Varazdin Development and Entrepreneurship Agency
in cooperation with
Azerbaijan State University of Economics (UNEC)
University North
Faculty of Management University of Warsaw
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Economic and Social Development

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"Socio Economic Problems of Sustainable Development"

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THE NATIONAL ECONOMY COMPETITIVENESS: EFFECT OF MACROECONOMIC STABILITY, RENEWABLE ENERGY ON ECONOMIC GROWTH

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ABSTRACT
According to the reports of the Global Competitiveness which developed by the World Economic Forum, the competitiveness was defined as "a set of institutions, policies and production factors that form the level of the country's performance". This paper investigates the effect of macroeconomic stability, environmental performance on economic growth. The object of investigation – the countries with transformation process from the recourses to the effective economic model according to the reports of the Global Competitiveness which developed by the World Economic Forum. The authors indicated that the main goal to achieve the stable growth – increasing the level of the national economic competitiveness could be realized not only through the growth of the key determinants of the competitiveness: institutions; infrastructure; macroeconomic stability and etc., but also considering the aspects and parameters of country's environmental performance. The methodology instruments of the investigation were modified production function of Cobb-Douglas which considering the level of the country's macroeconomic stability and environmental performance. The period of investigation was 2000–2017 years. Under this research, the authors used the dataset from World Data Bank, Global Environmental performance Index, Global competitiveness report. The findings proved the correspondence of the developed models to the input dataset. Moreover, the assessments of the elasticity of the developed model components were positive and statistically significant.
Keywords*: economic growth, environmental performance index, human capital, physical capital, stability*

1. INTRODUCTION

The systematic progress process of globalization an international competitiveness are the main features of the dynamic changes which observed in the world economic. Therefore, the convergence of abovementioned processes follows from the necessity to adapt countries according to the rapid scientific and technological progress, internationalization of economic cooperation, aggravation of common social, ecological and economic problems. The long-term of the country's macroeconomic instability, both in its internal and external appearance, lead to the high risks of a crisis, decreasing the economic growth temp and quality of life. The consequence of the last financial crisis in 2007 provoked implementing of new institutional decisions which were going to improve the EU functioning. Thus, the macroeconomic imbalance (internal and external aspects) in the euro zone (European Commission, 2015) were mitigating. The external macroeconomic balance describes the relationship with other countries and could be estimated through the volume of foreign investment, the volume of export and import, stable exchange rate and etc. The internal balance could be achieved when the country's actual production corresponds to the full using of production factors, unemployment level corresponds to the natural unemployment, the level of inflation remains at a low and stable level. At the same time, in 2015 UN General Assembly resolution "Transforming our world: the 2030 Agenda for Sustainable Development" indicated the main goals of sustainable development which characterise the relationship between economic, social and ecological processes. Therefore, the safety of environment has become the key factors of success future country's development. Energy sector is a main factor, which determines social and economic development in the world. According to Ener Data during 1990-2016 the world energy production increased by 59% (from 8 759Mtoe in 1990 to 13 903Mtoein 2016). The largest share to provide this growth included non-renewable energy sources – 75.5% (Sawin et al., 2018), most of which is produced at thermal power station owing to the burning processes. It causes the increase of combustion products growth among which there is CO2, and then increase of negative impact on environment. In particular, during 1961-1979 CO2 emissions average growth in the European Union (EU) was25.07% per year, which was4 647 643.766 thousand kt at the end of 1979. Understanding of the ecological problem for EU Member States lead to introduction of Directives 67/548/EU on the approximation of laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances (1967) and 70/220/EU on the approximation of EU Member States' legislation relating to the measures, taken against air pollution by vehicle emissions (1970). In 1972 UNO Stockholm Declaration on the Environment was adopted, and next year the first ecological program in EU was accepted (1972). Introduction of those regulatory documents lead to constant reduction of CO2 during1979-2014 on average by 14% annually. Volume of CO2 emissions in 2014 was at the level of 3 241 844.353 thousand kt, that is 1 405 799.413 less than in 1979.

