Country performance in industry and economic development and poverty eradication: A benchmarking approach applied to SDGs 1, 8 and 9

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Abstract

This study is based on the benchmarking technique, widely used nowadays to solve a problem present in governments and institutions, regarding the lack of monitoring of the evolution of productivity in the face of the "Sustainable Development Goals (SDGs)", of the 2030 agenda of the United Nations Organization (UNO). In this case, the benchmarking method used is the Data Envelopment Analysis (DEA) method and the Malmquist productivity indexes, implemented in the MATLAB software, which allowed verifying the behaviour of 85 countries belonging to different profile groups of nations, such as developing, emerging and developed countries, in the face of SDGs 1, 8 and 9. A literature review was also conducted in order to understand which conclusions and proposals have already been identified in the face of this type of problem, these SDGs and this method applied. Based on the results obtained, the behaviour and evolution of productivity of each country profile group were analysed both for the set of influence of the three SDGs and the individual influence of each SDG. The isolated case of Portugal was also studied in the face of these two scenarios identified above. It was found that the emerging group was the one that obtained a better evolution of productivity in the set of indicators of the three SDGs, followed by developing countries. Developed countries had the best influence of SDG 1 on the evolution of productivity. The behaviour of Portugal's productivity had little influence from SDG 9, obtaining, on the contrary, a lot of influence from SDGs 1 and 8.

Keywords: Sustainable Development Goals, United Nations, Data Envelopment Analysis, Malmquist index

1. Introduction

In the current times, there is a great concern at a global level regarding several issues, such as climate change, which has been very prominent in most of the conferences of the world's heads of state. In the process of creating the Paris agreement in 2015, it was determined that the main objective would be to limit the increase in global temperature to 1.5ºC. Recently the COP 26 took place in Glasgow, which reinforced the importance of the addition of funds with the aim of helping developing countries in the fight against climate change, as well as increasing the very resilience of these countries in security in the event of increased natural disasters arising from global warming. Another issue raised nowadays is the equality of all people on the path to the extinction of poverty in all aspects, such as hunger, education and access to essential goods, among others.

All these aspects are difficult to measure and organise. For this there is a fundamental tool that countries should use to measure and visualise their behaviour in several specific points. This tool created by the United Nations (UN) corresponds to the SDGs. Through this tool, each country can guide itself in the collection of data in relation to various aspects linked to overall sustainability. After the data collection there is a great difficulty in the interpretation of measures to be taken, due to the problem of lack or difficulty in monitoring the change in productivity over the years and benchmarking analysis for SDGs 1, 8 and 9, being these one of the crucial points in the good evolution of each country or region. Solving this problem can reveal to the various countries the path they are on, thus being able to decide on actions and policies to take, in case of negative evolutions.

To solve this problem related to the lack or difficulty of monitoring productivity change, it is possible to use operational research (OI). OI began in 1945, which according to Carvalho (2014) "emerges within the Allied forces, aiming to investigate how to improve the

decisions made regarding logistical resources and the operations of the armed forces". For this same author, the study of IO intends that the respective technicians work on data through various quantitative techniques in order to support decision makers in their actions at various levels. By obtaining quantitative results, as we can review in the quote *"The OI analyst or technician works the data, obtaining quantitative elements that support decision making. However, it is the managers (or other decision agents) who define the objectives and make the decisions"*.

Within OI there is a group of non-parametric methods, where Data Envelopment Analysis (DEA) is included, according to Álvarez et al. (2020). DEA enables benchmarking work between a set of comparable observations. This comparison is carried out using mathematical programming techniques, which have given rise to various models. These models can be joined to the Malmquist indices introduced by Caves, Christensen and Diewert in 1982, according to the author mentioned above, thus allowing the analysis of productivity change in two different periods. Using this tool it is possible to collect results of productivity change for the various countries, described in chapter four of this document. The individual results for each country provide a comparison between them, identifying the countries and profile group (developed, emerging and developing countries) that stood out the most.

