ANALYSIS OF RESEARCH AND DEVELOPMENT EXPENDITURE IN EUROPEAN UNION COUNTRIES

Ľubica Hurbánková[1]

DOI: https://doi.org/10.31410/ITEMA.2020.137

Abstract: *Paper deals with the analysis of research and development expenditure. Expenditure per capita in European Union countries in years 2009 - 2018 and total research and development expenditure in million Euro are analyzed. The aim of the paper is to find out in which countries expenditure per capita increased the most during the observed period and in which it decreased, what was the average annual growth rate of this indicator. Contribution method will help to analyze how the total research and development expenditure in 27 European Union countries has changed, what was the share of each country in this expenditure, which countries contributed the most to this change and which the least. Research and development expenditure per capita increased average annually between 2009 and 2018 in all analyzed countries, except Luxembourg and Finland, where it decreased. The highest average annual growth was recorded in Poland (12.48%), Latvia (10.50%), Slovakia (10.47%) and Bulgaria (10.38%). Total research and development expenditure increased in 2018 compared to 2009 by 41.65%, Germany (18.11%) and France (4.29%) contributed the most to this increase.*

Keywords*: Research and development expenditure, European union countries, Contribution method.*

INTRODUCTION

Research and development expenditure is an indicator, which includes expenditure on research and development by business enterprises, higher education institutions, government and private non-profit organizations (Eurostat, 2020).

Research and development expenditure comprise total amount of expenditures spent in organization on research and development activities, i.e. they are internal expenditures. Expenditures spent out of the organization include only those serving for support to the internal research and development (e.g. purchase of equipment for R&D institutions). Depreciation of buildings, machines and equipment is excluded from the statistical survey of internal expenditures on research and development (Štatistický úrad Slovenskej republiky, 2019).

Research and development expenditure is associated directly with the research and development of a company's goods or services and any intellectual property generated in the process. They are direct expenditures relating to a company's efforts to develop, design, and enhance its products, services, technologies, or processes. The industrial, technological, health care, and pharmaceutical sectors typically incur the highest degree of R&D expenses (Investopedia, 2020).

[1] University of Economics in Bratislava, Dolnozemská cesta 1, 852 35 Bratislava, Slovak Republic

The aim of the paper is to find out in which countries in the years 2009 – 2018 research and development expenditure per inhabitant increased the most and in which decreased, what was the average annual growth rate of this indicator. Next, we will analyze how the total research and development expenditure in 27 European Union countries has changed, what was the share of each country in this expenditure, which countries contributed the most to this change and which the least. We will use contribution method for this analysis.

USING METHOD

To find out how the analyzed indicator developed, we use the characteristics of time series – basic index and average growth rate (see Pacáková et al., 2009).
As our goal is to find out how individual countries have contributed to the total change in research and development expenditure, we will use contribution method.

Contribution method is used for the analysis of additive indicator *Y*, which arise from the sum of individual components:

$$Y = \sum_{i=1}^{n} y_i \tag{1}$$

where: Y is additive indicator,
y_i are individual components.

The procedure of this method is as follows (Hurbánková, Sivašová, 2018):

We calculate the relative increase of additive indicator, which expresses how the given indicator has changed:

$$k_{dt} = \frac{Y_t - Y_{t-1}}{Y_{t-1}} = \frac{d(Y)}{Y_{t-1}} = (k_Y - 1) \tag{2}$$

We calculate the relative increases of the individual components, which express how the individual components developed:

$$k_{dt} = \frac{y_t^i - y_{t-1}^i}{y_{t-1}^i} = \frac{d(y)}{y_{t-1}^i} = (k_y^i - 1) \tag{3}$$

We determine the structural numbers that express the share of individual components in additive indicator. We calculate the structural numbers in the period *t-1*, assuming that the analogous share of the component on the additive indicator is maintained during the continuous development of the additive indicator:

$$s_{t-1}^i = \frac{y_{t-1}^i}{Y_{t-1}} \tag{4}$$

We calculate the contribution to which *i*-th component contributed to the relative increase of the additive indicator:

$$\left(\frac{y_t^i - y_{t-1}^i}{y_{t-1}^i} \right) * \frac{y_{t-1}^i}{Y_{t-1}} = (k_y^i - 1) * s_{t-1}^i \tag{5}$$

The contribution of each additive component is equal to multiply of its relative increase and the share of this component in the additive indicator in the previous period.

