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Kontakt/Contact
ZBW – Leibniz-Informationszentrum Wirtschaft/Leibniz Information Centre for Economics
Düsternbrooker Weg 120
24105 Kiel (Germany)
E-Mail: *rights[at]zbw.eu*
https://www.zbw.eu/

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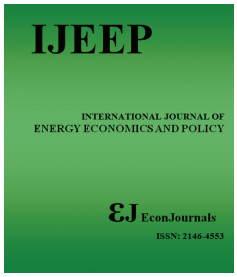

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Are Economic Growth and Sustainable Development Converging? Evidence from the Comparable Genuine Progress Indicator for Organisation for Economic Co-operation and Development Countries

Daniel Francisco Pais[1], Tiago Lopes Afonso[1], António Cardoso Marques[1,2]*, José Alberto Fuinhas[2,3]

[1]Department of Management and Economics, University of Beira Interior, Portugal, [2]NECE-UBI, University of Beira Interior, Rua Marquês d'Ávila e Bolama, 6201-001 Covilhã, Portugal, [3]Faculty of Economics, University of Coimbra, Portugal.
*Email: amarques@ubi.pt

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ABSTRACT

Academic literature has reflected increasing concerns about the trade-off between preserving the environment and economic growth. To address these concerns, new measurements are needed to evaluate sustainable development, given the limitations of gross domestic product (GDP) in quantifying welfare and sustainability. Genuine progress indicator (GPI) is one of those alternative measurements. This paper assesses sustainable development for 28 Organisation for Economic Co-operation and Development countries by computing a comparable GPI (CGPI). Two different approaches to economic growth and sustainable development are discussed. Results suggest that the richest countries are not always the most sustainable. Furthermore, the effect of the financial crisis is verified immediately in the GDP, in contrast to the lagged effect observed in the GPI. Additionally, measures that promote economic growth may not improve sustainability, and may even negatively affect it. Consequently, alternative indicators such as the CGPI can obtain more valuable information for policy-makers seeking to achieve both economic growth and sustainable development.

Keywords: Comparable Genuine Progress Indicator, Sustainable Development, Economic Growth
JEL Classifications: Q01, Q51, Q56

1. INTRODUCTION

"*Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs"* (WCED, 1987). The necessity to measure and quantify sustainability and wellbeing arises from the growing concern about climate change and the green performance of economies. Usually, wealth, welfare and sustainability are quantified by separate indicators, such as the Human Development Index, Happiness Index, Life Expectancy, Ecological Footprint, Surplus Biocapacity, Wellbeing Index, and the commonly used gross domestic product (GDP) (Frugoli et al., 2015). As alternatives, indicators that include the three aspects (economic, social and environmental) have emerged in the literature, namely, the index of sustainable economic welfare (ISEW) and the genuine progress indicator (GPI).

The ISEW has been both accepted and criticized since its inception in the seminal work of Daly and Cobb (1989). The GPI emerged in the literature later on in Cobb et al. (1995). The ISEW/GPI were designed with the aim of overcome the shortcomings identified in the commonly used GDP, when analysing welfare and sustainability. Many authors argue that the GDP (a standard indicator of economic growth, as a measure of the flow in market

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value of goods and services) ignores welfare and sustainability by not considering social and environmental externalities and, furthermore, is positively affected by factors that do not contribute to welfare. For example, it ignores the value of household work, the effects on welfare of income inequality and externalities such as the environmental degradation and depletion of natural resources that result from the functioning of the economy. Furthermore, it considers "defensive" expenditure to be positive, even though it does not contribute to welfare (Cobb et al., 1995; Daly and Cobb, 1989; Jackson and Stymne, 1996).

In fact, Neumayer (1999) states that GDP was not designed as a welfare indicator in the first place. Moreover, as one of the co-founders of GDP, Kuznets (1934), warned that "*the welfare of a nation can* (…) *scarcely be inferred from a measurement of national income.*" Considering it was not intended for that purpose, the use of economic indicators to analyse welfare and sustainability may lead to misguided policy decisions and unwanted implications (Stiglitz et al., 2009). Therefore, the ISEW/GPI should not be seen as substitutes for GDP, but as complements in the analysis of the state of the economy.

Even though the ISEW/GPI offer new insights on the state of the economy by incorporating social and environmental indicators that the GDP neglects, the literature on the topic indicates that ISEW/GPI itself suffers from several weaknesses. Some of the shortcomings presented by Neumayer (1999) among others are: (1) The lack of a theoretical foundation for the arbitrary choice of the indicators incorporated; (2) the duality of combining both welfare and sustainability in a single indicator; and (3) the implicit assumption of the perfect substitutability between natural and human-made capital (weak sustainability).

The vast number of different methods used in the calculation of the ISEW/GPI remains a strong criticism. Indeed, this diversity in methodologies hinders or even prevents inter-country comparisons, as the ISEW/GPIs are not comparable. This issue was presented by Lawn (2005) and further revisited by Bleys and Whitby (2015), who discussed the need for a standardized methodology in order to eliminate inconsistencies both in the choice of items and their specific valuation techniques. Minimising the subjectivity that the researcher introduces will improve the methodology's acceptance, credibility and legitimacy by reputable organizations and the community at large. By enabling comparability, benchmarking progress between countries becomes viable, thus making it a useful tool for promoting welfare and sustainability.

The use of existing variables available through reputable organisations, such as the World Development Indicators (WDI), the Organisation for Economic Co-operation and Development (OECD) and the United Nations Database, among others, present a consistent solution for dealing with the problem mentioned above. However, as stated by Lawn (2005), "*there is little point agreeing on the items if the data needed to calculate certain items is not readily available in many countries.*" The use of such data and the minimization of assumptions made in evaluating specific items (in the form of extrapolations or the monetization of certain factors) could reduce some of these limitations. However, since papers on the subject typically only address one country, this concern for the use of multi-country variables and for reducing the subjectivity of the assumptions has not occurred. As a consequence, the comparison of ISEW/GPIs from different papers is erroneous as we "*are faced instead with 'apples and oranges'*" (Bleys and Whitby, 2015). Thus, such comparison are possible, but likely to be erroneous.