In this document, as mentioned above, an analysis will be made that encompasses the three country profile groups mentioned above, in order to verify how each group is evolving towards the indicators and targets of SDGs 1, 8 and 9. Developing countries comprise all countries with a low standard of living, a still developing level of industrialisation and a low Human Development Index (HDI). The emerging ones are countries that in general can no longer be considered developing, due to their HDI and average standard of living and developing industrial sector, with the exception of some that already have a strong industry. Those considered developed have a high HDI and standard of living, with low poverty rates and high levels of industrialisation.

SDGs 1, 8 and 9 were chosen for this study because these are the ones that most define which profile group a country belongs to. For the reason that these SDGs identify a country's poverty, employment, economic growth and infrastructure. These aspects named above are very important in identifying each country profile group. These SDGs are also very much related to the daily lives and well-being of the people. Another very important factor that led to their inclusion in this paper is the lack of study of them in the literature. The connection of the SDGs with the well-being of the population is present in the study by the authors Arriani & Chotib (2021), which identifies that the indicators of SDGs 1 and 8 have effects on the HDI.

With the results of the Malmquist indices for the set of the three SDGs, the five best and worst countries in each group are analysed; the evolution of each group of country profiles during the periods of analysis is verified and then compared between them; the behaviour regarding geographical areas such as continents is analysed; and the behaviour of Portugal's productivity evolution is also studied.

Given the Malmquist indices referring to the behaviour of countries for each SDG individually, an analysis is made of the evolution and behaviour of each profile group according to the SDG and the analysis of Portugal referred to above is also carried out, but for the case of behaviour towards each SDG individually.

This paper aims to perform the analysis of the productivity evolution of the countries identified in chapter four, through the DEA models, Malmquist indices and the clustering and application of an extensive amount of data related to various indicators of the three SDGs, during the period 2010-2020 of the UN agenda 2030 for these countries. These three SDGs are composed of SDG 1 (No poverty), SDG 8 (Decent work and economic growth) and SDG 9 (Industry, innovation and infrastructure). After applying the data in the referred models, the results of productivity evolution based on Malmquist indices are analysed and, finally, implications and conclusions are drawn from the analyses of these same results.

The implications and conclusions to be drawn are based on understanding and indicating how the three profile groups are evolving, which group stood out the most, which SDG influenced each profile group the most, the behaviour of these same groups in the various continents and the behaviour of the isolated case of Portugal.

This extended summary is organised into the following sections. Section 2 discusses the literature review, section 3 the methodology and case study and section 4 the discussion of results and conclusions.

2. Literature review

Through the success of the Millennium Development Goals (MDGs) during the period 2000-2015. The UN developed the 17 Sustainable Development Goals (SDGs) of the 2030 agenda, where 169 targets and 232 indicators are included. Of these 17 SDGs only three are used in this study, these being SDGs 1, 8 and 9.

In order to understand the various studies related to this theme, a literature process of 35 articles collected based on the impact factor of the journal from which they were taken and their case study, through the use of some keywords, was carried out. From these it was performed the construction of a table named literature review. This table is formed by several columns such as "Authors", "Title", "Case study", "ODS", "Methodology", "Conclusions", "Variables" and "Database". The literature review table allowed the construction of three charts showing the number of times that each indicator, belonging to SDGs 1, 8 and 9, was mentioned in all articles in the table of articles. For SDG 1, indicators 1.1.1, 1.2.1 and 1.4.1 are the three most addressed indicators. For SDG 8 the three most cited indicators are 8.1.1, 8.5.2 and in third place divided by three indicators 8.2.1, 8.4.2 and 8.6.1. Finally, regarding SDG 9, the most cited indicator was 9.4.1, in second place indicators 9.1.2 and 9.2.1 and the third indicator 9.1.1.