The relative increase of the additive indicator is equal to the sum of the relative contributions of the individual components (Hindls, Hronová, 1997):

$$\sum_{i=1}^{n}\left(\frac{y_t^i - y_{t-1}^i}{y_{t-1}^i}\right) * \frac{y_{t-1}^i}{Y_{t-1}} = \frac{1}{Y_{t-1}}\sum_{i=1}^{n}\left(y_t^i - y_{t-1}^i\right) = \frac{1}{Y_{t-1}}\left(\sum_{i=1}^{n} y_t^i - \sum_{i=1}^{n} y_{t-1}^i\right) = \frac{Y_t - Y_{t-1}}{Y_{t-1}} \quad (6)$$

ANALYSIS OF RESEARCH AND DEVELOPMENT EXPENDITURE IN EUROPEAN UNION COUNTRIES

Table 1 shows data on research and development expenditure per inhabitant in European Union countries in years 2009 – 2018 in Euro. The trend of this indicator in 2018 compared to 2009 and the average annual growth rate are calculated.

Table 1. Research and development expenditure per inhabitant in European Union countries in 2009 – 2018 in Euro, its trend in 2018 compared to 2009 and average annual growth rate

GEO/TIME	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2018 /2009	Average annual growth rate
EU 27	473,7	490,8	519,0	537,2	543,9	558,2	582,7	594,9	629,2	661,9	1,3973	1,0379
Belgium	644,0	690,7	742,8	795,3	822,1	854,3	900,4	959,5	1 045,5	1 115	1,7314	1,0629
Bulgaria	24,7	29,0	29,8	34,6	36,6	46,9	60,4	52,5	54,7	60,1	2,4332	1,1038
Czechia	184,6	200,3	243,4	273,9	285	294,0	308,4	280,8	324,5	377,6	2,0455	1,0828
Denmark	1 282	1 281,6	1 312,7	1 360,0	1 371,8	1 376,2	1 473,7	1 534,2	1 551,4	1 580,9	1,2332	1,0236
Germany	818,0	855,9	942,0	984,8	990,1	1 043,1	1 093,4	1 121,7	1 206,4	1 266,3	1,5480	1,0498
Estonia	147,8	174,6	289,1	287,3	247	217,9	230,3	205,4	231,3	277,2	1,8755	1,0724
Ireland	605,0	586,8	583,2	595,7	610,3	639,8	664,6	671,8	768,2	769,5	1,2719	1,0271
Greece	133,9	121,6	125,1	120,7	133,2	136,2	156,9	162,7	189,3	202,5	1,5123	1,0470
Spain	315,4	313,8	303,9	286,0	278,5	275,6	283,6	285,5	302,2	320,3	1,0155	1,0017
France	665,7	672,3	694,3	712,6	722	724,2	749,9	745,1	757,7	773,6	1,1621	1,0168
Croatia	88,3	77,9	78,4	77,2	83,2	80,0	88,7	96,0	101,9	122,2	1,3839	1,0368
Italy	325,6	331,6	333,7	345,2	351,6	358,3	364,5	382,0	392,7	406,4	1,2482	1,0249
Cyprus	104,1	105,2	107,0	99,0	101,0	104,3	100,7	116,5	128,9	134,0	1,2872	1,0285
Latvia	39,2	51,2	67,8	71,7	69,1	81,3	76,6	56,1	70,7	96,3	2,4566	1,1050
Lithuania	70,2	69,9	92,6	99,3	111,9	128	133,4	113,4	133,0	151,8	2,1624	1,0895
Luxembourg	1 256,9	1 202,4	1 233,6	1 069,6	1 127,9	1 146,7	1 204,4	1 235,8	1 220,1	1 208,3	0,9613	0,9956
Hungary	106,4	112,4	120,6	126,6	142,8	144,7	153,3	139,5	170,8	209,8	1,9718	1,0784
Malta	77,3	96,7	111	141,9	139,8	141,0	162,6	130,3	143,2	148,8	1,9250	1,0755
Netherlands	631,3	657,1	734,6	747,9	759,6	788,4	810,4	833,0	857,0	974,8	1,5441	1,0495
Austria	897,4	965,9	988,2	1 104,6	1 132,4	1 207,7	1 223,0	1 279,9	1 286,9	1 388,1	1,5468	1,0497
Poland	55,0	68,6	74,5	90,1	90,3	101,6	113,6	108,3	127,3	158,5	2,8818	1,1248
Portugal	262,4	260,8	242,7	220,1	215,4	214,1	215,4	231,0	250,7	269,1	1,0255	1,0028
Romania	27,2	28,2	32,5	32,1	27,9	28,8	39,4	41,4	48,1	52,5	1,9301	1,0758
Slovenia	323,2	364,4	436,2	451,6	454,1	431,9	413,5	393,4	388,4	431,8	1,3360	1,0327
Slovakia	56,3	77,2	86,9	108,3	112,9	123,6	171,0	118,1	137,8	138,0	2,4512	1,1047
Finland	1 274,1	1 302,7	1 332,7	1 264,9	1 231,7	1 194,6	1 109,5	1 080,0	1 121,7	1 167,7	0,9165	0,9904
Sweden	1 154,1	1 270,8	1 397,4	1 464,9	1 507,6	1 411,3	1 504,3	1 537,0	1 615,0	1 544,6	1,3384	1,0329

