Application of green economy principles in the post-crisis period in the EU

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Abstract: The paper deals with the application of green economy principles within the EU in the post-crisis period. It builds on previously published research on the impact of the economic crisis on a selected set of green economy indicators. The aim is to find out, on the basis of the selected indicators, how the application of green economy principles has evolved in the two periods under study – immediately after the economic crisis and in the present. The study is based on statistical analysis of six indicators in the pre- and post-crisis period: GDP, Unemployment, Productivity, R&D expenditure, Share of RES, CO_2 emissions. In all monitored indicators, taking into account EU-wide averages, a shift towards a greener economy can be observed. Correlation analysis clarified the basic relationships between the indicators. Based on the factor analysis, it can be said that countries do not show significant variations and there is no significant tendency to form clusters. This may mean that the current selection of indicators no longer fully explains the changes associated with the green economy.

Keywords: green indicators, indicator, green economy, sustainable development
JEL Classification: Q56, O18

1 Introduction

The concepts of the green economy, bioeconomy, and circular economy are considered the mainstream pathways for achieving sustainable development enabling meeting economic, environmental, and social goals (D'Amato et al., 2017). All these concepts are well-recognized and discussed among policymakers, researchers, and businesses, and implemented into practice (D'Amato and Korhonen, 2021). The green economy appeared as a new paradigm to overcome various crises, including the financial crisis of 2008, and market failures through a transformation into low carbon, resource efficient, and socially inclusive economy. The green economy presents a market-based approach, yet it involves reformed policies, adequate subsidies, and investments to improve human well-being and social equity while reducing environmental risks and ecological scarcity (UNEP, 2011). The terms like green growth, green jobs, and green deal are used to represent the greening of the economy and policy, in which the economy and society gets connected with the biosphere, and the importance of the natural factor is highlighted, and sustainable development can be achieved (Adamowicz, 2022). Although being launched into practice after the crisis in 2008, the efforts to revive and strengthen the economies through the green economy can be recently seen as a way to combat challenges such as the Covid-19 pandemic, energy crisis, Russian invasion of Ukraine, and general economic uncertainty (Siksnelyte-Butkiene et al., 2022). In economic practice, many countries and regions turn to clean energy, green financing and investments, green bonds (Yang et al., 2022), green innovations, advanced green technologies (Ying, Li and Yang, 2021), green buildings, green transportation, green infrastructure, green agriculture, etc. (Pan et al., 2018).

The green labelling of terms is an obvious form of distancing from the former black economy, where growth is based on excessive resource exploitation led by economic interests neglecting environmental damage and crises (Sun et al., 2020). In some studies, the traditional economy is not reflected as a black, but as a brown economy, where unlimited growth is based on intensive use of fossil and other natural resources, overproduction, and overconsumption, resulting in tremendous amounts of waste, pollution, and the overall harm to the environment, biodiversity, and future generations (Niemczyk et al., 2022; Prokopowicz, 2020). However, the problems of the conventional economy are not connected

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solely to the environment and future generations as the paradigm leads to uneven economic growth and current social inequality (Poltarykhin et al., 2018). A transition towards a green economy is perceived as an opportunity for mitigating climate change, improving resource efficiency, reducing biodiversity loss, as well as socio-economic risks arising from climate change (Ansah and Sorooshian, 2019), and achieving the Sustainable Development Goals (SDG), although some of the goals are largely ignored within the green economy frameworks and indicators, e.g., SDG 5 gender equality (Merino-Saum et al., 2018)

The purpose of the indicators of the green economy is to determine its extent and implementation in various countries. While measuring the green economy, the indicators must cover social, economic, and environmental dimensions, yet the selection of criteria to characterize the phenomenon depends on the definition of the green economy (Cudlínová, Vávra and Lapka, 2015). The indicators should focus on poverty eradication, economic prosperity, and ecological preservation simultaneously to trigger the green economy by integrating all dimensions (Khoshnava et al., 2019). Many international organizations including the UNEP, the Global Green Growth Institute, the World Commission for Environment and Development, the OECD, and the EU have constructed their indicators and index systems to evaluate the green economy (Wang et al., 2019). Most common approaches are based on dashboards of indicators, composite indicators, environmental footprints, or adjusted monetary methods covering not only economic but also environmental and social dimensions (Godlewska and Sidorczuk-Pietraszko, 2019). The researchers also focus on measuring the green economy by utilizing green GDP, green economy efficiency, green economy indexes (Wang et al., 2019), green credit, renewable energy investment (He et al., 2019), green investment (Tarkhanova et al., 2020), green infrastructure (Khoshnava, 2020), etc. Although the index systems differ in the set of indicators, in general they usually involve those for energy consumption, environmental quality, and economic growth (He et al., 2019).