According to Barbier & Burgess (2019), there was an improvement in the world in general in relation to most SDG indicators during the years 2000-2016, except for SDG 8, which had a sharp decline, and SDG 9, which had a smaller decline. What stood out more positively in both country profiles (high-income and low-income countries) was precisely SDG 1. This last SDG, according to Leal Filho et al. (2021), is quite important, in the sense that the achievement of the goals and targets of the SDGs are at risk if this SDG 1 is not given due attention, and for the same author of the article, the main threats to this SDG are climate change and more recently the Covid-19 pandemic. Given that SDG 1 is more connected to the poorest countries, such as developing countries, the article of the authors Maksimov et al. (2017), indicates that for these nations it is important the existence of small and medium enterprises (SMEs), because they are the ones that sell and employ, allowing the population to retain reasonable wages above the poverty line. SMEs, according to the same authors, should undertake government contracts and promote incentives for exports to increase their efficiency and economic growth.

One of the essential tools that countries should adopt to be effective in achieving their goals in relation to the SDGs is the strengthening of international partnerships, where according to the article by Blicharska et al. (2021), there is a disparity in the division of these international partnerships in the world. As lower-income countries have fewer partnerships, and one of the main reasons for this is that they have less resource capacity, this results in greater difficulty for their development because they have less external aid. This same article also states that developed countries are more interested in partnerships related to SDG 8, that is, in terms of improving economic growth and job creation, mainly with countries that are also developed. International collaborations between developed and developing countries is higher in Europe due to its colonial legacy.

The articles also identified several inconsistencies in the UN 2030 agenda that according to Bali Swain & Ranganathan (2021), are represented by trade-offs between indicators at the SDG level, although the number of these is far fewer than the synergies found. In the same article, 66 negative interactions or trade-offs and 238 positive interactions or synergies were identified out of a total of 316 interactions. In the same article, the indicators of the most central SDGs are identified, that is, those that carry out the largest number of interconnections in each geographic region studied. Similarly, in the article by Biggeri et al. (2019) the various synergies and trade-offs between the SDGs for various countries are referred to and measured, corroborating the idea of the existence of inconsistencies in the UN agenda. The author noted that positive gains in SDG 6 and SDG 2 can drive poverty reduction in SDG 1 and that this also has synergistic relationships with SDG 3. In view of the trade-offs, the same author identified that at the expense of the negative evolution of some environmental and social SDGs, it was possible to reduce poverty SDG 1 and hunger SDG 2. The author also identifies that it is not advisable to analyse SDGs in isolation, but to relate them, due to such inconsistencies already mentioned above. For example, in this article it is mentioned that SDG 8 and 5 are at odds with each other, for the reason that SDG 8 does not recognize unpaid domestic work and that it is quite

based on the goals of SDG 5, which leads to increased exhaustion of women because they are mainly the protagonists of these domestic works.

To measure interactions such as synergies and trade-offs, the authors of the article Horvath et al. (2022) conducted a review and evaluation of 30 different methods to analyse these interactions. Qualitative methods were identified as less complex compared to quantitative methods, with both having advantages and disadvantages in the sense that one is not more suitable than the other, depending heavily on the database and information desired. The statistical method has challenges in data requirements despite presenting detailed information. And simulation and argumentative methods provide more detailed information on interactions between policies and SDGs.

Even though these inconsistencies exist in the 2030 agenda, the implementation of the SDGs is still quite important both for the well-being of society and businesses, and at the political level, according to Leal Filho et al. (2018). Sustainability is quite an important issue, especially at the level of resources and assets, before the article by Eisenmenger et al. (2020).

Another problem raised by the authors Dang & Serajuddin (2020), was some scarcity of data to track the progress of SDGs, so the authors propose that international organizations relevant in data collection should collaborate more with national organizations of each country, in order to disseminate these same data. This also points to the need to further refine the indicators of each SDG even if it is difficult, for the reason that the interpretation of the targets leads to different conclusions by various assessment methods.

In view of SDG 9, which is quite important for the development of countries' infrastructure and industries, leveraging their economies, the article by Luken et al. (2022) divides twenty sub-Saharan African countries into different clusters or groups in relation to their performance and progress towards the goals of SDG 9.

