Ecological Economics 70 (2011) 487–496

Contents lists available at ScienceDirect

Ecological Economics

journal homepage: www.elsevier.com/locate/ecolecon

Methods

Economic–environmental monitoring indicators for European countries: A disaggregated sector-based approach for monitoring eco-efficiency

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ARTICLE INFO

Article history:
Received 27 May 2009
Received in revised form 14 May 2010
Accepted 28 September 2010
Available online 12 November 2010

Keywords:
Eco-efficiency
European Pollutant Emission Register (EPER)
Environmental performance
Statistics
Environmental intensity
Environmental–economic structures

ABSTRACT

Eco-efficiency links economic efficiency with environmental efficiency. The main purpose of the concept is to identify and implement activities to enable production that is both economically more efficient and cleaner. This means that parameters with a high indicative value have to be used.
Since both the environmental and the economic performance of industries must be described concurrently, environmental intensity appears to be a good indicator of eco-efficiency. Environmental intensity is environmental impact per unit of economic performance. In this paper, the environmental impact of industry classes is derived from emission data, released by the European Pollutant Emission Register (EPER), and then aggregated and assessed using Eco-Indicator 99, a single-score life-cycle impact assessment (LCIA) method. The calculated ratio is thus an accurate description of the environmental–economic state of industry classes. The main advantage of this approach is the underlying consistent statistical framework, that permits, on a disaggregated level, economic data to be correlated with ecological data and to be frequently updated.
This single indicator facilitates a comparison of environmental intensity of different industry classes. The paper shows that it is possible to deduce a disaggregated eco-efficiency indicator, which is exemplified using German data, however could be analysed for different European countries.

1. Introduction

The concept of eco-efficiency aims at linking economic performance with its environmental impact. According to the World Business Council for Sustainable Development (WBCSD), eco-efficiency is "being achieved by the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resources intensity throughout the life cycle, to a level at least in line with the Earth's estimated carrying capacity" (WBCSD, 1992; WBCSD, 2000a, p. 4).

The simplicity of the concept and its practical importance led to its widespread acceptance by enterprises. The concept is used by them as an instrument to support decisions for alternative investment and production strategies to contribute to sustainable development because it connects improved competitiveness and better environmental performance (Saling et al., 2002). Seiler-Hausmann et al. (2004) demonstrate for example that the importance of the eco-efficiency concept varies for different companies. For some companies "the concept of eco-efficiency is a starting point that some companies may not yet have reached, others are already taking their initiatives much further" (Seiler-Hausmann et al., 2004, p. 9).

Although the eco-efficiency concept initially focused on companies, it was later adapted for the examination of policy strategies and their possible macroeconomic outcomes (European Commission, 2002). Outside its original field of application, however, the life cycle approach—an important principle of eco-efficiency (WBCSD, 1992)—loses its relevance for assessment since it is always related to a product or a service. The concept, furthermore, is now also being applied to the total economy with its interconnected processes.

A detailed examination of the eco-efficiency of economies, i.e. an analysis identifying and ideally quantifying the main driving forces of macroeconomic eco-efficiency, needs a rather disaggregated mapping of economic activities. Due to the heterogeneity of economic activities, macroeconomic policy measures could affect different enterprises and sectors in different ways, leading for instance to a loss of income and employment in those sectors that are negatively involved, which a society may not accept.

Disaggregated indicators are needed to better understand the eco-efficiency of economies. A disaggregated indicator should consider the eco-efficiency of branches, which could also be seen as the missing link between the activities of individual companies and the macroeconomic level or, in other words, as a means of connecting the micro level with the macro-level performance of societies (Huppes, 2007; Huppes and Ishikawa, 2009). The current state of eco-efficiency research and practice does not support measuring the eco-efficiency of branches. There is no generally accepted application and no widespread research on the eco-efficiency of the

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doi:10.1016/j.ecolecon.2010.09.033

companies in disaggregated sectors and on disaggregated macroeconomic approaches.

In this paper, we present an approach for analysing the environmental–economic performance of an economy at the level of disaggregated sectors, i.e. the industry-class level. It links data from the European Pollutant Emission Register (EPER) to the impact assessment method Eco-indicator 99 in order to facilitate a widespread assessment of environmental performance over a wide range of emissions. The data generated on the environmental impact are combined with statistical data on economic performance. The source data are updated at regular intervals.

The paper is organized as follows: In Section 2 is a discussion of the necessity of monitoring the eco-efficiency of industry classes. An examination of the current state of research on eco-efficiency indicators is viewed as a step toward implementing the concept of eco-efficiency in practice. Section 3 proposes a new eco-efficiency approach to analysing the structure of the environmental–economic performance of an economy that has implemented a European directive to combating environmental pollution (IPPC directive, Commission of the European Communities, 2000). In Section 4, the pattern of the eco-efficiency of German industry is analysed as an example for using the proposed indicator. The approach is discussed in more detail in Section 5. Section 6 offers some concluding remarks.

2. Monitoring Eco-efficiency

Although originally a concept formulated for companies, eco-efficiency is now also used to assess macroeconomic policy strategies and their potential impact on the economic–environmental progress of an economy (European Commission, 2002). As with the original concept, the adapted macroeconomic concept measures two of the essential ingredients of sustainable development, namely economic performance and the environmental impact of economic activity. Both ingredients are necessary if the economy is to prosper using fewer resources and producing fewer emissions.

