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Investments in R&D and intellectual property products as economic growth factors in the European Union from 2009–2018

Krzysztof Dobrowolski✉, Grzegorz Pawłowski

University of Gdańsk, Faculty of Economics
119/121 Armii Krajowej St., 81-824 Sopot, Poland
e-mail: k.dobrowolski@ug.gda.pl; grzegorz.pawlowski@ug.edu.pl
✉ corresponding author

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Abstract
In the article, an analysis of the impact of outlays for R&D and intellectual property products on the GDP dynamics in European Union countries from 2009–2018 was made based on a theoretical foundation. Two hypotheses were formulated: (1) The higher the share of outlays for R&D in the GDP, the higher the GDP dynamics; (2) The higher the share of investments in intellectual property products in GDP, the higher the GDP dynamics. The hypotheses were not confirmed by statistical data analysis.

Introduction

Investments are an essential element of any economic growth model, but the use of such investment funds is more important. This article focuses on two aspects of investing: investments in research and development (R&D) and investments in intellectual property products (IPP). The latter category is broader since it also contains outlays for R&D and, among others, outlays for software and databases.

The chosen research period begins in 2009, i.e. the period in which the impact of adverse factors shaped by the financial market crisis was felt on GDP growth in individual countries. The period ends, depending on the availability of data, in 2017 or 2018.

In accordance with the adopted methodology, the outlay rate of R&D and the investment rates in IPP were analyzed, i.e. the share of these values in the GDP of each country of the European Union (EU) from 2009–2017 for R&D outlays and from 2009–2018 for IPP investments. The calculated average indicators were compared with the average dynamics of GDP over the analyzed periods.

The authors are aware of the simplification resulting from using the average GDP growth rate in individual countries in this comparison, but it seemed justified at this stage of the study.

Pearson's correlation coefficients and determination coefficients for the R&D outlay rate and GDP dynamics, as well as the IPP investment rate and GDP dynamics for each EU country in the studied period were also calculated. For the assumed significance levels, it was examined whether there individual EU countries showed any statistically significant relationships between:

- the share of R&D outlays in GDP and GDP dynamics,
- the share of IPP outlays in GDP and GDP dynamics.

If any relationships were identified, their strength was estimated. Also specified were:

- to what extent the outlay rate for R&D explains the GDP fluctuation dynamics,
- to what extent the outlay rate for IPP explains the GDP fluctuation dynamics.

A basic level of significance of 0.05 was assumed, while the results for the level of significance of 0.1 were treated as auxiliary.

If the Pearson correlation coefficient was in the range of 0.2–0.4, the relationship between variables was weak, in the range 0.4–0.7 the relationship was moderate, and in the range 0.7–0.9, the relationship was strong. Taking into account theoretical studies, it was accepted that a stable rate of investment in R&D and IPP more favorably affected economic development than the rate exhibiting significant annual fluctuations.

Two hypotheses were formulated:

1. The higher the share of outlays for R&D in GDP, the higher the GDP dynamics.
2. The higher the share of investments in IPP in GDP, the higher the GDP dynamics.

It should be emphasized that only two of the above-mentioned indicators were examined in this article, although economic growth is also determined by many other complex factors that were not taken into account.

Analyzing the impact of outlays for R&D and IPP on economic growth does not take into account the spending efficiency of these funds. The same funds may have been spent on more or less effective projects in different countries, and also shared between the private and public sectors to different extents. The formulated hypotheses refer only to specific quantitative relationships between the examined indicators.

Outlays for development as an element of economic growth – elements of the theory

The foundations of the economic growth theory can be found in A. Smith's work, where it was noted that the annual work of every nation is a fund that provides it with all the necessities for living that the nation consumes. These necessities are either a direct product of this work or were purchased from other nations (Smith, 1776). Thus, the concept of economic growth can be understood as a long-term process where the goods and services in a given country quantitatively increase. According to another definition, economic growth is a process in which a nation accumulates wealth over time (Cornwall, 2018). The main measure of economic growth is the gross domestic product (GDP), which is the end result of residents' production activities (GUS 2019). Many factors affect the level of economic growth, and they can be divided into direct and indirect factors (Zienkowski, 2008):

a) direct – short-term: capital, work, and independent technical and organizational progress;
b) indirect – medium-term: business conditions and economic and social policies;
c) indirect – long-term: science, knowledge, innovations (capital of scientific knowledge), education and the level of knowledge of a society (knowledge capital of a society), civilization, and cultural level, i.e. mentality (social capital).

