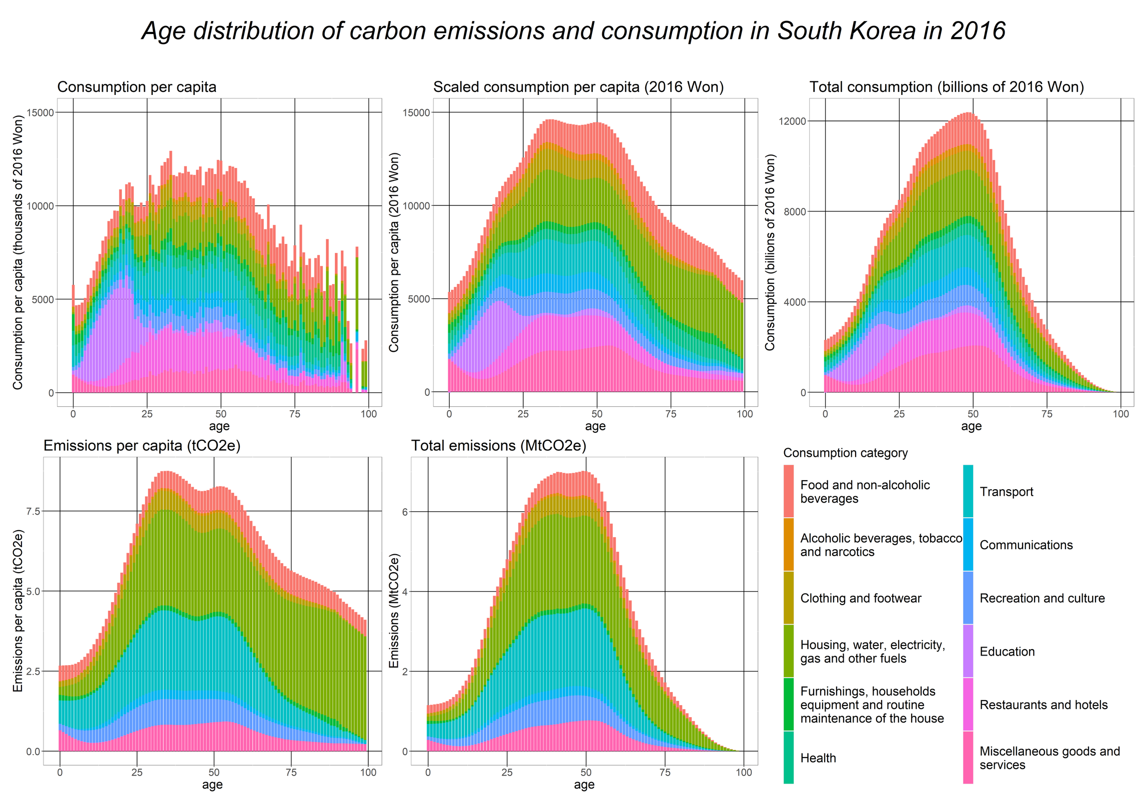
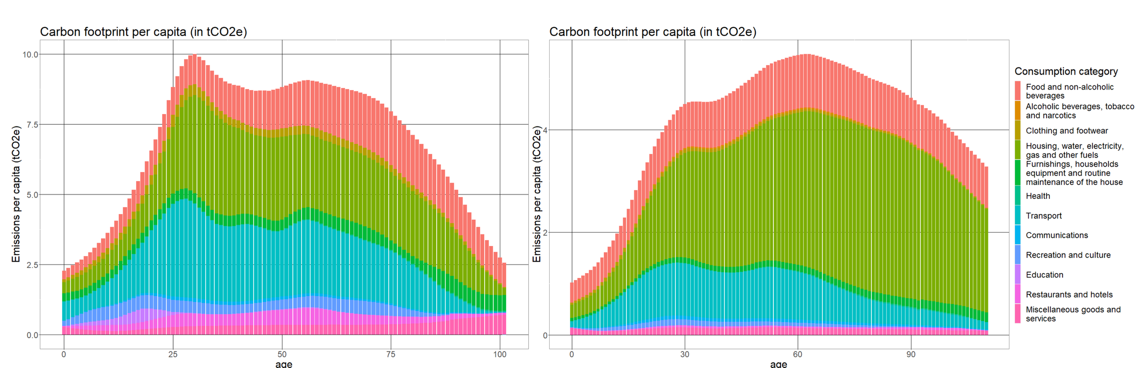


Figure 2. A case example for Korea 2016

For the carbon footprint data, emissions associated with goods in EXIOBASE are linked to the categories of consumed goods in the LIS database with a concordance matrix (*13*). Then, profiles and carbon footprints by type of goods are linked to obtain an emissions profile by age on a cross-section. Finally, numerous cross-sections allow me to construct pseudo-panels that demonstrate the existence of age, cohort and period effects (*5*).