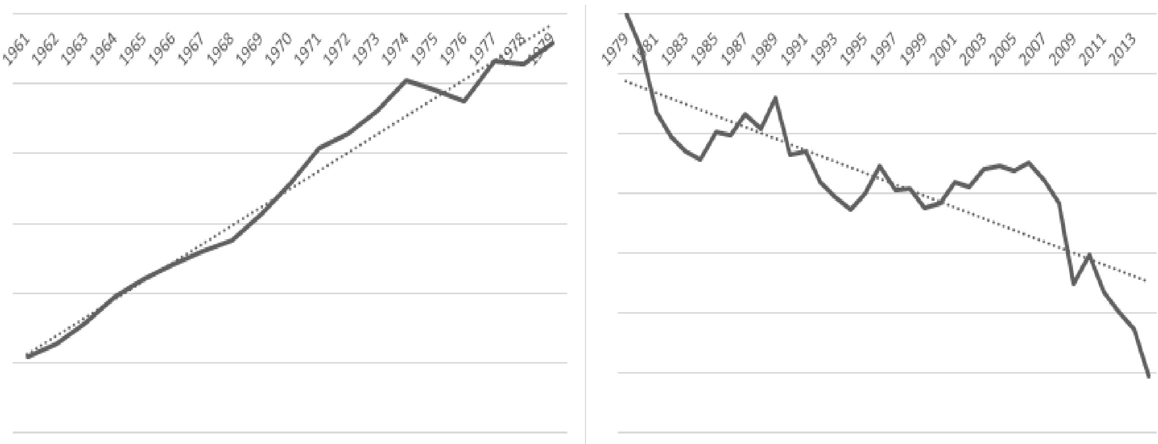

Figure 1: The temp of CO2 emission in EU 1961-1979 u 1979-2014 (World Bank Data)

At the same time, limited resources of fossil fuel as the main energy source, using of which has negative impact on the environment, made to look for ways of rational energy management and to get it by means of the renewable energy sources. In this case the perspective way to reduce CO2 emissions in the world is to use renewable energy sources (RES). Most countries, including all EU Member States and Ukraine, adopted programs on RES introduction and set up a goal to increase energy production based on RES.

Germany planned that 18% of the final energy consumption in electric power industry, transport sector and heat power industry will be provided through RES by 2020. In Poland, the main goal is that 15.5% of final energy consumption is provided through RES, in Lithuania – 23%, in Latvia – 40%, in Moldova –17%, in Estonia – 25% (Sawin et al., 2018, Prokopenko et all, 2017). 11 countries of EU achieved the set goals on RES in 2015, including Estonia and Lithuania. Total investment in RES in the world amounted to 113 billion $ in 2006 and 242 billion $ in 2016. The RES total installed capacity in the world in 2016was 2 017 GW (Sawin et al., 2018). During the Ukraine's independence the largest level of CO2 emissions of about 630 929,352 thousand kt was registered in 1992, figure 2.

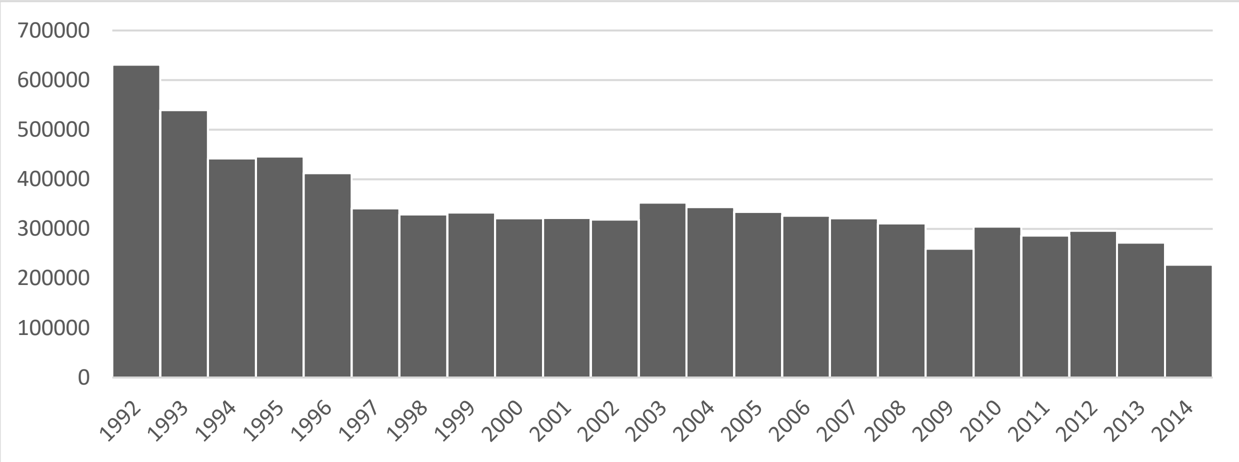

Figure 2: CO2 emissions in Ukraine during1992-2014, kt (World Bank Data)

