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## **THE GROSS EXPENDITURES ON R&D AND THE ECONOMIC GROWTH LEVEL IN THE EU COUNTRIES**

## **NAKLADY NA BADANIA I ROZWÓJ A POZIOM ROZWOJU GOSPODARCZEGO W UNII EUROPEJSKIEJ**

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**Summary:** The economic and social growth in the EU countries is dependent, to the greatest extent, on the level of research and development activity. The progressive economic growth, which means also the increase in the competitiveness on the world, especially of the emerging countries and stable competitiveness dominance of the USA – in comparison to the European countries, was the impulse to pay attention to expenditures on research and development in the economies of the member countries, which was enhanced in the Europe 2020 Strategy. The goal of this article is to identify the dependencies between the gross expenditures on research and development and the gross domestic product *per capita* in the European Union countries. In the research the cross sectional econometric models are used; the time range covers the years 2002, 2007 and 2012.

**Keywords:** GERD indicator, gross expenditures on research and development, economic growth, GDP, the European Union.

**Streszczenie:** Wzrost gospodarczy i społeczny krajów UE w dużej mierze uzależniony jest od poziomu rozwoju działalności badawczo-rozwojowej. Postępujący wzrost gospodarczy, a tym samym wzrost konkurencyjności na świecie, zwłaszcza krajów „wschodzących”, i utrzymująca się przewaga konkurencyjna Stanów Zjednoczonych, w stosunku do krajów europejskich, skłoniły Unię Europejską do zwrócenia szczególnej uwagi na wydatki na badania i rozwój w gospodarkach krajów członkowskich, co zostało uwypatnione w Strategii Europa 2020. Celem opracowania jest identyfikacja zależności między nakładami na badania i rozwój, a produktem krajowym brutto na jednego mieszkańca w państwach Unii Europejskiej. W badaniach wykorzystano przekrojowe modele ekonometryczne; zakres czasowy obejmuje lata 2002, 2007 i 2012.

**Słowa kluczowe:** wskaźnik GERD, nakłady na badania i rozwój, wzrost gospodarczy, PKB, Unia Europejska.

## 1. Introduction

In the theory of economics the basic factors of the economic growth are: natural resources, capital and labor [Gaczek 2009]. This assumption has been modified many times and nowadays, except capital or labor, one of the important factors is the technical progress [Solow 1957]. What is behind the technical progress can be defined as e.g. innovations, inventions or research and development works. This means that the increase in gross expenditures on research and development generates the technical progress as well.

The European Commission, which noticed the impact of the technical progress (which is the result of gross expenditures on research and development) on the economic growth, has designated the smart growth as the one of priorities – this means the economy development on the basis of knowledge and innovations. The project created for smart growth is called “The innovation union” – its goal is to improve the conditions and access to research and development funding, so that new innovations can be turned into new products and services, which will result in the economic growth and creation of new vacancies. In the realization of those goals not only the unit of the European Union is engaged, but also all the member countries whose objective is to increase gross expenditures on research and development [Europe 2020... 2010].

The goal of this paper is the attempt to explain if and to what extent the gross expenditures on research and development (GERD indicator described in the third point of this paper) are impacting on the increase of the gross domestic product *per capita* in the European Union countries in years 2002, 2007 and 2012.

## 2. Neoclassical Solow model and its extension

The neoclassical theory of economic growth attempts to answer the question about long-term factors which shape both the level and the growth of the added value in the economy. For this reason, it uses the mathematical production function [Dokurno, Fiedor 2010]. In 1957 Robert Solow published the paper in which he was proving that the main factor of the economy progress in the long-run, next to the capital and increase in labor, was the exogenous technical progress [Czupiał 1994].

Neoclassical Solow growth model, based on the Cobb-Douglas production function, is describing in what way the three above-mentioned production factors cooperate in the final product (revenue) formation [Balicki 2001]. The growth model enables to conclude research studies in the scope of the economic growth and its factors. It can be described as:

$$Y(t) = F(K(t), L(t), A(t)). \quad (1)$$

At each point of time ( $t$ ) the economy disposes fixed capital resources (K), labor/employment (L) and knowledge/technology (A). They are connected together to generate revenue or a product (Y) [Bal-Domańska 2010]. Moreover, time does not

enter the production function directly. It enters the function through K, L and A. This means that the output obtained from given quantities of capital and labor increases over the time – there is technological progress – only if the amount of knowledge increases [Romer 2006].

