Greenhouse Gas Emissions and Digital Competitiveness in CEE countries

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Abstract: This research is focused on the relationship between greenhouse gas emissions and digital competitiveness at the macro level because of the importance of climate conditions and the use of new technologies, especially digital technologies. Greenhouse gas emissions were measured using the composite index (CI) conducted by the DEA method. Digital competitiveness is measured using the Digital Competitiveness Index (DCI) calculated by the International Institute for Management Development (IMD). The research covered 11 CEE countries: The latest available data on greenhouse gas emissions were from 2019. Correlation analysis results showed that there was no correlation between these variables. Explanations for these results can be found at the DCI level. These index values show that CEE countries do not have a high value of digital competitiveness, which indicates that digital technology adoption is not at a high level, so it still has effects on gas emissions, the environment, and climate change.

Keywords: greenhouse gas emissions, digital competitiveness, composite index, DEA approach

1. Introduction

To protect the earth's ecological security, the Paris Agreement established the following target for managing the global temperature increase: achieving the objective of decreasing the global average temperature rise to no more than 2 °C and attempting to maintain it at 1.5 °C [1]. Countries must immediately lower emitting greenhouse gases to achieve this long-term objective, and they must help the world achieve carbon neutrality.

By acting as a less formal type of environmental regulation, the digital economy has a positive impact on environmental pollution control and is creating innovative stimulation for intelligent management of the environment with information technology at its core [2,3]. The extrusion impact of the digital economy can effectively encourage the transformation and modernization of the regional industrial structure and further constrain the growth of high-energy and high-polluting industries, thereby improving environmental quality [4]. On the other hand, the growing importance of the digital economy has increased, rather than decreased, energy consumption and the energy growth effect, increasing gas emissions [5].

Because of the opposite views in the literature, the paper aims to analyse correlation between greenhouse gas emissions measured by composite index and digital competitiveness on macro level measured by Digital Competitiveness Index.

2. Data and methodology

The research covers 11 CEE countries. The variables for researching gas emissions are CO_2 emissions (kg per 2017 ppp $ of GDP), methane emissions (kt of CO_2 equivalent) and nitrous oxide emissions (thousand metric tons of CO_2 equivalent) in 2019. Data are retrieved from World Bank database [6]. The Digital Competitiveness Index is used from the IMD World Digital Competitiveness Ranking report by the International Institute for Management Development (IMD) [7].

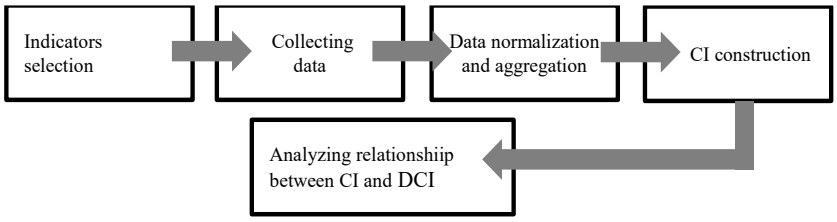

Figure 1. Research framework
Source: Authors' illustration

In order to maximize the value of the composite index for each country, the basic DEA (Data Envelopment Analysis) model posits that composite index for each country j ($j=0,1,...,m$) are calculated as the weighted sum of m indicators [8, 9, 10]. Normalization was performed in the range of 0 – 1. This results in the linear programming issue shown below for each country j [11]:

$$CI_j = \max_{wi} \sum_{i=1}^{m} y_{ij} w_i$$

In line with the sum of $y_{ik}w_i \leq 1$ and $w_i \geq 0$, where is: $i = 0,1,...,m$; $j = 0,1,...,m$; and $k = 0,1,...,n$; CI composite index, y_{ij} is indicator i for the country j, w is ponder used for aggregation and it is used m indicators for n countries.

After calculating the CI for gas emissions, the relationship between the CI and DCI was examined by correlation analysis with visualization of the results.

