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Carbon dioxide emissions: Who is responsible and who is actually doing research?

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C H R O N I C L E

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A B S T R A C T

During the past century, humans have increased atmospheric CO_2 concentration by at least a third, which is considered as the most important long-lived "forcing" of climate change. Scientists all over the world are responsible to do their best on offering practical solutions to reduce the effects of CO_2 on environment. This paper uses data envelopment analysis to measure the effects of researches accomplished by scientists from 30 countries which are representative of producing over 80% of CO_2 in the world. The study uses 10034 articles published in Scopus database from 1959 to March, 2019. The study uses the amount of CO_2 produced by each country as the input and total publications, *h*-index and *I*-10 as the output of the DEA model. The results indicate that despite the fact that China was responsible for producing nearly 30% of the CO_2, the scientists of this country contributed the least on carbon dioxide emissions. In addition, United Kingdom was responsible for about one percent of CO_2 emissions but the researchers of UK performed the best in terms of offering good quality studies.

1. Introduction

Most climate researchers believe that the current global warming trend is the results of human expansion called "greenhouse effect"[1] where the atmosphere traps heat radiating from Earth toward space. During the past century, humans have increased atmospheric CO_2 concentration by at least a third, which is considered as the most important long-lived "forcing" of climate change. Scientists all over the world are responsible to do their best on offering practical solutions to reduce the effect of CO_2 on environment[1]. Human activities are believed to be the main reason for changing the natural greenhouse. For years, the burning of fossil fuels such as coal and oil has been blamed for the concentration of CO_2. This occurs since the coal or oil burning process develops chemical reaction of carbon with oxygen in the air to generate CO_2. In other worlds, many agricultural, industry, and other human activities have increased the level of greenhouse gases. The primary consequence of green gas effect will increase temperature in most part of the world and we may expect some lands sink into the oceans. Other regions face with more natural disasters such as flood, starvation, etc. If this trends continuous, life conditions will become difficult and many people will face shortage of natural food. Therefore, it is necessary to do more studies on learning more about the green gas effects and learn how to handle the tough circumstances that next generations may face. This paper investigates how seriously scientists from major countries performed studies on carbon dioxide emissions during the past 80 years. The study uses a well-known method to measure the relative efficiency of the countries.

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2. The proposed study

The propose study of this paper uses data envelopment analysis[2] (DEA) to measure the relative efficiency of similar possibly non-financial units. The study considers different inputs and outputs and by assigning some weights for these inputs/outputs measures the relative efficiency of different units. DEA has been widely used for studies in green gas effects[3-12]. Fig. 1 shows the structure of the proposed study of this paper.

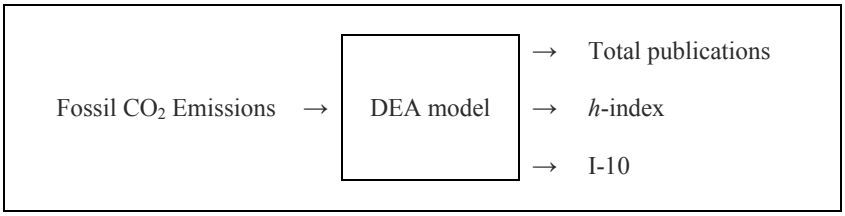

Fig. 1. The structure of the proposed method

As we can observe from the results of Fig. 1, Fossil CO_2 emissions in million ton per year is considered as the input. In other words, the more CO_2 emissions generated by each country, the stronger commitment for doing research on carbon dioxide emission. The proposed method also considers three outputs as scientometrics data; namely total publications, *h*-index and *I*-10 for measuring the effects of the studies published by each country. The output "Total publications" covers all papers published indexed in Scopus database over the period 1959-2019 with the keyword "carbon dioxide emission" in the title, keyword or abstract. Our survey has determined 10034 records of data. Next, we filtered the data based on each country and determined *h*-index and *I*-10 statistics. In our survey, the number of publications with at least 10 citations represents *I*-10 index while *h*-index is defined as the maximum value of *h* such that the given author(s) has published *h*-articles that have been cited at least *h* times[13].

Table 1
The summary of the input/output data

Country	Mt CO_2/Year Fossil Emission Per year 2017*	Total publication	h-index	I-10
China	10,877.22	1407	62	376
United States	5,107.39	1927	105	757
India	2,454.77	328	30	66
Russia	1,764.87	122	11	13
Japan	1,320.78	650	36	147
Germany	796.529	545	47	133
South Korea	673.324	207	26	54
Iran	671.45	113	16	23
Saudi Arabia	638.762	56	15	20
Canada	617.301	305	43	116
Indonesia	511.327	64	12	14
Mexico	507.183	65	15	20
Brazil	492.791	151	25	60
South Africa	467.654	76	14	22
Turkey	429.563	226	37	87
Australia	402.253	344	46	141
United Kingdom	379.15	914	74	353
Italy	361.176	288	36	122
France	338.193	229	36	80
Poland	319.028	139	13	19
Spain	282.364	192	31	84
Taiwan	279.74	200	33	69
Thailand	279.296	70	9	9
Kazakhstan	266.207	4	2	0
Malaysia	258.783	231	30	73
Egypt	258.668	42	9	9