In this perspective and while maintaining the assumption of the fixed income scale, decreasing marginal productivity of production factors and taking into account the limited substitution between capital and labor it has been proved that the economy is able (without the state interference) to enter the path of the sustainable growth. It has been also proved that the Solow economy will move towards the sustainable growth path if all the model variables (capital, labor, technology) will increase in the fixed rate. According to the Solow global stability proof, the increase of the savings rate (investment) increases the rate of production growth *per capita* in the transitional period only to the point at which it reaches the new equilibrium. The increase of the savings rate will not impact the long-run speed of the economic growth, which is determined by the technical progress rate. The technical progress increases the level of the accumulated capital *per capita* in the sustainable growth state. Thereby, it increases production *per capita* and the level of consumption *per capita* [Woźniak 2004].

On the basis of the Solow model, the Mankiw-Romer-White model was build. It was extended by the next factor – the human capital, which influences on production processes equally as the main two factors – fixed capital and labor [Bal-Domańska 2009]. This model belongs to the endogenous growth models. Moreover, the term of the endogenous equation of the capital resource growth proved that also in this case the economy preserves the natural convergence to a stable long-run equilibrium point [Woźniak 2004].

### 3. The impact of the gross expenditures on R&D and other factors on the level of the EU economic growth – cross sectional models

In this paper the econometric research was done based on the structure of the model, which was extended with the factors in accordance with the neoclassical extended Solow growth model (Mankiw-Romer-Weil).

Variables and years selection used in this research was determined with respect to data availability in the Eurostat<sup>1</sup> internet database. Research results, presented in this article, are for years 2002, 2007, 2012 and for 28 European Union member countries. For the purpose of the present analysis, the following variables were chosen:

- $GDP_t$  – gross domestic product at purchasing power parity *per capita* in  $t$ -year,
- $GFCF_t$  – gross fixed capital formation in  $GDP_t$  in  $t$ -year,
- $EMP_t$  – employment rate, the proportion of working age adults employed with working age between 20–64 in  $t$ -year,

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<sup>1</sup> See: <http://epp.eurostat.ec.europa.eu/>.



- $TETR_t$  – the proportion of working age adults with higher education employed with working age between 25–64 in  $t$ -year,
- $GERD_t$  – gross domestic expenditure on research and development in  $GDP_t$  in  $t$ -year.

$GERD_t$  and  $GFCF_t$  variables were used also in separate models with a lag in time of 1 period and of 2 periods in order to check whether gross expenditures on R&D from previous years have an impact on  $GDP_t$  in following years.

The output version of  $GDP_t$  model is presented by the following formula:

$$GDP_t = (GFCF_t)^{\beta_1} (GERD_t)^{\beta_2} (TETR_t)^{\beta_3} (EMP_t)^{\beta_4} \beta_0 \quad (2)$$

In the first stage of the research the data analysis of variance was used. It was assumed that in the model variables will be used which are characterized with the variance higher than 10% (measured by means of the analysis of variance). Variables:  $EMP_t$  and  $TETR_t$  were not used in the further research because their analysis of variance value in years 2002, 2007 and 2012 was lower or equal to 10%. The  $GERD_t$  variable was characterized with the largest variance – in 2002 more than 70%, in 2007 more than 60% and in 2012 more than 50%. The  $GFCF_t$  analysis of variance was between 13% and 20%. Eventually, to the model employed the  $GFCF_t$  and  $GERD_t$  variables. There were build three versions of models:

Model (1):  $\ln GDP_t = \beta_1 \ln GFCF_t + \beta_2 \ln GERD_t + \ln \beta_0$ ;

Model (2):  $\ln GDP_t = \beta_1 \ln GFCF_t + \beta_2 \ln GFCF_{t-1} + \beta_3 \ln GERD_t + \beta_4 \ln GERD_{t-1} + \ln \beta_0$ ;

Model (3):  $\ln GDP_t = \beta_1 \ln GFCF_t + \beta_2 \ln GFCF_{t-1} + \beta_3 \ln GFCF_{t-2} + \beta_4 \ln GERD_t + \beta_5 \ln GERD_{t-1} + \beta_6 \ln GERD_{t-2} + \ln \beta_0$ .