In 1992-2014 CO2 emissions into the air were constantly reduced in average by 4.15% annually in Ukraine. It was facilitated by Ukraine's signing of Kyoto Protocol, by taxes on harmful substances emissions into the air and by reduction of production volumes, related to crisis in Ukraine 1990-1999, 2008 and from 2014 till today. According to Global Status Report 2017 Ukraine set a goal to achieve the RES final consumption index of about 11% (Sawin et al., 2018).

2. LITERATURE REVIEW

The connection between energy production growth and the environmental load can be explained by Environmental Kuznets curve (Kuznets, 1955). It demonstrates relationship of economic and ecological indicators and confirms that in countries with extremely developing economic indicators (GDP growth) the load on environment is growing, and at the same time, as the country's welfare increases, demand for clean and safe environment grows. Using Environmental Kuznets curve on the example of 17 countries OECD during 1977-2010, Bilgili F and Ozturk Ilhan (2015) came to decision about relationship between RES consumption volumes and CO2 emissions. Thus, the authors in the papers (Bhandari, 2018; Mačaitytė et al., 2018; Pimonenko et al., 2017; Prokopenko et al., 2017; Cebula et al., 2015; Lyulyov et al., 2015;) analysed the causes of CO2 emission and issues to decrease it. Besides, the scientists in the papers (Masharskyet al., 2018; Vasylyeva et al., 2014;Dkhili, 2018;Chygryn, 2016) proved that RES is key part of countries' energy security. The similar conclusions were gained after study of 68 countries by scientist from Cyprus–Panayotou for the period 1980-1991(1993). Scientist concluded that there was relationship between economic growth and environment degradation. The scientists proved the linking between social indicators (Vasilyeva et al., 2015), ecological indicators which include efficiency of RES (Singh, 2018; Chygryn, 2018;Vasylieva et al., 2018), macroeconomic stability in low-middle income countries (Lyeonov et al., 2018).

At the same time, an empirical estimation of Environmental Kuznets curve for four countries with different income level for the period 1975-2014,fulfilled in the work of authors Azamand Khan (2016), proves absence of the proper dependences for countries with high income. In works (Apergis & Payne, 2014; Bildirici, 2013; Bilgili & Ozturk, 2015; Cho et al., 2015; Fang, 2011; Menegaki & Ozturk, 2016; Kahia et al., 2016; Ocal & Aslan, 2013; Salim & Rafiq, 2012) one of the proposed assumptions is bidirectional or unidirectional relationship of economic growth (GDP) and RES growth. For example, studies of Al-mulali (2015), Apergis and Payne (2014), Dogan, and Turkekul (2016), Menegaki (2016) are resulted in mathematic confirmation of bidirectional relationship between economic indicators growth (GDP) and RES growth in the country. Besides, works (Ben Jebli et al 2015; Mert, Bölük, 2016; Zoundi, 2017) study RES growth and associate it with volumes of CO2 emissions. Apergis (2010), Bildirici (2013), Ocal and Aslan (2013) prove dependence between CO2 emissions and RES(Ozturk & Bilgili, 2015). The research of Menegaki (2016) and Tugcu (2013) confirm independence (neutrality) of those indicators. To analyze relationship between RES and GDP in studies (Fang, 2011; Kahia et al, 2016; Tugcu, et al, 2012)authors use Cobb-Douglas production function:

$$Q = AL^{\alpha} * K^{\beta}$$

where Q = total production (the monetary value of all goods produced in a year); L = labour input (the total number of person-hours worked in a year); K = capital input (the monetary worth of all machinery, equipment, and buildings); A = total factor productivity; α, β are the output elasticity of labour and capital, respectively.

