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## Article

# The eco-innovation impact on economic and environmental performance of EU Member States

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## THE ECO-INNOVATION IMPACT ON ECONOMIC AND ENVIRONMENTAL PERFORMANCE OF EU MEMBER STATES

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**Abstract.** Development of innovation is recognised as a most powerful tool for the economic growth of countries. However, their effects on the quality of the environment are still being debated. To achieve sustainable development, eco-innovation becomes significant. EU countries expand eco-innovation activities, but it is not clear whether its development achieves the goal of economic growth and improves the quality of the environment.

*Purpose* – to present how EU Member States perform in economic growth, environment and eco-innovation development and to evaluate eco-innovations impact on economic and environmental performance.

*Research methodology* – the random effect regression was used for investigation relationship between eco-innovation, economic growth and environmental performance.

*Findings* – eco-innovation development influences not only EU MS economic growth but also has a positive effect on environmental performance.

*Research limitations* – eco-innovations development and economic growth can be interdependent, but this research investigates just one-way dependence. Granger causality test can be used for relationship assessment in the future.

*Practical implications* – the research results can be used for both the development of environmental policy and the policy of business support for eco-innovation implementation.

*Originality/Value* – study results confirmed previous assessment results on eco-innovation and economic growth and provided new knowledge of their effect on environmental performance.

**Keywords:** innovations, eco-innovations, economic growth, environment, Eco-Innovation Index, Environmental Performance Index.

**JEL Classification:** O11, O31, O50, O51.

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## **Introduction**

In recent times, politicians, the public, and, in parallel, researchers have been paying increasing attention to environmental quality analysis and initiatives to improve it. In response to environmental concerns, socially responsible businesses are developing new business and management models, new services or products, and new production processes that can protect and improve environmental quality. It means – implements eco-innovations to business activities. Nevertheless, it remains unclear whether ongoing eco-innovation development activities are achieving their goal and significantly improving the environment's quality. The development of innovations is generally considered to have a positive impact on business competitiveness, and in parallel, on the country's economic growth, through capital accumulation and productivity growth. Nevertheless, their development, especially eco-innovations, involves a significant investment, so it is unclear their return, especially in the short term. Moreover, the extent of eco-innovation development varies between countries, and outcomes at the macro level may vary.

Analysis of previous studies revealed that most studies on eco-innovation development outcomes were conducted in developed countries (Yurdakul & Kazan, 2020), and the impact of eco-innovations on the economic growth and environmental performance in the EU Member States (MS) is not thoroughly studied.

Scholars consider eco-innovations as a driving factor in EU member states. They analyse European eco-innovation performance from a global perspective, as well as key trends of the EU Eco-Innovation Index (Eco-Innovation Observatory, 2020), many of them assess the determinants of eco-innovation in the European Union (Andabaka et al., 2019), especially in the new member countries, whose economies are characterised by low productivity and high intensity of greenhouse gas emissions (Bartoszczuk, 2015; Wielgórka & Szczepaniak, 2019), but there is a research gap to determine whether EU MS that develop the most eco-innovations also have the best environmental performance and whether the most developed EU MS are more eco-innovative than the less developed ones.

Given the fact that assessing the effectiveness of eco-innovation in a country provides important information about which countries are leaders or lagging behind, scientists emphasised the importance of measuring progress towards eco-innovation in different countries (Rizos et al., 2015; Loučanová & Nosálová, 2020; Lesakova & Laco, 2020; Jang et al., 2015). Although there are no studies that assess the impact of eco-innovation on environmental performance and economic growth to identify, which EU countries are lagging in developing eco-innovations, compare countries in terms of environmental performance. Taking into consideration these facts and our insights, the study aims to present how EU MS performs in economic growth, environment, and eco-innovation development and evaluate the eco-innovations impact on economic and environmental performance. To achieve this goal, we developed two Random Effects econometric models for panel data covering real GDP per capita and Environmental performance index as dependent variables, eco-innovation index as an independent variable, and control variables.

This research contributes to previous studies by providing new knowledge on the eco-innovation effects. In parallel, it has a practical value by presenting recommendations

for environmental protection policy which is related to business support. As mentioned Andriušaitienė (2020), domestic socio-economic development and global economic challenges and problems call for a review of the country's economic and social policies. Given recently identified environmental quality problems, the search for ways to address them solving by adjusting environmental policies is very timely.