Menegaki and Tiwari (2017) have been successfully accomplishing the objective of estimating a comparative ISEW between countries for a considerate number of countries and years. Nonetheless, the number of components and consequently the number of factors addressed in the former are limited to a small fraction of those which actually make up the ISEW/GPI. When estimating the indicator, it is important not to undermine the conceptual framework on which the indicator is built. As it is dependent on the data available, neglecting some of the major factors that define the ISEW/GPI, results in an indicator with scant similarity to its original framework. Consequently, a trade-off should be considered, specifically between the comparability and robustness of the results, i.e., a bigger sample versus more components, respectively.

Overall, a gap still exists in the literature regarding robust measures that can be compared. As such, the present paper contributes to the literature by calculating the comparable GPI (CGPI) for the 28 countries according to the data available and a minimization of the assumptions made. Furthermore, a summarized literature review of past ISEW/GPIs is also presented. It is also important to note, with regard to the minimization of assumptions, that no extrapolations or interpolations were made. The use of such methods may lead to biased results. Globally, the main objective is to provide an enhanced indicator of welfare and sustainability that can enable comparisons between countries and be applied in multi-country empirical studies.

Before the computation of the CGPI, an overview is made, in Section 2, regarding the past 20 years of ISEW/GPI analysis. Following Section 3, the CGPI is computed, addressing all items in detail. A summary of the components is compiled at the end of the section. The analysis of the computed CGPI is made in Section 4. A subsequent analysis is made through direct observation of the variations in the items and by comparing both CGPI and GDP growth rates. Section 5 discusses the results obtained in the previous section. Finally, Section 6 concludes with a summary of the paper and the main findings.

2. AN OVERVIEW OF THE GPI

The history of welfare indicators can be traced back to Nordhaus and Tobin's (1973) measure of economic welfare which marked the start of subsequent welfare indicators using household consumption rather than GDP itself. From this, further adjustments were made, adding positive welfare factors and subtracting negative ones. Daly and Cobb (1989) estimated the first ISEW that would be later updated by Cobb et al. (1995) under the name of GPI. Since then, computations have been undertaken for a couple of countries. With slight differences in methodology,

Table 1 presents a comprehensive overview of peer-reviewed papers that have estimated an ISEW/GPI in the past 20 years, with information on the items computed. The components in bold are the ones applied in the present indicator.

The first column addresses the components commonly used. As can be seen in Table 1, there is a total of 27 items used in the computation of the ISEW/GPI. Items that are not commonly used (specific to one or two papers) are not included here. The second column shows the impact that the item has on the overall indicator. The References column lists the papers that have computed an ISEW/GPI in chronological order. The last row lists the countries assessed. Table 1 tries to establish an overall summary of past work on this issue, to help understand its methodology.

3. METHODOLOGY

As it can be seen in Table 1, slight differences exist between papers regarding the items used. However, it is clear that every ISEW/GPI calculation starts with private consumption which is first adjusted and then weighted for income inequality. The papers address income inequality through two main indexes: The Atkinson Index and the Gini Index. The weighting of income inequality is achieved, according to the literature (Table 1), through three different methods: (1) Weighting total private consumption; (2) weighting total private consumption after it is adjusted (note **c** in Table 1); and (3) weighting at the end of all calculations (note **b**). The authors who follow the second method (note **c**), remove expenditure on durable goods as well as defensive private expenditure on health and education, since these do not account for welfare. It is important to note that the methods used to compute the items in the indicator were based on the literature and are cited for specific methods.

3.1. Weighted Private Consumption (WPC)

Considering that an increase in income has a higher impact on the poor than rich, the Gini coefficient (household disposable income after-taxes) is here applied to weight for income inequality. The Gini coefficient was extracted from the Standardized World Income Inequality Database (SWIID) version 6.1 (Solt, 2016). This work was innovative in estimating the portion of adjusted private consumption, in that it included defensive and rehabilitative expenditure as well as the services from durable goods before weighting, but on the other hand, did not weight for public expenditure, since public consumption is supposed to be available to everyone, and thus no need for weighting. These modifications (in parenthesis below) refer to the adjustment of total private consumption. In line with the above, the WPC applied in the present work is as follows:

$$WPC = \left(PriC_t + SDur_t - ExDur_t - DRE_t\right) \times \left(1 - \frac{Gini_t}{100}\right) \quad (1)$$

Where, *PriC* stands for Private Consumption, *ExDur* is the expenditures on durable goods, *DRE* stands for private defensive and rehabilitative expenditure, *SDur* is the Services provided by the durable goods, and the subscript t is the year for each variable.

3.2. Services Provided by Durable Goods

In order to compute the services provided by durable goods, this paper, following most of the literature (Table 1), employs a 10% depreciation rate (on average 10 years per durable good) accumulated throughout the years (the interest rate was not considered). Equation 2 presents the calculation of services from durable goods:

$$SDur_t = \sum_{i=0}^{n} \frac{D_{t-i}}{n} = \frac{D_{t-0}}{n} + \ldots + \frac{D_{t-n}}{n} \quad (2)$$

Where $SDur_t$ stands for services from durables goods in year t, n stands for the service life of the durable goods, and D_t is the expenditure on durable goods in each year.