Modified function can be demonstrated as:

$$\ln Y_{\text{i}} = \phi + \alpha \ln \text{REC} + \beta \ln \text{SREC} + \gamma \ln K + \delta \ln L + \lambda \ln T + \mu$$

At the same time, we think that it is necessary to take into account level of country’s political and macroeconomic stability, while studying the relationship between RES level and economic growth. It is explained by the fact that power plants, which use RES technologies, have long payback period. That is why, in the investment assessment the macroeconomic and political stability factors more significant, because most programs on RES introduction is supported by government. And GDP drop in countries, including EU member countries, during the financial an economic crisis was caused by macroeconomic instability (Vasylieva et al., 2018; Lyeonov et al., 2018). The main object of the article is to reveal connection between country’s GDP fluctuation, RES volumes growth, considering political and macroeconomic situation in the country.

3. DATA

The authors have studied 7 European countries (Latvia, Lithuania, Moldova, Poland, Ukraine, Georgia and Belarus), which have similar economic situation by the time of the Soviet Union collapse. It lets to reveal general factors of development and dependencies between them. Analysing data of World Bank for the period 1995-2014, in relation to the ratio between average production volumes of RES and GDP per capita (fig 2),one may point out, that countries, which are not EU Member States - Moldova, Belarus and Ukraine, have low indicator regarding RES introduction and low GDP. At the same time Moldova, Belarus and Ukraine have larger potential of solar power plants, than other EU Member countries, but therefore, there is great difference in energy volumes, generated from RES. Poland and Lithuania have high indices of GDP per capita with low RES volume. We believe that soon one can observe increase of GDP level per capita and growth of the RES production. It is explained by the fact that there is relationship between GDP per capita and RES, because countries with high GDP per capita have large production volumes owing to RES, and in rare instances, another situation can be observed, such as in Georgia. Therefore, Georgia is a country, which has abilities to increase GDP per capita thanks to RES.

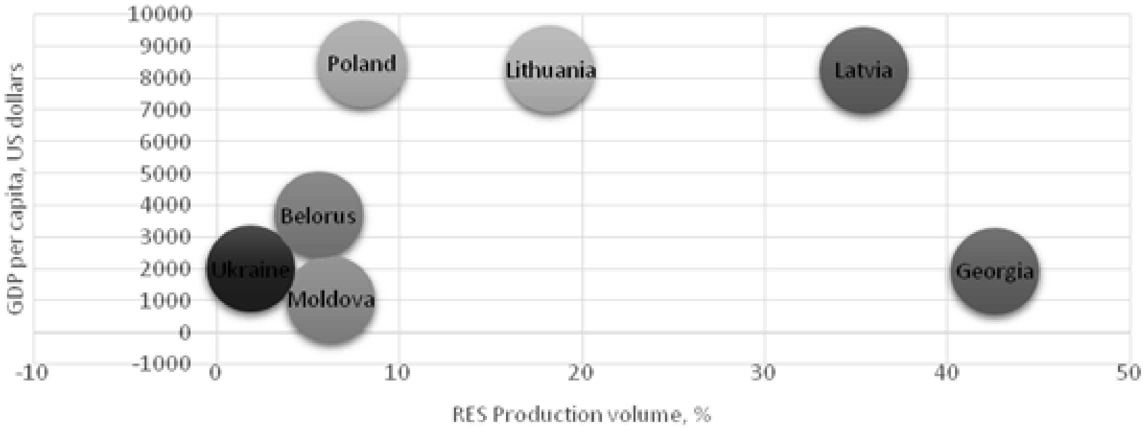

Figure 3:Ratio of energy production volumes thanks to RES and GDP per capita (the authors calculation)

4. METHODS

Considering studies (Fang, 2011; Kahia et al., 2016), we chose Cobb-Douglas production function as basic function of three constituents: technological coefficient, capital and labour, but it is modified considering RES production volumes, CO2 emissions, and political and macroeconomic stability level in the analysed countries. In works (Sadorsky, 2009) foreign investment impact on RES level is pointed out. In order to analyse panel data, we use fixed and random effects regression models, shown in the following way:

$$Y_{it} = \alpha + X'_{it}\beta + v_{it}, i = 1, \dots, N; t = 1, \dots, T$$

where α – intercept term, β – vector of dimension coefficients, X'_{it}vector-line of matrix, explaining the variables, t – time series of the model,v_{it} – modelling of the random fault. Herewith:

$$v_{it} = u_i + \varepsilon_{it}$$

where u_i –unobserved individual effect, which does not depend on time, but characterizes objects, which are not included into the regression model; ε_{it} – parameter, changed depending on time and analysed objects, may be observed as a random constituent.