Source: Eurostat, 2020 and own calculations

As can be seen from Table 1, the highest research and development expenditure (more than 1,000 € per inhabitant) was in Denmark (1,580.9 € per capita in 2018), Sweden, Finland and Luxembourg throughout the analyzed period. The lowest was in Bulgaria (only 24.7 Euro per inhabitant in 2009), Romania, Latvia, Slovakia, Poland, Lithuania and Malta. In 2018, compared to 2009, expenditure increased in all countries except Luxembourg and Finland, where it decreased - in Luxembourg by 3.87%, which represents an average annual decrease of 0.44% and in Finland it decreased by 8.35%, on average by 0.96% per year. This indicator grew the most in Poland in 2018 compared to 2009 by 188.18%, which is an average annual increase of 12.48%. In Slovakia, the third highest increase was recorded by 145.12%, which is an average annual increase of 10.47%.

In order to be able to calculate how countries have contributed to the total change in research and development expenditure, we need to have an absolute indicator. Therefore, we chose the indicator of total research and development expenditure, not per inhabitant. Input data and calculation using contribution method are shown in Table 2.

Table 2. Application of contribution method on research and development expenditure in European Union countries in 2009 and 2018

GEO/TIME	2009	2018	Relative increase	Structural number	Contribution
Belgium	6 924,591	12 709,638	0,8354	0,0332	0,0278
Bulgaria	184,610	423,818	1,2957	0,0009	0,0011
Czechia	1 924,518	4 006,462	1,0818	0,0092	0,0100
Denmark	7 065,873	9 139,430	0,2935	0,0339	0,0099
Germany	67 078,121	104 836,000	0,5629	0,3218	0,1811
Estonia	197,393	365,650	0,8524	0,0009	0,0008
Ireland	2 735,556	3 716,800	0,3587	0,0131	0,0047
Greece	1 485,940	2 174,670	0,4635	0,0071	0,0033
Spain	14 581,676	14 946,000	0,0250	0,0700	0,0017
France	42 834,917	51 768,559	0,2086	0,2055	0,0429
Croatia	380,677	501,756	0,3181	0,0018	0,0006
Italy	19 209,000	24 581,681	0,2797	0,0921	0,0258
Cyprus	82,988	115,800	0,3954	0,0004	0,0002
Latvia	84,882	186,200	1,1936	0,0004	0,0005
Lithuania	223,471	426,306	0,9077	0,0011	0,0010
Luxembourg	620,280	727,400	0,1727	0,0030	0,0005
Hungary	1 067,166	2 051,375	0,9223	0,0051	0,0047
Malta	31,761	70,792	1,2289	0,0002	0,0002
Netherlands	10 408,000	16 748,200	0,6092	0,0499	0,0304
Austria	7 479,745	12 246,010	0,6372	0,0359	0,0229
Poland	2 095,827	6 018,489	1,8717	0,0101	0,0188
Portugal	2 771,600	2 769,072	-0,0009	0,0133	0,0000
Romania	555,887	1 024,770	0,8435	0,0027	0,0022
Slovenia	656,882	892,399	0,3585	0,0032	0,0011
Slovakia	302,994	750,947	1,4784	0,0015	0,0021
Finland	6 786,472	6 437,900	-0,0514	0,0326	-0,0017
Sweden	10 682,826	15 631,342	0,4632	0,0512	0,0237
EU 27	208 453,653	295 267,466	0,4165	1,0000	0,4165