To achieve the targets proposed by SDG 8 and 9, investment is required for technological innovation and measures to transform the economy. However the article by authors Chen et al. (2021) states that there are problems mainly in developing and emerging countries. These problems assume that economic leakages such as the informal sector have a negative impact on the association of innovation and energy efficiency and that there is a lack of technological diffusion. The author cites that countries with higher level of informal sector such as developing countries have lower energy consumption per unit of production due to the informal sector being less energy intensive, i.e. the larger the informal sector the lower the energy consumption and the overall economy. To achieve energy efficiency it is necessary to improve and increase technological innovation with a focus on reducing energy consumption, but emerging economies find it difficult to achieve SDG 9 due to poor technology diffusion.

One of the drivers for the best performance of all countries to find sustainability according to the proposed goals with the UN agenda 2030, is the serious climate problem in which the world finds itself. Europe regarding this adversity should have a leading position because it is one of the continents with the greatest scarcity of natural resources as stated by Rodríguez-Antón et al. (2022). To this end, it is necessary to adopt circular economy methods that according to the same article, through a correlation analysis, it is possible to verify that the circular economy despite being important to meet sustainability, existing positive correlations in most SDGs. However, it has trade-offs, particularly with SDGs 3, 7, 13 and 15, which have negative correlations.

The combination of sustainable development and the goals stipulated with the SDGs should leave, according to Kubiszewski et al. (2022), in the sense that these have a role of policy goals that governments should implement, but countries in general have a great difficulty in understanding the 2030 agenda in order to create the best policies to adopt, as referred by the authors El-Maghrabi et al. (2018).

In framing with Leal Filho et al. (2018), the SDGs are also very much linked to politics as already mentioned by the articles in the previous paragraph, but the authors support that there should be greater transparency and sharing of the results achieved with the people themselves and international institutions and not only, the sustainability goals should not be centralized but specifically regionalized, that is, the necessary solutions to be taken should be regionally oriented.

The pandemic of covid-19 led to the stagnation and recession of various sectors in the world according to Odey et al. (2021), for whom, Africa was the continent that suffered most on the path to achieving

the SDGs, despite having contributed little in the numbers of infected globally, considering the territorial and demographic extent of this continent.

In as much as the methodology covered in chapter three, Methodology, is concerned, literature mentions that analysis via DEA and the Malmquist index enables productivity changes to be visualized, which enables future measures to be planned in a more cohesive manner. According to Álvarez et al. (2020) and Mendes et al. (2013), DEA allows benchmarking exercises through mathematical programming techniques, produce individual efficiency scores, identify efficient and inefficient units and also produce benchmark for each observation.

3. Methodology and case study

This study is based on benchmarking techniques. This is a concept widely used nowadays. Benchmarking is a procedure of constant comparison of various parameters as indicators of the SDGs for this study, or services and processes in the case of companies among the leaders in a certain sector. Benchmarking can be divided into two parts, average benchmarking methods and frontier benchmarking methods. The average benchmarking methods are based on the total productivity factor (TTP) used in the Törnqvist and Fischer indices. Regarding frontier benchmarking we have the corrected least squares (CLS) method, the stochastic frontier analysis (SFA) method and DEA where the Malmquist index implemented in this study is included.

DEA is a group of non-parametric methods that belong to operational research. It was introduced by Charnes, Cooper and Rhodes in 1978, according to Mendes et al. (2013). DEA can measure both efficiency through its basic models and productivity performance with the aid of the Malmquist Index. DEA is composed of five different basic models according to Álvarez et al. (2020). The first is the radial input oriented Model with constant or variable returns to scale (CRS and VRS respectively), the second is the radial output oriented Model with constant and variable returns to scale, the third is the directional Model with constant and variable returns to scale, the fourth is the additive Model and finally the fifth is the super-efficiency Model.

