
The Eco-Innovation versus Economic Development on the EU Example

Submitted 20/11/20, 1st revision 10/12/20, 2nd revision 23/01/21, accepted xx/02/21

Jolanta Pakulska¹

Abstract:

Purpose: The aim of the article is to present the results of research on the relationship between the Eco-innovation and the level of the economic development. The aim of the research was to confirm the hypothesis that countries with a higher level of economic development are also characterized by a higher level of eco-innovation.

Design/Methodology/Approach: The study was prepared on the basis of data on the European Union, due to the large role that this organization attaches to this issue. For this purpose, the correlation of the GDP per capita in constant price with the index Eco-IS was examined. Due to the nature of the data and their distribution, it was decided to use the Spearman's rank correlation coefficient.

Findings: The analysis confirmed largely the hypothesis of a relatively large correlation of GDP and Eco-IS, but it was expected that this correlation would be higher. In addition, it was not expected that in recent years there would be a downward trend.

Practical Implications: The development of eco-innovation is a necessary 'tool' to permanently reduce human pressure on the environment and efficient use of natural resources. Increasingly literature emphasizes the role of eco-innovation as one of the basic factors of sustainable development. It seems that economic development should entail greater concern for the environment and the development of eco-innovation.

Originality/Value: There are no analyses indicating a link between the level of the eco-innovation and the level of the economic development. This study contributes to further research on this issue.

Keywords: Eco-innovation, GDP, Spearman's rank correlation.

JEL classification: E01, O52, O300, Q01, Q560.

Paper Type: Research study.

¹Institute of Economy and Finance, Faculty of Social and Economical Sciences, Cardinal Stefan Wyszyński University in Warsaw, Poland, ORCID: 0000-0002-8605-2295, e-mail: jolanta.pakulska@gmail.com;

1. Introduction

Innovations are an important factor in economic development, as it has already been noted by the creator of the innovation theory, J. Schumpeter (1934). They play an ever increasing role over the years. Over time, however, economic growth has increased environmental pollution. Initially, a reduction in economic growth was seen as a solution to this problem. In the 1990s, another way to reduce human pressure on the environment was suggested, the introduction of eco-innovations. The development of eco-innovations is therefore closely linked, on the one hand, to the increase in awareness of environmental risks and, on the other hand, to the search for a more sustainable model of economic development. It must be noted, however, that the necessary condition for the innovative economy is an adequate level of its development, as it is a condition for the development of scientific and technical thought and the need to invest large capital.

Eco-innovations are a relatively new concept, so many different definitions can be found in the literature. In each of them, however, it is stressed that "novelty" must have a positive impact on the environment, reducing or removing the negative impact on the process, product or service environment. So the essence of innovations is to reduce the human impact on the environment, both through economic activity and the influence of human life on earth.

Innovations, and particularly eco-innovations, are closely linked to economic development. They are certainly accelerating economic development. On the other hand, however, it seems that eco-innovativeness is a feature of countries with high national income. Low-income countries do not have adequate capital to invest sufficient resources in the development of eco-innovation, especially since they do not guarantee the return of invested capital, because not every innovative project will bring profits. The aim of the study is to confirm this intuitive hypothesis that the level of eco-innovativeness is closely correlated with the wealth of the country.

2. Literature Review

Literature on eco-innovation is not very abundant, due to the relatively short history of the issue. Some authors have doubts as to whether eco-innovations are something different from innovations in general and whether they stand out more than just the need to reduce negative environmental impacts (Jakobsen and Clausen, 2014). In turn others believe that these innovations need a different approach and own theory (De Marchi, 2012; Rennings, 2000).

Fussler and James (1996) were among the first to define the concept, as well as Kemp and Pearson, who made it possible to call eco-innovation a 'green innovation', providing business and customer value with less environmental impact than previous solutions (Kemp and Pearson, 2008). A similar approach can also be found in Jones, Harrison, and McLaren (2001) and Ottman (2011), who state that the goal of eco-

innovation is to reduce a company's negative impact on the environment. Kanerva, Arundel, and Kemp define eco-innovation as any innovation that reduces the negative impact of business processes on the environment and reduces environmental damage (Kanerva, Arundel, and Kemp, 2009).

