A Structural Decomposition of Global Raw Material Consumption

Summary

This study investigates the evolution of Raw Material Consumption (RMC) in 38 countries from 1995 to 2008. Using a Structural Decomposition Analysis, we disentangle three drives of RMC: the level of consumption, the sectoral composition of consumption, and the material intensity with which goods are produced. The underlying data stems from World Input-Output Database (WIOD). Preliminary results suggest that RMC grew from 1995 to 2008 in almost all nations in our sample. The overall growth of consumption was the most important driver of this phenomenon. Falling material intensities reduced the RMC but did not compensate the consequences of boosting overall consumption. Changes in the sectoral composition of consumption had limited impacts.

Extended Abstract

In 1995, industries around the globe extracted 48 billion metric tons of materials from nature, including fossil fuels, minerals, and biomass. This number grew to 69 billion tons in 2008. In China alone, the extraction of materials more than doubled from 10 billion tons in 1995 to 23 billion tons in 2008. The extraction and use of materials is often interpreted as an important indicator for human pressure on ecosystems. Furthermore, increasing resource productivity is a policy goal in the EU and Germany, among others. A better understanding of what drives material extraction and flows is, thus, of great importance.

Raw materials are the basis of complex international value chains. The goods at the end of these chains are often consumed in countries other than those where the materials stem from (Bruckner, Giljum, Lutz, & Wiebe, 2012). Thus, taking a consumption based perspective is necessary to understand material flows. I use the Raw Material Consumption (RMC) as the indicator of how final consumption affects material use. It measures the amount of material extraction caused by final consumption, including materials which are not contained in the goods consumed but needed to produce them.

The paper presents a Structural Decomposition Analysis (SDA) of changes in Raw Material Consumption in 38 countries from 1995 to 2008. SDA is based on input-output techniques and has been used in a number of studies in energy economics (Su & Ang, 2012). Using the Log-Mean Divisia Index I method (Ang & Liu, 2001), I decompose changes in RMC into three drivers: the changes of overall consumption (level effect), the changes in the sectoral structure of consumption (structure effect), and the changes of the material intensity with which goods are produced (intensity effect). It is, to my knowledge, the first study performing a Structural Decomposition Analysis of RMC on a panel of countries.

Data underlying this paper is taken from the World Input-Output Database. WIOD provides a time series of harmonized input-output tables for 1995 to 2009. It distinguishes 34 sectors and 40 countries. Furthermore, WIOD provides output price indices and data on material extraction.

Preliminary results indicate a notable increase of RMC in almost all countries except for Japan and Germany. The four nations with the highest growth – China, Estonia, Ireland, and Lithuania – more than doubled their RMC from 1995 to 2008. Interestingly, China is still a net exporter of materials in 2008.

Increasing levels of consumption appear to be the most important driver of Raw Material Consumption. Holding consumption structure and material intensity of production constant, some countries would have exhibited a five-fold (China) or a six-fold (Latvia) of RMC. Even in mature industrialized countries, the level effect was more than 50 per cent bigger in 2008 than in 1995.

The material intensity of production fell in almost every country except Japan. In many cases, it dropped to less than 50 per cent of 1995's values. Thus, the intensity effect was the most important factor counteracting the growth in RMC. Interestingly, the intensity effect grew above 1995's levels in many countries in a period between 1998 and 2003 and fell afterwards.

Compared to the level and intensity effects, changes in the consumption structure were of limited importance. The structure effect remained below 1995 values in most nations, but usually only by around 10 per cent. No strong trend towards dematerializing consumption patterns could be identified.

A number of sensitivity checks will examine the robustness of the results with respect to important assumptions. These include the allocation of construction materials or the approach used to deflate the input-output tables.

The most important uncertainties of the analysis stem from the data resolution of WIOD. Further disaggregation of the data, in particular of the mining and agricultural sectors, would allow for more precise results. This study, nevertheless, provides an important step towards a better understand of what drives material flows.

References

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