To measure productivity the Malmquist Indices are required and these are based exclusively on the concepts of input or output radial efficiency models, thus creating the link between DEA and Malmquist Indices. The value of M (Malmquist index) is greater than one means that there is an increase in productivity for a given DMU, if this same index has a value less than one it represents a drop in productivity and, finally, if the value is equal to 1 productivity remains unchanged. There is another index that calculates the change in productivity called the Hicks-Moorsteen index.

The article by authors Kerstens & van de Woestyne (2014), states that Hicks-Moorsteen does not present any computational infeasibility for all specifications and technologies and for all periods, while Malmquist presented an infeasibility between 0% and 2.72%. If the interest of the study is FTP, it is better to opt for Hicks-Moorsteen.

All theoretical concepts mentioned during the methodology were applied in MATLAB software, through the Data Envelopment Analysis Toolbox. With this tool a workspace was built in the software both for the case of the analysis of the set of the three SDGs and for the case of the individual analysis of the SDGs. After a few lines of code and placing all the necessary data it was possible to extract the results of the malmquist indices for the case mentioned above, through the following example expression.

$$malmquist1 = deamalm(X_1, Y_1, \ 'orient', \ 'io', \ 'names', DMU)$$

This study is composed of the productivity change analysis for 85 decision making units (DMU). This consists of several countries which are grouped into three different country profile groups and 25 different geographic regions. The country profile groups are developing countries consisting of 41 countries, emerging countries consisting of 11 countries and developed countries consisting of 33 countries. The division of these three profile groups allows the creation of groups or clusters that will have between them an evolution frontier, which leads to the opportunity of understanding if the evolution towards sustainability is running faster in which group or even to verify that the speed of that evolution is decreasing or accelerating.

The DEA and Malmquist index models require input data made up of undesirable indicators and output data made up of desirable indicators.

Tabel 1- Identification of desirable and undesirable indicators

Desirable indicators (outputs)	Undesirable indicators (inputs)
1.4.1, 8.1.1, 8.2.1, 8.10.1.a, 8.10.1.b, 9.1.2, 9.2.1, 9.2.2, 9.c.1	1.1.1, 8.4.2, 8.5.2, 9.4.1

After choosing the countries that ultimately represent the DMUs, and selecting the indicators that configure the study variables, it was possible to begin creating the database tables. The data in the tables were taken from the SDG tracker with the help of the World Bank. Its databases come from various institutions that track and monitor data related to the SDGs of the 2030 agenda, such as the World Bank, UN, World Health Organization, Institute for Health Metrics and Evaluation, WHO JMP, UNESCO, UN Food and Agriculture Organization.

In the course of building the database some restrictions occurred. The first restriction is that there are countries that fail in more than one consecutive year for one of the indicators and the second restriction is the presence of some countries that fail in isolated years. The first restriction is that there are countries that fail in some of the indicators in more than one consecutive year and the second restriction is the presence of some countries that fail in isolated years. In order to combat the restrictions, two resolution methods were created. For the first case of restriction it was used the trend lines relative to the previous or successive years of those failures, while for the second restriction the solution resulted from the application of the average between the values of the previous and successive year to the failure.

Throughout the process of developing the study, three different versions were considered to allow for a more robust analysis. These versions differ in the number of years and indicators analysed. The first version is the largest with regard to indicators and the smallest with regard to the number of years, while the third version has the largest number of years and the smallest number of indicators, and the second version is in between.

4. Discussion of results and conclusions

With the results extracted from the MATLAB software, we began the analysis of the results for each version and for each case study mentioned above.

The analysis of results begins with the verification of the five best and five worst developing, emerging and developed countries, in terms of productivity evolution regarding the set of indicators of the three SDGs studied.

