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SUSTAINABLE DEVELOPMENT EFFICIENCY ANALYSIS OF BRAZIL AND OECD COUNTRIES

ANÁLISE DE EFICIÊNCIA DO DESENVOLVIMENTO SUSTENTÁVEL DO BRASIL E DOS PAÍSES DA OCDE

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RESUMO

O desenvolvimento de um país não está relacionado apenas ao seu crescimento econômico, uma vez que seu desenvolvimento sustentável deve considerar aspectos sociais, econômicos e ambientais. Este trabalho pretende medir e analisar a eficiência do Brasil e dos países da OCDE (Organização para o Desenvolvimento Econômico e de Cooperação) sob o ponto de vista do desenvolvimento sustentável, visto a atual ambição do Brasil em compor a OCDE. Esta análise utilizou um método de programação matemática denominado Análise Envoltória de Dados (DEA), que permitiu, a partir do modelo SBM e da análise de janelas, avaliar a capacidade dos países de reduzir os *inputs* (emissão de CO_2, consumo de energia, taxa de desemprego e índice de Gini), bem como aumentar os *outputs* (expectativa de vida, PIB, energia sustentável, saneamento básico). A comparação entre os países foi feita a partir do *ranking* de eficiência sustentável e os resultados deste estudo indicaram que a Letônia e o Chile são os mais eficientes; e em quarto lugar está o Brasil. Além disso, foram analisadas as folgas relativas e concluiu-se que, embora o Brasil não seja *benchmark* em nenhuma variável, suas folgas são relativamente baixas. Ressalta-se que o índice medido é importante para contribuir nas discussões relacionadas à avaliação da sustentabilidade dos países, ajudando a identificar aqueles com as melhores práticas no que diz respeito a aspectos sociais, econômicos e ambientais; e orientar as decisões políticas relativas aos incentivos governamentais para promover o desenvolvimento dos países em busca de uma produção mais sustentável.

ABSTRACT

The development of a country is not related to only its economic growth, once its sustainable development should consider social, economic and environmental aspects. This work intends to measure and analyze the efficiency of sustainability in Brazil comparing to other countries of OECD (Organization for Economic and Cooperation Development), understanding the current ambition of Brazil to compose the OECD. This analysis used a mathematical programming method called Data Envelopment Analysis (DEA), which enabled, from the SBM model and the window analysis, to evaluate the ability of countries to reduce the inputs (CO_2 emission, energy consumption, unemployment rate and Gini index), as well as to increase the outputs (life expectancy, GDP, sustainable energy, sanitation of quality). The comparison between the countries was made using the sustainable efficiency ranking and the results of this study indicated that the Latvia and Chile is the most efficient and in the fourth place there is Brazil. Moreover, relative slacks were analyzed and it was concluded that, although Brazil is not a benchmark in any variable, its slacks are relatively low. The index measured is important to contribute to the discussions related to evaluating the countries sustainability, helping to identify those with the best practices with regard to social, economic and environmental aspects; and guide policy decisions regarding government incentives to promote the development of countries in search of more sustainable production.

INTRODUCTION

Economic growth plays a vital role in countries' economic and human development. Nevertheless, the exploratory disposition experienced during the past centuries resulted in the increased consumption and production, which brought consequences for society, such as climate changes, global warm (Jabbour, & Santos, 2009) and social inequality (Sebastian, & Sebastian, 2016).

The sustainable development emerged to convert the humanity´s understanding of the environment, as well as to improve socioeconomic interaction (Van Bellen, 2002). Thus, countries that seek to achieve their full development and that have a long-term vision – about their resources and quality of life of the current and future generations - align their actions to achieve goals that reach social, environmental and economic factors, which make up the Triple Bottom Line, in other words, the pillars of sustainability highlighted by Elkington in 1997.

In order to establish partnerships for development and improve the population´s quality life, some countries join specific organizations, including the Organization for Economic and Cooperation Development (OECD). Founded in 1961, OECD currently comprises 37 countries and requires them to meet certain standards in the economic, commercial, social and environmental fields. There are several policies and public agreements that seek to promote a "green growth" for the countries involved (OECD, 2006). However, their success depends on how each government implements these policies and the progress of the technology involved (Shen, Boussemart, & Leleu, 2017). For many years, Brazil has been held as OECD partner and, in 2017, required to become a member of the organization as well. Although the country has achieved the intention of supporting from the United States in January of 2020, Brazil is still awaiting approval by part of the organization council (Tuon, 2020).

Thus, establishing criteria for comparisons between these countries is relevant to understand the position of each one and their competitive advantages. Therefore, considering the need to measure performance in a historical context in which the economic development needs to be accompanied by the environmental preservation and human development, the analysis of sustainability indicators is essential for such comparisons (Luukkanen, 2019).