Politics commonly focuses on certain key economic indicators, such as gross domestic product (GDP) and employment, for quantifying economic prosperity. Widely accepted eco-efficiency indicators could fulfil a comparable function; additionally incorporating the environmental impact of economic activities. Furthermore, the concept of eco-efficiency, if adequately defined, could also be used to assess the efforts to decouple economic activities from emissions. To achieve this, ongoing monitoring of macroeconomic eco-efficiency is necessary.

Yet just as GDP growth rates cannot reveal structural changes of an economy, a highly-aggregated macroeconomic eco-efficiency indicator cannot disclose the underlying forces driving macroeconomic eco-efficiency. The use of a single macroeconomic eco-efficiency indicator may not catch divergent developments, but rather generate a demand for additional information regarding specific impacts on the environment and their causes. Since economic activities are integrated into complex economic systems with heterogeneous industries, they neither react homogenously to macroeconomic policy strategies nor perform similarly in the longer term. Furthermore, governments do not treat industries uniformly. To satisfy the demand for information mentioned above, a detailed analysis takes an intermediate scale, the meso-scale, as its starting point. Such a meso-scale analysis should consider the eco-efficiency of industry classes.

A prerequisite for monitoring eco-efficiency is the availability of adequate indicators. Although this statement is trivial, the development of appropriate indicators is not because this entails relating the different scales, aspects, horizons and mechanisms used to describe different tasks (Huppes, 2009). Consequently, there is no unique definition of eco-efficiency indicators (Huppes and Ishikawa, 2007; Huppes, 2007). Finally, the lack of availability of data could hinder the application of a sound indicator.

According to the OECD (1994), an "indicator is a parameter, or a value derived from parameters, which points to, provides information about, describes the state of a phenomenon/environment/area, with a significance extending beyond that directly associated with a parameter value". An indicator should thus provide information beyond that directly associated with a parameter value (OECD, 1994), and the specific nature of this information depends on the intended aim. Since the potential purposes of eco-efficiency differ widely – not only between the macro- and micro-levels, but also at each level – there is a wide range of different eco-efficiency indicators.

The economic dimension of a company is generally described by the value added, whereas net sales can also be used (WBCSD, 2000b). Similarly, the sales price can be used as the valuation of individual products. The choice of economic indicator also depends on whether the object to be assessed is a product or a process (e.g. Saling et al., 2002), a technology (e.g. Hellweg et al., 2005), a company (e.g. Scholz and Wiek, 2005; Figge and Hahn, 2005) or a society (e.g. Managi and Kaneko, 2009). Basically there is a lack concerning the estimation of economic data that are to be used, but first approaches are being developed (Ciroth, 2009).

Among the environmental issues to be encompassed by eco-efficiency are the consumption of energy, materials and water and the emission of greenhouse gases and ozone-depleting substances (United Nations, 2004). The WBCSD (2000a) summarizes the environmental objectives of eco-efficiency for materials, energy, toxic substances, recyclability, the use of renewables, durability, and service intensity. The well-known footprint approach uses only land as the relevant unit (Wackernagel and Rees, 1996).

At the level of companies, eco-efficiency indicators are commonly defined as a ratio of the product or service value to its environmental influence (WBCSD, 2000a,b). Another possible approach is offered by the ADVANCE project (University of St. Andrews et al., 2006). The ADVANCE project defines the sustainable value of firms based on seven resources and emissions and on the gross added value. The value is calculated by comparing the company's result with the European average. A partial analysis of an environmental impact such as of resource extraction is essential, however, only if it is embedded in the larger framework of a sustainability analysis (Huppes and Ishikawa, 2009), or at least in an analysis combining environmental and economic assessments.

At the macroeconomic level, economic performance is normally measured by the GDP. Applying the concept of the OECD (1997), the European Commission (2002) assessed the economic dimension of highly aggregated sectors. The economic output is correlated to the environmental pressure, which in turn depends on the consumption of raw materials and energy and the emissions of greenhouse gases, acidification gases, ozone precursors, and ozone-depleting gases. The UNESCAP (2007) differentiates between resource usage and other forms of environmental impact.

In summary, there is an intensive discussion and widespread research on eco-efficiency, which are concerned with different scopes and scales (see for example the special issue of Ecological Economics 2009, volume 68, issue 6). This research is however still in its infancy with regard to using a consistent framework for determining the underlying forces driving macroeconomic eco-efficiency.

In the following section we propose an approach that focuses on the performance of industry classes using a consistent database to analyse the meso-scale pattern of macroeconomic eco-efficiency. This approach employs environmental intensity (i.e. environmental impact per economic performance) instead of environmental productivity (i.e. economic performance per environmental impact), which is most commonly used for eco-efficiency. Environmental intensity (Huppes and Ishikawa, 2005) has the advantage of simultaneous applicability as a decoupling indicator (Wursthorn et al., 2009). A decoupling indicator makes it possible to assess the efforts of economies, sectors, or companies to decouple economic