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Erika Loučanová; Miriam Olšiaková

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LOGISTICS, ECO-INNOVATIONS AND PANDEMIC

Erika Loučanová
Technical University in Zvolen, T.G. Masaryka 24, Zvolen 96001, Slovak Republic, EU,
loucanova@tuzvo.sk (corresponding author)
Miriam Olšiaková
Technical University in Zvolen, T.G. Masaryka 24, Zvolen 96001, Slovak Republic, EU, olsiakova@tuzvo.sk

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Abstract: The paper presents results of the evaluation of the development of eco-innovations in Slovakia in relation to GDP and the current situation in terms of logistics and COVID-19 pandemic. The issue is based on the analyses of overall eco-innovation index of the Slovak Republic in relation to GDP growth of Slovakia. The calculation regards the current state of logistics during the pandemic where GDP belongs to the main elements associated with effective eco-innovation supporting. The correlation and regression analysis are used to examine the degree of interdependence between economic growth and total eco-innovation index. The results from applied regression and correlation analysis of total eco-innovation index and GDP point to the fact that GDP belongs to key factors enabling effective eco-innovation supporting.

1 Introduction

The whole world economy is exposed to changes associated with the world economy globalization. Nowadays, the success in the business environment is strongly connected with innovations and it also applies to Slovakia. Moreover, it is really significant to understand that an innovative open society and knowledge are a condition of a modern economy. This is due to the fact that innovation affects present life as well as future occasions or living conditions interfering all life activities.

Now, there is a strong emphasis on innovation and its importance is constantly increasing. A strong emphasis is also placed on sustainability associated with ecological innovation. Effectiveness of innovation and efficient performance of organizations significantly depends on the skills and abilities of employees to create, design and apply innovation, but on many other factors, too. One of the most influencing factors is the coronavirus COVID-19 pandemic that actually impacts our lives in various areas.

The pandemics negatively affected economic growth, as well as gross domestic product (GDP). Therefore, the paper is aimed to analyse the relation of performance of eco-innovation in the Slovak Republic and its GDP with regard to pandemic situation that significantly affects economic situation as well as logistics.

2 Eco-innovation and pandemics in context with logistics

The economic development of new economy is generally aimed at increasing the life quality of its population which depends mainly on the economy performance, on the GDP level as well as on the growth in economy. Its growth is represented by economic changes. They are expressed in the elementary macroeconomic variables increase over time. From the short-term point of view, the economic growth is measured with respect to real GDP growth. Within the long-term period it is related to the potential product growth [1].

Mankiw et al. [2] presents that the growth of the economy belongs to the substantial goals of economic policy leading to population standard increase and better and more diverse consumption. Research, innovation, university education and other factors, including logistics belong among the most important factors supporting sustainable economic growth.

However, in recent times, it is not sufficient only to innovate. The more importance is placed on the innovation creation applied on the fundamentals of sustainability which represent eco-innovation. The EU [3] states that it is essential to apply eco-innovations which afford increasing environmental protection and the EU industry ability to be competitive, to introduce technologies, operations and business procedures using environmental sources much more effectively.

The Innovation Management introduces eco-innovation by innovation activities in the area of sustainable resources and used materials from the environment, taking into account the increasing significance of social and economic development [4-7]. The eco-innovation performance across the EU Member States illustrate Eco-Innovation Index. They aim at capturing the different aspects of eco-innovation by applying 16 indicators grouped into five dimensions: eco-innovation inputs, eco-innovation activities, eco-innovation outputs, resource efficiency and socio-economic outcomes. The Eco-Innovation Index shows how well individual Member States perform in different dimensions of eco-innovation compared to the EU average and presents their strengths and weaknesses. The Eco-Innovation Index complements other measurement approaches of innovativeness of EU countries and aims to promote a holistic view on economic, environmental and social performance [8].

As it is presented by Straka [9] the distribution logistics provides the organizational, information and physical interface between the innovation process and resources. It is associated with the significant role to arrange the most appropriate way how to select, analyse and transport these sources within the innovation process based on the principle of sustainable development and eco- innovations.

Eco-innovation belongs to the issues discussed within the goals in the European Union (EU). It is solved within the Eco-Innovation Action Plan (EcoAP) [10]. It is a significant integrant of all economic policies [11,12]. The extent of environmental issues and also challenges related to competitiveness within in individual global economies require higher care in the area how to recover current technological production as well as social patterns of behaviour. The situation is similar in Slovakia.