The rest of the paper is organised as follows: The first section is devoted to the literature review. We provided concepts of eco-innovation, systemise eco-innovation components, identified eco-innovation determinant; substantiated eco-innovations importance; discussed the relationship between eco-innovation development, economic growth and environmental performance; and impact transmission mechanism. The second section provides a research methodology, including the research model and data used. It also presents compositions of Eco-innovation and Environmental performance indexes that are used in research. The third section provides and discusses research results on eco-innovation, economic growth and environmental performance comparisons in EU MS, and on the relationship between them. The last section concludes the research results and provides recommendations for environmental policy.

## **1. Literature review on the effects of eco-innovations**

### **1.1. Definitions and classification of eco-innovation**

The requirements for eco-friendly products and services are ever-increasing throughout the world, and consequently, eco-innovations have become a quite topical issue. At the same time, it is a challenge for the countries at both micro and macro levels, as it is necessary to produce more quality products at low costs and at the same time, it is necessary to bear certain expenses to realise environmental protection measures (Fiore et al., 2018).

An eco-innovation implies the reduced impact of man's activities on the environment and maintenance of the environmental balance, better living quality, less unemployment and higher employment rates, job generation, maintenance of biodiversity, less use of natural and artificial materials and lower expenses in general (Dogaru, 2017).

Consequently, eco-innovation can bring both economic and ecological benefits. This conclusion was made based on the studies by different scientists (King & Lenox, 2001; Zeng et al., 2011; Yurdakul & Kazan, 2020), who analysed the ecological and financial-economic indices in their studies. It is clear that the companies will expand more investments in eco-friendly technologies and for environmental needs to as the social responsibility of the companies tends to increase customer satisfaction (Díaz-García et al., 2015).

It is clear that eco-innovation has a profound on business operations as it can improve outcomes, reduce costs and increase profits, also positively impact a company's environmental performance (Costantini et al., 2017).

The term "eco-innovation" is often used in the scientific literature (Schiederig et al., 2012), either in an ecological or in an economic context (Díaz-García et al., 2015), but there is still a lack of studies considering the complex characteristics of eco-innovations as a system.

An “eco-innovation” concept was first developed by Fussler and James (1996) as the supply of new products and processes in order to reduce the negative environmental impact and yield benefit for consumers and businesses (Hojnik & Ruzzier, 2016).

Based on the determination of innovations, several studies (Kemp & Pearson, 2008) have defined “eco-innovation” as the development, management or use of a production or management method for products and services that is an organisational novelty and leads to a reduction in environmental pollution and other negative impacts. Based on these approaches, the scientists (Kemp & Mainguy, 2011) draw the following conclusions: first, all resource-efficient processes are eco-innovations, since they are more environmentally friendly, and second, the term “eco-innovation” largely depends on the overall assessment of environmental impact and risks.

As per another opinion, eco-innovation is new ideas, behaviour, products and processes helping reduce an environmental load. Eco-innovation is any form of innovation to ensure sustainable development by reducing environmental impact and using natural resources more efficiently and responsibly. “The Business Case for Eco-Innovation” (United Nations Environment Programme, 2014), it was proved that eco-innovative enterprises have a high potential for growth.

On the other hand, the EU Commission views eco-investments in view of sustainability, competitiveness and job creation. It was established that eco-innovation, which directly reduces the impact of production on the environment, also exerts an indirect positive impact in other sectors by means of various market operations.

For an in-depth understanding of eco-innovations, the researchers (Reid & Miedzinski, 2008) consider it necessary to use a systemic approach, which means analysing the eco-innovations at the levels of services, processes and company as well as at regional, sector, supply chain or generally, macro-economic level.

As for their classification, we rely on the Organisation for Economic Co-operation and Development (2018), where two main types of innovations are considered instead of the four types described in the previous edition, in particular, product innovations and business process innovations instead of product, process, organisational and marketing.

However, despite different opinions, eco-innovations are able to respond to modern environmental challenges, in particular: climate change, decreasing biodiversity, food insufficient, land degradation, lack of resources, global warming and other global and local problems (Dogaru, 2020). In turn, eco-innovations depend on political decisions, effective legislative frame, resource availability, access to the sources of financing, the approach of the company management to eco-innovations and other factors (Pansera & Owen, 2018).

The economic and social-environmental benefits of eco-innovations are extremely important both for companies and macro-economic policy, and it is not only necessary but is also an essential factor for sustainable economic development (Dogaru, 2020).

Finally, it must be noted that the scientists’ (Oltra & Saint Jean, 2009; Hojnik & Ruzzier, 2016; Tamayo-Orbegozo et al., 2017) definition of eco-innovations incorporates two main factors: efficient and rational use of natural resources and reduction of negative environmental impact. Consequently, we focus on these two aspects in our study – how the development of eco-innovation influences the economic growth and ecology of the countries.

