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Eco-Innovation Perfomance of Slovakia

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Abstract: The aim of the article is to evaluate eco-innovation performance of Slovakia as well as to test the interdependence of the level of patenting of environmental technologies on government budget outlays or appropriations for research and development in the area of environment and energy. In order to test for the interdependence, regression was used. We used the eco-innovation index elaborated by the European Commision to evaluate the eco-innovation performance of Slovakia. The results reveal that the Slovak economy is one of the economies with insufficient eco-innovation performance. However, the regression analysis showed only a slight dependence of the variables surveyed.

Keywords: environment; sustainable development; eco-innovation; research and development; Slovakia.

Učinkovitost eko inovacij na Slovaškem

Povzetek: Namen članka je oceniti uspešnost Slovaške na področju ekoloških inovacij ter preizkusiti medsebojno odvisnost stopnje patentiranja okoljskih tehnologij od izdatkov državnega proračuna ali sredstev za raziskave in razvoj na področju okolja in energije. Za preverjanje soodvisnosti je bila uporabljena regresija. Za ocenjevanje uspešnosti na področju ekoloških inovacij na Slovaškem smo uporabili indeks ekoloških inovacij, ki ga je pripravila Evropska komisija. Rezultati kažejo, da je slovaško gospodarstvo eno od gospodarstev z nezadostno učinkovitostjo ekoloških inovacij. Vendar je regresijska analiza pokazala le rahlo odvisnost raziskovanih spremenljivk.

Ključne besede: okolje; trajnostni razvoj; ekološke inovacije; raziskave in razvoj; Slovaška.

1. Environmental sustainability in economic policies

Development of our society and the ongoing changes bring number of impacts that are reflected in individual areas of human life, including the environment.

The need for sustainable development is considered to be one of the consequences of environmental destruction caused by industrialization.

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Globally, all sustainable development initiatives aim at defining the very essence of sustainability, formulating principles and measures to improve and maintain economic, social, and environmental conditions and setting acceptable targets.

Rate and extent of degradation of the quality of the environment have caused the increased need for more intensive involvement of the regulatory function of the state. Environmental sustainability is becoming a part of every economic policy and also a factor that has a long-term impact on the competitiveness of individual economies. Ecological innovations, or just eco-innovations are becoming increasingly important in innovation, scientific and technical technologies.

The aim of the article is to evaluate eco-innovation performance of Slovakia, as well as to test the interdependence of the level of patenting of environmental technologies on government budget outlays or appropriations for research and development (GBOARD) in the area of environment and energy.

To evaluate the eco-innovation performance of Slovakia, we will use the eco-innovation index created for this purpose by the European Commission (EC).

In order to test for the interdependence of the number of patented environmental technologies on GBOARD, regression analysis was used.

2. Theoretical review

Eco-innovations as a theoretical concept are encountered in social research at the beginning of the first decade of the 21st century. Out of many definitions of eco-innovations offered by the theoretical literature, we state the definition of Arundel and Kemp (2009) who define eco-innovation as " the production, application or use of goods, services, production processes, organizational structures, managerial or business models that is new to the business or to users and results of which are aimed at reducing environmental risks, pollution and the negative impacts of resource utilization compared to existing alternatives."

EC (2011) defines eco-innovation as "... any innovation resulting in significant progress towards the goal of sustainable development, by reducing the impacts of our production modes on the environment, enhancing nature's resilience to environmental pressures, or achieving a more efficient and responsible use of natural resources."

Andersen (2008) distinguishes several categories of eco-innovations. The most widespread group consists of so-called add-on eco-innovations that have a limited systemic impact and additionally add to existing production or consumption models and improve the environmental performance of customers. Integrated eco-innovations (in the form of cleaner technology processes or products) contribute to change of production and consumption processes in businesses. Alternative product eco-innovations are based on new theories, equipment, or processes. Macro-organizational eco-innovations take the form of new organizational structures. Eco-innovations, which have a general purpose, represent the last category. They are derived from the use of information and communication technologies, biotechnology, and nanotechnology.

Creation and diffusion of eco-innovations can be either policy or market driven. In many cases, eco-innovation is indicated by economic policies. Economic and political authorities act on the innovative behaviour of enterprises as key actors through the adoption of specific legislative measures. The second approach, market driven, is based on the idea that a better environmental approach in business and eco-innovation improve competitiveness (Ambec and Lanoie, 2008).