However, the question is how the state of eco-innovations in Slovakia will progress because the world as well as our country is currently affected by the COVID-19 pandemic and modern production is not able to operate without completely organized material processing and transport, because they are the prerequisite for functional logistics [13,14]. However, there is a question how the state of eco-innovation in Slovakia will progress because it has to face the problems caused by the COVID-19 pandemic.

Nowadays, the pandemic-related measures have caused the closure of the largest automobile factories in Slovakia. The automotive industry has become an important engine connected with the growth of the Slovak economy for several years. Its significance also results from the fact that it directly employs circa 120,000 people.

After calculating the money that companies spend and people engaged in the passenger cars production as well as number of participated occupations increase to 200,000. Automobile production contributed up to 44% of the Slovak industry and passenger cars export presents 35% of overall domestic exports last year. Slovakia has become a leader in the amount of produced cars per thousand inhabitants during previous years [15,16].

This is the reason why we are interested in how these facts influence eco-innovations in the Slovak Republic. The paper´s objective is to evaluate eco-innovations in Slovakia with regard to the GDP and current situation in terms of logistics and the COVID-19 pandemic.

3 Methodology

Subsequently after the theoretical findings consideration, we have analysed the necessary and relevant information relating to the area of innovation as well as eco- innovation (total eco-innovation index) and GDP. The considered data are acquired from the database server Eurostat (2019) [17], European Commission, Environment, Eco-innovation Action Plan, The Eco-Innovation Scoreboard and the Eco-Innovation Index (2019) [18].

Relevant indicators from the point of view of the applied analysis of the relation between eco-innovation and GDP are organized with regard to the selected examined indicators. Then the correlation and regression analysis is used in order to find out dependencies between total eco-innovation index and the gross domestic product growth.

"With regression we analyse the relationship among variables. The dependent variable is denoted Y, the independent variable X. The variables will never be perfectly related, so there is always an error term. Variation from the regression line can be thought of as having two parts: explained variation, which is accounted for by the independent variable, and unexplained variation, which is unaccounted for by the independent variable. That is, part of the change in a variable is due to another variable that we hypothesize, and part is due to other factors.

In regression analysis we are concerned with whether the relationship pattern between two values of variables can be described as a straight line, which is the simplest and most commonly used form.

$$Y = a + bX \tag{1}$$

where:

Y is the dependent variable, measured in units of the dependent variable, X is the independent variable, measured in units of the independent variable, and a and b are constants defining the nature of the relationship between the variables X and Y.

a or Y-intercept (also known as Yint) is the value of Y when $X = 0$.

b is the slope of the line and it is known as the regression coefficient and it is the change in Y associated with a one-unit change in X.

The greater the slope or regression coefficient is, the more influence the independent variable has on the dependent variable, and the more change in Y associated with a change in X.

The regression coefficient is typically more important than the intercept from a policy researcher perspective as we are usually interested in the effect of one variable on another" (Regression Analysis, 2019).

Because visual examinations are largely subjective, we need a more precise and objective measure to define the correlation between the two variables. To quantify the strength and direction of the relationship between two variables, we use the linear correlation coefficient:

$$r = \frac{\sum \frac{(x_i - \bar{x})(y_i - y)}{s_x \quad s_y}}{n-1} \tag{2}$$

where:

$\bar{x}$ and s_x are the sample mean and sample standard deviation of the x's, and $\bar{y}$ and s_y are the mean and standard deviation of the y's,

n is the sample size is.

This statistic numerically describes how strong the straight-line or linear relationship is between the two variables and the direction, positive or negative.

In ANOVA, we partitioned the variation using sums of squares so we could identify a treatment effect opposed to random variation that occurred in our data.

The sums of squares and mean sums of squares are typically presented in the regression analysis of variance table. The ratio of the mean sums of squares for the regression and mean sums of squares for error form an F-test statistic used to test the regression model.

The relationship between these sums of square is defined as

$$\text{Total Variation} = \text{Explained Variation} + \text{Unexplained Variation} \quad (3)$$

The larger the explained variation, is the better the model is at prediction. The larger the unexplained variation, the worse the model is at prediction. A quantitative measure of the explanatory power of a model is R^2, the Coefficient of Determination:

$$R^2 = \frac{Explained\ Vatiation}{Total\ Variation} \quad (4)$$

The Coefficient of Determination measures the percent variation in the response variable (y) that is explained by the model. Values range from 0 to 1. An R^2 close to zero indicates a model with very little explanatory power. An R^2 close to one indicates a model with more explanatory power [19].