## 1.2. Relationship between eco-innovation and economic growth and environmental performance

Today, many countries consider technological transformations and eco-innovations in particular as the way to solve modern economic problems and respond to environmental challenges. But everyone is well aware that eco-innovation has not only technological, institutional or economic aspects but also a cultural and political dimension. Triguero et al. (2013) concluded that the consumers' demand for ecologically pure products might force a company to develop eco-innovations.

The study by Kiefer et al. (2017) results in evidence the importance of the consumers' engagement and cooperation of other stakeholders for the introduction of eco-innovations.

A number of scientific studies have highlighted the economic impact of eco-innovation from different perspectives (Porter & Van der Linde, 1995). They outlined that the Environmental Response Index can be seen as one of the leading indicators of competitiveness, as well-designed environmental standards can also stimulate eco-innovation. In addition to other driving factors such as regulation and tax incentives, there is additional revenue from the sale or licensing of technologies that stimulate eco-innovation.

The next question to be explored is whether it is possible to obtain both environmental and economic benefits through eco-innovation. Yurdakul and Kazan (2020) considered this issue and concluded that eco-innovation positively affects both of them, which serves as a basis for studying the impact of eco-innovation on financial and environmental performance.

Studies accomplished in different countries and sectors of the economy confirm that eco-innovation has a positive impact on all areas studied in terms of economic and environmental performance (Rabadán et al., 2019; Rennings et al., 2006; Nishitani et al., 2017; Vargas-Vargas et al., 2010; da Silva Rabêlo & de Azevedo Melo, 2019; Cheng et al., 2014; Zhang & Rong, 2019).

It was found that eco-innovation not only improves the financial performance of companies (Horbach et al., 2012) but also increases their competitiveness (da Silva Rabêlo & de Azevedo Melo, 2019). Consumers demand, regulatory decisions and the interest of the other stakeholders strongly influences companies' decisions to adopt eco-innovation as they play not only an important role in the implementation of eco-innovation (Roscoe et al. 2016; Santos et al., 2017) to improve the financial indicators of companies (Horbach et al., 2012), but it also increases their competitiveness (da Silva Rabêlo & de Azevedo Melo, 2019).

As the investments in eco-innovations are stimulated by the policy instruments (law, funding, subsidies, etc.), educational policy and technological system, organisational capabilities, cost economy and etc. (Kiefer et al., 2017) and given the fact that countries have different regulations, funding, subsidy, monitoring systems and law, the outcomes of eco-innovations are different too. Today, the developed countries surpass the developing countries, in terms of eco-innovations, as almost all ecological and social variables of eco-innovation develop in them, while only two of six environmental and six social variables were identified in the developing countries (Lopes Santos et al., 2019).

An eco-innovation has a positive impact on the ecological activity, which is reflected in by the prevention of environmental pollution, resource-saving, efficient use, recycling and engagement of waste in economic turnover and has an indirect positive impact on the company's economic and financial indicators (Cai & Guangpei, 2018).

The role of eco-innovations during foreign market operations is important too. In this process, eco-innovations play an intermediary role; the internationalisation leads to eco-innovations, and both (the internationalisation and the eco-innovations) have a positive impact on the company’s successful operation (Hojnik et al., 2018).

Thus, within the context of our research, we can conclude that investing in eco-innovations leads to better environmental and economic performance, increased sales, profit and market share, as well as better competitive advantage and strength image of the company.

Consequently, our aim is to examine the impact of eco-innovations on the economic and environmental activities of the EU countries within the given context.

## 2. Research methodology and data

In order to evaluate and compare eco-innovation performance and development in the different EU Member States, Eco-Innovation Observatory (2016) developed the Eco-Innovation index (Eco-II). This index covers five sub-indexes that involves 16 various indicators (see Figure 1).