To the models variables were chosen by using the *a posteriori* sequential method [Kufel 2004], which consists of the analysis of empirical statistics values for all the estimations of structural parameters [Nowak 2002]. With this assumption the models were recounted again but with omitting the variable with the largest value of  $p$ -Value, this process was repeated until all variables in the model were significant. As the statistical significance was assumed the value of 0.1 ( $p$ -Value). Two types of models were constructed: for cross-sectional series including 28 countries of the EU and for cross-sectional series including 27 countries of the EU – without Luxembourg, which is the untypical observation with very high *GDP per capita* in relation to other member countries, for this reason in the study it disrupts the dependencies between cross sectional models. The econometric models were evaluated with the values of  $R^2$  coefficient determination, to compare the models with different variables structure the Schwarz criterion was used (further recall as BIC – Bayesian Information Criterion).

Table 1 presents the estimation of the three growth model types ((1), (2), (3)) for 2002. The variable of the gross fixed capital formation in  $GDP_t$  was significant only in models (2) and (3) for 27 countries of the European Union. In the case of 28 countries of the EU the final three models were identical. In 2002 the better models

were built based on the data without Luxembourg. Out of three models estimated for 27 countries of the EU (without Luxembourg) in the meaning of BIC criterion the best was model (3) (the minimal value 19.89). The significant variables influencing the gross domestic product were  $GFCF_{t-1}$ ,  $GFCF_{t-2}$  and  $GERD_t$ . These variables explain over 64% of the  $GDP_t$  per capita variance.

**Table 1.** Estimations of the economic growth models in the EU countries in 2002

Lag in time	Specification	Coefficients	Standard Error	p-Value	Specification*	Coefficients*	Standard Error*	p-Value*
Model 1								
0	$\ln GERD_t$	0.461	0.098	0.000	$\ln GERD_t$	0.433	0.089	0.000
	$R^2$	0.459			$R^2$	0.482		
	BIC	29.397			BIC	23.267		
Model 2								
1 period	$\ln GERD_t$	0.461	0.098	0.000	$\ln GFCF_t$	-2.093	1.001	0.048
					$\ln GFCF_{t-1}$	1.974	1.121	0.092
					$\ln GERD_t$	3.000	1.368	0.039
					$\ln GERD_{t-1}$	-2.579	1.360	0.071
	$R^2$	0.459			$R^2$	0.597		
BIC	29.397			BIC	26.363			
Model 3								
2 periods	$\ln GERD_t$	0.461	0.098	0.000	$\ln GFCF_{t-1}$	-3.420	1.075	0.004
					$\ln GFCF_{t-2}$	3.165	1.019	0.005
					$\ln GERD_t$	0.378	0.079	0.000
	$R^2$	0.459			$R^2$	0.642		
	BIC	29.397			BIC	19.893		

\* Data exclude Luxembourg.

Source: own calculations.

$GDP_t$  per capita is growing much slower than the level of  $GERD_t$ . With the assumption that other variables have not changed, the 1% increase of  $GERD_t$  in the EU-28 causes the  $GDP_t$  increase by 0.46% *ceteris paribus* – regardless of whether in the model there were only variables without a lag in time or variables with 1 period or 2 periods of a lag in time.

For the models without data from Luxembourg with variables without a lag in time, the 1% increase of  $GERD_t$  causes the  $GDP_t$  increase by 0.43%, assuming that all the other variables have not changed. In the models without a lag in time and with

1 period of a lag in time the 1% increase of  $GERD_t$  causes the  $GDP_t$  increase by 3% *ceteris paribus*. For the model (3) the  $GERD_t$  variable is significant and its increase by 1% causes 0.38% *ceteris paribus* increase in  $GDP_t$ .

Table 2 presents the estimations of the  $GDP_t$  per capita for year 2007. The  $GFCF_t$  was significant only in one model (2) with observations from 28 countries of the EU.

**Table 2.** Estimations of the economic growth models in the EU countries in 2007

Lag in time	Specification	Coefficients	Standard Error	p-Value	Specification*	Coefficients*	Standard Error*	p-Value*
Model 1								
0	$\ln GERD_t$	0.455	0.091	0.000	$\ln GERD_t$	0.426	0.071	0.000
	$R^2$	0.489			$R^2$	0.590		
	BIC	16.806			BIC	2.469		
Model 2								
1 period	$\ln GFCF_t$	-0.609	0.352	0.096	$\ln GERD_t$	0.426	0.071	0.000
	$\ln GERD_{t-1}$	0.368	0.100	0.001				
	$R^2$	0.552			$R^2$	0.590		
	BIC	16.411			BIC	2.469		
Model 3								
2 periods	$\ln GERD_{t-1}$	0.457	0.090	0.000	$\ln GERD_{t-2}$	0.420	0.068	0.000
	$R^2$	0.499			$R^2$	0.605		
	BIC	16.243			BIC	1.501		

\* Data exclude Luxembourg.

