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Measuring resource efficiency and circular economy: A market value approach

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ABSTRACT

This paper proposes a new value-based indicator to assess the performance of actors in the supply chain in terms of resource efficiency and circular economy.

Most of the methodologies developed so far measure resource efficiency on the basis of the environmental burden of the resource relative to the value of output. However, the key point of circular economy is keeping resources within the economy when products no longer serve their functions so that materials can be used again and therefore generate more value.

The unit in which resource efficiency and circular economy are measured greatly affects both the ease of acceptance by policymakers and the direction in which green policy will change our society.

Whereas the most common approaches to assessing resource efficiency and circular economy use mass, in this paper we advocate measuring both resource efficiency and circular economy in terms of the market value of 'stressed' resources, since this value incorporates the elements of scarcity versus competition as well as taxes representing urgent social and environmental externalities. The market value of resources is well-documented and responds automatically to the locality and time at which resources are used.

Applying this unit, circularity is defined as the percentage of the value of stressed resources incorporated in a service or product that is returned after its end-of-life. Resource efficiency is the ratio of added product value divided by the value of stressed resources used in production or a process thereof. It is argued that precisely the concept of a free market, in which materials, parts and components are exchanged purely on the basis of their functionality and cost, allows the resource efficiency of a process (KPI for industry and governance) to be distinguished from the resource efficiency of a product (KPI for consumers and governance).

Using standard industry data from Statistics Netherlands, the resource efficiency of several Dutch industries were evaluated using the new methodology and compared with a traditional mass-based approach.

1. Introduction

Europe has the world's highest net imports of resources per person, and its open economy relies heavily on imported energy and raw materials. Secure access to resources has become an increasingly strategic economic issue, while possible negative social and environmental impacts on third countries are an additional concern. In 2013, a total of 8.0 billion tonnes (McKinsey and Company, 2015) of materials were used by the European Union economy to create goods and services. In terms of value, this amounts to about 560 billion euros.[1] This is why policy attention to natural resource security is growing worldwide with the aim of decreasing dependence on international trade in securing raw materials and of minimising the risks associated to the rising prices of raw materials (European Commission, 2011; National Research Council, 2008).

Besides the implications of the fact that most materials extracted from the earth and utilised for economic purposes are not literally 'consumed' but become waste residuals that do not disappear and may cause environmental damage and result in unpaid

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[1] The value of materials at the point where they are in their final chemical composition, but not yet manufactured as a part or component.

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social costs (Ayres and Kneese, 1969), experts have calculated that without a rethink of how materials are used in the current linear 'take-make-dispose' economy, the virgin stocks of several key materials appear insufficient to sustain the modern 'developed world' quality of life for the global population under contemporary technology (Gordon et al., 2005). It is therefore necessary to move towards an industrial model that decouples economic growth from material input, by using waste and bio-feedstock as inputs for industry: the circular economy. Circular Economy models maintain the added value in products for as long as possible and minimise waste. They keep resources within the economy when products no longer serve their functions so that materials can be used again and therefore generate more value (Pearce and Turner, 1990). Thus, circular business models create more value from each unit of natural resource compared to traditional linear models (Di Maio and Rem, 2015). In addition to secondary resources through recycling, advanced methodologies of design and manufacturing can produce the same functional value using less resources (natural resources and recycled resources alike).

According to Brundtland (World Commission on Environment and Development, 1987), sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Resource efficiency can be considered one of the interpretations/consequences of Brundtland's definition of sustainable development. Although it may seem odd to quote Brundtland's statement on sustainable development so long after she made it and now that almost everyone is aware of it, we believe that this meaningful quotation has been translated so many times into derivatives that we have somehow lost track of the message she wanted to convey. Moreover, Brundtland's statement helps us to clarify our definitions of both resource efficiency and stressed resources.