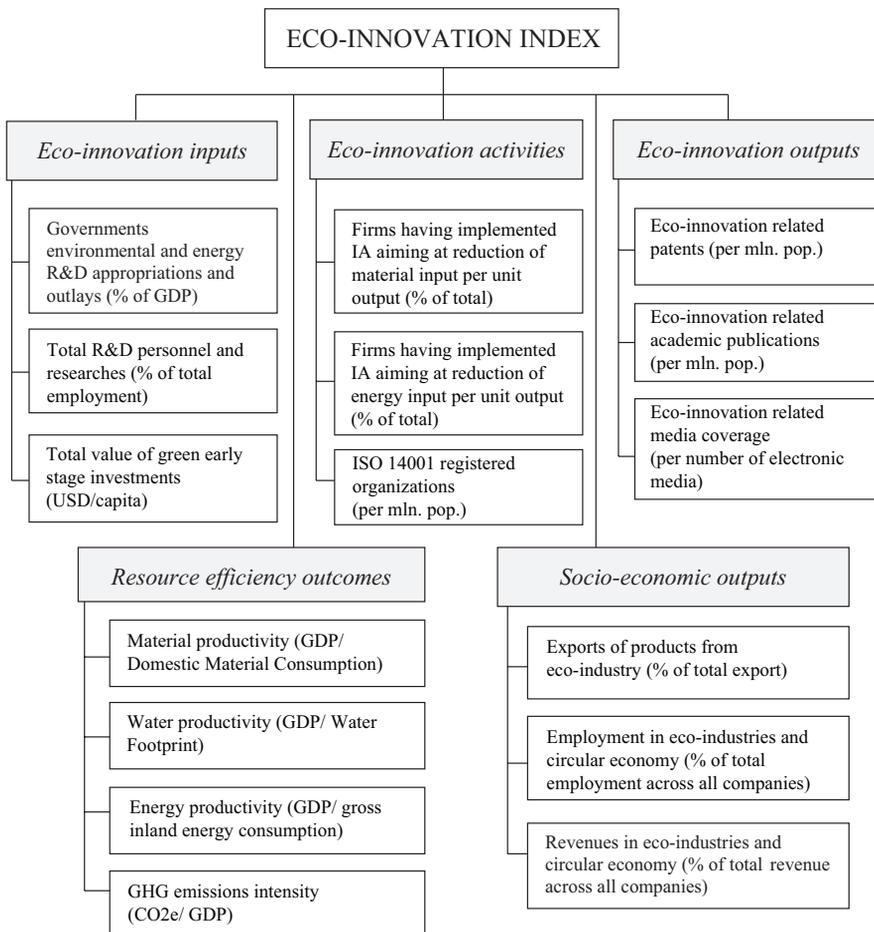


Figure 1. Structure of Eco-innovation index (source: based on Eco-Innovation Observatory, 2016)

This index illustrates eco-innovation performance and allows for complex evaluation of eco-innovation development. The overall index score is calculated by the unweighted mean of the 16 indicators. It demonstrates how well EU MS performs in eco-innovation compared to the EU average equated with 100 (index EU = 100) (Eurostat, 2020a). Eurostat provided Eco-innovation index data for the 2000–2019 period (Eurostat, 2020a). Data from 2010 will be used for the evaluation of eco-innovations development.

For assessment of EU MS environmental performance, we decided to use the Environmental performance index (EPI). EPI covers 32 indicators divided into 11 categories and provides countries ranking according to the health of environment and vitality of ecosystem (Wendling et al., 2020) (see Figure 2).

This index is calculated every two years from 2010 onwards. Therefore, for data compatibility, we used 2010, 2012, 2014, 2016, 2018 data for both indicators when we evaluated the impact of eco-innovations on environmental performance.

Real GDP per capita we used as an indicator reflecting countries economic performance and development.

Developing models for impact assessment, we included control variables in models because not only eco-innovations but also other factors can influence environment performance and economic growth. One of the critical economic development sources is a new business creation (Jian et al., 2021). Since businesses are related to CO<sub>2</sub> emissions and level of pollution, from our point of view, the number of businesses in the territory can influence the countries environment. To capture those effects, we included a new business density indicator (new business registrations per 1000 per working year (15–64 ages) people) as a control variable in both models.

In case of evaluating eco-innovation effects on economic growth in base of previous studies results as control variable we include: i) expenditure on research and development % GDP that reflect innovation development (Freimane & Bāliņa, 2016); ii) trade openness expressed as the ration international trade (export + import) to GDP (Fetahi-Vehapi et al., 2015); iii)

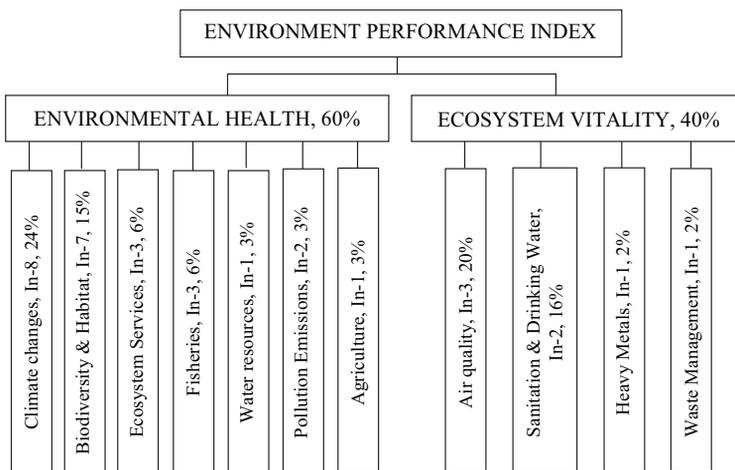


Figure 2. Structure of Environment Performance Index (source: formed by authors based Wendling et al., 2020)

foreign direct investment % GDP (Musah et al., 2018; Mačiulytė-Šniukienė & Davidavičienė, 2020; Cicea & Marinescu, 2021); iv) initial GDP per capita to control EU MS differences of the depended variable. Usage data expressed as a percentage of GDP allow us to eliminate the effect of EU MS size differences on results.