In the first version, some oscillations of extreme positions followed were verified for some developing countries, as the case of Thailand that registered in M4 the worst position, with a Malmquist value of 0.4488 and in M5, the best country with a value of 1.4655. This discrepancy is due that in M4 Thailand between the years 2013 and 2014 worsened considerably in some indicators. In M5 the returned to approach some values of 2013 through the rise of the values in some indicators. Other countries that suffered from these oscillations were Panama, which in M1 was the best and went to the negative highlight in M2, Papua New Guinea between M4 and M5 and Democratic Republic of Congo between M6 and M7. Tanzania, on the other hand, was in the top five three times in M1, M5 and M6, and came out on top in the latter. It was never in the worst group. For emerging countries the oscillation situation was much smaller than in the case of developing countries, only Algeria in three consecutive sub-periods M3, M4 and M5. In the long-term period between 2010 and 2017, China and the United Arab Emirates stood out quite positively. Among the developed countries, the unexpected happened with Luxembourg. Luxembourg was in the worst position in the M1 period and in the productivity evolution between 2010 and 2017.

In the second version the values did not vary much from the values in the first version, both for developing, emerging and developed countries. With the values and positions of the countries from M1 to M7 not changing significantly, only some positions changed. These slight changes between M1 and M7 are only due to the elimination of two indicators in the second version from the 13 indicators in the first version. However, this version 2, as mentioned above, analyses the year 2010 to 2019. Therefore, this version has the results for M8 2017-2018 and M9 2018-2019.

With regard to the third version, the positions and results obtained for each country varied greatly

from the two previous versions. And if the year 2020 is included, it allows the evolution values to be considerably reduced for most of the countries included in this study due to the Covid-19 pandemic.

After the analysis of the five best and five worst, the results were compared with the articles in the literature. The authors Odey et al. (2021), refer that Covid-19 brought all sectors of the world to a stagnation and regression at a rate never before seen including the SDGs themselves. This idea is corroborated by the fall in productivity of most of the countries studied, through M10 of the third version, which corresponds to 2019-2020. The results obtained in the course of the study are not in agreement with the conclusions referred to in the article by Barbier & Burgess (2019), in the sense that in the literature article it refers that the low-income or developing countries were the ones that obtained the most negative results, because in this study the first two versions indicate the opposite, that the ones that had the least evolution were the developed ones.

A continental analysis was also conducted, where all the countries in the study were divided and grouped into clusters according to the continent they belong to. The Groupings consisted of Africa, Middle East and Asia, America and Europe. For the African continent only the curves for developing and emerging countries are present, for the reason that this continent does not contain any developed countries. In this continent in general, in all three versions, developing countries obtained higher values in most sub-periods than emerging countries.

For the Middle East and Asia, there is already a curve in the graphs of the three versions for the developed countries. In this continent, developed countries showed a quite stable behaviour compared to the other two profile groups. Emerging and developing countries, on the contrary, obtained large oscillations, and in the third version developing countries suffered two quite high peaks at M6 and M9, which did not happen in the other two previous versions.

The American continent in the first two versions had an irregular behaviour in the three profile groups, while in the third version between M2 and M9 the behaviour was quite stable over the various sub-periods. This indicates that the specific characteristics of this version influenced it in a very different way from the others. At the end of each version, the countries that stood out the most were the developing countries, followed by the emerging countries and, finally, the developed countries.

In relation to the European continent, there is a curve only for the developed countries because this continent does not have developing and emerging countries. During the three versions the behaviour of this profile group was different until M7. After this sub-period in the last two versions, the developed countries suffered a constant drop during the following sub-periods. One aspect that was observed in all the continents was the high fall in the productivity value for all the country profile groups in the M10 subperiod of the third version.

After the continental analysis against those of the three SDGs as a whole, the analysis of the individual influence of each SDG in the three groups of country profiles was carried out through three representative graphs.

In the group of developing countries, the influence of each SDG was quite distinct. SDG 1, in the first four sub-periods influenced an oscillatory behaviour, that is, there were two peaks. In relation to SDG 8, it is possible to observe that the behaviour of these countries towards this SDG is quite irregular throughout the various sub-periods. ODS 9 in the first four sub-periods showed a very constant variation between the sub-periods, with a rise value between M1 and M2 very similar to the rise value between M3 and M4. Finally, the SDG that best influenced developing countries was SDG 8, followed by SDG 1 and lastly SDG 9. The graph overall corroborates the idea of a greater number of developing countries with improved productivity than with decreased or unchanged productivity.

