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Environmental-Economic Accounting
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September 2017

London Group Meeting San José

Material flows from final use to production – how to treat in RME?

– a paper for discussion –

Material flows and material flows in RME[1]

The idea of environmental-economic accounting (EEA) is to describe the interrelationships between the environment and the economy[2] in a system of national accounts (SNA) comparable and complementing style[3]. One part of EEA is economy wide material flow accounts (EW-MFA)[4] – describing the flows of material between the environment and anthroposphere also called the economy and vice versa. Its relevant boundaries are between the environment and anthroposphere on the one and between anthroposphere and environment on the other side. In term of stocks, this anthroposphere envelops all material used or bound in production, buildings, in the public sector or the private households.[5]

Material flows in RME are an extension of the common material flows ascribing all goods and services the raw materials needed for their production.[6] This makes this concept pretty close to the monetary concept of production value comprising the gross value added plus intermediate consumption. Common ways of calculating these RME are different IO-techniques[7] often using monetary IO-tables as proxy for the material flows.

Comparing the boundaries

The main system boundary in environmental-economic accounting is between the environment and the economy.[8] In contrast, the fundamental boundary in SNA is the production boundary[9] deliminating the production from the external input[10] and the final use[11]. Figure 1 and Figure 2 illustrate these different boundaries for the case of EW-MFA and EW-MFA in RME.

[1] Raw material equivalents
[2] [2, p. iii]
[3] [2, p. 305]
[4] [2, p. 79]
[5] Having a closer look at SEEA's system boundary between environment and economy shows certain methodological caprice leading to some problem. While mines as places where material is extracted are counted as part of the environment, landfills – at least managed ones – are counted as part of the economy. This means that material going to a managed landfill must be in SNA-sense either intermediate consumption of the production sector or final use. [2, p. x]
[6] [1, p. 20]
[7] [1, p. 46]
[8] [2, p. 40]
[9] [4, p. 6]
[10] 3rd quadrant of an input output table (IOT)
[11] 2nd quadrant of an input output table (IOT)

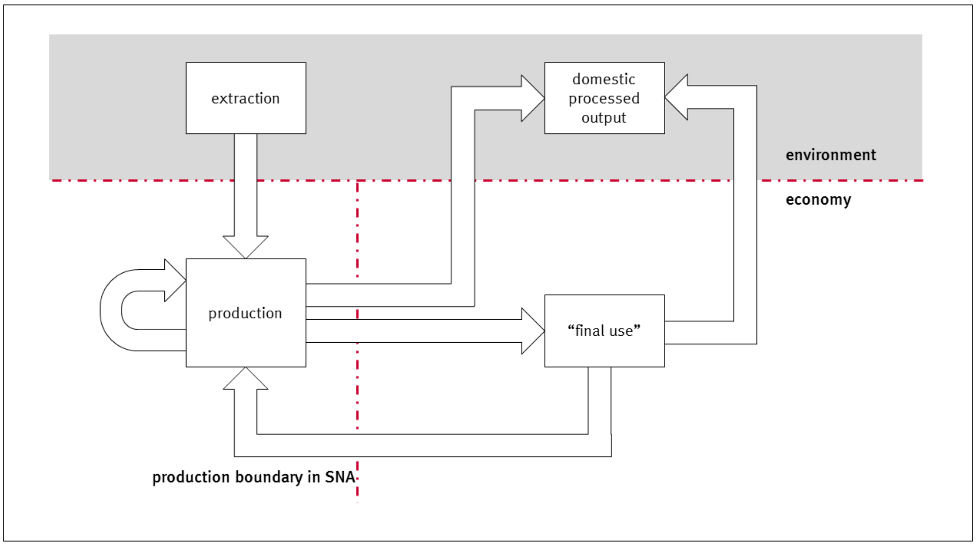

Figure 1: Flows in NA and EW-MFA

Calculating the MFA in raw material equivalents changes the picture. By definition, no material flow from production to environment exists in RME. Material leaving the production process towards environment is virtually added to the next use of the goods or service for which production it was used up. This forces all material in RME to leave production to consumption, capital formation or export.