In the first stage of empirical research, we analyse eco-innovation and environment performance, economic growth of EU MS, and its changes over the 2010–2019 or 2010–2020 period (depending on indicator). This analysis allowed us to identify which countries are lagging in developing eco-innovations, compare countries in terms of environmental performance, and make insight into the links between these indicators and economic growth.

In the next stage of the research, we have ranked EU MS according to Eco-innovation and Environment Performance Indexes, as well as according to Real GDP per capita using the last available data (2019 for Eco-II and real GDP per capita, 2020 for EPI). Also, we have calculated the difference between ranks. It allows us to determine whether EU MS that develop the most eco-innovations also have the best environmental performance and whether the most developed EU MS are more eco-innovative than the less developed ones.

The last stage of the empirical research was intended for assessing the impact of eco-innovation on environmental performance and economic growth. We used EU MS panel data, including the United Kingdom, because most of the period analysed UK was EU MS.

The Random Effects Model (RE) econometric models were developed for the evaluation of the eco-innovations impact on environment performance [1] and economic growth [2].

$$\ln(EPI)_{(i,t)} = \alpha + \beta_1 \ln(Eco\_II)_{(i,t)} + \beta_2 \ln(NBD)_{(i,t)} + \varepsilon_{i,t} + v_{i,t}; \quad (1)$$

$$\begin{aligned} \ln(GDP\_pc) = & \alpha + \beta_1 \ln(GDP\_pc_{t-1})_{(i,t)} + \\ & \beta_2 \ln(Eco\_II)_{(i,t)} + \beta_3 \ln(NBD)_{(i,t)} + \beta_4 \ln(R\&D)_{(i,t)} + \\ & \beta_5 \ln(TO)_{(i,t)} + \beta_6 \ln(FDI)_{(i,t)} + \varepsilon_{i,t} + v_{i,t}. \end{aligned} \quad (2)$$

where:

- Logarithmic dependent variables:
  - $\ln(EPI)_{(i,t)}$  – Environment Performance Index in the country  $i$  in year  $t$ ;
  - $\ln(GDP\_pc)_{(i,t)}$  – real gross domestic product per capita in the country  $i$  in year  $t$ .
- Logarithmic independent variable:
  - $\ln(Eco\_II)_{(i,t)}$  – Eco-Innovation Index in country  $i$  in year  $t$ .
- Logarithmic control variables:
  - $\ln(NBD)_{(i,t)}$   $\beta_1 \ln RGDP_{(i,t)}$  – new business density in country  $i$  in year  $t$ ;
  - $\ln(GDP\_pc_{t-1})_{(i,t)}$  – previous years real gross domestic product per capita in country  $i$  in year  $t$ ;
  - $\ln(R\&D)_{(i,t)}$  – expenditure on research and development % GDP in country  $i$  in year  $t$ ;
  - $\ln(TO)_{(i,t)}$  – trade openness ((export + import)/GDP) in country  $i$  in year  $t$ ;
  - $\ln(FDI)_{(i,t)}$  – foreign direct investment % GDP in country  $i$  in year  $t$ .
- $\alpha$  – constant.
- $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6$  – elasticity coefficients, reflecting the impact of independent and control variables on the dependent variable.

- $\varepsilon_{i,t}$  – random error (heterogeneity specific to a country).
- $v_{i,t}$  – random error (specific to a particular observation).

All variables will be logarithmic to obtain the coefficients of elasticity. Considering that EPI index data are available for 2010, 2012, 2014, 2016, 2018, realising compiled econometric models, we used the data of all indicators of this period.

### 3. Research results and discussion

#### 3.1. Results of the economic and environmental performance and eco-innovation development analysis

To present the economic and environmental performance of EU Member states and how MS performs in development eco-innovations, the analysis of real GDP per capita, EPI, and Eco-II dynamics for the ten years was conducted (see Table 1).