Difference between fixed and random model consists in the fact that in the fixed model u_i is fixed parameter and ε_{it} is an individual equally distributed random parameter. It is expected that $X_{it}$is a parameter, which does not depend on ε_{it} for all *i* countries and *t* (2000-2014 in our model). Random effects model differs in the fact that individual random effects $\mu_i$are presupposed to exist. Besides, $u_i \sim \mathrm{IID}(0, \sigma_u^2)$, $\varepsilon_{it} \sim \mathrm{IID}(0, \sigma_\varepsilon^2)$ and μ_i do not depend on $\varepsilon_{\mathrm{it}}$ (Clarke et al., 2015). X_{it} does not depend on $u_i$andε_{it} for all countries (*i*) and years (*t*). This model is implemented for random set of objects. In order to select a model, which will describe the data most adequately, Hausman test may be used. It let to estimate and to choose the most objective model among fixed and random models. Main hypothesis is compared in the test, where u_i is fixed effect.

$$H_0: corr(u_i, X_{it}) = 0$$

or u_i is expressed as a random effect.

$$H_A: corr(\alpha_i, X_{it}) \neq 0$$

Hausman test is based on differences of assessments: $\hat{q} = \widehat{b_{FE}} - \widehat{b_{RE}}$, where$b_{FE}$ – assessments of fixed effect model, andb_{RE} – assessments of random effect model.
Based on the above, modified Cobb-Douglas function may be shown in the following way:

$$\ln Y_1 = a_1 + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + b_7 \ln X_7$$

where Y_1 – GDP (current US$), X_1 – capital (gross fixed capital formation), X_2 – labour (total population), X_3 – foreign direct investment, net inflows (BoP, current US$),$X_4$ –economy openness, X_5 – macroeconomic stability in the country,X_6 – amount of renewable energy sources in the energy production system (%),X_7 – CO2 emissions.

Based on this function, hypothesis was checked by two ways: fixed method regression and random effects regression.

4.1. Panel results

Based on the calculations, we can see small similarity of fixed method regression and random effects regression results, table 1. Following the fixed method regression, non significant indicators include foreign direct investment (0.513) and economy openness (0.872). Data about CO2 emissions and macroeconomic stability are valid (0.003and 0.001), they are within acceptable parameters (X < 5%). The model is totally described with zero error. Dispersion is less than 0.06%. It should be mentioned that with increase of labour index, economy openness and foreign direct investment, total population (X_2) by 1%, will lead to GDP (Y_1) reduction by 2.953%. At the same time, RES volumes change (X_6) by 1% causes GDP growth by 0.2707%. GDP is positively influenced by capital (X_1), macroeconomic stability (X_5) and CO2 emissions (X_7).

Table 1: Fixed and Random Effects Regression (authors' calculations based on the World Bank data, estimated with Stata 14.2. and** represents significance at the 1% and 5% levels.)*

Variables		Fixed Effects Regression		Random Effects Regression	
Depend	Inderpend	Coef.	P>│t│	Coef.	P>│t│
Y_1	X_1	0.6571554*	0.000	0.7735829*	0.000
	X_2	-2.953006*	0.000	0.292325	0.703
	X_3	-0.029413	0.513	0.0072939	0.397
	X_4	-0.182067*	0.001	-0.4799553*	0.000
	X_5	0.0148275	0.872	0.2501649**	0.033
	X_6	0.2707344*	0.000	0.1588645*	0.000
	X_7	0.3252465*	0.003	0.2427948*	0.000
	const	51.94154*	0.000	2.494204**	0.018
R-sq		0.9784		0.9604	

Following the random effects regression Table 2, insignificant figures are the same ones as in the fixed method regression, particularly–foreign direct investment (X_3: 0.397) and economy openness (X_5:0,033).

