Expanding the supply and use framework: from technologies to needs

Topic: Input-Output Theory and Methodology - II
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The ongoing transition to sustainable energy implies the need to expand the portfolio of renewable energy technologies. The large availability of renewable energy sources represents a great opportunity to produce low-carbon energy services. However, many technical barriers have hindered the large-scale deployment of low-carbon energy technologies. The need to decarbonise society while meeting all its needs is one of the greatest and most complex scientific challenges of this and the next decades. The use of models that combine the expertise of engineers and economists, such as those offered by industrial ecology and, in particular, input-output analysis, is a valuable approach. However, transformations such as the sustainable energy transition require the introduction of new types of machinery, interventions or, more generally, innovations in the way inputs are transformed into outputs. Such technologies are usually introduced to meet a specific need - usually already met by an existing solution - with the promise of reducing operational impacts. Among the various approaches to input-output analysis, the supply and use framework is an important starting point for mapping new supply chains and exploring different market share scenarios. However, supply and use frameworks only allow a partial and not explicit representation of such aspects of the economic system.

The Technology-Activities-Commodity-Need (TACN) framework, presented in this paper, extends the traditional supply and use tables by allowing the two crucial missing pieces of the economic system (i.e. technologies and needs) to be represented. The framework is applied in the context of a large-scale development of a specific technology for the conversion of marine energy into electricity, and the economic, environmental and social impacts associated with the introduction and operation of a new dedicated supply chain are analysed.

The aim of the TACN framework is to allow a wide range of models to be represented within the accountability principles clearly defined by supply and use tables.

The technology level and the need level are introduced to overcome the lack of representation of two crucial aspects of modelling. On the technology side, the concept of installed capacity is not usually present in supply and use tables. In fact, the level of activity is usually recorded without considering the maximum level of output theoretically possible from each of them. Taking this into account in meso-economic models would allow for the accounting of unused capacity. Let's take the example of chip production or lithium extraction: both are constrained by a lack of productive capacity (i.e., the installed capacity of these specific activities in modelling terms). Knowing the capacity rate of each industrial activity could provide valuable information to better manage supply chain disruptions.

On the needs side, the concept of needs that can be satisfied by different commodities allows competition between activities. It can be seen as the functional unit in demand. From a meso-economic point of view, it would be possible to introduce a new level of accounting that takes into account not only "what" is consumed, but also "why" it is consumed, thus broadening the attribution of final consumption (e.g., 90% of the final consumption of methane by Italians is attributed to heating and 10% to hot sanitary water). Let's take the example of energy demand: every year we demand heating in our homes in winter, regardless of whether this heating comes from heat pumps, which consume the good electricity, or from gas boilers, which consume the good methane. Explicitly consider the level of needs allows for a greater competitiveness in scenarios

considering multiple technologies.

A demonstrative application in this context allowed for the analysis of the large-scale deployment of devices capable of converting sea energy into electricity by expanding EXIOBASE with a new sector built using specific case-specific data.