The analysis reveals that in 12 countries out of 28, real GDP per capita was higher than the EU average in 2010, and in 11 countries – in 2019. All these countries joined the EU before 1995. The highest real GDP per capita in 2010 was generated in Luxembourg, Denmark, and Sweden. By 2019, the situation in this group of countries has changed little – the second position in terms of real GDP per capita took Ireland, third position – Denmark. In this group of countries, real GDP per capita rose by 6–14%, except Ireland, where real GDP per capita increased by 63.64%, and Italy, where real GDP per capita fell by 0.04%. More significant changes have occurred in the new EU MS that joined the EU in 2004 and later. In this group of countries, real GDP per capita increased by 16–55%, except Cyprus, where real GDP per capita rose by 5%, and Greece, where real GDP per capita decreased by 12%. The highest growth is recorded in Lithuania (54.81%), Romania (47.10%), Latvia (46.83), Estonia (41.35%), Poland (38.30%).

Although EU MS's economic situation is improving in almost all countries, the environment quality is deteriorating in some of them. The value of EPI has decreased in 13 countries over the 2010–2020 period. The biggest negative change took place in Latvia, Sweden and Slovakia, where EPI's value respectively decreased by 10.9, 7.3, and 6.2 points. The biggest positive changes have occurred in Belgium (15.2 p.), Luxembourg (14.5 p.), Denmark (13.3). But are these changes related to the development of eco-innovation?

The Eco-II value has increased in 17 EU MS, has decreased in 10 countries, and in Sweden remained stable over the period analysed. Although countries' position according to the value of Eco-II has changed, in the top ten positions at both 2010 and 2019 are the same countries: Luxembourg, Denmark, Finland, Sweden, Austria, Germany, UK, Italy, Netherlands, and France. This fact allows us to suggest that countries with a better economic performance developing eco-innovation more intensively. This is also seen in Table 2.

Table 2 provides EU MS ranking according to Eco-innovation index, Environment Performance Index and Real GDP per capita results, and differences between ranks.

Differences between countries rank according to Eco-II and real GDP per capita reveal that most developing countries do not necessarily invest the most in eco-innovation. For example, in terms of real GDP per capita, Ireland took second place between EU MS in 2019, but in terms of Eco-II took 13th place. In terms of real GDP per capita, Cyprus took

Table 1. Results of the real GDP per capita, EPI, and Eco-II dynamic analysis in EU MS (source: authors calculations based on Eurostat, 2020a, 2020b; Yale Center for Environmental Law & Policy [YCELP], 2020; and Socioeconomic Data and Applications Center [SEDAC], 2020 data)

Country	GDPpc€, 2010	GDPpc€, 2019	$\Delta\text{€}$	$\Delta\%$	EPI, 2010	EPI, 2020	$\Delta$	Eco-II, 2010	Eco-II, 2019	$\Delta$
Belgium	33330	35940	2610	7.83	58.10	73.30	15.2	109	85	-24
Bulgaria	5050	6840	1790	35.45	62.50	57.00	-5.5	31	34	3
Czech R.	15020	18330	3310	22.04	71.60	71.00	-0.6	74	96	22
Denmark	43840	49720	5880	13.41	69.20	82.50	13.3	149	146	-3
Germany	31940	35840	3900	12.21	73.20	77.20	4.0	134	123	-11
Estonia	11150	15760	4610	41.35	63.80	65.30	1.5	49	73	24
Ireland	36770	60170	23400	63.64	67.10	72.80	5.7	100	97	-3
Greece	20150	17740	-2410	-11.96	60.90	69.10	8.2	43	75	32
Spain	23040	25200	2160	9.38	70.60	74.30	3.7	105	104	-1
France	30690	33270	2580	8.41	78.20	80.00	1.8	109	107	-2
Croatia	10520	12450	1930	18.35	68.70	63.10	-5.6	91*	72	-19
Italy	26930	26920	-10	-0.04	73.10	71.00	-2.1	105	112	7
Cyprus	23400	24570	1170	5.00	56.30	64.80	8.5	62	56	-6
Latvia	8520	12510	3990	46.83	72.50	61.60	-10.9	51	86	35
Lithuania	9050	14010	4960	54.81	68.30	62.90	-5.4	47	82	35
Lux.	79160	83640	4480	5.66	67.80	82.30	14.5	112	165	53
Hungary	9960	13260	3300	33.13	69.10	63.70	-5.4	69	54	-15
Malta	16440	21800	5360	32.60	76.30	70.70	-5.6	67	73	6
Neth.	38470	41870	3400	8.84	66.40	75.30	8.9	117	110	-7
Austria	35390	38170	2780	7.86	78.10	79.60	1.5	127	130	3
Poland	9400	13000	3600	38.30	63.10	60.90	-2.2	40	59	19
Portugal	16990	18590	1600	9.42	73.00	67.00	-6.0	71	100	29
Romania	6200	9120	2920	47.10	67.00	64.70	-2.3	48	57	9
Slovenia	17750	20700	2950	16.62	65.00	72.00	7.0	87	94	7
Slovakia	12560	15860	3300	26.27	74.50	68.30	-6.2	43	62	19
Finland	35080	37170	2090	5.96	74.70	78.90	4.2	139	145	6
Sweden	39950	43900	3950	9.89	86.00	78.70	-7.3	143	143	0
UK	29830	32910	3080	10.33	74.20	81.30	7.1	116	118	2
Average	24164	27831	3667	20.67	69.62	71.05	1.4	100	100	8