Finally, the inductive-deductive method presents identified results and resultant conclusions based on the findings from prevenient analyses [8,17-20].

4 Result and discussion

Taking into account the values related to eco-innovation reached in 2018, Slovakia is one of the countries whose eco-innovation index reaches rather low level. Sweden, Finland, Germany and Luxemburg belong to the best-rated countries. The Slovak Republic occupies the eighth place within the group of countries with the lowest eco- innovation index [20].

At present, from the perspective of the COVID-19 pandemic, Slovakia has applied actions which, from the logistics point of view, meant closing important enterprises for the country's economy (such as industrial enterprises, various services, etc.). As Bibel states, telecom operators have noticed decreased movement of people by 30%, and some operators report a decrease in their clients' movements by as much as half [8] and according to the Google COVID-19 Mobility Report for Slovakia [21], Figure 1.

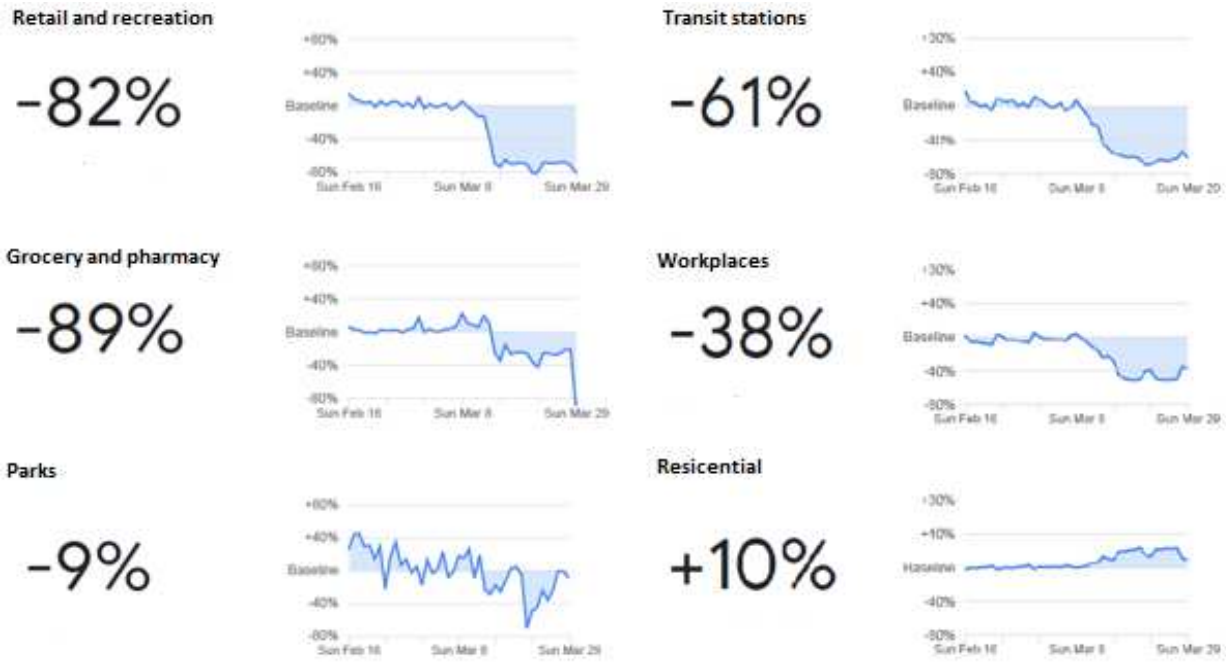

Figure 1 Google COVID-19 Mobility Report for Slovakia [21]

These facts have a significant impact on the economy of the Slovak Republic and therefore we have also examined the relation of eco- innovations and GDP by means of regression analysis.

Data from Eurostat [17] and the Eco-Innovation Index [18] are the basis for the correlation and regression analysis which we carry out with the intention of finding out the dependence between total eco-innovation index and GDP

in the case of Slovakia. Table 1 presents the values calculated on the base of realized statistical analysis.