The aim is to find out, on the basis of the selected indicators, how the application of green economy principles has evolved in the two periods under study – immediately after the economic crisis and in the present. To meet the objectives, the following research questions were set: 1. How have the values of the selected indicators changed across the selected periods? 2. Is there a statistically significant relationship between the indicators to explain their changes?

2 Methods

This study is based on statistical analysis of six indicators in the pre- and post-crisis period: GDP, Unemployment, Productivity, R&D expenditure, Share of RES, CO_2 emissions. The approach is based on the publication Cudlínová, Vávra & Lapka (2015). Using a statistical analysis of six selected indicators, the authors answer the question to what extent the principles of the ambitious green economy concept, introduced in response to the financial crisis, have been applied in the EU. The results showed that there has been a demonstrable increase in the material productivity of economies, an increase in R&D spending, an increase in the share of renewable energy and a reduction in CO_2 emissions. The negative phenomena were that for some countries GDP fell and unemployment rose. As an important result can be considered the findings of the correlation analyses that show a certain shift in the meaning of green economy principles (Cudlínová, Vávra & Lapka, 2015).

The same set of indicators was chosen for data analysis in this paper as in the previous study by Cudlínová, Vávra & Lapka (2015).

- GDP per capita
- Total unemployment rate
- Resource productivity
- Gross domestic expenditure on R&D
- Share of renewable energy in gross final energy consumption
- Greenhouse gas emissions per capita

Data were obtained from Eurostat. Two periods were selected: the post-crisis period and the present. The post-crisis period contains values from 2012. The present period represents the values of selected indicators from 2020 and 2019 in the case of GHG emissions per capita. The procedure was as follows. First, the change in indicator values was calculated for the two periods under review. Subsequently, correlation analyses were performed for the change between periods. Subsequently, the change in indicator values was subjected to factor analysis. IBM SPSS Statistics was used.

3 Research results

There were changes in six indicators in the two reporting periods. The first indicator was GDP per capita. Positive growth was recorded for all countries. The highest growth was recorded for Ireland (82%), Romania (54%), Lithuania (43%). On

the other hand, the lowest growth was recorded for Greece (1%), Italy (5%), Slovakia (5%). Across the EU, the indicator rose by 16% on average. The second indicator monitored was Total unemployment rate. The largest decrease was found out in Portugal (-9.6%), Ireland (-9.6%), Spain (-9.3%). On the other hand, an increase was found in Luxembourg (1.7%), Austria (0.8%), Sweden (0.3%). The EU-wide average was -3.8%. Resource productivity increased the most in the Netherlands (1.17 euro per kilogram), Ireland (0.97 euro per kilogram), Italy (0.71 euro per kilogram). On the other hand, the largest decreases were in Hungary (-0.3 euro per kilogram), Sweden (-0.07 euro per kilogram), Romania (-0.07 euro per kilogram). The EU average was 0.17 euro per kilogram.

The next indicator is Gross domestic expenditure on R&D. It is reported as a percentage of GDP. The largest increases were found in Belgium (1.24%), Greece (0.78%), Croatia (0.52%). On the other hand, the largest declines were found in Finland (-0.46%), Slovenia (-0.41%), Estonia (-0.33%). The EU average was 0.24%. Share of renewable energy in gross final energy consumption increased the most for Sweden (10.7%), Cyprus (9.8%), Finland (9.6%). In the case of Hungary, it even decreased (-1.7%). The smallest increase was recorded for Romania (1.7%) and Slovenia (3.5%). The EU average was 6.1%. Greenhouse gas emissions per capita fell the most for Estonia (-4.1), Luxembourg (-4.1), Malta (-3). On the other hand, the largest increases were for Latvia (0.6), Hungary (0.5), Lithuania (0.2). The EU average was -0.9.

In all monitored indicators, taking into account EU-wide averages, a shift towards a greener economy can be observed. Table 1 shows the correlations of changes in indicators between the observation periods. The results show that countries with higher GDP growth had lower R&D expenditure. This development was most pronounced in the case of Ireland. Further, states with larger unemployment declines or lower growth had larger GHG emissions. This special relationship can probably be explained by developments in Cyprus, Latvia, Lithuania, Portugal, where there has been a relatively significant decrease in unemployment and a simultaneous increase in GHG emissions. As the final statistical relation was discovered that states with higher resource productivity growth also have a larger increase in the share of renewables.