Note: \*data of 2012.

14th place, but in terms of Eco-II took 26th place. Nevertheless, in many countries, the position according to economic and eco-innovation development does not differ much. This fact confirms the presumption of the existence of an interaction between indicators. However, it does not answer whether the outcome of eco-innovation ensures a positive return on economic growth.

Table 2. Rank of EU MS according to Eco-Innovation Index, Environment Performance Index, and Real GDP per capita (source: authors calculations based on Eurostat, 2020a, 2020b; YCELP, 2020; and SEDAC, 2020 data)

Country	Eco-II, 2019	Rank according to Eco-II	EPI, 2020	Rank according to EPI	Difference on rank*	Real GDP per capita, 2019	Rank according to GDP	Difference on rank**
Luxemb.	165	1	82.30	2	-1	83640	1	0
Denmark	146	2	82.50	1	1	49720	3	-1
Finland	145	3	78.90	6	-3	37170	7	-4
Sweden	143	4	78.70	7	-3	43900	4	0
Austria	130	5	79.60	5	0	38170	6	-1
Germany	123	6	77.20	8	-2	35840	9	-3
UK	118	7	81.30	3	4	32910	11	-4
Italy	112	8	71.00	15	-7	26920	12	-4
Netherl.	110	9	75.30	9	0	41870	5	4
France	107	10	80.00	4	6	33270	10	0
Spain	104	11	74.30	10	1	25200	13	-2
Portugal	100	12	67.00	19	-7	18590	17	-5
Ireland	97	13	72.80	12	1	60170	2	11
Czech R.	96	14	71.00	14	0	18330	18	-4
Slovenia	94	15	72.00	13	2	20700	16	-1
Latvia	86	16	61.60	26	-10	12510	25	-9
Belgium	85	17	73.30	11	6	35940	8	9
Lithuania	82	18	62.90	25	-7	14010	22	-4
Greece	75	19	69.10	17	2	17740	19	0
Estonia	73	20	65.30	20	0	15760	21	-1
Malta	73	21	70.70	16	5	21800	15	6
Croatia	72	22	63.10	24	-2	12450	26	-4
Slovakia	62	23	68.30	18	5	15860	20	3
Poland	59	24	60.90	27	-3	13000	24	0
Romania	57	25	64.70	22	3	9120	27	-2
Cyprus	56	26	64.80	21	5	24570	14	12
Hungary	54	27	63.70	23	4	13260	23	4
Bulgaria	34	28	57.00	28	0	6840	28	0

Differences between countries rank according to Eco-II and EPI reveal that in countries with more intensive development of eco-innovation, the environment's quality is better. A more pronounced difference between the country's position under the Eco-II and EPI is reordered only in Latvia, which took 16th place in terms of Eco-II and 26th position in terms of EPI. Nevertheless, it can be assumed that Eco-innovation development has a positive impact on the environment. This assumption is further verified by regression analysis.

### 3.2. Results of the economic and environmental performance and eco-innovation development analysis

The Random-effects model for panel data was developed for estimation eco-innovation impact on economic growth and environmental performance of EU MS (formula 1 and 2). The results obtained after the realisation of the models are presented in Table 3.