In addition to them population index is an insignificant parameter (X_2:0,703).Therefore, all these parameters have positive impact on GDP level ($У_1$). As the fixed method, this model has minimum dispersion and is described by these data. Macroeconomic stability parameters (X_5:0.2501) and RES level (X_6:0.1588) positively influence the GDP level ($У_1$). While using both methods, RES percentage (X_6), macroeconomic stability indicator (X_4) and CO2 emissions volume (X_7) are significant and have positive impact on GDP level ($У_1$). The received results have to be inspected for the necessity to implement instrumental variables using Hausman test. This test is a general test for model specification correctness. It is used to check the random effect model correctness in comparison with fixed effect model for penal data, the results of test are shown in the table 3. The received results show p-level <0.01, that is why, in our case determined model is better suited to us. It was to be expected, because countries-neighbours of the European region with the same parameters are chosen in the concrete research. Based on data from Hausman test, it is necessary to use results of fixed method regression, since data of random effects regression do not conform to the fixed method.

Table 2: Hausman Test
(authors' calculations based on the World Bank data, estimated with Stata 14.2.)

	Coefficients		(b-B) Difference	sqrt (diag(V_b-V_B)
	(b) fixed	(B) random		
X_1	0.6571554	0.7735829	-0.1164275	
X_2	-2.953006	0.292325	-2.982239	0.4173638
X_3	-0.029413	0.0072939	-0.102352	
X_4	-0.182067	-0.4799553	0.2978946	
X_5	0.0148275	0.2501649	-0.2353374	
X_6	0.2707344	0.1588645	0.1118699	0.231371
X_7	0.3252465	0.2427948	0.0824517	0.842984
b= consistent under Ho and Ha; obtained from xtreg B= inconsistent under Ha, efficient under Ho; obtained from xtreg				
Test	Ho: difference in coefficients not systematic chi2(7)=(b-B)`[(V_b-V_B)^(-1)](b-B)=54.39 Prob>chi2=0.000 (V_b-V_B is not positive definite)			

Although there is different GDP level, the studied countries have an explicit trend to increase GDP, and small reduction in all countries during 2005-2010, caused by the world crisis in 2008.

5. CONCLUSIONS

Providing humanity with energy is directly related to the environmental load. Most energy in the world is produced by means of the burning process. It leads to harmful substances emissions into the atmosphere. During 1961-1979 CO2 emissions into the atmosphere were constantly increased. Understanding the environmental problem, important documents were approved in European Union, among which Directives 67/548/EU, 70/220/EU and UNO Stockholm Declaration, the goal of which was to reduce the environmental load and emissions volume. It lead to decrease of CO2 emissions into the atmosphere on the average by 14 % annually. In order to ensure goals of the sustainable development and modern demands in energy in the world, renewable energy sources implementation gains great popularity. Many countries, including Latvia, Lithuania, Moldova, Poland, Ukraine, Georgia and Belarus set a goal to be greatly provided with energy thanks to renewable sources in future. The relationship between economic development and environmental load is studied by scientists from the whole world, among which Panayotou, Apergis, Bildirici, Ocal, Menegaki, Tugcuand others. They study linking between economic growth (in GDP) and renewable energy sources, and growth of renewable energy sources with CO2 emissions volume. In order to investigate changes of GDP level in the country with renewable energy sources growth taking into account political and macroeconomic stability of the country, we choose modified Cobb-Douglas production function, constituents of which are: technological coefficient, capital, labour, RES production volume, CO2 emissions, macroeconomic stability level. The fixed and random effects regression model to analyse panel data of seven countries (Latvia, Lithuania, Moldova, Ukraine, Georgia, and Belarus) during 1995-2014 were used. In order to choose more adequate and objective model, Hausman test may be used. Based on the findings of fixed method regression parameters of foreign direct investment and economy openness were not significant. Parameters of labour, capital, CO2 emissions, macroeconomic stability and RES production volumes were significant. Model was described with zero error, dispersion is less than 0.06%. The research's hypothesis is confirmed by the findings. The RES energy production volumes and macroeconomic stability were statistically significant. Growth of one parameter leads to GDP growth. In case of RES growth by 1% GDP growth will be 0.2707%. Increase of macroeconomic stability index by 1% will cause GDP growth by 0.0148%. In this case, it is necessary to update mechanism and instruments of spreading RES considering the statistically significant linking between RES and GDP with purpose to decrease CO2 emission and achieve the macroeconomic stability.

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