*https://en.wikipedia.org/wiki/List_of_countries_by_carbon_dioxide_emissions

Table 1 demonstrates the summary of the data used for the proposed study of this paper. According to Table 1, China has published 1407 articles which are associated with carbon dioxide emissions. The country has published at least 62 articles received 62 times of citations and maintains 376 articles where each articles has received at least 10 citations. The country produced 10,877.22 million ton CO_2 in 2017. These 26 countries have produced about 80% of the fossil emissions per year 2017. Thus, it is important to learn who serious they are in doing research for reducing the effect of green gas effect. The implementation of DEA has provided the relative efficiency of 26 countries and **Fig. 2** presents the results of our survey.

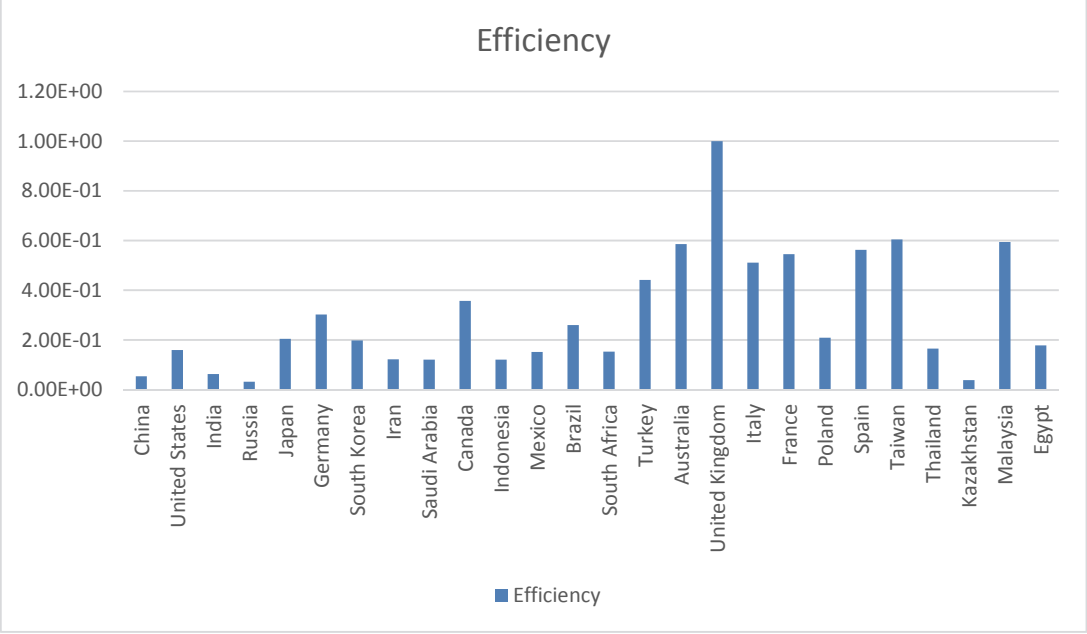

Fig. 2. The results of measuring the relative efficiency of different countries

3. Discussion

According to the results of Fig. 2, United Kingdom has been considered efficient compared with other countries in terms of generating higher good quality papers generating only about one percent of total carbon dioxide emissions. It appears that UK based researchers have been more serious about global warming. On contrast, China which is responsible for about 30% of global carbon dioxide emissions has performed poorly in terms of contributing high quality achievements for scientific society (efficiency = 0.05365). The other observations is that some developing countries such as Malaysia and Taiwan with relative efficiency of about 0.60 have maintained good contribution to scientific community despite the fact that they were not blamed by generating significant amount of CO_2 emissions. United States produced about 5107 million ton CO_2 in 2017 which is almost half of the pollution generated by China but maintained an efficiency of about 16%. Although the number seems to be better than China but it is significantly lower than many other European countries such as France with relative efficiency of 0.54 and Italy with relative efficiency of 0.51. The results have indicated that countries like China and United States with big economy are not as serious as many other developing or developed countries for supporting scientific studies on carbon dioxide emissions. Global warming is a long-term rise in the average temperature of the Earth's climate system, a climate change perspective given by temperature measurements and by multiple impacts of the warming.

3. Conclusion

This paper has presented an implementation of data envelopment analysis to measure the relative efficiency of 26 countries representing of at least 80% of carbon dioxide emissions in the world using

a well-known method called data envelopment analysis. The study has tried to measure the effects of good quality articles in this area using two scientometrics figures; namely *h*-index and *I*-10. The study has revealed that while many developing countries such as Malaysia and Turkey have successfully contributed scientific achievements on carbon dioxide emissions, many developed countries such as China and United States have performed poorly. It appears that European countries have been more serious about global warming since many of them have contributed high quality articles. While United Kingdom produced only about one percent of carbon dioxide emissions, the country has been nominated efficient compared with other 25 countries for contributing high quality articles. As public reactions to global warming and concern about its effects tend to increase, we need more awareness among researchers for placing more efforts on carbon dioxide emissions.

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