Table 3. The results of evaluations the impact of eco-innovation on economic growth and environment performance in EU MS

Random-effects (GLS), using 112 observations					Random-effects (GLS), using 140 observations						
Included 28 cross-sectional units					Included 28 cross-sectional units						
Time-series length: minimum 2, maximum 4					Time-series length = 5						
Dependent variable: l_GDP_pc					Dependent variable: l_EPI						
	Coefficient	Std. Error	z	p-value		Coefficient	Std. Error	z	p-value		
const	-0.0173	0.1422	-0.1216	0.9032	const	3.7443	0.1435	26.1000	3.88E-150	***	
l_Eco_II	0.0685	0.0261	2.6240	0.0087	***	l_Eco_II	0.1196	0.0314	3.8000	0.0001	***
l_RD	0.0046	0.0149	0.3112	0.7557		l_NBD	0.0024	0.0121	0.2006	0.8410	
l_TO	0.054	0.0148	3.6550	0.0003	***						
l_FDI_IN	-0.0022	0.0042	-0.5242	0.6001							
l_GDP_pc <sub>t-1</sub>	0.9468	0.0147	64.2600	<0.0001	***						
l_NBD	0.0065	0.0071	0.9144	0.3605							
Mean dependent var	9.894	S.D. depended var	0.62	Mean dependent var	4.28	S.D. depended var	0.14				
Sum squared resid	0.3719	S.E. of regression	0.06	Sum squared resid	2.44	S.E. of regression	0.13				
Log-likelihood	186.22	Akaike criterion	-358	Log-likelihood	84.93	Akaike criterion	-163				
Schwarz criterion	-338.64	Hannan-Quinn	-350	Schwarz criterion	-155	Hannan-Quinn	-160				
Durbin-Watson	1.5802			Durbin-Watson	1.82						

Note: \*\*\*Indicates significance at the 1% level.

The estimations results are in line to prove our presumptions because we observed that eco-innovation development has a positive effect on both economic growth and environmental performance.

Inconsistent with previous studies on economic growth, we also find that a higher level of trade openness positively correlates with economic growth. It is not a surprising result, but surprising that we did not find evidence for a significant effect of R&D expenditure and inward FDI on economic growth. The relationship between new business density and economic growth, as well as environmental performance, is not significant.

Nevertheless, the study’s main findings made it clear that the development of eco-innovation in the EU should be encouraged and supported. European Commission (2020) carries eco-innovation support initiatives via a variety of programs: EU Framework Programme for Research and innovation (HORIZONT 2020), EU Funding Instrument for the Environ-

ment and Climate Action (LIFE), Programme for the Competitiveness of Enterprises and Small and medium-sized Enterprises (COSME), European Structural and Investment Funds (ESIF). But these programs included support not only for eco-innovations development, and only part of the support funds is used for projects related to eco-innovation development. Considering that the EU support programming period (2014–2020) ended, and EC is setting new support priorities and directions, it is important to pay attention to the need for an independent eco-innovation support program.

## Conclusions

Through literary review on empirical studies we found evidence that eco-innovations help the countries to improve growth potential, create new opportunities and help the business sector to reduce expenses, strength a company image among its customers, investors and stakeholders, improve cost proficiency, increases sales and profit, expand market share and achieve sustainable competitive advantage.

Eco-innovation has a positive effect on environmental protection, on the efficient use of resources, waste recycling and their economic reuse, helps to save natural and artificial resources, allows companies to achieve both economic and environmental benefits through the low price, leads countries to be more competitive and achieve environmental sustainability. But there are still differences even between EU member states and sectors of the economy in promoting and introducing eco-innovations.

Within this context, we evaluated the eco-innovations impact on economic and environmental performance in EU member states.

In all EU MS, the economic situation in terms of real GDP per capita has improved over the last ten years, except Greece and Italy. The economy grew faster in the new EU countries that joined the EU in 2004 and later. These results are not surprising because new EU MS have a big potential for growth, and old EU MS have already reached a high level of development and have exploited the potential for intensive growth.

Although economic prosperity is growing in almost all countries, the development of eco-innovations is intensifying just in part of countries. The value of the Eco-Innovation index has decreased in ten countries comparing 2019 with 2010. The intensity of innovation development decreased the most in Belgium, Croatia, Hungary, and Germany. Judging by Environmental Performance Index, environment quality in Belgium and Germany is satisfactory, but Croatia and Hungary, according to this index, is in the 23<sup>rd</sup> and 24<sup>th</sup> position among EU MS. These countries, including countries where the performance of the environment is particularly deteriorating (Latvia, Sweden, Portugal, Bulgaria, Croatia, and Malta), should develop strong policies to improve the quality of the environment and one of the ways could be the promotion of eco-innovation.

Although the extent of eco-innovation development varies across the EU, the overall impact of its development on economic growth and the quality of the environment is significant and positive. These results broaden the knowledge about the impact of eco-innovations not only on economic indicators but also on the state of the environment. It also complements the results of previous research carried out at the micro and industry level, and highlights the importance of eco-innovation development.

Considering those findings, including the fact that the environmental quality is not improving in all counties, the development of eco-innovation in the EU should be encouraged and supported. Although the EC supports the development of eco-innovation through various funding initiatives, EC has to initiate an independent eco-innovation support program.

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