In the literature, one can also find the concept of sustainable innovations, i.e., those that are not only environmentally friendly but also have a positive impact on the economy and society (Steward, 2006). In all definitions found in the literature, eco-innovations should result in a significant reduction of negative environmental impacts (Kemp and Pearson, 2008; Reid and Miedziński 2008). With eco-innovations dealt also Chodyński (2007), Hassi, Peck, Dewulf, and Wever (2011), Carley and Spapens (1998) and Graczyk (2008).

In the literature there are no analyses linking the level of eco-innovation to GDP, so this article contributes to research on this issue filling a gap in this area.

3. Methods

The article analyses the correlation between the level of eco-innovativeness and the magnitude of national income in the example of Member States of the European Union. To illustrate the eco-innovativeness, data from Eco-Innovation Scoreboard were selected, whereas the Gross Domestic Product per capita in constant prices was used as a measure of economic development.

Eco-Innovation Scoreboard (Eco-IS) has been created since 2010 by the European Commission for all Member States and shows how much the level of eco-innovation in the Member States differs from the EU average, indicating at the same time the strengths and weaknesses of each country.

Gross Domestic Product is the most widely used macroeconomic indicator, as it is considered to be the best (albeit not perfect) prosperity meter. With data availability in USD, we can compare the degree of economic development of different countries. It is therefore used as a measure of the size of economies, which allows us to compare one economy at different times or to compare the economic efficiency of different economies. GDP is a synthetic measure of the value of production generated in the economy during the year. To assess the level of development of the country, GDP per capita, for obvious reasons, should be used. It was decided to use GDP in constant price as it is insensitive to price rises in the economy and is therefore a better measure of actual economic activity (Krugman and Wells, 2006; Kwiatkowski and Milewski, 2005).

To examine the correlation, it was decided to use the Spearman's rank correlation coefficient. The choice of this coefficient was due to the occurrence of a large divergence in observation. The rank correlation measures determine the variability of the two traits that are attributed to the rank. If the arrangement is fully compatible

for both features, then the rank correlation coefficient is set to 1, otherwise its value is -1. The Spearman's rank correlation coefficient is based on the observations ordered by size, and subsequent observations are given numeric values called ranks (these are the numbers of the places occupied by observations in an ordered sequence) (Kot, Jakubowski, and Sokołowski, 2011; Pułaska-Turyna, 2011).

4. Results and Discussion

4.1 GDP in the EU Member States

GDP in EU countries is characterised by a very large differentiation not only in absolute terms, but also on a per capita basis (Figure 1). By far the highest GDP per capita for the entire period under consideration is recorded in Luxembourg. It is an undisputed leader, not endangered in its position. On the other hand was Bulgaria with the lowest GDP per capita for the entire period. In the case of other countries the position has also in principle not changed throughout the whole period. The differences between the positions are no longer as significant, although the richest and poorest countries still have a very large divergence (in 2015 the second country in terms of GDP per capita was Ireland with GDP at more than 64 thousand US dollars, and the last was Bulgaria, whose GDP per capita was below 19 thousand US dollars). The situation also looks similar in all other years of the period under consideration.