Regarding the first approach, there are several ways how the state (or a multinational entity) creates positive or negative incentives for eco-innovative behavior of businesses and consumers as key drivers of change. According to Foster, et al. (2006) the regulator can create barriers to the use of unwanted technologies or products. The second way is to determine specific product quality parameters. The third way is to create new markets for innovation. Finally, it is regulatory measures that require the substitution of an existing product for an environmentally sound alternative.

3. Evaluation of eco-innovations in Slovakia

Innovation is the result of a whole complex of factors. In the case of eco-innovation energy and material intensity of the economy, waste management, tax and expenditure instruments of fiscal policy are considered to be the main framework factors. Selected environmental and economic indicators of the SR are presented in Table 1.

Table 1: Selected environmental and economic indicators of the SR and selected EU countries

Selected indicators	year	EU 28	SR	CR	HU	PL	FI
Environmental tax revenue (percentage of total revenues from taxes and social contributions)	2016	6.29	5.61	6.07	7.01	8.14	7.05
Carbon dioxide equivalent (metric tons per capita)	2015	8.7	7.6	12.2	6.3	10.2	10.5
$PM_{2,5}$ exposition (average of population, micrograms per cubic meter)	2015	14.45	22.54	20.25	22.44	23.45	6.02
Resource productivity and domestic material consumption (euro per kg)	2015	2.15	1.76	1.59	1.55	1.19	1.04
Material intensity - without energetic materials (i.e. domestic material consumption per GDP, USD per kg)	2015	2.83	2.55	2.91	2.42	1.84	1.4
Share of renewable energy sources (RES) in gross final energy consumption	2016	17.00	12.00	14.9	14.2	11.3	38.7
Government expenditure on environmental protection (% of GDP)	2016	0.8	0.7	0.7	0.5	0.4	0.2
Landfill rate of waste excluding rock wastes (%)	2014	25	52	22	46	26	17
Recycling rate of municipal waste (%)	2016	45.8	23	33.6	34.7	44	42

Source: Eurostat and OECD data

In connection with the increasing importance of eco-innovations, the EC created so called The EU Eco-Innovation Scoreboard, on the basis of which it quantifies the eco-innovation index, which assesses the Member States' eco-innovation performance. It is a synthetic index composed of sixteen indicators

covering eco-innovation inputs, activities, outputs and economic and environmental results. According to the latest edition of the EU Eco-Innovation Scoreboard 2018, Slovakia is in the group of countries with the lowest eco-innovation performance, known as the catching-up countries. The Slovak economy achieves only 68% of the average of eco-innovation performance of the EU countries average. As figure 1 shows, this is the second decline in a row after the previous year.

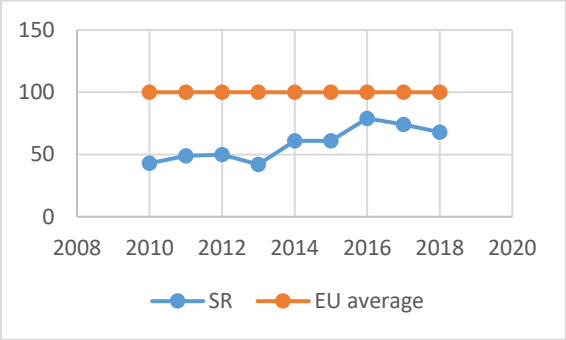

Figure 1: Evaluation of eco – innovation index for Slovakia
Source: The EU Eco – Innovation Scoreboard 2010 - 2018

This is largely due to the financing of eco-innovation. Science and research are a key source of innovation for developed economies. For the purposes of our analysis of eco-innovations, we will take into account those components of GBOARD that are spent on the environment and energy. As figure 2 shows, environmental and energy spending is low. In this respect, in relative terms per capita (average from 2008 to 2016 at constant prices and purchasing power parity), the Slovak economy is among the countries with the lowest height. We reach only a quarter of the EU average and 10% level of the best country - Finland.

There are several reasons for low funding of the eco-innovation development. As a key factor we can clearly mention the low funding rate of the total RD, resp. low share of corporate investments to RD. In Slovakia, the intensity of total gross expenditure on RD (measured as % of GDP) has long been below EU level (average for 2011-2016: Slovakia 0.89% GDP; EU 2.01% GDP).

