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Monitoring sustainable development in Brazil through a composite index

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Abstract

Sustainable development indicators gained visibility with the United Nations 2030 Agenda and its 17 Sustainable Development Goals. At the same time, two basic problems became relevant: data availability and results communication. The present study aims to deal with both of them by proposing a Sustainable Development (SD) Index for Brazil. Collecting data for such composite index gave the opportunity for facing the data problems: availability and frequency mainly. On the other side, by comparing the Brazilian SD Index in 2001 and 2015, it is possible to show its efficacy in monitoring and easiness in communicating the progress, as well as problems, a country faces in meeting the UN Sustainable Development Goals.

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1. Introduction

Assessing Sustainable Development (SD) by an index is undoubtedly a challenge since neither sustainable development nor its indicators are uniquely defined. Dissension can arise from different views of sustainability (weak or strong, for example) as well as from statistical methodology chosen while constructing a composite index. But such kind of index can provide useful information, by synthetizing multidimensional problems and presenting them in a simplified way, for policy makers and the public in general. It is important to remember that SD Index, as any form of quantification, is the result of a series of "interpretative decisions about what to quantify, how to categorize, and how to label it" (Rottenburg & Merry, 2015, p.11). Therefore, data quality and accessibility are basic characteristics able to affect the quality of the measurement. As Porter states "A quantitative index or indicator typically cannot measure the very thing of interest, but in its place something whose movements show a consistent relationship to that thing" (Porter, 2015, p. 34). And consistency is deeply rooted in the quality of raw data.

In this paper a SD Index is proposed and used to measure the Brazilian experience comparing two years, 2001 and 2015. After a review of the evolution of SD concept and its measurement, the composite index methodology will be presented. In the third sections, the analysis of the results of such index applied to Brazil is the opportunity for discussing the quality of such tool for monitoring sustainable development and communicating the result to a large audience. Detailed information on variables selection, data sources and availability can be found in the appendix.

2. The need for assessing Sustainable Development

Measuring a country performance has been at the core of economic inquiries since its beginning (Quesnay and his 1785 Tableau Économique for example (Blasé et al., 1993)).

For a long time, economic growth was viewed as the essential premise for development. Starting from economic growth, development includes changes in the quality of life, institutions and productive structure (Myrdal, 1960; Lewis, 1969; Hirschmann,1983).

In the XX century, the Keynesian revolution in Economics revealed the urge to find a common indicator to measure the production value of the capitalistic activities of a nation. The UN Statistical Commission, headed by Richard Stone, defined a set of rules for national accounting, the System of National Accounts, and the Gross Domestic Product (GDP) became a well-known and widely used. The GDP concept gained relevance and visibility, being used (and misused) for assessing economic growth as well as quality of life. Its flexible usage for measuring phenomena other than the economic performance of a nation is responsible for a plethora of criticisms that surrounds the GDP. Undoubtedly some relevant methodological drawbacks are also responsible for the search of alternative to GDP, even when used to value the economic performance, such as externalities, non-market activities, among many others. But resuming the result of productive activity of a nation by a single number is undeniably the strength of GDP and one of the reasons for its popularity. An interesting synthesis of its limits and suggestions for a better measure of well-being can be found in the Report by the Commission on the Measurement of Economic Performance and Social Progress written by Stiglitz, Sen and Fitoussi (2009).

The idea of development evolved from its unique economic dimension to a multidimensional structure focused on people and society. According to Sachs (2000), this debate is fundamental for the creation of the United Nations after World War II.

The growing concern with the environmental limits to growth, as the Brundtland Report (WCED, 1987) shows, led to a more comprehensive definition of development, including environment along with social and economic aspects, that is Sustainable Development (SD).