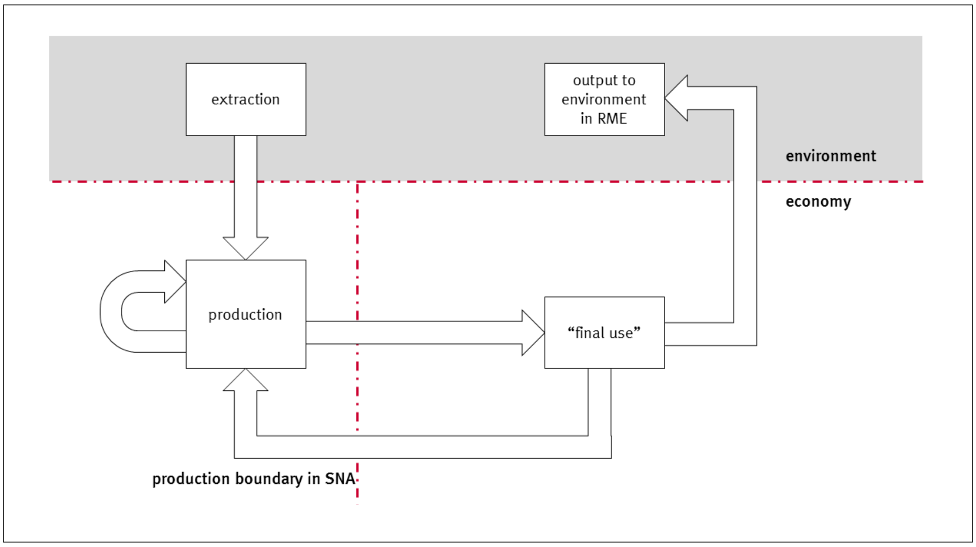

Figure 2: Flows in NA and MFA in RME

Looking at these figures, it becomes obvious that what is called final use in an SNA point of view is not identical with what should be called final use in a material flow sense. As some material is flowing back to production it is neither technically nor linguistically seen a "final use" of this material. Rather, the final use would be returning to the environment.

Even though the use of a SNA comparable production boundary as suggested by SEEA-CF[12] does not help much in solving this issue as the SNA does not foresee such flows.

[12] [2, p. 6]

While in theory[13] a general broad consensus exists how material flows are calculated from extraction through production to consumption, capital formation (and export), the treatment of flows from here back to production is controversial.

General relation between MFA and MFA in RME indicators

For reasons of simplification economists like closed economies having neither foreign trade nor international financial flows. Looking at all national economies together abstracting from international interlinkages the whole world could be understood as one global closed economy. Using the definition of the relevant indicators DEU, DMI, DMC, RMI and RMC[14] in such simplified world would show that they all lead to the same numerical value: The global extraction equals the material first time entering production from the environment and as per definition no foreign linkages exists: Import, exports and production process abroad are zero.

For a world with different economies having imports and exports, at least in theory, when adding up all national DMCs or RMCs to a global one, all imports and exports would cancel out. This shows that from a global perspective DMC and RMC are just a question of allocating the global extraction to the different national economies.

The DMC shows all material that was used up in production and left towards the national environment as well as the material that ended up in national consumption and capital formation. The RMC contains all material that was used for national consumption and capital formation including all material that left to environment during the production process regardless whether this was domestic or overseas. This stipulates one general requirement for DMC and RMC calculation: Their global sum should equal global extraction. Material flowing back as input to production should not distort this picture.

However, the material required for production and thus for consumption, capital formation and export could be higher than global extraction. Not only primary material is used for this but also material that was already used before (secondary material).

What is the value of material flowing back to production?

As described, quite often monetary-based IO-techniques are used to estimate material flows in RME. This raises the question how material returning from household consumption and capital formation is treated in a monetary table. Some suggest that secondary material should have no weight and thus no RME at all.[15] On first glance, this assumption might seem handy and it fulfils the requirement of additivity. However, this assumption is neither economically correct nor does it lead to a meaningful allocation of material to users. Especially economies having huge recycling facilities benefit from this assumption: They receive the material for free. Economies only collecting materials to be recycled abroad are at disadvantage as they have the effort for collecting but not the benefit. On top this view underestimates the material requirement for some uses and thus might send problematic signals.

From an economic perspective, one has to split a good reaching consumption or capital formation into its current use and its material value. The current use is depreciated by using the good but the material value remains to a certain extent.

Even if households are not compensated for returning material into production, as soon as it arrives in the production sector it has a certain economic value. This monetary value is linked to its use. Material returning into the production process replaces new material and thus its value

[13] For practical calculation different methods exist leading to different results [1, p. 45]
[14] For a description of the different indicators see eg. [3, p. 20]
[15] [5, p. 22]

is linked to its capacity in replacing new material.[16] Ignoring this leads to wrong allocations when estimating material flows as reversed monetary flows. On top, especially when analysing final uses in detail, it does not make any difference if new or secondary material was used during the production process as they are to a certain extent full substitutes.