4.2 The Level of Eco-Innovation in the EU Member States

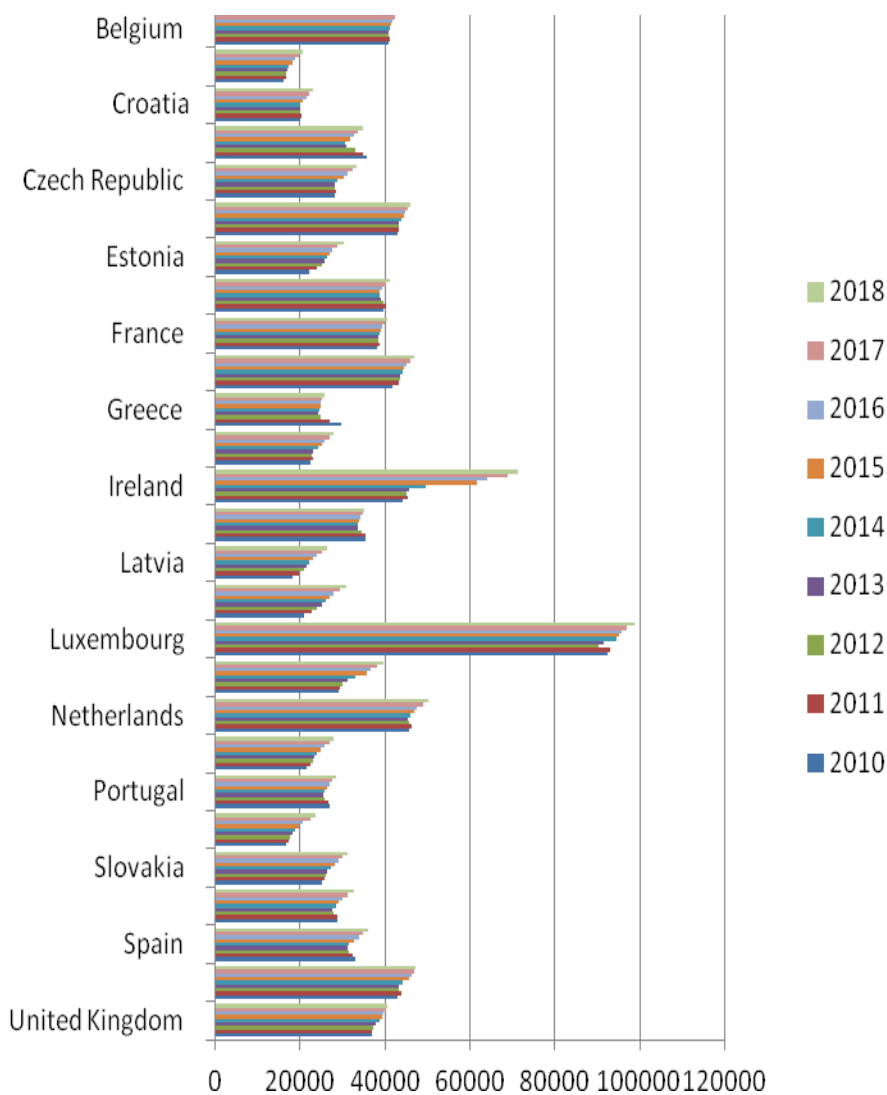
The index Eco-Innovation Scoreboard (Eco-IS) currently consists of two groups of indicators: indicators connected with eco-innovations and indicators connected with introducing eco-innovations. The indicators connected with eco-innovations include (Pakulska and Rutkowska, 2018):

1. Eco-innovation inputs include investments that stimulate eco-innovation. This applies to both financial investments and investments in human resources.
2. Eco-innovation activities show the activity of enterprises in the field of eco-innovation.
3. Eco-innovation outputs give a picture of the results of eco-innovative activities regarding patents, scientific literature and mass media news.

The indicators connected with introducing eco-innovations include:

1. Resource efficiency outcomes refer to the achievements of eco-innovation aimed at saving resources such as materials, energy and water, and the volume of greenhouse gas emissions.
2. Socio-economic outcomes inform to what extent the introduction of eco-innovations gives positive effects from the point of view of social (employment) and economic (turnover, exports) aspects.

Figure 1. Gross domestic product per capita in EU countries, constant prices (purchasing power parity; 2011 international dollar).



Note: Date after 2016 in Austria, Belgium, Bulgaria, Croatia, Cyprus, Greece, Hungary, Italy, Luxembourg, Netherlands, Romania, United Kingdom are estimated.

Date after 2017 in Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Latvia, Lithuania, Malta, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden (all other countries) are estimated.

Source: Own preparation based on

<https://www.imf.org/external/pubs/ft/weo/2018/01/weodata/weorept.aspx?sy=2010&ey=2016&ssm=1&scsm=1&sc=1&ssd=1&sic=1&ssc=1&sort=country&ds=.&br>

Calculating this index, it was assumed that the average level of Eco-IS is 100, i.e., a country with an average level of eco-innovation is a country with an index of 100. The index close to the average was recorded in 2010 in Italy, Ireland and Spain, in 2011 in France, in 2012 in the United Kingdom, in 2013 in Belgium, in 2014 in Portugal, Italy and United Kingdom, in 2015 in the Czech Republic, in 2016 in the Czech Republic and France, in 2017 in France, Ireland, Portugal and United Kingdom, in 2018 Austria, Greece and Estonia. The Eco-IS indicator for individual countries ranges from 11 to almost 190 (Table 1).