3.3. Private Defensive and Rehabilitative Expenditure

The calculation of the DRE includes 13 items of household expenditure, available in the OECD statistics[1] and detailed in equation 3. The formulation of the DRE and the parameters used are based on Delang and Yu (2014).

$$DRE_t = 0.5 \times PHe_t + PEdu_t + 0.25(2Fo_t + (To_t + Nar_t) + 0.5\ 5Alc_t + 0.25(2Clo_t + 0.25(2Hou_t + 0.25(Fur_t + 0.25(2(Tran_t + Com_t) + 0.125 \times Rec_t + 0.5 \times (Res_t + OGS_t) \quad (3)$$

The *DRE* were calculated by considering private expenditure on: Health (*PHe*), Education (*PEdu*), Food (*Fo*), Tobacco (*To*), Narcotics (*Nar*), Alcohol (*Alc*), Clothing (*Clo*), Housing (*Hou*), Furnishing (*Fur*), Transport (*Tran*), Communication (*Com*), Recreation (*Rec*), Restaurants (*Res*), and Other Goods and Services (*OGS*).

3.4. Public Non-Defensive and Rehabilitative Expenditure

Following this, positive and negative welfare magnitudes were added and subtracted, respectively. As was previously mentioned, public consumption expenditures should not be added before the income inequality adjustment, but after, since the services provided by these are meant to be available to everyone irrespective of their income. Most of the papers addressed here, include a share of public consumption expenditure as beneficial to welfare, primarily half the expenditure on health and education. Although this practice has been followed since the conception of the indicator, through the various papers, some modifications have been made. For example, Gigliarano et al. (2014) for Italy, apply a mixed strategy for the different types of public expenditure. Considering the data available from the OECD[2], the mixed strategy employed by the former was followed in the present paper. Equation 4 shows the calculations for the adjusted public non-defensive and rehabilitative expenditure ($NDRE_t$) used in this study.

$$NDRE_t = 0.25 \times (Def_t + POS_t) + 0.50 \times 0EA_t + Edu_t + EP_t + GPS_t + He_t + HCA_t + SP_t) + 0.75RCR_t \quad (4)$$

The *NDRE* were calculated by considering public expenditure on Defence (*Def*), public order and safety (*POS*), economic affairs (*EA*), education (*Edu*), environmental protection (*EP*), general public services (*GPS*), health (*He*), housing and community

1 Following the system: National Accounts → Detailed Tables and Simplified Accounts →Final consumption expenditure of households.

2 Following the system: National Accounts General Government Accounts, Government expenditure by function.

Table 1: Literature on ISEW/GPI papers

Items	Impact	References																												
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Private consumption	+	•[a]	•	•	•	•	•	•	•	•	•	•	•	•	•[a]	•	•	•	•[a]	•	•[a]	•[a]	•	•	•	•	•	•	•
Index of income inequality	−	•[b]	•	•	•[b]	•	•	•	•	•	•	•	•	•	•[c]	•	•	•	•[c]	•	•[c]	•	•	•	•	•	•	•	•
Expenditure on consumer durables	−	•	•		•	•		•	•		•	•	•	•	•	•	•	•	•		•		•		•			•	•
Services of consumer durables	+	•	•		•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•		•		•			•	•
Public NDRE on health and education	+		•	•	•		•		•	•		•	•	•			•	•		•[d]			•	•		•	•	•	•
Private DRE on health and education	−	•	•	•	•		•	•	•			•	•		•[f]		•	•	•[f]		•[f]	•[f]	•					•	
Services from public infrastructure	+	•	•	•	•	•	•		•		•			•	•	•	•		•		•	•	•		•			•	
Value of household work	+	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•
Value of voluntary work	+			•		•					•		•		•	•					•	•	•	•	•		•		•
Costs of commuting	−	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•		•			•		•			•	•
Costs of car accidents	−	•	•	•	•	•		•	•		•	•	•	•	•	•	•	•		•			•		•			•	•
Costs of crime	−		•	•		•					•		•	•	•	•			•		•	•	•		•				•
Costs of family breakdowns	−										•		•	•	•	•					•	•	•	•	•				
Costs/Gains of loss of leisure time	−/+					•					•		•	•		•					•				•				
Costs of un- and/or underemployment	−			•		•					•		•	•	•	•					•	•			•				
Cost of water pollution	−	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•		•	•	•	•		•			•	•
Cost of air pollution	−	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•			•	•
Cost of noise pollution	−	•	•	•	•	•	•	•			•	•	•	•		•	•	•		•	•			•	•				•
Cost of private pollution abatement	−					•		•			•	•	•			•		•						•	•				
Cost of agricultural land loss	−	•	•		•	•		•	•		•	•	•	•		•	•			•	•	•	•		•				•
Cost of forest land loss	−			•		•	•				•			•	•	•	•					•			•	•	•		
Cost of wetland loss	−	•		•	•	•		•	•		•			•		•				•	•			•	•	•	•	•[g]	•
Cost of non-renewable resource depletion	−	•	•	•	•	•		•	•	•	•	•	•	•		•	•	•		•	•	•		•	•	•	•	•	•
Cost of long-term environmental damage	−	•	•	•	•	•	•	•	•	•	•	•	•				•	•		•	•	•	•	•	•	•	•	•	•
Costs of ozone layer depletion	−			•	•	•				•	•	•	•			•		•							•				
Net capital growth	+/−	•	•	•	•	•		•	•	•	•	•	•	•		•	•	•		•			•	•	•	•	•		
Change in net international position	+/−	•		•	•					•	•	•	•	•	•	•		•	•	•	•	•							
Countries assessed		AUT	CHL	AUS	POL	USA	THA	GBR	ITA	NLD	CHN	BEL	FRA	PRT	7[h]	US	ITA	BEL	KOR	ITA	HKG	BRA	JAP	GRC	USA	42[h]	7[h]	ESP	DEU