Impact of using collected materials

In an economy, rather some material is flowing back from consumption and capital formation to the production sector or is exported to be treated as input in the production overseas. In a research project in collaboration with the Federal Environmental Agency, the Federal Statistical Office had a closer look at some important products being collected to be recycled and their impact on the eschewal of freshly extracted material in 2010.[17]

collected material	replacing approx.
13.7 mill t paper	15.7 mill t wood
2.3 mill t glass	2.4 mill t quartz and 0.2 mill t limestone
65.2 mill t mineral demolition waste	65.2 mill t sand and gravel
18.1 mill t metal	120.4 mill t ores

This shows that the use of collected secondary material is a significant input into production and thus needed to produce the required goods for consumption, capital formation and export. Only the four mentioned product groups – paper, glass, mineral demolition waste and metals – saved up more than 200 mill tonnes of environmental extraction.

Separating between goods made from newly extracted material, scrap, waste and secondary material looks on the first glance advantageous. It seems that looking at newly extracted material only makes things easier. Nevertheless, this leads to an enormous amount of uncertainty, as it is not possible to clearly distinguish between newly extracted material, scrap, waste and secondary material. Quite often primary and secondary material is mixed in production processes; scrap resulting from production could by definition either be scrap or intermediate input; some secondary material replaces in quality totally new material etc. Thus, such a separation does not help much.

What have we learned?

There are certain findings we have to accept: Material reaching consumption or capital formation has not necessarily reached its "final use". There is a stream back to production as only a certain use but not necessarily the material itself has depreciated. This material has an economic value determined by its capacity replacing new material. As EW-MFA (and thus EW-MFA in RME) should follow SNA, this monetary value has to result in a RME. Like extraction from environment, the use of secondary material ("extracted" from consumption or capital formation) is part of the external inputs to production following the SNA style of IO-tables. This would lead to a material input output table as shown in Figure 3.

In this sense, the RMC would be consumption + capital formation + change in inventories – replacement capacity of material sent back to production.

Using such an approach would lead in general to higher demand of material for consumption, capital formation, imports and exports. Furthermore, it would reflect more realistically the actual amount of material required to satisfy the needs. However, the global sum of all RMCs would still

[16] A good example is bauxite and aluminium: While a tonne of bauxite costs only a few ten US-$, a tonne of aluminium scrap (replacing four tonnes of bauxite) is some hundred Euros. Thus, because of the complex refinement process the aluminium scrap has a high capability in replacing primary aluminium.

[17] [3]

be the amount of material extracted from environment. On top the RMI would represent the final use of RME as it would comprise all RME that was either sent abroad, sent to the environment or was depreciated.

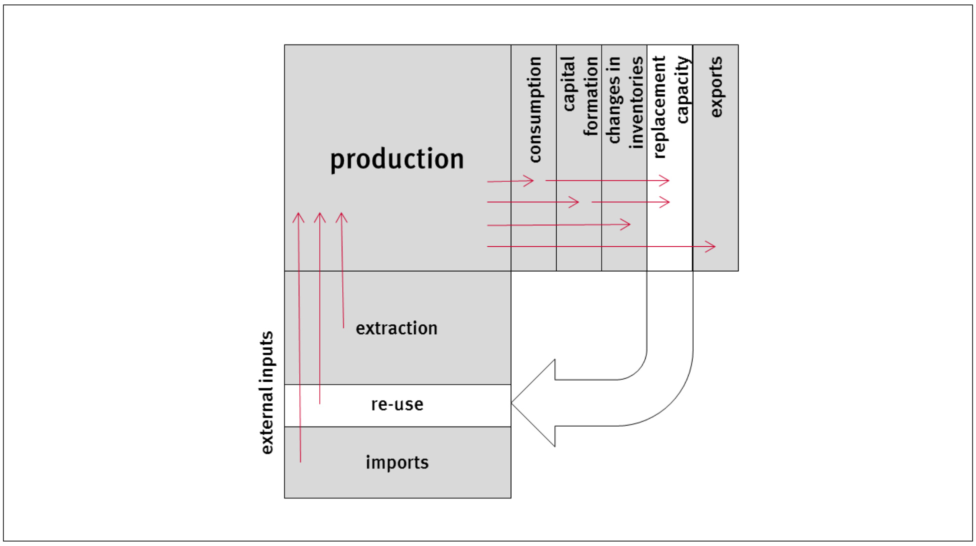

Figure 3: Flows in RME including re-using material

Literature

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