Table 1 Correlation analysis

	GDP	**Unemployment**	**Resource productivity**	**R&D expenditure**	**Share of renewables**	**GHG emissions**
GDP	--					
Unemployment	-0,186	--				
Resource productivity	0,310	0,020	--			
R&D expenditure	-0,384*	-0,114	0,112	--		
Share of renewables	0,085	0,052	0,394*	-0,072	--	
GHG emissions	-0,006	-0,525**	-0,140	0,363	-0,210	--

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Own processing

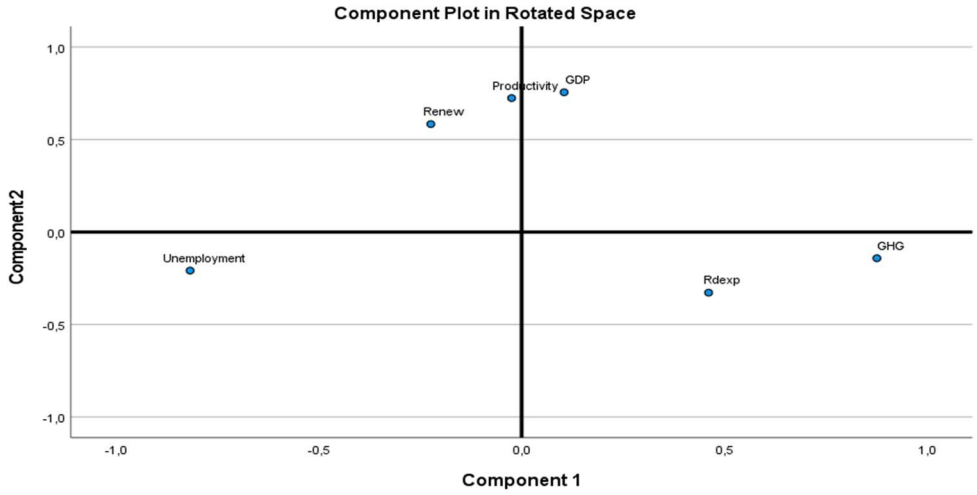
Factor analysis that would simplify and clarify possible hidden relationships between the observed variables is borderline valid, as the Kaiser-Meyer-Olkin Measure of Sampling Adequacy = 0.441. Extraction was by principal component analysis (PCA), rotation by Varimax method with Kaiser Normalization. Only components with factor loadings greater than 0.3 are shown. Overall, the analysis explains 55.262% of the variability in the data. Table 2 shows, according to component 1, that as unemployment has low growth or falls, R&D spending rises, but GHG emissions also rise. Component 2 shows us that as GDP rises, resource productivity and the share of renewables also rise. Conversely, R&D spending has low growth or falls as GDP rises. Graphically, these relationships can be seen within Figure 1.

Table 2 Factor analysis - Rotated Component Matrix

	Components	
	1	2
GDP		0,755
Unemployment	-0,817	
Resource productivity		0,724
R&D expenditure	0,461	-0,328
Share of renewables		0,584
GHG emissions	0,876	
Cumulative % of variance	***28,493 %***	***26,760 %***

