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The traditional energy-growth nexus: A comparison between sustainable development and economic growth approaches

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ABSTRACT

Gross Domestic Product (GDP) is the indicator commonly used to measure economic growth and sustainable development. However, this indicator can be very inefficient for evaluating development. The most prominent alternative indicator is the Index of Sustainable Economic Welfare (ISEW). Indeed, this index can be used to control for the way that countries use available resources, balancing ecological development, damages caused to the environment and income distribution between citizens. This paper compares a sustainable development approach, using the ISEW, with the traditional economic growth approach using GDP, and its relationship with energy consumption. The traditional hypotheses of the energy-growth nexus are tested through Panel-Corrected Standard Errors estimators, for a panel constituted by twenty European countries, with an annual data frequency for the time span 1995–2014. The results indicate a new negative feedback hypothesis for the alternative measure of development and a conservative hypothesis for economic growth with energy consumption. This study also finds various other effects on sustainable development by economic growth factors, such as Terms-of-trade and Rents from natural resources. These findings indicate that the economic growth approach, widely studied using GDP, has been wrongly interpreted by policy makers trying to achieve increased sustainable development.

1. Introduction

The highest recorded global annual average temperature was surpassed in 2015, and represents a clear indication of climate change. To counter this phenomenon, every country must decrease its environmental footprint. It is not enough for some emerging countries to show more respect for the environment, if others do nothing. Several international conferences have been organized, since 1972, with the latest being held in Paris in 2015. All have had unsatisfactory results, but several have produced promising initiatives, such as the Sustainable Development Goals.

Europe is the region where environmental concerns have been most fully addressed, as reflected in related European treaties. Even though this region has the most appropriate economic and legal framework to achieve a sustainable path, around 70% of energy use in 2016 in the European Union is still derived from fossil resources (World Development Indicators). On the whole, European countries not only contribute to environmental degradation but also belong to first ones putting legal restrictions on any activities causing an environmental threat. Despite being a leader in the fight against environmental damage, this region is still far from attaining the goal of "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987).

Despite all the legal frameworks, there is still no indicator in European policy for the economic development of each country. Gross Domestic Product (GDP) is the indicator most used, but it was recognized long ago by one of its creators (Kuznets, 1934) as being insufficient to evaluate sustainable development. Indeed, GDP is unable to measure environmental damage (Aşıcı, 2013) and it is inefficient for quantifying social welfare (Costanza et al., 2009; Li and Fang, 2014; Stockhammer et al., 1997). In the literature, the Index of Sustainable Economic Welfare (ISEW) arose as an alternative (e.g. Beça and Santos, 2014, 2010; Menegaki and Kumar, 2016; Menegaki and Tsagarakis, 2015). This Index is more reliable from an ecological point of view than the GDP, because it takes into account environmental depletion through the costs of using available natural resources. It is also more consistent for achieving the Sustainable Development Goals, as noted by Hák et al. in

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Nomenclature

CO_2	Carbon dioxide
EGA	Economic growth approach
EU	European union
FEE	Fixed effects estimator
FEVD	Fixed effects vector decomposition
GDP	Gross domestic product
ISEW	Index of sustainable economic welfare
L	Operator meaning natural logarithm
LM	Lagrange multiplier
LR	Likelihood ratio
OECD	Organization for economic Co-operation and development
PCSE	Panel-Corrected standard errors
REE	Random effects estimator
SDA	Sustainable development approach
TOT	Terms-of-Trade
VIF	Variance inflation factor
WDI	World development indicators

2016, the United Nations' main objectives for this century. The ISEW has undergone various transformations since it was created, but its intent has always been to measure the extent to which countries are improving their social welfare without compromising the future.