Source: Eurostat, 2020 and own calculations

From Table 2 we found out that total research and development expenditure in EU-27 increased by 41.65% in 2018 compared to 2009, with the largest increase in Poland by 187.17% (similar to research and development expenditure per inhabitant) and in Slovakia by 147.84%. They decreased only in Portugal (by 0.09%) and Finland (by 5.14%). Germany (32.18%) and France (20.55%) had the highest share in total expenditure in 2009. Germany (18.11%) and France (4.29%) contributed the most to the 41.65% increase in total expenditure. In 2009, Slovakia had only a 0.15% share in this indicator for all EU-27 countries and contributed only 0.21% to the increase.

CONCLUSION

From the realized analysis we can draw the following conclusions:

- The highest research and development expenditure was in Denmark in 2018 (1,580.9 € per capita). The lowest was in Bulgaria (only 24.7 Euro per inhabitant in 2009).
- In 2018, compared to 2009, expenditure increased in all countries except Luxembourg and Finland, where it decreased - in Luxembourg by 3.87% (average annual decrease of 0.44%) and in Finland by 8.35% (on average by 0.96% per year). This indicator grew the most in Poland in 2018 compared to 2009 by 188.18% (average annual increase of 12.48%). In Slovakia, the third highest increase was recorded by 145.12% (average annual increase of 10.47%).
- Total research and development expenditure in EU-27 increased by 41.65% in 2018 compared to 2009, with the largest increase in Poland by 187.17% and in Slovakia by 147.84%. They decreased only in Portugal (by 0.09%) and Finland (by 5.14%). Germany (32.18%) and France (20.55%) had the highest share in total expenditure in 2009. Germany (18.11%) and France (4.29%) contributed the most to the 41.65% increase in total expenditure. Slovakia contributed only 0.21% to the increase.

ACKNOWLEDGMENT

This research was supported by the Grant Agency of Slovak Republic [KEGA grant number 007EU-4/2020 Interactive and interdisciplinary teaching of Services and Tourism Innovation subjects using information technology].

REFERENCES

Eurostat (2020) https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=rd_e_gerdtot&lang=en (cited 22.9.2020).

Eurostat (2020) https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do (cited 22.9.2020).

Eurostat (2020) https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Gross_domestic_expenditure_on_R_%26_D_(GERD) (cited 22.9.2020).

Hindls, R. & Hronová, S. (1997). Vývoj domácího produktu z hlediska přispění jednotlivých faktorú. *Politická ekonomie,* 1997 (5), pp. 699-707.

Hurbánková, Ľ. & Sivašová, D. (2018). *Hospodárska štatistika I.* Bratislava: Vydavateľstvo EKONÓM. pp. 140.

Investopedia (2020) https://www.investopedia.com/terms/r/research-and-development-expenses.asp (cited 22.9.2020).

Pacáková, V. et al. (2009). *Štatistické metódy pre ekonómov*. Bratislava: Iura Edition. pp 405.

Štatistický úrad Slovenskej republiky (2019). *Štatistická ročenka Slovenskej republiky 2019*. Bratislava: Veda.