Table 1. Eco-Innovation Scoreboard (Eco-IS) 2010-2018.

| Country\Year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|----------------|---------|---------|---------|------|------|------|------|------|---------|
| UE | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Germany | 139 | 123 | 120 | 132 | 134 | 129 | 140 | 139 | 175 |
| Denmark | 155 | 138 | 136 | 129 | 185 | 167 | 123 | 120 | 154 |
| France | 96 | 99 | 96 | 108 | 112 | 115 | 99 | 99 | 136 |
| Finland | 157 | 149 | 150 | 138 | 135 | 140 | 137 | 141 | 135 |
| Sweden | 128 | 142 | 134 | 138 | 123 | 124 | 115 | 144 | 130 |
| Slovenia | 75 | 109 | 115 | 74 | 91 | 96 | 104 | 117 | 109 |
| United Kingdom | 103 | 105 | 102 | 122 | 100 | 106 | 110 | 105 | 107 |
| Estonia | 56 | 74 | 78 | 72 | 74 | 80 | 78 | 62 | 103 |
| Greece | 55 | 59 | 67 | 66 | 72 | 72 | 96 | 77 | 100 |
| Austria | 131 | 125 | 112 | 106 | 106 | 108 | 104 | 113 | 95 |
| Luxembourg | 94 | 130 | 108 | 109 | 188 | 124 | 139 | 139 | 93 |
| Netherlands | 110 | 109 | 111 | 91 | 96 | 98 | 91 | 88 | 92 |
| Belgium | 114 | 115 | 118 | 101 | 96 | 97 | 81 | 83 | 89 |
| Czech Republic | 73 | 92 | 90 | 71 | 92 | 99 | 100 | 82 | 79 |
| Ireland | 102 | 118 | 113 | 95 | 107 | 106 | 97 | 99 | 78 |
| Spain | 101 | 128 | 118 | 110 | 136 | 134 | 98 | 112 | 69 |
| Italy | 98 | 90 | 92 | 95 | 99 | 106 | 105 | 113 | 67 |
| Portugal | 72 | 81 | 84 | 79 | 99 | 102 | 95 | 105 | 63 |
| Hungar | 70 | 83 | 73 | 61 | 79 | 81 | 60 | 63 | 56 |
| Poland | 54 | 50 | 54 | 42 | 63 | 59 | 72 | 52 | 51 |
| Latvia | 48 | 52 | 54 | 47 | 68 | 72 | 85 | 73 | 34 |
| Croatia | no data | no data | no data | 57 | 87 | 67 | 81 | 75 | 28 |
| Slovakia | 45 | 53 | 53 | 66 | 71 | 73 | 86 | 74 | 25 |
| Romania | 52 | 67 | 78 | 63 | 76 | 82 | 69 | 65 | 22 |
| Bulgaria | 58 | 67 | 80 | 38 | 49 | 49 | 41 | 38 | 20 |
| Malta | 66 | 82 | 72 | 67 | 57 | 64 | 65 | 86 | 11 |
| Cyprus | 64 | 71 | 74 | 43 | 59 | 60 | 70 | 45 | no data |

Source: Own preparation based on www.database.eco-innovation.eu.

Eco-IS illustrates how the individual EU Member States are doing in various areas of eco-innovation compared to the EU average. Eco-Innovation Index gives the opportunity to analyse the impact of the eco-innovation policy on the environment, as well as it gives an answer to the question when and whether a new or improved

product or process limits a negative impact on the environment (Berkhout, 2011). As Pakulska (2018) shown, there is at least the average variation in the level of eco-innovation in the European Union. However, as also countries with low ecological innovativeness put an increasingly more emphasis on the need to care for the environment, they also try to introduce the economy onto the path of sustainable development.

