

Calculating subnational consumption-based emissions: recommendations for downscaling MRIO

Topic: Input-Output Analysis: Sustainable Production and Consumption policies (9)

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Problem

It is well established that current consumption patterns in Sweden and other high-income countries are unsustainable[JG1.1]. In Sweden, consumption-based GHG targets have been proposed at the national level, and several cities and municipalities have adopted their own. Local authorities are now looking for ways to follow up those targets. Consumption-based emissions are typically calculated on a national level using environmentally-extended multi-regional input-output (EE-MRIO) analysis, which complicates subnational evaluation to reach such targets.

Aim

This work reviews approaches for estimating consumption-based emissions at subnational levels. The objective is to provide recommendations to support local decision-makers in designing resilient policies to mitigate consumption-related environmental pressures, hence answering the question: What is best practice for downscaling national emissions to subnational levels? Since different uses may have different requirements, the context for the recommendations needs to be considered.

Method

We perform a literature review to identify approaches, and synthesize methodological choices as well as identified limitations. Material is selected following a snowballing method starting from a set of selected articles based on the author's knowledge and complemented by a scoping literature review.

Context

Input-output (IO) analysis can theoretically be implemented at high sectoral and spatial resolution, provided that adequate data are available. In practice, input-output tables (IOTs) are commonly produced at the national level, leaving practitioners interested in subnational consumption-based emissions with two options: develop own tables of higher resolution, or downscale national emissions to desired resolution.

Statistics Sweden (SCB) calculates consumption-based emissions as part of Sweden's official statistics along production-based and territorial emissions. A large share of Sweden's consumption-based emissions takes place abroad, which makes this perspective particularly interesting for Sweden as a country with relatively low territorial emissions.

Results

Several studies that perform downscaling are identified, but no best practice has been defined nor has any review of approaches been found. Our findings indicate that subnational emissions are most often calculated by using micro-level consumption data – often derived from Household Budget Surveys (HBS) or similar datasets from national statistical agencies or Eurostat – combined with (national) emission intensities calculated using MRIO models. Frequently applied MRIO databases include EXIOBASE and EORA, as well as national models such as PRINCE for Sweden and ENVIMAT for Finland.

Another method uses income as a proxy to distribute national emissions across regions. This can be applied as a stand-alone approach – allocating total emissions proportionally to income – or as a complement to consumption data where such data doesn't cover all consumption categories. Downscaling approaches that adjust demand while maintaining national level production does (more

or less explicitly) assume nationally homogenous production, which can lead to over- or underestimation of emissions in regions with distinct industrial profiles. However, only a limited number of studies use or construct full regional IO models incorporating regional data on production and trade, as such data is limited.

In addition to top-down MRIO, some studies apply bottom-up approaches. Emissions are then calculated for selected consumption activities by combining activity data with emission factors. This method allows greater flexibility and higher resolution for specific consumption activities but does not provide a full system coverage as less significant activities are excluded.

Data availability remains a central limitation. Updated, freely accessible data with sufficient spatial resolution are often lacking. One study employed commercial micro-consumption data developed for marketing firms, offering high granularity and timeliness but raising concerns about transparency and reproducibility in policy contexts. Other identified sources of consumption data are online carbon footprint tools (e.g., WWFs Carbon Footprint Calculator), and literature for specific product groups.

This study forms part of a broader project aimed at designing and evaluating resilient policy packages for sustainable consumption. It includes the development of best-practice MRIO-based scenario modelling to assess policy instruments under different future conditions, combined with the downscaling approaches identified here to support local decision-making. While Sweden serves as the illustrative case, the insights are transferable to other regions, subject to differences in data availability and context.