Source: own calculations.

In the 28 countries of the EU the best model is model (3), in the sense of the BIC criterion (16.24). The models built for 27 countries of the EU (without Luxembourg) are, similarly as in the models in Table 1, better. The best model is model (3), the BIC criterion is 1.50 and it is the model with significant  $GERD_{t-2}$  variable, which explains more than 60% of the  $GDP_t$  per capita variance.

Also, similarly as in the models in Table 1, the level of the economic growth increases slower than the  $GERD_t$  level (with the assumption that other variables have not changed). In the model with variables without a lag in time with 28 countries in the EU the 1% increase of  $GERD_t$  causes the  $GDP_t$  increase by 0.46% *ceteris paribus*. After omitting the Luxembourg observations, with no time lag, the increase is lower by 0.03 pp. In the model with a time lag of 1 period for the EU-28 the 1%  $GERD_{t-1}$  increase causes 0.37% *ceteris paribus*  $GDP_t$  increase; without Luxembourg this ( $GERD_t$ ) is equal to 0.43% *ceteris paribus*. Additional variables with a time lag of 2 periods make the  $GERD_{t-1}$  variable significant and its increase by 1% causes the 0.46%

*ceteris paribus* increase in  $GDP_t$  for the EU-28, for the EU without Luxembourg the 1% increase of  $GERD_{t-2}$  causes the  $GDP_t$  increase by 0.42% *ceteris paribus*.

The models' estimation with data from 2012 are presented in Table 3.

**Table 3.** Estimations of the economic growth models in the EU countries in 2012

Lag in time	Specification	Coefficients	Standard Error	p-Value	Specification*	Coefficients*	Standard Error*	p-Value*
Model 1								
0	$\ln GFCF_t$	-0.510	0.259	0.060	$\ln GFCF_t$	-0.567	0.162	0.000
	$\ln GERD_t$	0.379	0.082	0.000	$\ln GERD_t$	0.365	0.051	0.000
	$R^2$	0.493			$R^2$	0.716		
	BIC	12.072			BIC	-13.642		
Model 2								
1 period	$\ln GFCF_{t-1}$	-0.606	0.280	0.040	$\ln GFCF_t$	-0.591	0.158	0.000
	$\ln GERD_{t-1}$	0.360	0.080	0.000	$\ln GERD_{t-1}$	0.369	0.050	0.000
	$R^2$	0.511			$R^2$	0.730		
	BIC	11.037			BIC	-15.047		
Model 3								
2 periods	$\ln GFCF_{t-2}$	-0.771	0.362	0.042	$\ln GFCF_t$	-0.548	0.152	0.001
	$\ln GERD_{t-2}$	0.324	0.081	0.000	$\ln GERD_{t-2}$	0.364	0.047	0.000
	$R^2$	0.529			$R^2$	0.748		
	BIC	10.023			BIC	-16.936		

\* Data exclude Luxembourg.

Source: own calculations.

For data from 2012 the  $GFCF_t$  (or  $GFCF_{t-1}$  or  $GFCF_{t-2}$ ) variable appeared together with  $GERD_t$  as the significant variable in all six models.

Among 28 countries of the EU the best model is (as in the previous years) the model (3) in the sense of the BIC criterion (10.02). The models estimated for 27 countries of the EU were better (also as in the previously described models). Model (3) is the best model in the BIC criterion (-16.94). It is also the best model among six of them, presented in Table 3, with significant variables:  $GFCF_t$  and  $GERD_{t-2}$  explaining more than 74% of the gross domestic product *per capita* variance.

In the models with variables without a lag in time the 1% of  $GERD_t$  increase causes the economic growth by 0.38% *ceteris paribus* in the EU-28 and by 0.37% *ceteris paribus* in the EU-27. In the models (2) the 1%  $GERD_{t-1}$  increase causes economic growth by 0.36% *ceteris paribus* in the EU-28 and by 0.37% *ceteris paribus* in the EU-27. In the models (3) this growth is respectively 0.32% *ceteris paribus* and 0.36% *ceteris paribus*.