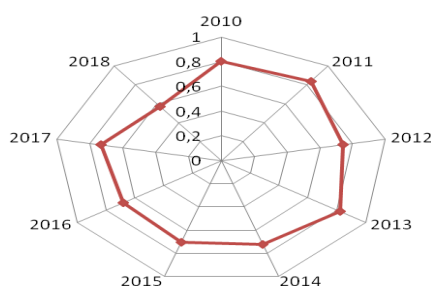
4.3 Eco-Innovation versus GDP

Observing the level of innovation in the world, it appears that this is a feature of highly developed countries. The analysis carried out confirms that this situation also occurs in EU countries and also applies to eco-innovativeness.

For much of the period considered, the Spearman's rank correlation coefficient reaches values indicating a strong or very strong correlation between the two characteristics. The biggest correlation are noticed in 2011 (0.83) and in 2013 (0.82). However, since 2013, the coefficient decreases and in 2018 reaches the size of 0.57, which indicates only a moderate dependence, but it is near strong correlation (0.6 - 0.8). It should be noted, however, that GDP data for the year 2016 for a large group of countries are estimated rather than actual, and date for the year 2017 for the other countries are estimated. As we can see in the Figure 2 the correlation rate fluctuated, but the dependence was always at least strong.

It is hard to say whether the decline in correlation will continue or remain at a similar level in the next few years, or whether it will grow. It could be assumed that the decline in correlation is related to the behaviour of countries with a lower level of GDP per capita, which have begun to take more care of eco-innovativeness. However, the analyses carried out do not confirm the occurrence of significant changes in the level of eco-innovativeness in the EU countries (Pakulska and Rutkowska, 2018). If, in the following years, the trend of the decline in the correlation is maintained, it will be worthwhile to study the identification of the factors that affect the situation.

Figure 2. Spearman correlation between GDP per capita and Eco-IS in the EU Member States.



Source: Own preparation.

Despite the decline in correlations, it continues to be at least moderate in recent years. This confirms, to a large extent, the hypothesis that the correlation between eco-innovativeness and the level of economic development is likely to occur. It can therefore be concluded that, with the increase in GDP per capita, the level of eco-innovativeness increases. However, it cannot be interpreted in such a way that it is sufficient for the level of GDP to increase and that the level of eco-innovativeness will also increase, as there is no such dependency. Higher eco-innovativeness of countries with higher GDP is the result of their policies and the fact that they are giving greater importance to innovations, especially ecological, as well as a greater amount of resources. And eco-innovations require funding, as well as other forms of support.

The Member States of the European Union to a varying extent meet the requirements of eco-innovation, which largely depends on the level of their economic development and the development needs of their economies.

5. Conclusions

The statistical analysis carried out confirmed to a large extent the hypothesis that there is a correlation between the level of economic development measured by GDP per capita and the level of eco-innovativeness measured by the Eco-IS indicator. On the basis of the calculations, it is not possible to find out whether this relationship is single-sided, that is to say, whether GDP affects Eco-IS, while Eco-IS does not affect GDP, or bilateral, i.e., both GDP affects Eco-IS and Eco-IS affects GDP.

However, the knowledge of the economy and the benchmark used for its measurement, namely GDP and eco-innovativeness, allows us to assume that, due to the relative novelty of eco-innovations, rather only GDP affects the Eco-IS level. However, with the development of eco-innovativeness, it will probably also have a positive impact on GDP, as innovations have already proven to be a positive contributor to economic development and arguably its specific variety namely eco-innovativeness, too, will have such an impact on the economy.

References:

- Berkhout, F. 2011. Eco-innovation: reflections on an evolving research agenda. *Int. J. Technology, Policy and Management*, vol. 11, no. 3/4.
<http://doi.org/10.1504/IJTPM.2011.042079>.
- Carley, M., Spapens, P. 1998. *Sharing the World: Sustainable Living and Global Equity in the 21st Century*. Earthscan. London.
- Chodyński, A. 2007. *Wiedza i kompetencje ekologiczne w strategiach rozwoju przedsiębiorstw*. Difin. Warszawa.
- Fussler, C., James, T. 1996. *Driving Eco-innovation. A Breakthrough Discipline for Innovation and Sustainability*. Pitman Publishing. London.
[http://doi.org/10.1002/\(SICI\)1099-0836\(199711\)6:5<297::AID-BSE128>3.0.CO;2-R](http://doi.org/10.1002/(SICI)1099-0836(199711)6:5<297::AID-BSE128>3.0.CO;2-R).