Resources can be divided into abundant and scarce resources. The former are available for everybody and will remain so in the future. However, if we use the latter resources, we prevent somebody else from using them now and in the future. We define those resources as stressed resources. When we discuss resource efficiency in this article, we mean efficiency in the use of stressed resources.

What needs attention in the coming years is the methodology of measurement of resource efficiency. The details of this methodology will define to a great extent both the direction in which the European economy will change as a result of this new policy, and the speed and economic efficiency of this change.

There is, in particular, a major difference in direction of change resulting from minimising, for example, the mass or the value of resources that are used in producing some service or product. Minimising the environmental impact of the resources used in producing services or products creates yet another direction of change. In other words, resources can be measured in different units, and the selection of a unit of measurement is directly linked to the effect of policy. Another issue is whether the measurement of resource efficiency is focused on a particular good or service, or is applied to a certain part of the production process along the value chain. Focusing on products[2] might be considered a global methodology of measurement, as it delivers a number related to the entire process of delivering a product to the market. Focusing on individual production process steps is in effect a local measurement, as it tells us only how much resources are used by a single actor in the supply chain. A global measurement takes into account the whole supply chain and requires more assumptions than a local measurement. It is therefore typically more expensive and less robust (i.e. it is more error-prone) than local (i.e. national) measurement. A global measurement tells us whether the product or service is 'bad' or 'good' in terms of resource efficiency, and improvements in the resource efficiency of a product or service involve a series of actors along the supply chain, who have to work together and may be active in different countries.

[2] Goods or services.

Local measurement identifies single actors as 'bad' or 'good', so improvements concern only the process step of this actor and therefore can be realised more easily. At the country level, a local measurement may evaluate the local actors, so improvements concern only the process step of this actor and can easily be linked to national policy decision making.

Focusing on a product may tell us whether the resource efficiency of a product is 'bad' of 'good' in terms of resource efficiency, but provides no information about the related industry. Thus, it is less clear whom to address to steer or manage it. There can be many steps/actors involved in the process of making a product. If a product is evaluated as being 'bad', all steps/actors should be studied to find out where the process can be improved. This will make it possible to address the actors in the supply chain who made the parts and the semi-finished product, provided the transport, etc. and to steer them in the right direction. This is difficult in terms of governance because at the product groups level, different actors may be active in different countries and it is difficult to compute what each actor adds to the product value, in particular its marginal addition to the product value in relation to the resources it used.

We therefore believe that the crucial next step for Europe is to develop a methodology to assess the resource efficiency performance of all individual actors in the supply chain.

In an ideal world, an environmentally and societally corrected efficiency indicator would be needed. In such an indicator, the inputs would be weighted by their environmental and societal impact. However, the impacts are many and cannot be fitted to a common unit of impact. The concepts and methodology to calculate such an indicator do not exist. Since these numbers and methodologies are missing, the use of the market value of resources is a good proxy solution. Assuming that the high-value inputs have a higher environmental impact, a kilogram of gold has a different societal and environmental impact than a kilogram of clay (Di Maio and Rem, 2015).

Moreover, the mass of inputs does not necessarily address all implications. This shortcoming can be overcome by weighting in the value of the used resources, rather than focusing only on the physical units.

The research underlying this paper used existing robust statistical frameworks, such as the Netherlands' System of National Accounts and its Material Flow Monitor, to construct new resource efficiency indicators that incorporate the value. This is useful to measure the performance of different industries, and can potentially reduce significantly the number of indicators to evaluate policymaking.

2. Resource efficiency measurements

Considering the large number of natural resources with different characteristics, it is extremely complex to develop indicators that properly reflect resource use and its impacts on environment, economy and security (Behrens et al., 2015). BIO Intelligence Service et al. (BIO Intelligence Service, 2012) distinguish between four key categories of resource use: material use, energy use & climate change, water use and land use. For each one, they present indicators related to the scale of consumption (resource use) and to the impact of consumption on the environment. They also distinguish between indicators that reflect domestic consumption and impacts, and those that relate to global demand and impacts. In total, they