For numbers, 1 - (Stockhammer et al., 1997), 2 - (Castañeda, 1999), 3 - (Hamilton, 1999), 4 - (Gil and Sleszynski, 2003), 5 - (Costanza et al., 2004), 6 - (Clarke and Islam, 2005), 7 - (Munday and Roberts, 2006), 8 - (Pulselli et al., 2006), 9 - (Bleys, 2007), 10 - (Wen et al., 2007), 11 - (Bleys, 2008), 12 - (Nourry, 2008), 13 - (Beça and Santos, 2014; 2010), 14 - (Lawn and Clarke, 2010), 15 - (Posner and Costanza, 2011), 16 - (Pulselli et al., 2012), 17 - (Bleys, 2013), 18 - (Feeny et al., 2013), 19 - (Gigliarano et al., 2014), 20 - (Delang and Yu, 2014), 21 - (Andrade and Garcia, 2015), 22 - (Hayashi, 2015), 23 - (Menegaki and Tsagarakis, 2015), 24 - (Kubiszewski et al., 2015), 25 - (Menegaki and Tugcu, 2016), 26 - (Menegaki and Tugcu, 2017), 27 - (O'Mahony et al., 2018), 28 - (Held et al., 2018). For letters, a denotes that public consumption was also considered, b denotes that income distribution was weighted at the end of the calculus, c denotes that income distribution was weighted after adjustments to consumption (DRE and Durables), d denotes that other public expenditures were also considered besides health and education, f denotes that other private expenditures were also deduced besides health and education, g denotes that the item is considered positively in the respective paper, and h denotes the number of countries. ISEW: Index of sustainable economic welfare, GPI: Genuine progress indicator

amenities (*HCA*), social protection (*SP*), and recreation, culture and religion (*RCR*).

3.5. Services Provided by Public Infrastructure

Still in the area of public expenditure, the services provided by public infrastructure were examined. Public investment in roads was considered, and a depreciation of 5% (20 years) was followed. The value of the services provided by public investment in roads was accumulated throughout the years. After adding public investment, the authors chose not to incorporate this component due to the insignificant changes it made in the overall indicator and the absence of data for some years in certain countries. Thus, equation 5 demonstrates the formula for calculating the services provided by public infrastructures (SPI),

$$SPI_t = \sum_{i=0}^{n} \frac{D_{t-i}}{n} = \frac{D_{t-0}}{n} + \ldots + \frac{D_{t-n}}{n} \quad (5)$$

where SPI_t stands for the depreciation of durable goods in year t, n stands for the service life of the durable goods, and Dt is the expenditure on durable goods in each year.

3.6. Unpaid Work

One of the main items that the GPI is known for, is benefits from domestic labour. GDP does not incorporate this type of income as it is not detected in the economy. Most of the papers (Table 1) include this item, although the methods may differ. Valuing the time spent on household labour using a shadow price for domestic work is the method normally used. Bearing in mind that this paper aims to produce a common (and as such, comparable) method for all countries according to the data available, a proxy for domestic labour is applied instead. This does raise the possibility of overestimating the value of domestic labour, as the average wage might be larger than the average wage for domestic labour. However, the unpaid work used here concerns not only household workers, but every individual who works but does not get paid for it, including volunteers. The minimum wage could also be used, but since most of the countries do not have a minimum wage, the average wage was applied. Additionally, volunteer work is also incorporated in some papers (Table 1). Equation 6 shows the calculations for the unpaid work (UW) item included.

$$UW_t = UWs_t \times AW_t, \quad (6)$$

Where *UWs* stands for unpaid workers and *AW* for average wages. *AW* values are extracted directly from the OECD. The variable UWr is not directly available on the WDI database. As such, it was computed as follows:

$$UWs_t = EMP_t - WSW_t \quad (7)$$

Where:

$$EMP_t = \frac{EMP_{\%\,population}}{100} \times population \quad (8)$$

And

$$WSW_t = \frac{WSW_{\%emp}}{100} \times EMP_t \quad (9)$$

Employment as a share of the total population ($EMP_{\%population}$)[3], wage-earning and salaried workers as a percentage of total employment ($WSW_{\%emp}$)[4] and population are directly extracted from the WDI database. These two variables allow total employment (EMP) and the total of wage and salaried workers (WSW) to be calculated.

3.7. Cost of Air Pollution

Since the aim of the GPI is to measure welfare by considering both social and environmental externalities, from here on, the costs arising from these externalities are subtracted. In contrast to the social items, the environmental items are less subjective. Water, air and noise pollution are the items most commonly considered. However, due to a lack of data and the aim of reducing subjectivity in the items used, only the air pollution item has been computed. Following the method commonly applied, emissions of several types of pollutants[5] have been assessed by the OECD, namely carbon monoxide (CO), nitrogen oxide (NOX), sulphur oxide (SOX) and volatile non-metal components (VOC). These were then multiplied by the marginal social cost (MgScost). Following Nourry (2008), the MgScosts are: 969.5 €/T, 8093.4 €/T, 5245.4 €/T and 5762.3 €/T for CO, NOX, SOX and VOC, respectively. In equation 10, the calculation of the cost of air pollution (CAP) is presented.

$$CAP_t = \sum_{i=1}^{4} (MgScost_{it} \times pollutants_{it}), \quad (10)$$

Where the subscript i = 1, 2, 3 and 4 stands for CO, NOX, SOX and VOC, respectively.

The cost of private pollution abatement is included by some authors and considers the cost each household pays to manage and treat pollution at home. Public expenditure on waste management is available through the OECD database, but a marginal social cost was not found for the respective item, so the item was excluded from the computation. The items corresponding to agricultural land, forest and wetland losses were also excluded for lack of data and the ambiguity regarding the marginal costs associated with the respective losses.

3.8. Energy Depletion

The cost of non-renewable resource depletion and the cost of long-term environmental damage has long been a subject of debate in the literature. From the first criticisms of Neumayer (2000), to the proposed changes of Bleys (2008), and the most recent "revisiting" of the various approaches to the valuation of these items by O'Mahony et al. (2018). The methods mainly differ in the marginal costs used to account for the cost of the long-term damage of greenhouse gases (GHG) on the one hand; and the substitution cost of replacing fossil fuels with renewable sources, on the other. Following the objective of minimizing subjectivity, the present paper applies the methods used by O'Mahony et al.