Many publications have pointed out that, apart from work and capital, technical progress is highly important for economic growth. Therefore, not only is the level of investment important for long-term economic growth, but also its nature. The key issue in this case is outlays for R&D, and more broadly, for IPP.

At the end of the 20th century, many economists had already highlighted the role of R&D as a factor of economic growth. The most important works from this period include those of Khan (Khan, 2015) Romer (Romer, 1987; 1990), Aghion and Howitt (Aghion & Howitt, 1992), Grossman and Helpman (Grossman & Helpman, 1991), as well as Barro and Sala-i-Martin (Barro & Sala-i-Martin, 2004). According to Blackburn, Hung, and Pozzolo (Blackburn, Hung & Pozzolo, 2000) R&D leads to inventions and innovations which improve production quality and modernize existing technologies. Their model recommends gathering skills and knowledge in the economy to achieve long-term growth.

In recent years, many economists have undertaken further detailed research into the role of R&D as a growth factor. The importance of this issue was recognized by awarding the 2018 Nobel Prize in Economics to Romer for his research contribution on understanding the impact of long-term technological changes on economies (The Committee for the Prize..., 2018).

Outlays for R&D as a factor of economic growth

Outlays for R&D are an important factor for increasing the effectiveness of total investments. Table 1 shows the share of outlays for R&D in the GDP from 2009–2017 (data for 2018 are not yet available).

The average share of outlays for R&D in the GDP in the entire EU was 1.57%, whereas the average GDP growth dynamics was 1.16%. The highest average share of outlays for R&D in GDP in the analyzed period was recorded in two Scandinavian countries: Sweden (3.28%) and Finland (3.27%). Finland, however, achieved a low average rate of

Table 1. The R&D outlays rate in the European Union countries and the average GDP growth in 2009–2017 (%) (calculations based on (Eurostat, 2019))

GEO/TIME	2009	2010	2011	2012	2013	2014	2015	2016	2017	Average outlays on R&D	Average GDP growth
Belgium	1.99	2.05	2.16	2.27	2.33	2.39	2.46	2.55	2.58	2.31	0.98
Bulgaria	0.49	0.56	0.53	0.60	0.64	0.79	0.96	0.78	0.75	0.68	1.46
Czech Republic	1.29	1.34	1.56	1.78	1.90	1.97	1.93	1.68	1.79	1.69	1.43
Denmark	3.06	2.92	2.94	2.98	2.97	2.91	3.06	3.10	3.05	3.00	0.89
Germany	2.72	2.71	2.80	2.87	2.82	2.87	2.91	2.92	3.02	2.85	1.28
Estonia	1.40	1.58	2.31	2.12	1.72	1.43	1.47	1.25	1.29	1.62	1.62
Ireland	1.61	1.59	1.56	1.56	1.56	1.50	1.19	1.19	1.05	1.42	5.36
Greece	0.63	0.60	0.67	0.70	0.81	0.83	0.96	0.99	1.13	0.81	−3.09
Spain	1.35	1.35	1.33	1.29	1.27	1.24	1.22	1.19	1.20	1.27	0.22
France	2.21	2.18	2.19	2.23	2.24	2.23	2.27	2.25	2.19	2.22	0.84
Croatia	0.84	0.74	0.75	0.75	0.81	0.78	0.84	0.86	0.86	0.80	−0.36
Italy	1.22	1.22	1.21	1.27	1.31	1.34	1.34	1.37	1.35	1.29	−0.43
Cyprus	0.44	0.45	0.46	0.44	0.48	0.51	0.48	0.53	0.56	0.48	0.11
Latvia	0.45	0.61	0.70	0.66	0.61	0.69	0.63	0.44	0.51	0.59	0.68
Lithuania	0.83	0.78	0.90	0.89	0.95	1.03	1.04	0.84	0.89	0.91	1.34
Luxembourg	1.68	1.50	1.46	1.27	1.30	1.26	1.28	1.30	1.26	1.37	2.04
Hungary	1.13	1.14	1.19	1.26	1.39	1.35	1.36	1.20	1.35	1.26	1.16
Malta	0.52	0.61	0.67	0.83	0.77	0.71	0.74	0.57	0.54	0.66	4.57
Netherlands	1.67	1.70	1.88	1.92	1.93	1.98	1.98	2.00	1.99	1.89	0.73
Austria	2.60	2.73	2.67	2.91	2.95	3.08	3.05	3.13	3.16	2.92	0.89
Poland	0.66	0.72	0.75	0.88	0.87	0.94	1.00	0.96	1.03	0.87	3.27
Portugal	1.58	1.53	1.46	1.38	1.33	1.29	1.24	1.28	1.33	1.38	−0.07
Romania	0.44	0.46	0.50	0.48	0.39	0.38	0.49	0.48	0.50	0.46	1.92
Slovenia	1.82	2.06	2.42	2.57	2.58	2.37	2.20	2.01	1.86	2.21	0.39
Slovakia	0.47	0.62	0.66	0.80	0.82	0.88	1.17	0.79	0.88	0.79	2.10
Finland	3.75	3.73	3.64	3.42	3.29	3.17	2.89	2.74	2.76	3.27	0.06
Sweden	3.45	3.21	3.25	3.28	3.30	3.14	3.26	3.27	3.40	3.28	1.81
United Kingdom	1.68	1.66	1.66	1.59	1.64	1.66	1.67	1.68	1.66	1.66	1.26
Average										**1.57**	**1.16**