Table 1 Calculated values from statistical analysis

SUMMARY OUTPUT	
Regression Testing	
Multiple R	0.890235
R Squared	0.792517
Adjusted R Squared	0.723357
Standard Error	7.55457
Observations	5

ANOVA

	Degrees of freedom	Sum of squares	Mean Square	F-value	Significance F
Regression	1	653.9854	653.9854	11.45905	0.042929
Residual	3	171.2146	57.07152		
Total	4	825.2			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	-150.764	63.3563	-2.37962	0.097652	-352.392	50.86438
Eco-innovation	2.612389	0.771727	3.385122	0.042929	0.15641	5.068368

Source: authors' computation

At the beginning of the regression testing we have to compute the correlation analysis. The calculated correlation coefficient value is 0.890235. The closer the value is to 1, the more positive correlation (dependence) is between measured variables. The value calculated by us indicates a strong relationship between GDP and eco-innovations in the Slovak Republic.

The R-Squared represents the value of the coefficient of determination. Its calculated value is 0.792517. After multiplication this value by 100 it denotes that the determined regression line specifies the variability in average GDP growth to 79%. Other factors reflect unexplained variability and other unspecified effects such as the influence of random factors.

Adjusted R-squared regards the quantity of estimated parameters and the number of measurements, too. It is recommended to determine the Standard Error as small as possible. This analysis of the dependence between the monitored variables (GDP and eco- innovations) is carried out for the conditions of Slovakia.

Another part of testing includes the analysis of variance (known as ANOVA). It allows us to test a null hypothesis which considers that the selected model to explain dependency is not appropriate. An alternative hypothesis assumes the opposite statement. We applied the F test to evaluate this assumption. The significance value F = 0.042929 < 0.05. Because the calculated value is lower than 0.05 (α - significance level) it denotes that we reject the null hypothesis. It means that the model has been chosen correctly from which it follows that average GDP growth is dependent on eco-innovations.

We have also realized the regression analysis. Regarding its results where Intercept-b0 equals -150.764, we can assume that if the eco-innovation index were zero, the average GDP growth would be -150.764 euros.

From the relation of the eco-innovation index to average GDP growth results that X Variable is 2.612389. It means: If average GDP growth increases by 1%, the eco-innovation index will increase by almost 3 points. This statement is statistically significant with respect to the p-value for the eco- index and average GDP growth, where we have found out that its value is less than 0.05 (0.042929).

Moreover, this part of our calculations also takes into account a 95% confidence interval for b0 and b1. If the average GDP growth increases by 1%, the total eco- index increases in the range from 0.15641 to 5.068368 points with the probability of 95%.

Results from the given calculations acknowledge the theoretical findings. Lisý et al. [1] presents that economic growth signifies economic changes, which are expressed in an increment of essential macroeconomic variables over time. By presented calculations and their results it has been proven there is dependence between the examined parameters - average GDP growth and eco-innovation index [1].

The confirmed assumptions are also presented by Mankiw et al. [2]. He considers that research, innovation (eco-innovation as well) and many others are significant factors influencing as well as supporting sustainable economic growth.

However, the results also point to the fact that if GDP growth would be -150,764 euros then eco-innovations would reach 0. In the current situation accompanied by the closing of enterprises, representing the centrepiece of the Slovak economy, during the COVID-19 pandemic, this is supposed to be a positive finding for eco-innovation. If a recession occurs, economists currently estimate that Slovakia's economy will decline by 6% on average for the whole of 2020. The probability of a recession is 50% when we are talking about a strong recession [22]. Eco-innovations based on the analysis would also be realized during the recession or would remain at least 0.

This fact is caused by their nature, because eco-innovations present a selection of generally appropriate materials. They are also associated with distribution processes that require less energy, fewer natural sources, and complexly they do not burden the environment so much [23]. It means that if we do not burden nature with a negative impact of human, it can make some positive changes through its own regenerative ability, which are practically also eco- innovations, realized by nature itself.

This is also confirmed by actual images from the Copernicus satellites from the European Space Agency, where Sentinel-5P monitors air pollution around the world. Recent satellite data show that in January and February nitrogen dioxide pollution was significant. When restrictive measures began to apply, the amount of gas began to decline, see Figures 2 and 3. Compared to the same period a year earlier, the current values are much lower [24].