3 Employment as a share of total population available at: https://data.worldbank.org/indicator/SL.EMP.TOTL.SP.ZS.

4 Wage and salaried workers as a percentage of total employment https://data.worldbank.org/indicator/SL.EMP.WORK.ZS.

5 Data for NH3 and PMx pollutants were not available for all countries and hence not applied.

(2018). The authors, besides using the most recent information on methods for the marginal costs, do not follow the assumptions made on the escalation of substitution costs, or the assumptions on accumulation for the GHG emissions, both criticized by Neumayer (1999).

$$ED_t = Scost_t \times (coal_t + oil_t + gas_t) \quad (11)$$

For non-renewable resource depletion (energy depletion), a substitution cost (Scost) of €575.99 per tonne of oil equivalent in €2010 was assumed. Following O'Mahony et al. (2018), this value is based on the 2050 no-nuclear reference scenario from Vallejo et al. (2013). The primary energy requirement on non-renewable energy in all countries is assessed via the international energy agency (IEA), namely data on coal, oil and gas (Equation 11).

3.9. Cost of Climate Change

Moreover, following Ackerman and Stanton (2012), for long-term environmental damage (the cost of climate change) a marginal social cost (*Msc*) of €175.37 per tonne of CO_2 equivalent in €2010 was applied with a damage curve (*damc*) of 1.9837% compound growth per year (*n*). This method is also followed by O'Mahony et al. (2018). Equation 12 presents the calculation of long-term environmental damage.

$$CCC_t = Msc_t^{(damc \times n)} \times GHG_t. \quad (12)$$

Data on the six Kyoto GHG, namely carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_6), was assessed via OECD statistics, where all pollutants are in CO_2 equivalent. However, following O'Mahony et al. (2018), the item concerning the cost of ozone layer depletion is not included due to its incompatibility with the Fisherian concept of income (Lawn, 2013). It can be seen in Table 1 that the latter item was left out of most of the papers analysed.

3.10. Not Considered Items (Capital Growth and Social Items)

Finally, the items: Changes in capital growth and the net international investment position have been excluded from the computation of the present indicator as recommended by Bleys (2008). Indeed, these items are not compatible with the Fisherian concept of income (the theoretical foundation of the GPI), which is discussed in detail in Lawn (2013). As shown in Table 1, some other authors also excluded these items.

However, none of the social items have been considered for the sake of the consistency and impartiality of the CGPI. These suffer from subjectivity, as they are greatly dependent on the author and the methodologies used, as well as the availability of data. Following the literature (Table 1), the social items commonly applied are:

1. The cost of commuting;
2. The cost of car accidents;
3. The cost of crime; and
4. The cost of family breakdowns.

The CGPI for a total of 28 OECD countries is assessed, in constant 2010 local currency units, for different time-spans starting from 1995 until 2015. The main source was the OECD database. Table 2 summarizes the items computed, including the subitems used, the impact and the source accessed.

4. RESULTS

Following the explanations of the CGPI calculations in the previous section, the aim of the Results section is to analyse the CGPI computed for the 28 countries assessed. The analysis will be followed by a comparison with GDP. In other words, both CGPI and GDP levels will be compared and discussed. It is important to understand, not only the path countries have been taking with respect to sustainable development, but also the objectives and importance countries attribute to economic growth and sustainable development, i.e., whether countries neglect one to benefit the other. Figure 1 lists all the countries assessed as well as the time-span analysed for each.

Considering the number of the countries assessed here, and to facilitate the analysis, the countries were grouped into two regions, namely Europe and the Rest of the World. Since most of the countries belong to Europe, the present paper will focus mainly on Europe, further sub-sectioning the latter into four sub-regions, namely, Northern Europe, Western Europe, Eastern Europe and Southern Europe. Supplementary material is available for download in which all the figures regarding the countries and items can be assessed.

4.1. The Absolute Gap

In the first type of analysis, the CGPI is assessed through the absolute difference between the GDP and the CGPI, where the calculation is as follows:

$$Absolute\ Gap_t = GDPpc_t - CGPIpc_t \quad (13)$$

The absolute gap, in local currency units, can be compared for all the countries in Figure 2 with the European regions described earlier.

Following Figure 2, it is possible to conclude that a divergence between economic growth and sustainable development is evident for all countries, with the exception of Italy and the United Kingdom. The countries with the highest absolute gap are Latvia, Luxembourg and Estonia, i.e., where economic growth and sustainable development are diverging the most. Only Italy and the United Kingdom actually follow a path of convergence, while for the rest of the countries there is a divergence between the GDP and the CGPI.

However, a common shock is visible. In 2009 all the countries suffered a considerable decrease in GDP, while showing an increase in CGPI. This explains the reduction of the gap. It is also important to exercise caution when assessing the absolute gap. Indeed, a smaller absolute gap could mean that economic growth is decreasing while sustainable development is constant. Italy and the UK are converging due to the higher growth rates presented in the CGPI compared with the GDP.