The continuing growth in world energy consumption is the biggest threat to sustainable development (Oyedepo, 2014; Ozturk and Yuksel, 2016). As proven in the literature, the rise of energy consumption is related to economic growth (Eggoh et al., 2011; Hu et al., 2014; Lise and Van Montfort, 2007), and countries have no incentive to stop energy consumption. Therefore, it is essential to compare, as we do in this paper, the sustainable development proxy (ISEW) with the economic growth indicator (GDP), and study the relationship of these two variables with energy consumption; thereby, comparing the Sustainable Development Approach (SDA) with the Economic Growth Approach (EGA). As such, the central question of this paper is: is the usual EGA of the traditional energy-growth nexus (measured by GDP) valid when using an SDA, specifically the ISEW? Consequently, the paper's main objectives are: (i) to assess the impact of energy consumption on sustainable development; (ii) to appraise the different effects on the ISEW from classic growth factors; and (iii) to illustrate the differences between economic growth and sustainable development. For this purpose, annual data for twenty countries, covering the period from 1995 to 2014, was used. To achieve the paper's main goals, panel data was analysed with Panel-Corrected Standard Errors (PCSE) and Fixed Effects Vector Decomposition (FEVD) estimators.

The results show differences between using SDA and EGA in energy nexus studies. Energy consumption, as opposed to economic growth, is harmful to sustainable development. For GDP, a conservative hypothesis is determined, and for the ISEW a new negative hypothesis. Despite this being a new hypothesis, it has proved very robust. However, it must be studied in more detail. Some traditional economic growth factors have different effects on the ISEW and GDP, such as inflation, terms-of-trade (TOT) and natural resource rents.

The remainder of this study is organized as follows: Section 2 presents the ISEW and Section 3 provides the literature review; Section 4 describes the data and the methods; Section 5 offers the results, which are discussed in Section 6; and Section 7 states the final conclusions.

2. Measuring sustainable development

Gross Domestic Product is commonly used to measure both economic growth and implicitly sustainable development. However, economic growth and sustainable development have different characteristics, which have given rise to doubts about the appropriateness of using GDP to measure both economic growth and sustainable development. GDP arose as the principal indicator in the post-World War II period, when fast economic growth was imperative for peaceful international relations. The indicator did this job, since it was a good way to look at the pace of the flow of goods and services, energy consumption and capital formation. However, without looking at the depreciation of human, natural and social capital, the growth of GDP, after a certain point, increases income inequality and can reach a threshold point (Costanza et al., 2009; Max-Neef, 1995; Stockhammer et al., 1997).

Over time, GDP growth has become the main goal for countries. However, increasing economic activity could imply future costs, such as inequality, resource depletion and un-sustainability, which should not be forgotten. The repayment of these costs is likely to be spread over generations like a debt (Daly and Cobb, 1989). Therefore, to compensate the costs of economic activity, a share of production outputs must be considered; the so-called defen-

Table 1
ISEW components.

Component	Data Source	Computation
Adjusted private consumption (+)	Final household consumption expenditure – WDI Gini index – WDI	Final household consumption expenditure * (1- Gini index). The Gini index is a measure of statistical dispersion, measuring the area between the Lorenz curve and a hypothetical line of absolute equality, expressed as a percentage of the maximum area under the line. Thus a Gini index of 0 represents perfect equality, while an index of 100 implies perfect inequality.
Net capital growth (+/–)	WDI	Gross Capital Formation – Gross Capital Consumption
Health expenditure (+)	WDI	Public health expenditure * 0,5
Education expenditure (+)	WDI	Public education expenditure * 0,5
Unpaid work (+)	Number of unpaid workers- WDI Minimum wage – OECD	Number of unpaid workers * Average wage
Mineral depletion (–)	WDI	Ratio of the value of the stock of mineral resources to the remaining lifetime reserve (capped at 25 years). It includes tin, gold, lead, zinc, iron, copper, nickel, silver, bauxite, and phosphate.
Net forest depletion (–)	WDI	Calculated as the product of unit resource rents and the excess of round wood harvest over natural growth.
Energy depletion (–)	WDI	Ratio of the value of the stock of energy resources to the remaining lifetime reserve (capped at 25 years). It includes coal, crude oil and natural gas.
Carbon dioxide damage (–)	WDI	Carbon dioxide damage is estimated to be $20 per ton of carbon times the number of tons of carbon emitted.

Notes: WDI, The World Bank- World Development Indicators; OECD, The Organisation for Economic Co-operation and Development Statistics