Following the Rio Earth Summit in 1992, an increasing number of sustainable indicators centered on economic, social and environmental aspects of SD appeared. In 1997 a group of leading experts on sustainable measurement elaborated the Bellagio Principles (Hardi & Zdan, 1997), that were later revised by the Bellagio Sustainability Assessment and Measurement Principles (STAMP) (IISD, 2009). The 2009 version resumed the previous one and it removed duplications present in the older version while delineating the "basic values and systemic, let alone holistic, approach to sustainable development" (Pintér et al., 2018). Among the eight principles, two are of special interest for our study, and they are listed in table 1.

Table 1. Two of the Bellagio Sustainability Assessment and Measurement Principles

Principle 4: framework and indicators
Assessment of progress toward sustainable development will be based on: • a conceptual framework that identifies the domain within which core indicators to assess progress are to be identified

• standardized measurement methods wherever possible, in the interest of comparability • comparison of indicator values with targets, as possible
Principle 6: effective communications
In the interest of effective communication, to attract the broadest possible audience and minimize the risk of misuse, assessment of progress toward sustainable development will: • use clear and plain language • present information in a fair and objective way that helps to build trust • use innovative visual tools and graphics to aid interpretation and tell a story • make data available in as much detail as is reliable and practicable

Source : Pintér et al., 2018.

By stating the need for using standardized measurement method, the Bellagio STAMP remind us one of the basic aims of an index: its use for comparability, among places and over time. More, it implies the importance of a sound statistical ground, especially for composite indexes. When emphasizing the importance of using a clear and plain language, they look at the potential users: government, researcher, higher education institution as well as anybody interested in knowing more on sustainability. To improve communication, information must be accurate and appealing in order to capture attention.

In 2000, the United Nations promoted the Millennium Development Goals, a set of 8 goals and 22 targets that member states committed to achieve by 2015. They were: 1) to eradicate extreme poverty and hunger; 2) to achieve universal primary education;3) to promote gender equality and empower women, 4) to reduce child mortality; 5) to improve maternal health; 6) to combat HIV/AIDS, malaria and other diseases; 7) to ensure environmental sustainability; and 8) to develop a global partnership for development.

These objectives and targets came along with indicators aimed to enable comparisons, within a country and between countries, and to evaluate the result of each country commitment to reach the goals.

By the year of 2015, United Nations member states adopted the 2030 Agenda and its 17 Sustainable Development Goals (SDG), and 169 targets. The SDG can be seen as a further step in the global commitment to SD, started with the Millennium Development Goals experience. For example, SDG aimed not only to eliminate poverty but also reducing inequality within and between countries. This wide range of goals and targets inspired the search for common indicators at international and local level.

In this research the SDG indicators where used during for the variable selection phase as commented in the next section.

3. Method

Given that the SD concept is intrinsically multidimensional, it requires a large set of indicators for monitoring progress in economic, social and environmental targets.

3.1 Data selection

During the 47th Session of the UN Statistical Commission the Inter-agency Expert Group (IAEG) on SDG Indicators presented a set of criteria that SDG indicators should share (UN, 2016). In this research we followed the official list of proposed Sustainable Development Goal indicators published in December 2017 (UNSTATS, 2017)[1]. Classifying the indicators according to frequency, methodology and diffusion, the IAEG classified indicators in three groups (or Tiers). For our study indicators Tiers 1 type were selected because

> Indicator (Tiers 1) is conceptually clear, has an internationally established methodology and standards are available, and data are regularly produced by countries for at least 50 per cent of countries and of the population in every region where the indicator is relevant (UNSTATS, 2017).

Among the 17 SDG, it was possible to collect data only for 13 of them, which represent the partial indexes used to build de SD Index.

The complete list of 50 indicators selected can be found in the appendix, along with a detailed definition of the selected variables and the list of all sources of data. After selecting the indicators, Brazilian official statistical databases were used looking for data covering the years 2001 and 2015. When data were not available for the selected here, the closest year with data was chosen.

3.2 Rescaling

In order to compare different indicators, each variable was rescaled from 0 to 1, with 0 denoting the worst contribution to sustainable development and 1 being the best. Rescaling is a delicate operation since it depends on the extreme values of a distribution. Fortunately, no outliers were found. The minimum and maximum values of each variable in the two years of analysis were chosen as lower and upper bounds. This option allows to compare data for the years/over time under study.