In this context, the objective of the current research is to analyze the performance of Brazil in comparison to the OECD countries, with regard to their sustainable efficiency, through the development of sustainable indicators, in order to ensure an understanding of the position that Brazil is. To this end, variables that consider the three pillars of sustainability were considered, based on a methodological analysis that uses the technique of Data Envelopment Analysis (DEA), with the Slacks-Based Measure (SBM) model. Comparisons of countries will also be carried out considering their relative slacks.

Previous studies on sustainable efficiency through the DEA method (Zhou, Yang, Chen, & Zhu, 2018) demonstrate its applicability and relevance for checking and monitoring the level of the sustainable development of its samples. Based on this, the present study adds the exploration of countries and variables that were not covered in other studies (Apergis *et al.*, 2015; Zhou & Ang, 2008; Rashidi; Shaban & Saen, 2015), seeking to provide, in addition to the general indicator of sustainable efficiency, a direction for government policy strategies, through information such the results of the relative slacks for the countries analyzed.

The following chapters are organized as follows: section 1 discusses the concept of sustainable development, as well as the importance of using sustainable indicators; section 2 presents the method used in the work, as well as the technique of Data Envelopment Analysis; section 3 presents and discusses the results that were found; lastly, the conclusions are discussed in section 4.

1. SUSTAINABLE DEVELOPMENT

The development sustainable concept was built based on ideas from the eco development provided and evidenced through global conferences and publications. The first conference about those questions was Stockholm Conference, in Sweden, in 1972. The Stockholm Conference can be considered an international political landmark due to the awareness of nations on social and environmental issues (Penedo *et al.,* 2016).

Although it was essential for the emergence of sustainable development, it was only with the publication of Brundtland report "Our Common Future", in 1987, that its definition started to be consolidated (Szopik *et al*., 2018). It was defined that sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs (United Nations, 1987), showing the importance of the rational use of natural resources. The Brundtland Report was also a great foundation for the Rio 92 International Conference, which highlighted the importance of developing new research and tools for assessing sustainability and development through the implementation of Agenda 21 (Azar & Lindgre, 1996; Penedo *et al*., 2016).

In order to integrate the concept of sustainable and the development from an organizational, national, global point of view, the researcher and consultant Elkington, established the term Triple Bottom Line (TBL) in which he defines three dimensions, closely linked to each other, motivating the pillar to foster the sustainable development; they are: environmental, social and economic dimensions. According to Elkington (1997), the isolated action of each one does not characterize sustainable systems or organizations, but the broad and integrated action of the three mentioned variables (Elkington, 1997).

The TBL concept has subsequently been used by several studies and organizations (Wilson, 2014), including the 2005 United Nations World Assembly, which addressed the need for balance between environmental, social and economic demands and stated "We reaffirm that development is a central goal in itself and that sustainable development in its economic, social and environmental aspects constitutes a key element of the general structure of the activities of the United Nations" (UN General Assembly, 2005).

The same organization published, in September 2015, the Agenda 2030, setting the 17 Global Goals for the Sustainable Development (SDGs). Such goals seek, in essence, to contemplate the Human Rights (Szopik, 2018; United Nations in Brazil, 2015) and influence the integration of sustainable development through decision-making and policy processes, recognizing that the end of poverty must be linked to sustainable economic growth strategies (Luukkanen, 2019; Megyeiova, 2018). Table 1 introduces the 17 proposed goals.

Table 1. 2030 Agenda - Sustainable Development Goals.

1. Poverty eradication	7. Clean and affordable energy	13. Action against global climate change
2. No hunger	8. Decent work and economic growth	14. Life on water
3. Health and wellness	9. Industry, Innovation and Infrastructure	15. Land life
4. Quality education	10. Reduction of inequality	16. Peace, justice and effective institutions
5. Gender equality	11. Sustainable Cities and Communities	17. Partnerships and means of implementation
6. Portable water and sanitation	12. Responsible consumption and production	

Source: Sustainable Development Goals (2015).

In order to monitor the status and dynamics of the variables that are part of the Sustainable Development Goals for OECD member countries, Megyesiova and Lieskovska (2018) use univariate statistical methods and multivariate analysis. Added to this, Zafar *et al*. (2020) emphasize that the difficulty of achieving the SDGs is also imposed on developed countries. They also show the importance of using renewable energy and education to promote environmental quality and reduce CO_2 emissions, in addition to the positive impact of using renewable energy for economic growth.

1.1 INDICATORS OF SUSTAINABILTY

According to Endenhofer *et al*. (2014), the consolidation of sustainable development requires multidisciplinary factors and efforts from all areas, as well as the monitoring of results for possible inferences and decision-making (Endenhofer *et al*., 2014). For this, it is essential to use indicators that explore the necessary aspects and establish methods that configure the synergy between the dimensions of sustainability (Gaspar, Marques, & Fuinhas, 2017; Bossel, 1997), ensuring the balance of development and fulfillment of the 17 Sustainable Development Goals (Luukkanen, 2019).