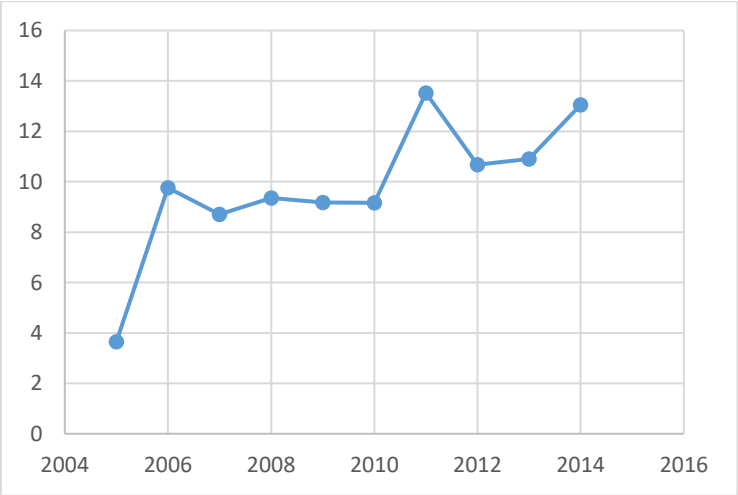

Figure 2: GBAORD environment and energy (euro, millions)
Source: OECD data

Moreover, Slovakia is characterized by significant economic, social, and environmental differences among regions. The Bratislava self-governing region generates more than 25% of GDP, attracts most of

foreign direct investment and receives a huge share of research and development expenditures. People living in capital generate more waste and have better access to environmental services. On the other hand, the Prešov and Košice regions in the east are lagging behind in water supply, while the Trnava and Nitra regions in wastewater management. Selected regional indicators in Slovakia are shown in the Table 2.

Table 2: Selected regional indicators of the SR for 2009

region	SO_x[a] (kg/cap.)	NO_x[a] (kg/cap.)	PM[a] (kg/cap.)	Municipal waste generation (kg/cap.)	Population connected to sewerage (%)
Bratislava	14	10	1	434	85
Trnava	1	3	3	413	52
Trenčín	60	13	7	329	58
Nitra	2	5	4	366	47
Žilina	5	6	9	317	57
Banská Bystrica	7	9	10	262	61
Prešov	2	3	6	247	56
Košice	16	19	9	252	60

Source: Statistical Office of the Slovak Republic data

Note: a – emissions from stationary sources only

Patents or patent applications are used as an additional indicator of innovation performance. The development of the number of patents of environmental technologies in Slovakia in 2005 - 2014 is shown in the table 3.

Table 3: Patents in environment – related technologies in Slovakia in 2005 - 2014

Environment – related technologies	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
All technologies	178.68	227.18	244.91	200.57	195.36	258.41	267.41	239.09	262.04	289.75
from that										
Environmental management	8.83	16.33	15.5	5.23	21.33	20	21.33	20.17	12.5	8
Water – related adaptation technologies	0	0	1	0	2	0	0	1.33	1.5	1.5
Climate change mitigation technologies	12	21.98	20.25	10.92	11.17	18.28	33.73	14.33	21.58	20.58

Source: OECD data

Regarding the national productivity of environmental patents (i.e. number of environmental patents per 1 million of inhabitants), the Slovak economy is with 2.2 patents per 1 million of inhabitants at a level comparable to other V4 countries. However, the distance from the OECD or innovative countries (Finland) average is considerable (Table 4).

Table 4: Number of environmental patents per 1 million of inhabitants in 2006 - 2014

Selected countries	2006	2007	2008	2009	2010	2011	2012	2013	2014
CR	2.6	4.3	3.0	3.1	4.1	4.2	3.4	4.1	3.7
HU	1.6	3.5	2.7	2.7	3.0	3.8	1.9	1.7	1.9
PL	0.6	0.7	1.3	1.4	1.3	1.6	2.7	2.0	2.1
SR	1.3	1.1	1.1	1.1	2.5	4.1	1.3	2.0	2.2
FI	26.8	29.9	37.3	32.2	45.0	52.5	53.4	42.9	34.6
OECD	16.7	17.9	18.8	20.8	23.2	24.2	23.6	22.1	18.9

Source: OECD data

In the following text, we will join the two variables we described, and we will observe the interdependence of the number of environmental technology patents on GBOARD that are spent on environment and energy through the regression analysis.