Table 2: Summary of the items used for calculation of the CGPI

Items			Impact	Methodology
WPC	Weighted private consumption expenditure			Eq. (1)
PriC	Private consumption		+	OECD
ExDur	Expenditures on durable goods		−	OECD
SDur	Services provided by the durable goods		+	Eq. (2)
DRE	Private defensive and rehabilitative expenditures		−	Eq. (3)
	Health	Education		OECD
	Food	Tobacco		OECD
	Narcotics	Alcohol		OECD
	Clothing	Housing		OECD
	Furnishing	Transport		OECD
	Communication	Recreation		OECD
	Restaurants	Other Goods and Services		OECD
GINI	Income distribution inequality		−	SWIID
NDRE	Public non-defensive and rehabilitative expenditures		+	Eq. (4)
	Defence	Public order and safety		OECD
	Economic affairs	Education		OECD
	Environmental protection	General public services		OECD
	Health	Housing and community amenities		OECD
	Social protection	Recreation, culture and religion\		OECD
SPI	Services provided by public infrastructure		+	Eq. (5)
UW	Unpaid work		+	Eq. (6)
UWs	Unpaid workers			WDI
AW	Average wages			OECD
CAP	Cost of air pollution		−	Eq. (10)
CO	Carbon monoxide			OECD
NOX	Nitrogen oxide			OECD
SOX	Sulphur oxide			OECD
VOC	Volatile non-metal components			OECD
ED	Energy depletion - non-renewable resources depletion		−	Eq. (11)
	Coal			IEA
	Oil			IEA
	Gas			IEA
CCC	Cost of climate change - long-term environmental damage		−	Eq. (12)
CO_2	Carbon dioxide			OECD
CH_4	Methane			OECD
N_2O	Nitrous oxide			OECD
HFCs	Hydrofluorocarbons			OECD
PFCs	Perfluorocarbons			OECD
SF_6	Sulphur hexafluoride			OECD
NF_6	Nitrogen trifluoride			OECD
CGPI	CGPI (constant 2010 LCU)		=	Aggregated indicator

CGPI: Comparable genuine progress indicator, OECD: Organisation for Economic Co-operation and Development

4.2. Ranking System

Another analysis that was followed is the ranking system, where countries are ranked based on their GDP and CGPI levels. This analysis indicates which countries have the greatest disparity between the two indicators, compared to countries with similar indicators. Table 3 presents both the GDP and CGPI ranks as well as the changes in the position from the GDP to the CGPI (Δ). The year 2013 was chosen since it is a period when data is available for all the countries (Figure 1). Originally, the CGPI was calculated in local currency units but, in order to facilitate the comparison between countries, the World Bank[6] methodology was applied to convert it into US dollars. This methodology preserves the variation of local currency units in US dollars.

The top 5 of the GDP is mostly occupied by the Northern European countries. Luxembourg takes the lead, followed by Norway, Denmark, Sweden respective and the United States comes in 5th. Moreover, the top 5 of the CGPI is occupied by the same countries, excluding the United States, which suffers the highest negative change in positions (−10). Finland achieved the highest positive change in positions (+5), from the 10th in the GDP rank to the 5th in the CGPI rank. Japan, the Netherlands and Austria appear in both top 10s, while France and Belgium achieve a positive increase, positioning themselves in the top 10 of the CGPI.

With respect to the United States, this change of position, from 5th ranking in the GDP to 15th ranking in the CGPI, could mean that, although the country is economically rich, the country does not necessarily favour welfare and sustainability. Conversely, for Finland this is reversed, i.e., although it occupies the 10th position according to its GDP, Finland could be considered richer in welfare and sustainability, compared to countries with similar wealth.

On the other hand, the bottom 5 of GDP is mostly occupied by the Eastern European and Northern European countries. Indeed, within

6 The methodology is detailed in: https://datahelpdesk.worldbank.org/knowledgebase/articles/114943-what-is-your-constant-u-s-dollar-methodology.