Source: Own processing

Figure 1 Factor analysis - results

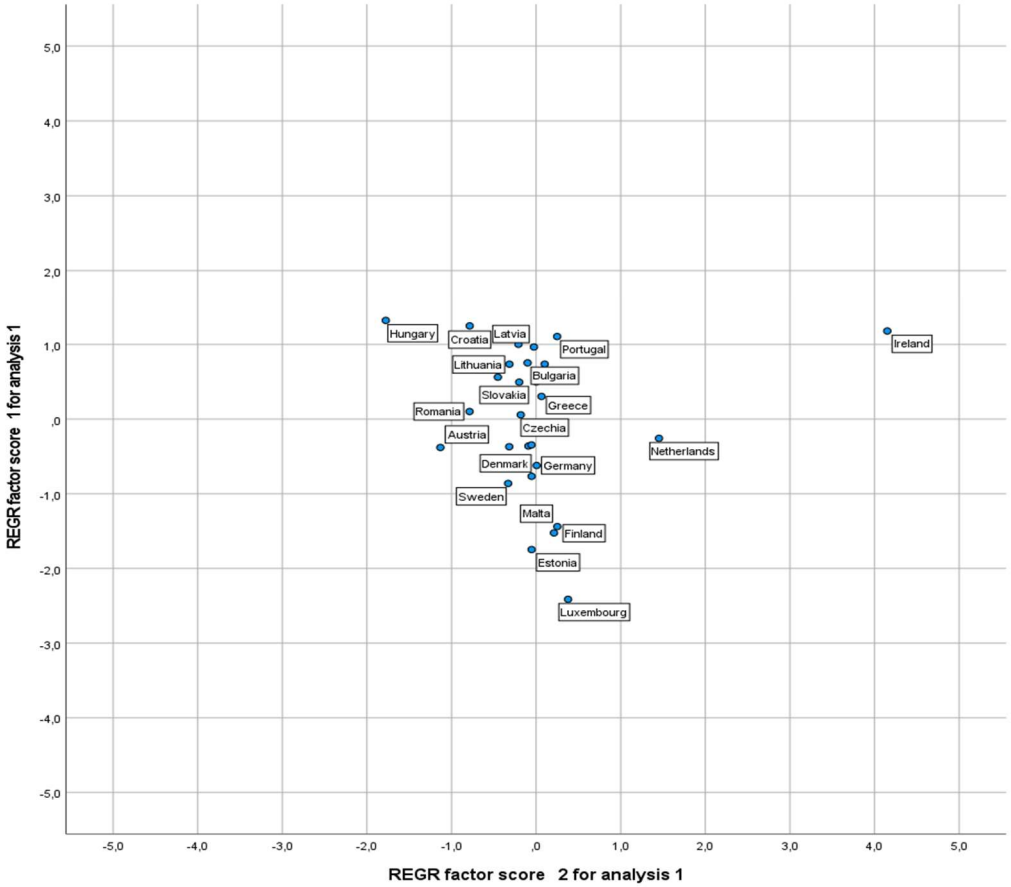


Source: Own processing

In order to be able to use factor analysis to explain the differences between EU countries, factor scores calculated by regression method were used to plot all countries on a Figure 2. The figure shows at first glance that the states are in one big cluster. Only Ireland stands out. Compared to the original Cudlínová, Vávra & Lapka (2015) study, the countries here appear uniform in their development in the indicators under study and there are no significant deviations.

Ireland's position, which is significantly to the right of the chart, can be explained by high GDP growth and an increase in resource productivity according to component 2. On the other hand, R&D spending in this country has fallen. In contrast, the positions of Luxembourg and Estonia at the bottom of the graph can be explained by component 1. For both countries, there was a significant reduction in GHG emissions and there was a simultaneous increase in unemployment and a decrease in R&D spending.

Figure 2 Changes in indicators by country



Source: Own processing

4 Conclusions

Overall, the factors behind the changes have shifted. The original six indicators no longer adequately explain the transformation associated with the green economy. However, from a wider perspective, based on the EU averages, we may see positive development of the indicators towards a greener economy. The GDP, although being criticized, represents a traditional indicator for assessing economic growth and wealth of the nations and was increasing in all the EU countries. The economic growth is emphasized by many concepts of the green economy, and often mentioned as a goal of green economy. The resource productivity, which can be considered as an indicator representing the resource efficiency, therefore another goal of green economy, was not increasing in all the EU countries, yet on the EU average, it increased. Similarly, unemployment rate was increasing in few countries, but on the average, it was decreasing. The issue of employment and job opportunities, especially so-called green jobs, is also one of the crucial aspects of a shift towards moving to a green economy. Increasing job opportunities and lowering unemployment rate is perceived as a necessary step in order to overcome the socio-economic problems related to unemployment, support the social inclusion, and to enable the green transformation. The gross domestic expenditure on R&D was on the EU average increasing. R&D is essential to attain progress in knowledge, technologies, but also eco-innovations. The share of renewable energy in gross final energy consumption increased in all the EU countries except for Hungary, that it increases on an EU-average. Greenhouse gas emissions per capita fell on the EU average, although some countries experienced its increases. Greenhouse gas emissions need to be reduced over time to achieve the low carbon future, or net zero emissions, and to combat the climate crisis. Some interesting, and even two shocking relationships were observed by our analysis, such as that countries with higher GDP growth had lower R&D expenditures, countries with larger reduces of unemployment had larger GHG emissions, and countries with higher resource productivity had higher increase in the share of renewables.

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