- Graczyk, A. 2008. Zarządzanie środowiskowe w przedsiębiorstwie. Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu. Wrocław.
- Hassi, L., Peck, D., Dewulf, K., Wever, R. 2000. Sustainable Innovation – Organisation and Goal Finding. <http://gin.confex.com/>.
- International Monetary Fund. 2010. <https://www.imf.org/external/pubs/ft/weo/2018/01/weodata/weorept.aspx?sy=2010&ey=2016&ssm=1&scsm=1&ssc=1&ssd=1&sic=1&ssc=1&sort=country&ds=.&br=.> URL.
- Jakobsen, S., Clausen, T. 2014. Comparing the Innovation Process in Environmental and Non-environmental Firms: A Look at Barriers to Innovation. DRUID Society Conference. CBS. Copenhagen.
- Jones, E., Harrison, D., McLaren, J. 2001. Managing creative eco-innovation, structuring outputs from ecoinnovation projects. *The Journal of Sustainable Product Design*.
- Kanerva, M., Arundel, A., Kemp, R. 2009. Environmental innovation: Using qualitative models to identify indicators for policy. Maastricht: United Nations University, Working Papers Series.
- Kemp, R., Pearson, A. 2008. Measuring Eco-innovation, final report of MEI project for DG Research of the European Commission. <https://search.oecd.org/env/consumption-innovation/43960830.pdf>.
- Kot, S.M., Jakubowski, J., Sokołowski, A. 2011. *Statystyka*. Diffin. Warszawa.
- Krugman, P., Wells, R. 2006. *Macroeconomics*. Worth Publishers. New York.
- Kwiatkowski, E., Milewski, R. 2005. *Podstawy ekonomii*. PWN. Warszawa.
- Marchi De, V. 2012. Environmental Innovation and R&D Cooperation: Empirical Evidence from Spanish Manufacturing Firms. *Research Policy*, 41. https://econpapers.repec.org/article/eeerespol/v_3a41_3ay_3a2012_3ai_3a3_3ap_3a614-623.htm. <http://doi.org/10.1016/j.respol.2011.10.002>.
- Ottman, J. 2011. *The New Rules of Green Marketing: Strategies, Tools, and Inspiration for Sustainable Branding*. Sheffield: Greenleaf Publishing. <http://doi.org/10.4324/9781351278683>.
- Pakulska, J., Rutkowska, M. 2018. The level of eco-innovations in the EU Member States. In Staničková, M., Melecký, L., Kovářová, E., Dvoroková, K. (eds.). *Proceedings 4th International Conference on European Integration*, vol. 3. Ostrava: VŠB Technical University of Ostrava, Faculty of Economics, Department of European Integration. Ostrava.
- Pakulska, J. 2018. Diversification of Eco-innovation in the EU Member States. In Staničková, M., Melecký, L., Kovářová, E., Dvoroková, K. (eds.). *Proceedings 4th International Conference on European Integration*, vol. 3. Ostrava: VŠB Technical University of Ostrava, Faculty of Economics, Department of European Integration. Ostrava.
- Pułaska-Turyna, B. 2011. *Statystyka dla ekonomistów*. Diffin. Warszawa.
- Ranking Innovation Union Scoreboard. www.database.eco-innovation.eu.
- Reid, A., Miedziński, M. 2008. Eco-innovation. Final Report for Sectoral Innovation Watch, Systematic Eco-Innovation 70 Report. Technopolis Group. www.technopolis-group.com/resources/downloads/661_report_final.pdf.
- Rennings, K. 2000. Redefining Innovation – Eco-innovation Research and the Contribution from Ecological Economics. *Ecological Economics*, 32. [http://doi.org/10.1016/S0921-8009\(99\)00112-3](http://doi.org/10.1016/S0921-8009(99)00112-3).

- Schumpeter, J.A. 1934. *The theory of Economic Development. An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle*. Transaction Books. New Brunswick, New Jersey.
- Steward, F. 2006. *Opponent Note: Ecoinnovation – Environmental Benefits: Economic growth and job creation*. https://www.dors.dk/files/media/graphics/Synkron-Library/Publikationer/IMV/2006/GG_version_6.pdf.