## 4. Conclusion

The research presented in this article shows the significant impact of the gross expenditures on research and development in  $GDP_t$  per capita on the economic growth level. Additionally, the research allowed formulating more conclusions:

- the indicator of expenditures on research and development ( $GERD_t$ ) was the variable which had a significant impact on the gross domestic product per capita ( $GDP_t$ ) in all presented models;
- the gross fixed capital formation in  $GDP_t$  had a significant impact on the gross domestic product per capita in 2002 and 2012;
- omitting an untypical observation in the research, as Luxembourg, allowed obtaining the models of the better quality, in the sense of BIC criterion;
- the best models in the researched years were the models (3) – for 27 EU countries, with variables: gross fixed capital formation in  $GDP_t$  and gross expenditures on research and development in  $GDP_t$  both in the current and previous years.

The cross sectional models analyzing the impact of the gross expenditures on R&D in  $GDP_t$  per capita on the level of economic growth can be a basis for further, more detailed research studies and analyses of dependencies between the  $GERD_t$  indicator and the economic growth.

## References

- Bal-Domańska B., 2009, *Konkurencyjność polskich regionów ze względu na poziom gospodarki opartej na wiedzy*, [in:] Nowakowska A. (ed.), *Innowacyjność regionów w gospodarce opartej na wiedzy*, Wydawnictwo Uniwersytetu Łódzkiego, Łódź, pp. 45–61.
- Bal-Domańska B., 2010, *Analiza zależności między innowacyjnością a dynamiką rozwoju europejskiej przestrzeni regionalnej*, [in:] Strahl D. (ed.), *Innowacyjność europejskiej przestrzeni regionalnej a dynamika rozwoju gospodarczego*, Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu, Wrocław, pp. 115–137.
- Balicki J., 2001, *Pomiar rezultatów działalności gospodarczej w makroskali. Wzrost i rozwój gospodarczy*, [in:] Pająkiewicz J. (ed.), *Makroekonomia: Wybrane zagadnienia teorii wzrostu i funkcjonowania współczesnych systemów gospodarki rynkowej*, Wydawnictwo Akademii Ekonomicznej im. Oskara Langego we Wrocławiu, Wrocław, pp. 75–81.
- Czupiał J., 1994, *Rozwój ekonomiki innowacji*, [in:] Czupiał J. (ed.), *Ekonomika innowacji*, Wydawnictwo Akademii Ekonomicznej im. Oskara Langego we Wrocławiu, Wrocław, p. 18.
- Dokurno Z., Fiedor B., 2010, *Teorie wzrostu gospodarczego*, [in:] Fiedor B., Kociszewski K. (eds.), *Ekonomia rozwoju*, Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu, Wrocław, pp. 59–67.
- Europe 2020: A European Strategy for Smart, Sustainable and Inclusive Growth*, 2010, European Commission, Brussels.
- Eurostat, <http://epp.eurostat.ec.europa.eu> (22.07.2014).
- Gaczek W.M., 2009, *Kapitał wiedzy a poziom rozwoju gospodarczego regionów europejskich*, [in:] Nowakowska A. (ed.), *Innowacyjność regionów w gospodarce opartej na wiedzy*, Wydawnictwo Uniwersytetu Łódzkiego, Łódź, pp. 11–26.

- Kufel T., 2004, *Ekonometria, Rozwiązywanie problemów z wykorzystaniem programu GRETL*, Wydawnictwo Naukowe PWN, Warszawa, pp. 94–96.
- Nowak E., 2002, *Zarys metod ekonometrii*, Wydawnictwo Naukowe PWN, Warszawa, p. 139.
- Romer D., 2006, *Advanced Macroeconomics*, Third edition, McGraw-Hill, New York, p. 9.
- Solow R., 1957, *Technical change and the aggregate production function*, *Review of Economics and Statistics*, vol. 39, no. 3, pp. 312–320.
- Woźniak M.G., 2004, *Wyznaczniki pro wzrostowej strategii ograniczającej nierówności społeczne wynikające z teorii wzrostu*, [in:] Woźniak M.G. (ed.), *Nierówności społeczne a wzrost gospodarczy. Polityka społeczno-ekonomiczna*, Uniwersytet Rzeszowski, Katedra Teorii Ekonomii, Rzeszów, pp. 81–84.