economic growth (0.06%), which was considerably below the EU average. The correlation between the R&D outlays rate and the GDP dynamics was statistically insignificant (Table 2), and other factors more substantially influenced the pace of development.

In Sweden, the average R&D outlays rate was 3.28%, with a growth rate of 1.81%, which was 0.65 p.p. higher than the EU average. In this country, the linear relationship between the share of outlays for R&D in GDP and the dynamics of economic growth was statistically significant (Pearson's correlation coefficient –0.7%). However, the negative value of the coefficient indicates that increasing the share of outlays for development in the GDP was accompanied by a decrease in growth dynamics. This relationship is on a moderate level. The share of outlays for R&D explains the 49% volatility in the GDP dynamics, which may point to ineffective use of these investment funds.

In Sweden, the share of outlays for R&D in GDP remained stable throughout the studied period, in the range of 3.14%–3.45%. In contrast, in Finland, it remained above 3% (3.17%–3.75%) from 2009–2014 and decreased in following years to 2.74%–2.89%.

The same conclusion as in the case of Finland regarding the impact of the development of outlays on GDP growth can be drawn for a third Scandinavian country – Denmark. In this country, the average R&D outlay rate was 3%, and the average growth rate was 0.89%, which was 0.27 p.p. below the EU average. The linear correlation between these indicators was statistically insignificant. In 2009, the share of outlays for R&D in GDP amounted to 3.06%, while in the following years, it decreased to

Table 2. Pearson's correlation coefficient (r) and coefficient of determination (R^2) for GDP dynamics and the R D outlays rate in European Union countries from 2009–2017 ((calculations based on (Eurostat, 2019))

GEO/TIME	Average outlays on R&D	r	R^2	Level of significance 0.05	Level of significance 0.1
Belgium	2.31	0.39	15%	insignificant	insignificant
Bulgaria	0.68	0.72	52%	significant	significant
Czech Republic	1.69	0.51	26%	insignificant	significant
Denmark	3.00	–0.15	2%	insignificant	insignificant
Germany	2.85	0.29	8%	insignificant	insignificant
Estonia	1.62	0.37	14%	insignificant	insignificant
Ireland	1.42	–0.61	38%	significant	significant
Greece	0.81	0.82	68%	significant	significant
Spain	1.27	–0.80	65%	significant	significant
France	2.22	–0.19	4%	insignificant	insignificant
Croatia	0.80	0.32	10%	insignificant	insignificant
Italy	1.29	0.40	16%	insignificant	insignificant
Cyprus	0.48	0.60	36%	significant	significant
Latvia	0.59	0.52	27%	insignificant	significant
Lithuania	0.91	0.34	11%	insignificant	insignificant
Luxembourg	1.37	–0.54	29%	insignificant	significant
Hungary	1.26	0.66	44%	significant	significant
Malta	0.66	0.30	9%	insignificant	insignificant
Netherlands	1.89	0.65	42%	significant	significant
Austria	2.92	0.43	19%	insignificant	insignificant
Poland	0.87	0.10	1%	insignificant	insignificant
Portugal	1.38	–0.46	21%	insignificant	insignificant
Romania	0.46	0.17	3%	insignificant	insignificant
Slovenia	2.21	–0.03	0%	insignificant	insignificant
Slovakia	0.79	0.58	34%	insignificant	significant
Finland	3.27	–0.42	18%	insignificant	insignificant
Sweden	3.28	–0.70	49%	significant	significant
United Kingdom	1.66	–0.25	6%	insignificant	insignificant