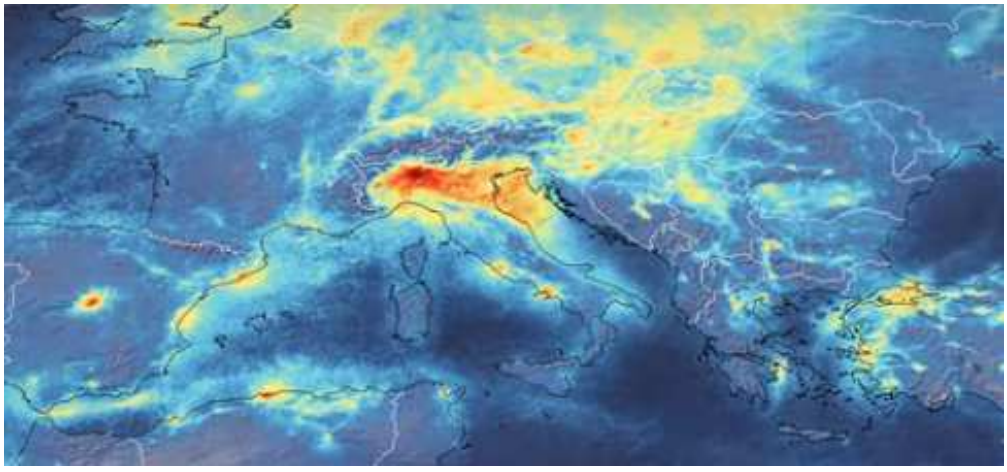

Figure 2 View on Europe showing air-pollution before launching measures related to the COVID–19 pandemic [24]

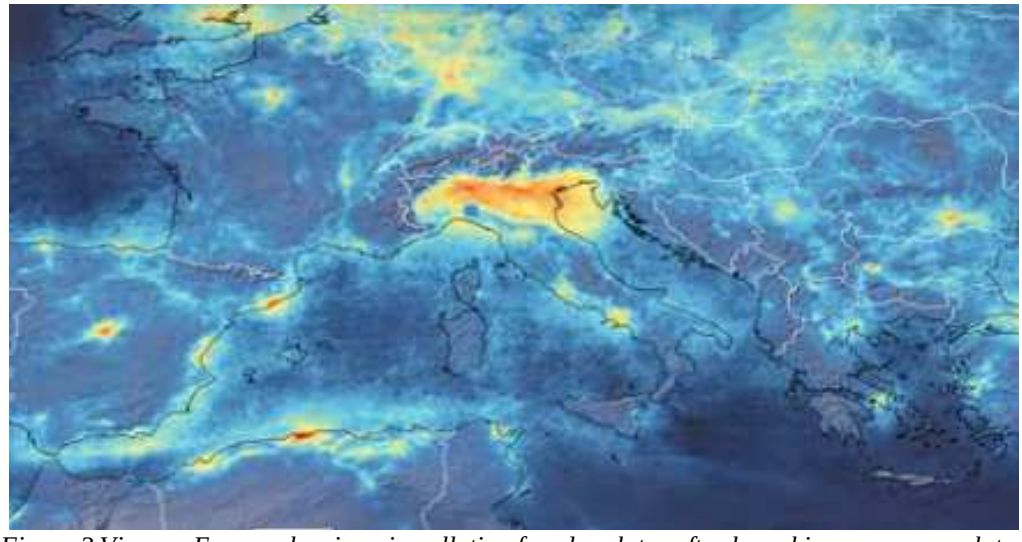

Figure 3 View on Europe showing air-pollution few days later after launching measures related to the COVID–19 pandemic [24]

These facts point to the regeneration of eco-innovations based on natural resources to a certain extent. The measures related to the COVID-19 pandemic have a strong global logistics impact and are now we are more focused on local logistics [25,26], which also positively affects eco-innovation.

5 Conclusions

This paper presents results of the evaluation of the development of eco-innovations in Slovakia in relation to GDP and the current situation in terms of logistics and COVID-19 pandemic. With respect to the carried-out analyses, we can state that:

- Slovakia is one of the countries within the European Union, characterized by the low eco-innovation index.
- GDP belongs to key factors enabling effective support for eco-innovation.
- The failure of global logistics replaces local logistics, which is also a positive factor for eco-innovation.

These facts are significant mainly these days, where the pandemic negatively affected economic growth, and mutual relationship GDP and eco-innovation can affect the sustainable economic development of Slovakia in the time of a pandemic.

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