Regarding sustainability indicators, Van Bellen (2002) argues the need for the interrelationship of different types of specific indicators, such as social, health, environmental and economic indicators, since such indicator systems cannot, by themselves, be considered sustainability indicators (Van Bellen, 2002). Chapter 8 – The integration between environment and development in decision making – of Agenda 21, expresses such relevance and states that countries should develop systems for monitoring and evaluating the progress towards sustainable development, adopting indicators that measure changes in the economic, social and environmental dimensions (Agenda 21 Global, 1992).

Several studies adopting the DEA methodology were carried out in order to analyze sustainable aspects of institutions or countries through the creation and analysis of efficiency indicators (Zhou *et al*., 2018). Camioto *et al*. (2018) used the method to evaluate Latin American countries considering the period from 1991 to 2013, whose result presents Brazil in first place in the ranking of renewable and sustainable energy efficiency. In the case of OECD countries, most of the previous studies are also related to their energy efficiency.

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Zhou and Ang (2008) apply different DEA linear programming models to measure energy efficiency performance in 21 OECD countries from 1997 to 2001. While, with the same intention, Apergis *et al*. (2015) combine the GLMM–MCMC (Generalized linear mixed model - Markov chain Monte Carlo methods model) and SBM variant of the DEA methods, but for a selection of 20 OECD countries and for the period from 1985 to 2011. The results reveal that the energy efficiency levels for the analyzed countries are high, but they decrease over time (Apergis *et al*., 2015).

Xie *et al*. (2014), in addition to analyzing the members of the OECD, include countries considered emerging market, BRICS, in their work. However, the research in question also applies the SBM for analysis of indices related to environmental energy efficiency. In this sense, although previous studies have been of great relevance for the construction of sustainable indicators and for targeting the countries analyzed, this paper explores the results even more, adding social, environmental and economic variables, in addition to making a comparison with Brazil, thus filling gaps in current literature.

2. DATA AND METHOD

This research is based on a methodological study that uses the technique of Data Envelopment Analysis (DEA) to generate efficiency indicators for sustainable development through comparisons between Brazil and 34 countries of the OECD, which represent the most economically developed countries.

Data envelopment analysis corresponds to a mathematical programming method for evaluating comparative efficiencies of Decision-Making Units, the DMU, whose representation is made through performance variables of a production system called inputs and outputs. The DEA technique assumes that if a DMU is capable of producing a certain output using X inputs, then other units can also perform the same, if they are acting efficiently (Shen, Boussemart, & Leleu, 2017).

In this sense, the objective of this method is to identify the DMUs that are not being efficient and define the origin of such inefficiencies. This methodology considers several linear programming methods to construct a nonparametric surface as frontier on the data (Coelli *et al*., 2005). The calculation of the efficiencies is made from the comparison with the projection on the frontier, that is, an optimal standard for the Decision-Making Units (Wang & Chin, 2010). Therefore, the results will always be limited between 0 and 1 or else in percentage values. In this way, maximum efficiency is reached when it is at the border (Cooper, 2006).

The DMUs considered in this work represent the OECD countries and Brazil. Therefore, their relative efficiencies were compared to each other by generating a ranking with sustainable indicators. Furthermore, according to sustainable efficiencies, the relative slacks were calculated for each variable and country analyzed.

In this study, we applied the Slacks-Based Measure (SBM) model, a variant of Data Envelopment Analysis, which, according to Tone (2001), aims to minimize inputs and maximize outputs simultaneously. Furthermore, the model allows the comparison of DMUs that operate with different scales; therefore, there is no mandatory proportion in the relationship between the variation of outputs and the variation of inputs, the inverse being also true (Camioto *et al.*, 2018).

The Expressions (1) to (7) represent the SBM Variant model, from the DEA approach, according to Tone (2001):

$$Min\ \tau = t - \frac{1}{n}\sum_{j=1}^{n}\frac{S_j}{x_{J0}} \quad (1)$$

Subjected to:

$$1 = t + \frac{1}{m}\sum_{i=1}^{m}\frac{S_i}{y_{i0}} \quad (2)$$

$$\sum_{k=1}^{z} x_{jk}.\lambda_k + S_j = t.x_{j0}, \qquad para\ j = 1,2,3,\dots,n \quad (3)$$

$$\sum_{k=1}^{z} x_{ik}.\lambda_k + S_i = t.x_{j0}, \qquad para\ i = 1,2,3,\dots,m \quad (4)$$

$$\sum_{k=1}^{z} \lambda_k = t \quad (5)$$

$$\lambda_k, S_j, S_i \geq 0 \quad (6)$$

$$t > 0 \quad (7)$$

In which:

λk: Participation of DMU k on goal of DMU under analysis;

xjk: Entry quantity j of DMU k;

yik: Output quantity i of DMU k;

xj0: Entry quantity j of DMU under analysis;

yi0: Output quantity i of DMU under analysis;

z: Number of units under evaluation;

m: Number of outputs;

n: Number of entries;

Si: Output slack variable i;

Sj: Input slack variable j;

t: Linear adjustment variable.