2. Results and Discussion

There is a positive correlation between the selected variables. There was a weak correlation between CO_2 emissions and methane emissions and between CO_2 emission and nitrous oxide emission, with Person coefficient of 0-382 and 0.353, respectively. Methane and nitrous oxide emissions showed a statistically significant positive correlation, with a Pearson coefficient of correlation of 0.964. Figure 2 shows the data distribution with scatter graphs.

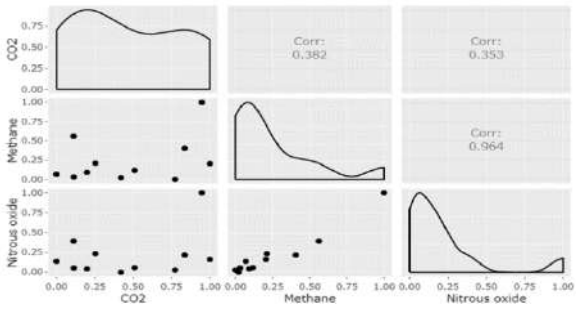

Figure 2. Correlation between individual indicators

Source: Authors

The countries with least greenhouse gas emissions measured by CI are Slovenia, Lithuania and Estonia with the highest value of CI. The worst result is achieved by Poland (CI=0). The most countries form the sample has CI value higher than 0.50. For the purposes of correlation analysis, the DCI was normalized. DCI shows that 5 countries have an index higher than 0.5. (Czech Republic, Estonia, Lithuania, Latvia, Poland and Slovenia) and 3 countries with index lower than 0.2 (Bulgaria, Croatia and Slovak Republic).

Table 1. Normalized data of selected indicators, CI and DCI

	BGR	HRV	CZE	EST	HUN	LTU	LVA	POL	ROU	SVN	SVK
CO2	1.00	0.20	0.84	0.77	0.25	0.00	0.11	0.95	0.01	0.42	0.51
Methane	0.21	0.09	0.41	0.00	0.21	0.07	0.03	1.00	0.56	0.02	0.12
N. oxide	0.16	0.04	0.22	0.03	0.23	0.14	0.05	1.00	0.39	0.00	0.06
CI	0.46	0.86	0.38	1.00	0.74	1.00	0.91	0.00	0.60	1.00	0.75
DCI	0.20	0.00	0.63	1.00	0.29	0.94	0.67	0.73	0.47	0.81	0.14

Source: Authors' calculation

The results of correlation analysis show that there is no statistically significant correlation relationship between CI and DCI in selected countries. The matrix of results for selected countries is shown in Figure 3. The calculated values of CI and DCI divided the economies into four categories, with the most prosperous nations in the top-right corner.

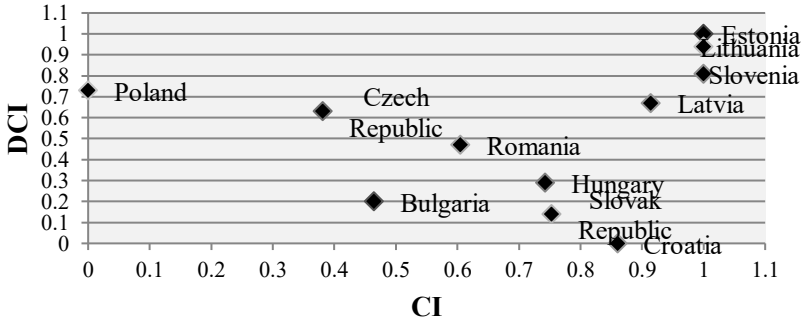

Figure 3. CI and DCI for selected CEE countries in 2019

Source: Authors

3. Conclusions

Based on the presented results, it can be concluded that there is no relationship between greenhouse gas emissions and digital competitiveness in CEE countries. This can be explained by the level of digital technology adoption. In other words, digital technology applications are not at a high level in these countries, so they have not yet affected gas emissions or the environment.

Acknowledgment

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