Results



(a) Japan 2013 (b) Mexico 2018

Figure 3. Carbon footprint per capita by age

When it comes to some preliminary results, Figure 2 presents the intermediate and final outputs obtained by following the method in the case of South Korea in 2016, while Figure 3 focuses more specifically the carbon footprint per age in Japan in 2013 and in Mexico in 2018. Generally, all results are relatively consistent on a number of specific aspects. First, per capita emissions increase in the early part of life, while they decrease from about 60 years of age. In addition, there is a more or less pronounced camel-back shaped curve between about 25 and 60 years of age, which is mostly explained by two things: the average size of the household to which an individual of a certain age belongs and the average income of this same household. In fact, the camel-back shape between the ages of 30 and 50 can be explained by the economies of scale permitted by the larger household size, in particular for the consumption of transport. Moreover, the decrease of the carbon footprint after 60 years can be explained by the variation in transport consumption, whereas the consumption related to heating slightly increases.

The analysis of pseudo-panels sheds another light. Figure 4 shows that, first of all, consumption has increased globally over time in France while the associated emissions have decreased, which highlights the importance of technological developments for studying the evolution of the carbon footprint. Similarly, consumption has increased over the life cycle for almost every cohort considered.

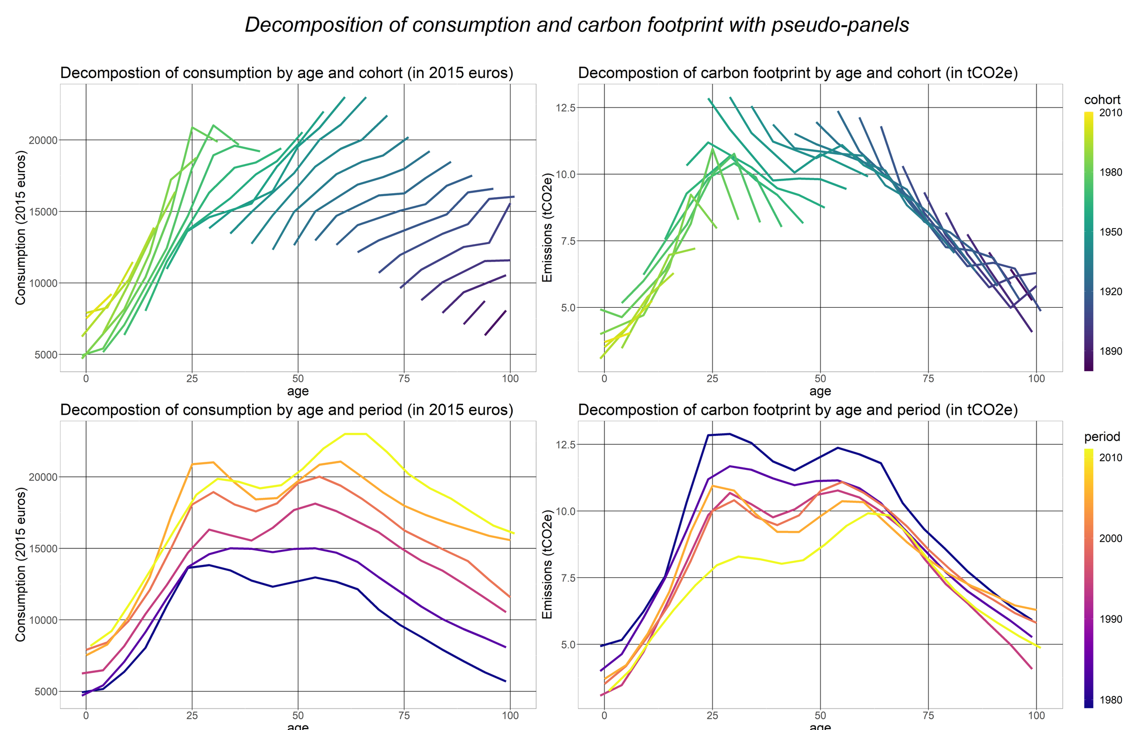


Figure 4. Pseudo-panel decomposition of consumption and carbon footprint for household budget survey between 1979 and 2011 in France

However, the generational aspect on emissions is much less obvious. On the one hand, the older cohorts see their emissions decrease over the life cycle. On the other hand, the hump marking the highest emitting age group shifts over time towards the highest age groups.

Conclusion

The method proposed here is relatively general and would allow in other cases the analysis of the distribution of greenhouse gas emissions along other axes such as gender. However, some limitations remain to be noted. For the time being, only emissions linked to household consumption are considered, and it would be necessary to take into account emissions related to public services and gross fixed capital formation, via NTA data and the analysis of household savings respectively. Moreover, there is a strong limitation due to the high degree of aggregation of the different types of consumption considered. Finally, the estimation of the impact of population ageing on greenhouse gas emissions is not clear-cut at this stage of the project. However, the results already show that there is a very significant heterogeneity of emissions by age group linked to consumption practices that vary according to age. Moreover, the brief pseudo-panel analysis highlights the importance of the analysis by decomposing age, period and cohort because the three effects seem to accumulate and intermingle (*6*).

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