The variables considered as inputs and outputs were defined according to the pillars of sustainability: economic, social and environmental, in addition to considering the 17 Sustainable Development Goals for 2030, the availability of data for all countries analyzed and other previous studies. All data were obtained from the World Bank website (World Bank, 2020) (Table 2).

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Table 2. Performance variables.

Category	Sustainable dimension	Variable	Unit of measurement	References
INPUT	Environmental	CO_2 emissions	Kiloton (kt)	(1) Xie *et al.* (2014) (2) Wang *et al.* (2013)
	Environmental	Energy consumption	Kilogram (kg) per capita	(1) Song *et al.* (2013) (2) Wang *et al.* (2013)
	Social/Economic	Gini index	Index from 0 to 100	(1) Thévenot (2017)
	Economic/social	Unemployment rate	% of the total workforce	(2) Rashidi *et al.* (2015)
OUTPUT	Economic	GDP	US$	(1) Song *et al.* (2013) (2) Dhahri e Omri (2018)
	Social	Life expectancy	Years	(1) Santana *et al.* (2015) (2) Megyesiova e Lieskovska (2018)
	Environmental	Sustainable energy	% of the total energy consumed	(1) Apergis *et al.* (2015) (2) Shafiei e Salim (2014)
	Environmental Social	Quality basic sanitation	% of the total population	(1) Minh e Hung (2011)

Source: Adapted from World Bank (2020).

In order to verify the behavior of indicators over time, Window Analysis was used, which consists of evaluating the performance of DMU panels for different combinations of years (windows).

With Window Analysis it was possible to run the DEA using an analogy to a moving average, in which a DMU in each distinct period is treated as if it were a distinct entity. Thus, with the application of Window Analysis, the performance of a DMU in a given period is compared with its performance in other periods and with that of other DMUs (Charnes *et al.*, 1994).

The first step in performing this analysis is to determine the size of each window and the number of windows needed. Such information can be found from the expressions (8) and (9) (Camioto *et al*., 2018).

$$p = \frac{k+1}{2} \tag{8}$$

$$n = k - p + 1 \tag{9}$$

In which:

p: means the size of the window;

k: number of periods;

n: number of windows.

In this research, the period from 2006 to 2014 (k=9). Thus, the window size (p) and the number of windows (n) are 5. Note that when a new year is added when moving from one window to another, the first one is discarded.

The SBM model allows the calculation of relative slacks, which provide guidance on how much each country needs to increase (outputs) or decrease (inputs) in a given variable in order to obtain greater efficiency, using as a reference the countries with target results (targets), also known as benchmark countries. The targets for input and output and the relative slack can be calculated from expressions 10, 11 and 12 respectively (Camioto *et al.*, 2018).

$$Input\ target = x_{j0} - S_j \qquad for\ j = 1,2,3 \dots n \tag{10}$$
$$Output\ target = y_{i0} + S_i \qquad for\ i = 1,2,3, \dots m \tag{11}$$
$$Relative\ Slacks = \frac{(target - current)}{current} \tag{12}$$

3. RESULTS AND DISCUSSION

3.1 VARIABLES ANALYSIS

An econometric analysis was performed in order to capture the statistical significance of each explanatory variable (input) in relation to each output. The equations has been estimated by the method of fixed effects. The first estimate was of the function that considered the inputs "CO_2 emissions", "energy consumption", 'Gini index" and "Unemployed rate", and the output "GDP", from 2006 to 2014, according to Expression 13. After, the equations were estimated considering as output, instead of "GDP", the variable "Life expectancy", according to Expressions 14; the variable "Sustainable energy", according to Expression 15; and the variable "Quality basic sanitation", according to Expression 16.

GDP = α + β1 . CO_2 Emissions + β2 . Energy Consumption + β3 Gini index +β4 .Unemployment rate (13)

Life expectancy = α + β1 .CO_2 Emissions + β2 .Energy Consumption + β3 . Gini index +β4 . Unemployment rate (14)

Sustainable energy = α + β1 . CO_2 Emissions + β2 . Energy Consumption + β3 . Gini index +β4 . Unemployment rate (15)

Quality basic sanitation = α + β1 . CO_2 Emissions + β2 . Energy Consumption + β3 . Gini index +β4 . Unemployment rate (16)

Table 3. Econometric estimates for the variables

[	GDP	Life expectancy	Sustainable energy	Quality basic sanitation
CO_2 Emissions	2.452e+06***	3.84e-08	-7.73e-06*	3.50e-06
	(100,650)	(3.62e-07)	(4.39e-06)	(2.43e-06)
Energy Consumption	-4.854e+07*	-5.53e-06	0.000891	0.000596
	(2.713e+07)	(0.000193)	(0.00131)	(0.000505)
Gini index	-6.216e+09	-0.0162	0.437*	-0.847**
	(1.008e+10)	(0.0926)	(0.255)	(0.334)
Unemployment rate	8.773e+08	0.143***	0.491***	0.366***
	(3.375e+09)	(0.0212)	(0.0745)	(0.116)
Constant	7.770e+11**	78.25***	-0.0412	105.6***
	(3.862e+11)	(3.683)	(9.819)	(10.20)
Observations	272	272	272	272
Number of paC-s	34	34	34	34

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Authors (2020).