After defining the lower and upper bounds, all variables were transformed according to the following formulas:

$$x^* = \frac{x - \min(x)}{\max(x) - \min(x)} \quad (1)$$

$$x^* = \frac{\max(x) - x}{\max(x) - \min(x)} \quad (2)$$

Where x* is the normalized values after rescaling; x is the raw data, min and max represent the lower and upper bounds.

Formula (1) was applied to those variables which positively contribute to sustainable development. An example is the proportion of households with access to sewage or clean water.

Formula (2) was applied when the indicator selected negatively contributes to sustainability. For example, the poverty rate.

[1] The data selections was realized before the publication of the 2018 updates: https://unstats.un.org/sdgs/files/Tier%20Classification%20of%20SDG%20Indicators_11%20May%202018_web.pdf

3.3 Weighting and aggregation

After rescaling all variables, the next step is to weight and aggregate them in order to calculate the composite index. According to Sachs et al. (2017) there isn´t a universal agreed answer to the weighting problem. "As a normative assumption, we therefore opted for fixed weights and decided to give equal weight to every SDG to reflect policymakers' commitment to treat all SDGs equally and as an "integrated and indivisible" set of goals" (Sachs et al., 2017, p. 44).

In this study, the arithmetic mean was chosen to aggregate indicators within each SDG, reflecting the weak sustainability concept. The same decision was taken to aggregate different indices in order to calculate de SD index. As Sachs et al. (2017) wrote, the use of arithmetic mean is easy to understand (and to communicate) and, reflecting the weak sustainability idea, it allows to treat each SDG equally.

4. Results

Brazil is a federation of 26 States and a Federal District. For each selected indicator, data were collected on a local unit base (States and the Federal District).

As stated before, it was possible to collect data only for 13 SDG, which represent the partial indexes used to build de SD Index.

For communication purposes, each partial index was named after the SDG it aimed to measure. The results for Brazil are summarized in table 2. Since the SD Index ranges from 0 to 1, a value of 0,51, as for 2001, can be interpreted as Brazil in 2001 is on average 51% on the way to fulfill SDG. Or, in a plain language, is halfway to reach a full economic, social and environmental development. During the next 14 years progress was made in Brazil and the SD Index reached 0,61 in 2015.Observing the partial indexes values it is possible to see those that are limiting the move toward sustainable development and those that score well above the average.

Table 2. The Sustainable Development Index and its components, Brazil, 2001 and 2015

	2001	2015
SDG1	0,587	0,862
SDG3	0,553	0,619
SDG4	0,544	0,569
SDG5	0,216	0,330
SDG6	0,415	0,656
SDG7	0,746	0,947
SDG8	0,467	0,551
SDG10	0,372	0,506
SDG11	0,602	0,769
SDG12	0,684	0,316
SDG13	0,465	0,500
SDG16	0,782	0,888

SDG17	0,157	0,661
SDI	**0,510**	**0,610**

Source: The authors.

Figure 1 is a different way of showing the results of table 2. Visually it is easier to notice the general improvement, comparing 2001 blue line with the 2015 red one. At the same time, it becomes clearer where progress was more relevant (SDG 17, 1 and 7) and a regress was registered (SGD 12), as well as where more effort is needed (SDG 5 and 13).