Regarding the emerging countries, SDG 1 was the only one that had a positive influence in all sub-periods, with its lowest value in the M9 sub-period equal to 1.0555. ODS 8 is the one that suffered most variations of the three ODS, having two peaks of opposite influence, that is, in M4 there was the peak with the highest value and in M6 the lowest value. The ODS 9 of the three was the most linear for this group of nations, with two peaks not very high at M3 and M7. In the last sub-period the values were close to one, with two ODS below the neutral value one, that is, only ODS 1 had a positive influence for emerging countries.

In the case of developed countries, ODS 1 always presented values higher than one, and in

subperiods M4, M5 and M8 they were quite high. SDG 8 was the only one that presented values lower than one, and these were in subperiods M2 and M3, while the remaining subperiods presented values higher than one, but not very high. ODS 9 was the one that suffered less oscillations between the various sub-periods analysed, there were only two sub-periods that stood out from those of more sub-periods, M4 and M7, these were the ones that recorded the highest value. M4 with 1.1032 and M7 with 1.0821. Finally, in M9 this obtained the value that stood out most positively from the other ODS. All sub-periods of this ODS remained above one.

The study was carried out for the case of Portugal, both for the set of the three SDGs and for the individual influence of each SDG. For the case of the three SDGs as a whole, it is possible to verify that Portugal's behaviour in the three versions is quite close and with an upward trend, except in subperiod M7 and M10 of version 3, where there was a high positive and negative peak, respectively. Regarding the individual influence of each SDG, it was found that the influence of each SDG is quite disparate, in the sense that the value of SDG 9 changed little over the various sub-periods. However, the other two ODS obtained a rather oxylatory behaviour. In the end, in M9 the three SDGs contributed positively to the evolution of productivity in Portugal, and the one that contributed most was SDG 9, followed by SDG 1.

After the results analysis it is possible to understand the policies applied by the benchmarking countries. The developing countries, despite having had the greatest evolution relative to the Malmquist index, cannot be considered the benchmark countries. On the contrary, developed countries continue to be the benchmark countries, because despite not having had the greatest increase in productivity, they continue to stand out for their high level of prosperity. The developed countries used for policy ascertainment were Germany, Canada and Japan. These countries were chosen because they belong to the group of the most industrialised countries with the most advanced economies, that is, they belong to the group of seven, better known as the G7 group and for presenting low poverty levels, very strong economies and quite high levels of industrialisation and infrastructure. For these reasons they can be considered benchmarks for SDGs 1, 8 and 9. All these countries have policies oriented towards innovation, development, export of goods with high commercial value linked to technology sectors and immigration policies for skilled workers. The latter will allow accelerating the process of innovation and modernization already mentioned above in the country's industries, enabling the increase of more efficient and competitive companies, leading the country's economy to grow.

It can be seen that although these three countries have many cultural differences and are quite distant geographically, they have very similar policies that allowed their economies to grow, good infrastructure and working conditions.

All these policies previously mentioned enabled economic growth and development of the labour market, which are the main factors associated with the goals of SDG 8. This economic development enables investment in civil and industrial infrastructure, which are the factors linked to good performance in relation to SDG 9. In turn, it enables reducing the poverty level of the population, which is related to SDG 1.

This document was developed within the scope of the study of the productivity evolution of several countries belonging to different profile groups for three SDGs 1, 8 and 9. This objective was achieved with some limitations that did not allow this document to become as complete as possible. These limitations arose mainly in the area of database construction. Overall the DEA method and the Malmquist indices performed positively within the scope of the benchmarking analysis carried out, allowing the results to be drawn for all countries, both for the set of indicators of the three SDGs and for each SDG individually. It is possible to carry out studies encompassing more countries than those available in this document, as well as including more SDGs or even all SDGs of the UN 2030 agenda. It is also feasible to carry out work related to benchmarking through other approaches and methods, such as the Hicks-Moorsteen index method.

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