Estimating household energy intensities with uncertainty: The cases of France and India

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There is increasing interest in understanding the relationship between inequality and sustainability â€" does reducing income inequality trade-off higher resource use? How does this relationship differ at different stages of industrialization? Using a novel method of household energy footprinting using I/O analysis with uncertainty, we examine the implications of different patterns of income growth on energy use and carbon emissions. We choose France and India as case studies to represent an industrialized and emerging economy respectively.

One recent study (Chancel and Piketty, 2015) asks a similar question, but at the global level. However, they use a hypothetical power law between household income and emissions, rather than calculating actual embedded energy footprints using I/O analysis.

Over the last few decades, several studies (Park and Heo 2007; Liu et al. 2009; Minx et al. 2013; Cohen, Lenzen, and Schaeffer 2005; Lenzen et al. 2006; Wei et al. 2007; Steen-Olsen 2015) have reported household energy requirements or carbon footprints for various countries. These papers, to various extents, may inform our question, since they sometimes indicate whether energy/carbon intensity of consumption increases or decreases with rising income. However, these studies are all deterministic despite considerable uncertainty in linking household consumption to I/O tables. Second, they make methodological simplifications or omissions that make their results unreliable and subject to unobserved biases. For instance, these studies do not allocate government expenditure (associated with social transfers) to household consumption, or account for different prices paid for similar commodities by different income groups.

In this study, we develop a randomized mapping and visualize uncertainties induced in the mapping process.

This study contains three methodological advances that allow for a more robust and accurate characterization of household energy and carbon footprints:

1) Characterizing uncertainty in mapping consumer expenditure surveys (CES) to I/O tables: the mapping of consumption expenditure categories to industrial sectors requires knowledge production processes and pricing structure, which are not typically made available by national statistics offices. Hence, considerable number of assumptions have to be made. Instead, we first develop a qualitative mapping from consumption categories to sectors, and then assign probability distributions to allocation shares among them. We run a Monte Carlo simulation that constrains the random draws so that all allocations sum to 1 in each draw. We then visualize the range of uncertainty in results, as shown in the Preliminary results below.

2) Allocation of â€˜social transfersâ€™ to households: We allocate government transfers for health and education to income deciles, because lower income groups tend to benefit disproportionately. We base the allocation of social transfers to household consumption for France on the 2003 breakdown estimates by income quintile (Insee 2003). For India (yet to be done) we plan to use available data on fossil fuel and electricity subsidies.

3) Price adjustments: We have prices paid for most commodities in the household surveys. We

normalize these across income groups, so that energy footprints aren'€™t artificially increased by price-induced increases in expenditure for the same product quantities. We focus on energy-intensive items, including food.

Since our main focus is on the global implication of consumption on energy, we adopt multi-regional IO data from the most recent EXIO project (CREEA) covering the year 2007. We select EXIO among other MRIO databases based on the fact that it has the largest number of harmonized commodity sectors (200 sectors) and an improved energy extension by sector with high resolution of energy carriers (Wood et al. 2014). We use the National Sample Survey 2011-2012 (68th round) for India and Household Budget Survey 2011 for France.

We base our qualitative mapping of India'€™s CES to COICOP categories on a mapping suggested in an Indian governmental material (Verma 2014). For France, we use the mapping provided by EXIO.