Figure 1: Time-span for comparable genuine progress indicator by country

Figure 2: Absolute gap (constant 2010 LCU) for European Regions

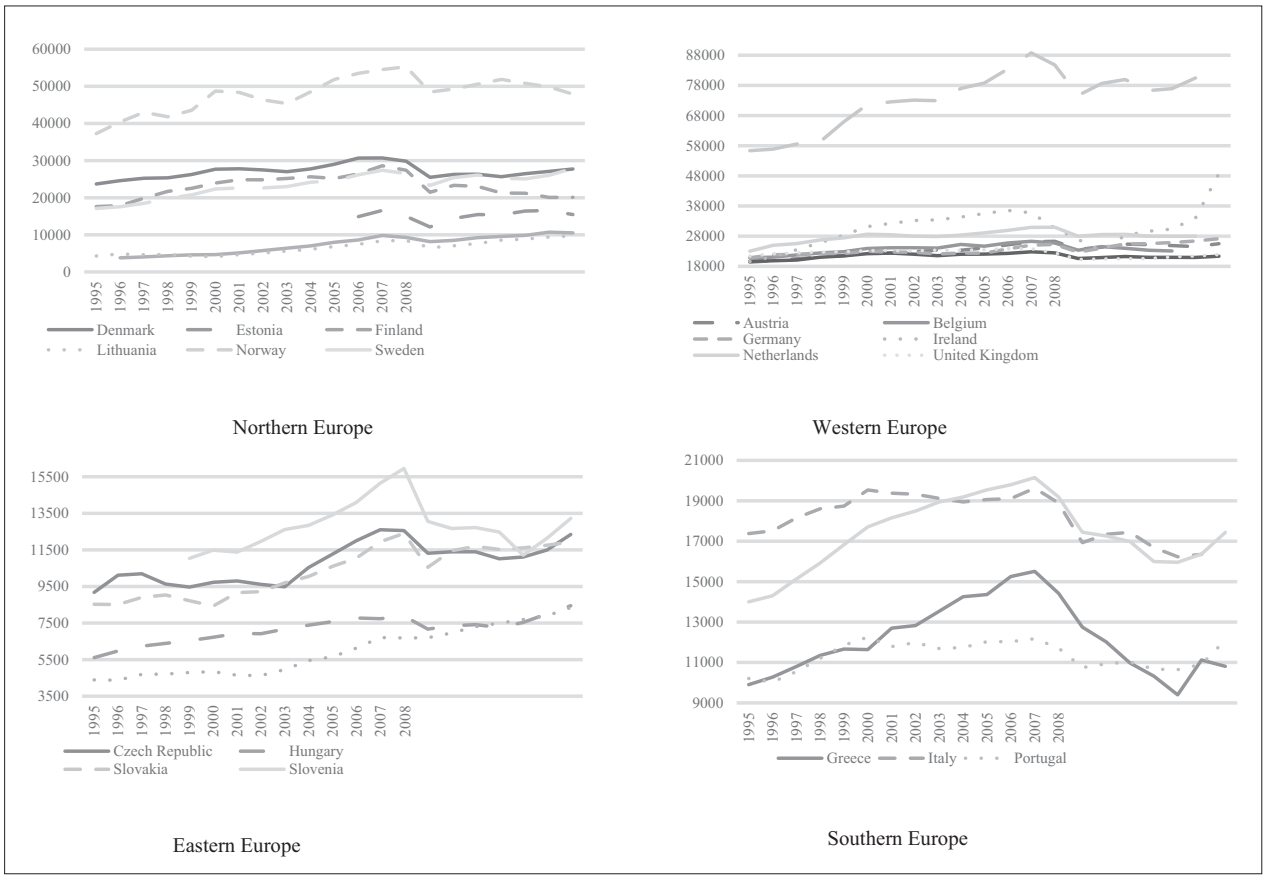

Table 3: Ranking list for GDP pc and CGPI pc for 2013

Position	GDP pc rank	CGPI pc rank	Δ
1	Luxembourg	Norway	+1
2	Norway	Denmark	+1
3	Denmark	Sweden	+1
4	Sweden	Luxembourg	−3
5	United States	Finland	+5
6	Netherlands	Japan	+3
7	Ireland	Austria	+1
8	Austria	Netherlands	−2
9	Japan	France	+4
10	Finland	Belgium	+1
11	Belgium	Ireland	−4
12	Germany	United Kingdom	+2
13	France	Germany	−1
14	United Kingdom	Italy	+1
15	Italy	United States	−10
16	Israel	Israel	0
17	Spain	Spain	0
18	Republic of Korea	Greece	+2
19	Slovenia	Republic of Korea	−1
20	Greece	Slovenia	−1
21	Portugal	Portugal	0
22	Czech Republic	Czech Republic	0
23	Slovakia	Hungary	+3
24	Estonia	Slovakia	−1
25	Lithuania	Poland	+2
26	Hungary	Lithuania	−1
27	Poland	Latvia	+1
28	Latvia	Estonia	−4

GDP: Gross domestic product, CGPI: Comparable genuine progress indicator

the Northern European countries, a difference must be highlighted between the Nordic countries and the North-eastern countries, which differ significantly, as shown by their positions in both ranks. The bottom 5 of the CGPI is occupied by the same 5 countries, although assuming different positions. Israel, Spain, Portugal and the Czech Republic occupy the same positions in both ranks.

Overall, Finland, Japan and France as well as Hungary and Poland demonstrate better results in terms of welfare and sustainability, compared to their counterparts in terms of wealth; while Luxembourg, Ireland, the United States and Estonia succeed in achieving better results in terms of economic growth, neglecting sustainable development.

4.3. Growth Rates and Components

As a result of the supplementary material available for download, in which the growth rates of GDP and CGPI can be assessed as well as the individual components that constitute the CGPI, some general insights can be derived[7]. While GDP growth is very similar for all countries, as is the evident decrease in 2009 for the majority of the countries due to the financial crisis felt worldwide, CGPI growth rates present more disparities when compared among countries.

The time-span can be split into two periods, before and after the financial crisis, more precisely 2008-2009. In the first period (until 2008) most of the countries revealed a similar path, in terms of GDP and CGPI. Both indicators reported a positive trend, although the gap between the two became more accentuated over the time as GDP increased at higher rates than CGPI. While GDP maintained a positive growth over the entire first period, CGPI was more volatile, and exhibited some ups and downs.

Conversely, in the second period (after 2008), the GDP and CGPI did not follow such similar paths, and contradictory trends are evident from 2009 onwards. Whereas a strong decrease was felt in GDP in 2009 for most of the countries, an increase was observed in CGPI for the same period. However, during the post-crisis period, the trend changed for both indicators. Indeed, after the shock in 2009, most of the countries showed a slight economic recovery with an increase in GDP in the following years.

For the CGPI, however, the contrary is observed. The shock from the financial crisis, although not felt in 2009, is evident in the following years. Negative growth rates are observed for most of the countries after 2009. For example, while Greece, a southern country, felt a decrease in CGPI shortly after in 2010, Slovenia, an eastern country, only felt a decrease in the CGPI much later, in 2012. Additionally, Sweden, a northern country, showed no decrease in CGPI, while France, a central country, only presented a slight decrease in 2015. This insight suggests that GDP is more volatile during financial shocks than CGPI, although the impact of the financial crisis was also observed at a later period. These contradictory rates of growth rates in GDP and CGPI, are discussed in the second part of the analysis below.

5. DISCUSSION

As seen in the individual graphs presented in the supplementary material, a general relationship can be established between GDP and the environmental components applied here, specifically the components of long-term environmental damage and the depletion of natural resources. The positive growth rates observed for the CGPI in 2009, could be explained mainly by these two components. As a consequence of a decrease in GDP in 2009, most of the countries, experienced a reduction in both aforementioned negative components of the CGPI. While most of the positive components (private consumption, public expenditures and unpaid work) increased or stagnated in 2009. As the crisis was only felt later, there was a corresponding decrease in environmental costs, so the CGPI ended up increasing in value. The pollution rates decreased, mostly because of a reduction in the productive sector, which was evident in the negative growth rates shown by GDP in 2009.

This relationship, and the consequent impact on the CGPI, recalls the issue of weak sustainability which Neumayer (1999) warned about. Since there is a direct substitutability between components, a decrease in environmental costs, while all other variables such as private consumption, public expenditures and unpaid work, remain constant, would ultimately increase the value of the CGPI but not necessarily represent a positive increase in welfare. However, in terms of sustainability, it could be argued that the countries increased their efficiency by spending the same while

7 The supplementary data shows all data here analysed through an interactive pivot chart where the reader can choose freely what to analyse. It is recommended for the reader to use this supplement for a better visualization and consequently comprehension of the results presented here in this section.

consuming less resources. This clearly represents a limitation of the GPI methodology that has been recognised in recent decades and needs further assessment.