Table 3 shows the input "CO_2 emissions" is significant for "GDP" and "Sustainable energy" variables. The input "Energy consumption" is significant for "GDP" variable. "Gini index" is significant for “Sustainable energy” and “Quality basic sanitation” variables; and “Unemployment rate” is significant for “Life expectancy”, “Sustainable energy” and “Quality basic” variables.

It is possible to observe that each input is significant to at least one output, and there is no variable that is not significant to any other variable. This way, it was considered interesting to include in the DEA all the variables analyzed in order to incorporate the three pillars of the triple bottom line in the analysis.

Furthermore, the fact that the input variables "CO_2 emissions" and “Energy consumption” are not fully independent was considered, since the consumption of fossil fuels is considered as information for the variable “Energy consumption”, as well as for the variable "CO_2 emissions". Therefore, there is a bias for the countries in which the energetic consumption of fossil fuels is high, since for them any reduction in energy consumption suggested by DEA will also automatically generate a reduction in CO_2, and this cannot be considered in the analysis. This bias will ultimately penalize the countries that have an energy matrix that is more dependent on fossil energy sources, and its distance to the frontier estimated by DEA would be greater than the real one.

3.2 EFFICIENCY RANKING

Through the application of the DEA method, the sustainable efficiency ranking was built, which establishes the countries that obtained the best results in relation to the performance variables adopted, that is, the countries that are more efficient in terms of maximizing outputs and minimizing inputs for the period considered. It is noteworthy that the ranking was prepared from the average of the five analyzed windows. The results are in Table 4.

Table 4. Ranking of indicators for sustainable efficiency.

Ranking	Country	Window 1	Window 2	Window 3	Window 4	Window 5	Average	Deviation
1	Chile	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	0.00%
2	Latvia	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	0.00%
3	Turkey	100.00%	100.00%	99.24%	100.00%	100.00%	99.85%	0.76%
4	Brazil	99.27%	99.64%	98.90%	97.82%	98.07%	98.74%	1.90%
5	Sweden	100.00%	98.93%	98.36%	98.36%	97.83%	98.69%	2.88%
6	Iceland	98.83%	98.50%	97.36%	97.63%	99.19%	98.30%	3.00%
7	Slovenia	97.23%	100.00%	100.00%	100.00%	92.76%	98.00%	5.61%
8	Switzerland	97.50%	96.63%	96.63%	98.50%	96.62%	97.18%	4.39%
9	Norway	100.00%	94.41%	94.50%	97.02%	96.09%	96.41%	6.17%
10	Italy	94.81%	99.09%	98.89%	97.26%	90.83%	96.17%	6.62%
11	Portugal	91.85%	94.64%	100.00%	100.00%	91.71%	95.64%	8.15%
12	Denmark	91.89%	92.98%	94.46%	97.77%	96.04%	94.63%	6.45%
13	Hungria	93.90%	96.38%	95.41%	91.11%	94.00%	94.16%	9.74%
14	France	97.26%	92.06%	95.00%	93.86%	92.49%	94.13%	6.57%
15	Austria	93.39%	92.76%	91.17%	93.16%	98.15%	93.73%	8.63%

16	Finland	94.11%	95.10%	92.15%	91.52%	91.94%	92.96%	7.69%
17	Germany	92.06%	88.58%	91.81%	95.05%	94.28%	92.35%	8.63%
18	United States	97.63%	95.39%	90.32%	86.11%	86.88%	91.27%	9.36%
19	Luxembourg	84.95%	93.67%	92.26%	93.75%	87.90%	90.51%	14.92%
20	Mexico	94.47%	89.53%	89.87%	87.78%	89.86%	90.30%	13.99%
21	Netherlands	81.62%	87.69%	93.34%	87.39%	92.76%	88.56%	17.84%
22	Lithuania	86.28%	83.09%	90.74%	82.36%	90.89%	86.67%	20.09%
23	Spain	80.85%	84.67%	89.47%	86.78%	85.94%	85.54%	11.70%
24	Estonia	89.93%	88.81%	77.22%	76.87%	83.47%	83.26%	25.40%
25	United Kingdom	89.10%	85.18%	83.74%	78.27%	77.67%	82.79%	21.30%
26	Greece	72.15%	66.07%	73.10%	66.41%	71.06%	69.76%	21.21%
27	Canada	60.21%	59.16%	60.65%	62.20%	61.10%	60.67%	3.32%
28	Slovakia	59.50%	61.89%	54.17%	54.98%	62.62%	58.63%	18.41%
29	Czech Republic	41.66%	43.42%	46.13%	65.65%	71.34%	53.64%	17.31%
30	Poland	48.79%	53.00%	54.00%	53.96%	50.54%	52.06%	4.85%
31	Israel	55.61%	42.04%	39.47%	51.16%	33.31%	44.32%	18.56%
32	Ireland	35.76%	35.29%	37.59%	40.20%	41.32%	38.03%	6.33%
33	South Korea	12.29%	14.24%	17.88%	45.77%	62.76%	30.59%	29.24%
34	Belgium	22.09%	25.68%	28.98%	32.53%	36.27%	29.11%	7.80%

Source: Authors (2020).