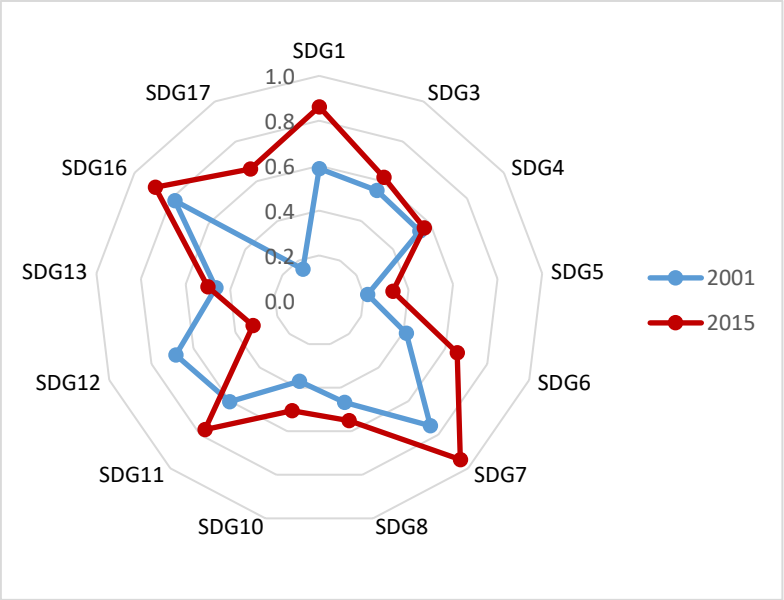

Figure 1. The Sustainable Development Index for Brazil, 2001 e 2015

Source: The authors.

The SD Index indicates relevant progress in three partial indexes, those related to SDG 1, 7 and 17. SDG17, the best performing component of this index, is measured by access to fixed internet broadband and by the number of internet users. Following the IAEG directions for selecting SD indicators, those available on a national bases are related to technology and its contribution to implement SD. In this sense, having more people accessing internet is a way of improving access to information and, therefore, making citizens aware of the importance, among other thing, of SDG. SDG1 aims to end poverty and during the 15 years under study the Brazilian government did engage in policies aiming to reduce poverty directly, via income transfer programs, and indirectly, via economic growth. SDG7 is related to the access to reliable and sustainable energy. The indicators used here measure access to electricity. In this area Brazil has nowadays reached almost all households. Unfortunately, no information is available on the type of energy source and therefore such variable does not allow to discriminate between sustainable and unsustainable energy sources. The only component in which Brazil moved away from the SD targets is on the use of pesticides in agriculture, as shown by de indicators related to SDG12. This is an alarming result given the importance of agriculture in the Brazilian economic structure. More efforts are needed for implementing a gender equality agenda (SDG5) and fighting climate change by reducing greenhouse gases (SDG13).

In synthesis, the SD Index allows to state that while Brazil is on the right track to reach sustainable development, more work is needed, especially on the environmental part (as indicators related to SDG 12 and 13) and social terms (by actively reducing inequality).

5. Conclusion.

A range of social, economic and environmental concerns delimits the sustainable development. With the UN 2030 Agenda, a global commitment was taken by a large number of countries and engaged institutions at different levels, as well as individuals. In order to monitor actions and their result toward SDG, indicators and indexes gained a relevant position.

The SD Index proposed in this research is a first attempt to show how a quantitative tool based on publicly available data can be elaborated to assess development over a span of time. By using a composite index by aggregating a group of partial indices, it was possible to show a global improvement, as the SD Index rose from 0,51 to 0,61 in 15 years. At the same time, by analyzing its components, some additional information was easily available, making the analysis much more enlightening. It was possible, for example, to identify the need for more action against greenhouse gases and pesticide and the need to foster gender equality.

Clearly this index can be improved by including more variables. In Brazil, the Official Statistical Office is undertaken a large effort, along with other research centers, in order to organize a complete set of indicators related to the 2030 Agenda (IPEA, 2018). The expected result of such effort is undoubtedly attending the Bellagio STAMP, making regular and reliable data available to public.

A composite index, as the one proposed, can synthetize complex, multidimensional, problems to a limited set of relevant features. It is a simplified, but reliable, tool to effectively inform policy makers and citizens. Clearly it does not cover all the SD components, but it is movements, as Porter´s citation in the introduction states, are consistent to it.