As the results of the regression show (figure 3), the correlation coefficient becomes 0.6, i.e. there is a moderate dependence between the number of environmental technology patents and GBOARD spent on the environment and energy.

This is also confirmed by the coefficient of determination, according to which 35% variability in the number of patents can be explained by a regression model to the overall variability GBOARD spent on environment and energy.

Summary output					
Regression Statistics					
Multiple R	0,588169				
R Square	0,345942				
Adjusted R Square	0,264185				
Standard Error	9,047962				
Observations	10				
ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	346,4011	346,4011	4,231338	0,0737
Residual	8	654,9249	81,86562		
Total	9	1001,326			

Figure 3: Regression output

4. Eco-innovation policy and its tools

Eco-innovation policy is integrated into several policies in Slovakia. We find it in environmental protection policies, but also in innovation, as well as in research and development policies. Not only in Slovakia, but overall, we can qualify it as a cross-cutting policy. This is a relatively young area compared to other 'traditional' policies. Its creation is strongly determined by the pressure of multinational institutions and EU policies, whether indirectly, through environmental legislation, or directly through the implementation of cohesion policy in the SR. It relates to the fact that it is not institutionally concentrated, but its parts are found in several ministries and institutions. Its strategic objectives, frameworks and instruments are part of several legislative standards.

After the entry of the Slovak Republic to the EU, EU funds became the key source within direct financial interventions into the economy. Support for the development of eco-innovation (direct or indirect) is identified in two programming periods (2007-2013 and 2014-2020). Projects financed from EU resources in these two programming periods are mainly of an infrastructure nature. Although they were originally designed as a complementary source to national sources, actually they represent a relatively large part of public capital expenditure in Slovakia and often replace domestic sources. Even in the current programming period, we can identify support for eco-innovation in several operational programs.

Within the domestic direct sources of funding for research and development, we will mention projects of the Slovak Scientific Grant Agency of the Ministry of Education of the Slovak Republic and Slovak Academy of Sciences, The Slovak Research and Development Agency, Environmental Fund programmes for environmental Infrastructure and programmes for energy effectiveness or renewable energy sources granted by Slovak Innovation and Energy Agency.

In addition to direct financial instruments, there are also some soft instruments implemented in Slovakia that motivate actors to eco-innovative behaviour, including green public procurement.

5. Recommendations

As we pointed out, eco-innovation policy in Slovakia is not institutionally concentrated, but it is integrated into several policies. The objectives of reducing environmental risks, pollution, and negative impacts of resource utilization through the implementation of new products, processes, management and organizational structures and models can be found in environmental protection policies, as well as in innovation and scientific and research policies. Its strategic objectives and frameworks, as well as its instruments, are fragmented to a number of legislative standards and the so-called "soft" legislation (strategic documents, action plans, etc.). Regarding this, it is important to create a coherent concept of a systematic support of eco-innovation in Slovakia with an active involvement of state and public administration, regional and local self-government for a functional concept of achieving sustainable development in Slovakia.

It is public sector which remains a long-term source of funding for innovation. Moreover, it is very low compared to EU average. The attention should be dedicated to the opportunities offered by direct financial support of EU resources. In the current programming period, we can identify support for eco-innovation in several operational programs.

In general, the innovation policy of the Slovak Republic is characterized by relatively low private sector activities (Belanová, 2018). SMEs in Slovakia achieve relatively low overall innovation performance and thus also relatively low performance in the area of creation and implementation of eco-innovations (SBA, 2018). There is a lack of higher, longer-term incentives for businesses and households to take an active approach to implementation of eco-innovations, and for better public awareness. Examples of the implementation of eco-innovations from the world, but also from Slovakia, which can help to ensure sustainable growth, should be promoted. Slovakia is rich in renewable and natural resources such as wood, mineral water, water resources and thermal springs, selected agricultural products and others that can be actively used in eco-innovation at the business environment level, especially in SMEs as key actors in the creation and diffusion of eco-innovation. There is a need to increase the incentive for businesses to eco-innovate, whether by appealing to the implementation of an environmental management system according to ISO 14001 or by issuing labels such as eco-friendly product or the EU ecolabel.

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