Chile and Latvia are the first position in the ranking, simultaneously, since both countries achieved 100% efficiency, that is, both managed to generate more output with less input, when compared to the other countries in the sample. According to the OECD (2019), Latvia is among the leaders in the use of sustainable energy in the countries of the group, in addition, it has been working since 1990 to reduce the emission of greenhouse gases.

In Chile, green economies are expanding and the country has strengthened its institutional framework for environmental management at the national level. In addition, the Chilean economy grew by around 5.4% annually between 2010 and 2014, more than double the average for OECD countries. However, as of 2014, this growth rate began to slow down due to falling raw material prices and the effects of the global economic crisis (OECD, 2016; OECD,2018).

Turkey ranks third and Brazil ranks fourth, with an average efficiency of 98.74%, thus placing itself ahead of many countries in the sample. Brazil has a great biodiversity, as well as hydrocarbon and mineral reserves. Furthermore, its energy matrix is based on hydraulic and biofuel sources, which helps to maintain a low-carbon economy. In 2014, Brazil was the seventh largest investor in the world in renewable energy sources (BNEF, 2015; OECD, 2018).

Although Brazil is well positioned in the ranking, from the third window onwards its efficiency decreases slightly. One of the factors that may have caused this decrease is the drop in the country's growth rate (World Bank, 2020). On the other hand, some countries that promoted

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low efficiency promoted advances over time, such as Belgium, South Korea and the Czech Republic (Table 2).

3.3 RELATIVE SLACKS ANALYSIS

Based on the results obtained in Table 4, the relative slacks by variable were calculated, which are found in Table 5. It is important to emphasize that the greater the slacks, the greater the distance from the target results, that is, the more it is necessary to increase or decrease the variable for better efficiencies. Talking that into account, countries with 0% slack are considered references or benchmarks.

Table 5. Relative slacks by performance variable.

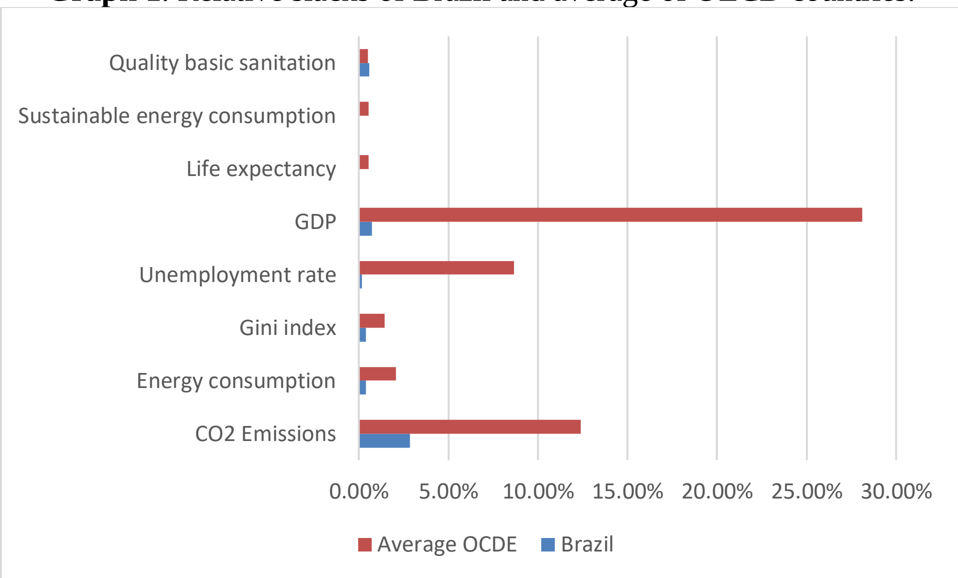
Country	CO_2 Emissions	Energy consumption	Gini index	Unemployment rate	GDP	Life expectancy	Sustainable energy consumption	Quality basic sanitation
Germany	3.54%	0.00%	0.15%	9.22%	0.00%	0.51%	0.20%	0.00%
Austria	10.91%	0.55%	0.31%	0.06%	15.93%	0.62%	0.00%	0.00%
Belgium	54.51%	1.52%	2.53%	11.02%	4.25%	1.62%	2.76%	0.00%
Brazil	2.84%	0.39%	0.39%	0.18%	0.73%	0.02%	0.02%	0.60%
Canada	53.34%	36.27%	15.87%	35.58%	0.00%	0.10%	0.58%	0.62%
Chile	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
South Korea	38.39%	9.97%	0.47%	0.00%	0.02%	1.38%	4.37%	0.00%
Denmark	4.37%	0.00%	0.00%	5.25%	8.66%	0.44%	0.10%	0.31%
Slovakia	2.94%	0.00%	0.00%	42.38%	161.61%	4.37%	0.60%	1.38%
Slovenia	0.00%	0.00%	0.00%	0.74%	7.55%	0.12%	0.07%	0.58%
Spain	15.00%	0.00%	1.90%	25.17%	1.87%	0.16%	0.31%	0.00%
United States	5.18%	1.65%	1.09%	9.52%	0.00%	0.31%	0.19%	0.00%
Estonia	0.00%	2.71%	0.91%	4.69%	133.93%	0.19%	0.00%	0.02%
Finland	7.87%	5.16%	0.00%	2.90%	12.87%	0.58%	0.08%	0.05%
France	0.04%	0.49%	0.79%	1.83%	0.00%	0.07%	0.19%	0.20%
Greece	31.23%	0.00%	0.31%	11.43%	31.05%	0.00%	0.68%	0.97%
Hungary	0.31%	0.00%	0.00%	3.87%	23.50%	0.60%	0.10%	0.07%
Ireland	18.16%	0.00%	0.43%	41.06%	102.83%	0.00%	1.62%	4.37%
Iceland	0.00%	0.44%	0.21%	5.61%	4.88%	0.15%	0.00%	0.68%
Israel	31.07%	0.00%	17.59%	27.58%	158.57%	0.20%	1.38%	1.62%
Italy	4.49%	0.09%	0.57%	0.09%	0.00%	0.05%	0.12%	0.07%
Latvia	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.08%
Lithuania	0.00%	0.69%	1.28%	3.05%	70.75%	0.97%	0.15%	0.10%
Luxembourg	0.00%	0.73%	1.32%	0.23%	5.53%	0.10%	0.44%	0.16%
Mexico	1.92%	0.00%	0.01%	0.00%	9.33%	0.00%	0.16%	2.76%