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Appendix

Appendix 1. SDG indicators for Brazil

SDG	Indicators	Years	Sources
Goal 1. End poverty in all its forms everywhere	Proportion of population living below the national poverty line (1/4 of the minimum wage)	2001 2015	[6]
	Proportion of population living below the national poverty line (1/2 of the minimum wage)	2001 2015	[6]
Goal 3. Ensure healthy lives and promote well-being for all at all ages	Maternal mortality ratio	2001 2011	[4]
	Under-five mortality rate	2001 2011	[4]
	Neonatal mortality rate	2000 2010	[4]
	Proportion of HIV infections per 1,000 population	2001 2015	[4]
	Tuberculosis incidence per 1,000 population	2001 2012	[4]
	Mortality rate attributed to cancer	2001 2011	[4]
	Suicide mortality rate	2001 2011	[4]
	Death rate due to road traffic injuries	2001 2011	[4]
	Adolescent birth rate (aged 10-14 year)	2001 2011	[4]
	Adolescent birth rate (aged 15-19 years)	2001 2011	[4]
	Health worker (doctors) density (per 1000 inhabitants)	2001 2010	[4]
Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	Proportion of children under 5 years of age who are in kindergarten	2000 2010	[1]
	Proportion of children and young people (6 to 14 years) who are not attending school	2000 2010	[1]
	Proportion of 19 to 21 years old with high school diploma	2000 2010	[1]
	Proportion of those with 25 years or more who have not ended high school	2000 2010	[1]
	Proportion of those with more than 25 years with undergraduate degree	2000 2010	[1]
Goal 5. Achieve gender equality and empower all women and girls	Proportion of seats held by women in national parliaments and local governments	2001 2015	[2]
	Proportion of male time spent on household activities compared to female time	2004 2014	[5]
Goal 6. Ensure availability and sustainable management of water and sanitation for all	Proportion of household using safely managed drinking water services	2001 2015	[6]
	Proportion of household with wastewater safely treated	2001 2015	[6]

	Proportion of local administrative units with established procedures for participation of local communities in environment management (with Conselho de Meio Ambiente)	2001 2013	[6]
	Proportion of local administrative units with established and operational policies on environmental care (with Fundo Municipal de Meio Ambiente)	2001 2013	[6]
Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all	Proportion of population with access to electricity	2000 2010	[6]
Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	Annual growth rate of real GDP	2003 2015	[6]
	Youth (15-24 years) unemployment rate, by sex	2001 2015	[6]
	Proportion of informal employment in non-agriculture employment, by sex	2002 2015	[6]
	Average hourly earnings of female and male employees (proportion)	2001 2015	[6]
	Proportion of youth (aged 15-24 years) not in education, employment or training	2004 2014	[6]
	Proportion of children engaged in child labor, by sex	2001 2011	[6]
	Frequency rates of fatal and non-fatal occupational injuries, by sex	2001 2011	[3]
Goal 10. Reduce inequality within and among countries	Working poor (proportion of those earning half minimum wage)	2001 2015	[6]
	Gini Index, by sex	2000 2010	[1]
Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable	Proportion of household with urban solid waste regularly collected	2001 2015	[6]
	Proportion of urban solid waste regularly collected and with adequate final discharge out of total urban solid waste generated	2000 2008	[6]
	Proportion of local administrative units with environmental law	2002 2013	[6]
	Proportion of urban population living in slums, informal settlements or inadequate housing	2001 2015	[6]
Goal 12. Ensure sustainable consumption and production patterns	Pesticides commercialized by planted area (kilogram per hectare)	2005 2014	[6]

Goal 13. Take urgent action to combat climate change and its impacts	Greenhouse gas emission (carbon dioxide CO_2)	2001 2015	[7]
	Greenhouse gas reduction (carbon dioxide CO_2)	2001 2015	[7]
Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	Proportion of victims of violence	2001 2015	[4]
	Proportion of children whose births have been registered with a civil authority	2001 2015	[4]
Goal 17. Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development (Technology)	Fixed Internet broadband subscriptions per 100 inhabitants	2003 2015	[6]
	Proportion of 10 years old and more using internet, per 1000 inhabitants	2005 2015	[6]

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