Furthermore, when the economy starts to recover and begins to grow, so do the environmental components of environmental damage and depleting natural resources, consequently affecting the CGPI. However, the negative components of CGPI addressed here can be supressed if the positive components, such as public expenditure and unpaid work, increase at a higher rate. This would prevent a negative growth rate for the CGPI, although it could result in minor increases, albeit smaller than those usually observed for GDP. In some cases, the negative growth rates observed in the CGPI are due, not to an increase in environmental components, as, in some countries, these appeared to decrease in the later years of analysis, but to the reductions in public expenditure. This component is often used as a backup to sustain the economy in times of greater need such as the financial crisis. This component increases in the years 2009 and afterwards, maintaining the CGPI in a positive trend. However, a reduction of public expenditure could also lead to a reduction in the CGPI, resulting in negative growth rates.

Globally, the main insight obtained is that economic growth and sustainable development have been following a divergent path throughout the study period, with the exception of Italy and the United Kingdom. This fact has been documented in past and recent literature such as Nourry (2008), Posner and Costanza (2011) and O'Mahony et al. (2018), which analysed earlier periods; and validated the "threshold hypothesis" presented by Max-Neef (1995). Although, there is no evidence of a specific point in time where the "threshold hypothesis" is observed, i.e., an overall decline in welfare while economic growth continues to increase, it is evident that, throughout the period, the gap between the two measurements has been widening. The "threshold hypothesis" was verified, further strengthening the difference between the GDP and the GPI and thus furthering the importance of the latter as a complementary measurement for informed policymaking.

The differences between the GDP and the GPI are also highlighted by an analysis of the post-financial crisis period, which is analysed for the first time in this paper for a considerable number of the countries. Policy-makers should not forego the use of GDP, as it addresses important aspects of the economy. However, they should enrich their assessment by incorporating the GPI as an auxiliary measure, since it contrasts with the GDP by adjusting it for factors which it does not take into account, such as income inequality and natural resource depletion. By doing this, policy-makers could address economic growth more effectively, that is, without neglecting sustainable development.

Academics and researchers should also seek to ensure that the GPI is followed by policy-makers. As shown in Table 1, the GPI has been addressed by various authors over the past few decades, and through this the GPI has been being modified and strengthened as new methods and data appear. As in policymaking, the GPI should also be applied in statistical analysis and empirical research. This paper makes a contribution by calculating a GPI that is comparable for 28 countries and thus establishes a path for empirical research through econometric panel data analysis. The characteristic of comparability also facilitates benchmarking between countries, because policy-makers should always look at other countries for good examples of effective policy.

Finally, as in the case of GDP, the estimated CGPI also suffers from some limitations. For example, compared to other papers, the number of components used for the calculations here is among the lowest, (Table 1). However, considering the objective of making a CGPI for the maximum number of countries possible, the obstacle of the availability of data was assumed as a limitation. Furthermore, this limitation only highlights the need for more data from international databases such as the OECD, World Bank, Eurostat, etc. Indeed, in order to better understand and study sensitive subjects such as sustainable development, more data is needed, but this data cannot easily be quantified in monetary terms. Environmental externalities such as air pollution, water pollution and other environmental components incorporated in the GPI need to be further studied and converted into monetary terms in order to understand their real impact. The costs of car accidents, family breakdowns, or commuting, etc, are some examples of social components that also need to be converted. The methods of conversion need to be standardized for all countries so as not to compromise comparisons between GPIs.

Another limitation of GPI is the issue of weak sustainability. Even if positive components are weak, if they are higher than the negative components, the GPI will still show a positive value, even a desirable one, if the positive components significantly surpass the negative ones. The issue of substitutability between components also needs to be addressed, as the indicator could lead to erroneous implications. Conversely, with the adjustment for income inequality, as well as the inclusion of domestic labour and certain environmental externalities, the GPI also addresses some of the GDP's limitations. Once again, the application of a diversified range of metrics is recommended for informed policy-making, with both GDP and GPI acting as complementary measurements of analysis.

6. CONCLUSION

Economic growth and sustainable development are two different aspects. Typically, both aspects are combined in the same package of policies with the objective of simultaneously promoting growth and sustainability. To separate these, this paper computed a CGPI. The comparability aspect of the indicator is a major innovation of the present paper since it fills a gap identified in the literature. The computations were presented in detail. As with GDP, having a comparable indicator makes it possible to compare the sustainable development of different countries, and enables benchmark analysis.

The CGPI was calculated for the highest number of years available, with the time span varying between countries. The gap between GDP and CGPI was further assessed through different analyses. The first was the absolute gap, followed by the ranking system, and finally the direct observation of the growth rates and individual components. The CGPI was calculated in local currency units

and converted into US dollars in order to rank the countries. Overall, the GDP and CGPI are diverging, except for Italy and the United Kingdom. The results reveal that countries with higher economic relevance do not always achieve the same satisfactory levels in terms of sustainable development. Therefore, when addressing policy, policy-makers should differentiate between the two aspects, and take action on both of them, i.e., promote growth without hampering sustainability, and vice-versa.

When analysing the financial crisis, the CGPI demonstrated a lag, compared with the GDP. In periods of recession, while a contraction in GDP is evident, the CGPI increases due to the decrease in negative items, such as the costs of air pollution, climate change and energy depletion. The reduction of these negative items is associated with the decrease in the productive sector of the country in times of recession. The GDP and the CGPI must be seen as complementary but measuring different events. Both are needed to provide different points of view to policy-makers. This diversity of indicators could provide more information about public policy and enable more effective sustainable policies to be devised. The promotion of both economic growth and sustainable development must be pursued with careful consideration of their relationship.

Supplementary Data

Supplementary data associated with this article can be found at http://dx.doi.org/10.17632/zhw7j4ztnv.1

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