Norway	5.83%	4.09%	0.44%	1.31%	4.70%	0.10%	0.00%	0.51%
Netherlands	4.20%	1.06%	0.00%	1.85%	0.00%	0.07%	0.51%	0.10%
Poland	64.51%	0.00%	0.00%	9.89%	47.01%	1.22%	1.22%	0.44%
Portugal	0.00%	0.00%	0.17%	1.22%	12.20%	0.00%	0.10%	1.22%
UK	1.08%	0.00%	0.91%	3.90%	0.00%	0.68%	0.62%	0.10%
Czech Republic	45.85%	0.00%	0.00%	22.15%	102.01%	2.76%	0.97%	0.12%
Sweden	1.46%	0.81%	0.04%	2.60%	2.09%	0.08%	0.05%	0.19%
Switzerland	2.42%	1.70%	0.61%	1.23%	6.22%	0.19%	0.07%	0.19%
Turkey	0.14%	0.00%	0.00%	0.00%	0.23%	0.00%	0.00%	0.15%
OCDE average	12.39%	2.06%	1.45%	8.65%	28.11%	0.53%	0.53%	0.52%

Source: Authors (2020).

In Table 5 it is possible observe that Brazil is not a benchmark in any variable, since none of the slacks was 0%; however, it maintains its highest slack index at 2.84% for CO_2 emissions, thus obtaining slacks considerably below the average among OECD countries (Graph 1). Despite the slack for the Gini index being only 0.39% and for the GDP, 0.73%, the OECD (2018) points to the need for programs to improve these variables, since income inequality remains huge in Brazil, in addition to the fact that, as of 2012, its economic growth has slowed down (OECD, 2018).

Graph 1. Relative slacks of Brazil and average of OECD countries.



Source: Authors (2020).

On the other hand, the United States, the world's largest economy currently, stands out as a benchmark for GDP, as expected, and for Quality Basic Sanitation, but it has a representative slack for the Unemployment Rate (9.52%), indicating relationship with the 2008 crisis, which triggered an increase in the Unemployment Rate, reaching, in 2010, 9.63% (World Bank, 2020).

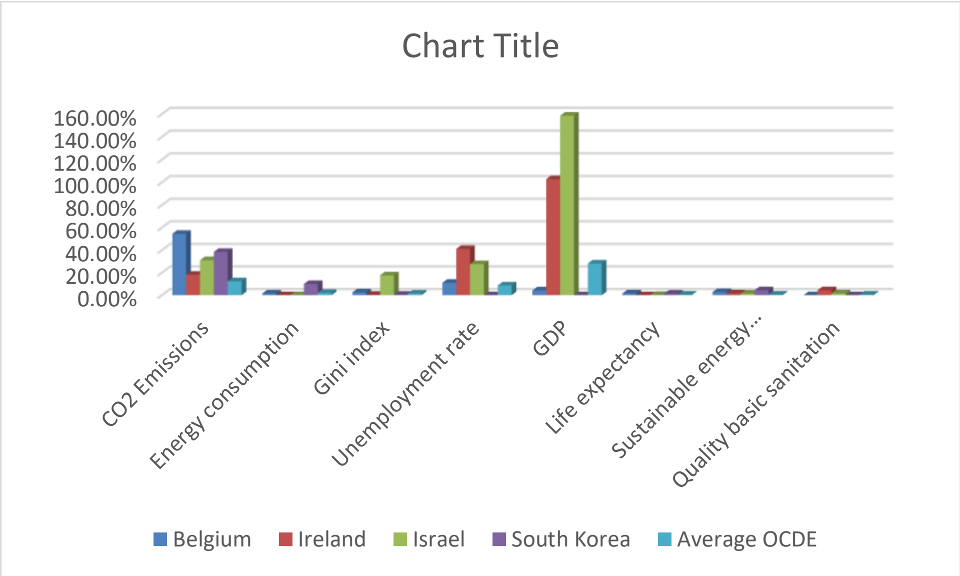
Some slacks related to GDP draw attention to the great need to improve the performance of this output for certain countries, since they present a percentage greater than 100% of slack. Among such countries are Slovakia (161.61%), Estonia (133.93%), Israel (158.57%), Ireland (102.83%) and the Czech Republic (102.01%), countries whose days off in other variables are not as representative, being even characterized as a benchmark for certain items.

Four countries achieved sustainable efficiency below 50%, namely: Israel (44.32%), Ireland (38.03%), South Korea (30.59%) and Belgium (29.11%). Analyzing their relative slacks, it is noted that Belgium could improve its sustainable performance if it improves the CO_2 Emissions (54.51%) and Unemployment Rate (11.02%) rates at the same time as South Korea, the CO_2 Emissions (38.39%) and Energy Consumption (9.97%) rates. For Ireland, the importance of improving GDP (102.83%), Unemployment Rate (41.06%) and CO_2 Emissions (18.16%) are highlighted. For Israel, GDP (158.57%), CO_2 Emissions (31.07%), Unemployment Rate (27.58%) and Gini index (17.59%).

Through Graph 2, it is observed that the relative slacks, related to the variables of GDP, CO_2 Emissions and Unemployment Rate, are highly representative for countries with efficiency below 50%. Thus, it is assumed that, for them to obtain better sustainable efficiency indices, it is necessary to invest in public economic policies in order to reduce unemployment and promote GDP growth, as well as in actions to reduce emissions of CO2, as the replacement of fossil fuels by renewable energy sources (Arndt, Hartley, & Mondal, 2019).

It is also observed (Graph 2) that considering the average of slacks in the OECD countries, there is also a greater representation, but in a smaller proportion, of relative slacks for the GDP variables (28.11%), CO_2 Emissions (12.39%) and Unemployment Rate (8.65%), making use, therefore, of the same considerations above regarding the improvement of sustainable efficiency indices for OECD countries in general, considering the period analyzed.

Graph 2. Relative slacks for countries with sustainable efficiency below 50% and average for OECD countries.



Source: Authors (2020).

4. CONCLUSION

In this study, the importance of sustainable development for the entire evolution of a country or institution was evidenced, based on indicators that explore the pillars of sustainability and establish methods that configure a synergy between its dimensions. The analyzes and comparisons made led to the conclusion that Brazil occupies an advantageous position in terms of its sustainable development in relation to OECD countries, occupying the fourth position in the ranking of sustainable efficiency (98.74%), which demonstrates that it concerned itself with contemplating and promoting economic, social and environmental aspects over time. However, of course, some issues need to be explored for Brazil to present better results, such as the resumption of its economic growth and the continuity of the process of overcoming social challenges, such as social inequality, at the same time, conservation and the sustainable use of its environmental assets.

In addition, through the analysis of relative slacks, it was shown that, in general, GDP, CO2 Emissions and the Unemployment Rate are the main variables that OECD countries, especially with low sustainable efficiency indices, need improve to achieve better results in the ranking elaborated.

It is important to consider that, due to lack of data, this research does not analyze all the variables necessary to ensure the sustainable development of a country, such as educational variables. Furthermore, data up to 2014 were covered, so the results of recent public policies are not included in the study. It should also be noted that the countries have their differences and that, using the DEA method, we can have a direction and not an exactness regarding which variable needs to be improved.

Finally, despite the limitations, the method proved to be effective in generating indicators that unify economic, social and environmental aspects, as well as in guiding the position in which Brazil finds itself regarding its sustainable efficiency compared to the countries of the OECD. In addition, the index measured is important to contribute to the discussions related to evaluating the countries sustainability, helping to identify those with the best practices with regard to social, economic and environmental aspects; and guide policy decisions regarding government incentives to promote the development of countries in search of more sustainable production.

For future works in the area, it is important to analyze the insertion of different variables and research on the impact of the COVID-19 pandemic on the ranking, in order to show how each country is reacting to the changes promoted by the scenario in question.

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