2.91%–2.98% and from again it again exceeded 3% (3.05%–3.10%).

Although Austria spent on average 2.62% of its GDP on R&D, it achieved a low rate of economic growth of 0.89% (0.27 p.p. below the EU average), with a linear relationship between the share of development outlays in the GDP and its dynamics, which was not statistically significant. Other factors had greater impacts on economic growth dynamics. From 2009–2013, the R&D outlay rate remained below 3% (2.60%–2.95%), which was exceeded in the following year (3.08%), and slightly decreased in 2015, reaching 3.13% in 2016 and 3.16% in 2017.

Another country with an above-average share of outlays for R&D in its GDP is Germany (2.85%), which also achieved a relatively low average growth rate (1.28%), although it was 0.12 p.p. higher than the EU average. In the case of this country, the linear relationship between the share of outlays on the development of GDP and its growth dynamics was statistically insignificant, which indicates that other factors had stronger impacts on its economic growth. From 2009–2016, the share of outlays for R&D in the GDP remained stable at 2.71%–2.72%, and in the last year of the examined period, it slightly exceeded 3% (by 0.02 p.p.).

In Belgium, the average share of outlays for development in the GDP was 2.31%, and the average growth rate was 0.98%, which was 0.18 p.p. below the EU average. The linear correlation between these indicators was statistically insignificant. In 2009, the share of outlays for R&D in the GDP amounted to 1.99%, and then exceeded 2% in subsequent years and fluctuated from 2.05%–2.58%.

The last countries with average R&D outlays rates above 2% are France and Slovenia, with very similar ratios of 2.2% and 2.1%, respectively. In both countries, the average rate of economic growth was below the EU average. In France, it was 0.84%, which was 0.32 pp. below the EU average, and in Slovenia, it

was 0.39%, which was 0.77 pp. below the EU average. In each country, the linear correlation between the share of outlays for development in the GDP and its dynamics was statistically insignificant, i.e. other factors more strongly impacted GDP growth. In France, the share of outlays for R&D in the GDP for the entire period was below 3% (2.18%–2.27%), and in Slovenia, was from 1.82%–2.58%.

Above-average shares of outlays for R&D in the EU were also recorded in the Netherlands, the Czech Republic, the United Kingdom, and Estonia, at 1.89%, 1.69%, 1.66%, and 1.62% respectively. In the Netherlands, the link between the share of development outlays in the GDP and the dynamics of this indicator was moderate and statistically significant (0.65), and the share of outlays for development in the GDP explains the 42% volatility in the economic growth dynamics. The low average GDP growth rate of 0.73% (0.43 points below the EU average) demonstrates the ineffective use of funds allocated for development compared with other EU countries. The share of outlays for R&D in the GDP only reached 2% in 2016, while in remaining years it was in the range of 1.67%–1.99%.

In the Czech Republic, Great Britain, and Estonia, the share of outlays for development in the GDP were not significantly correlated with the growth rate, which on average reached 1.43% (0.27 pp above the EU average), 1.26% (0.1 pp above the EU average), and 1.62% (0.46 pp above the EU average), respectively.

The countries with the highest average growth rate were Ireland, Malta, and Poland, which had development outlays in their GDP of 1.42%, 0.66%, and 0.87%, respectively. Ireland is a unique situation, as the high growth rate was fueled by exceptional circumstances that occurred in 2015. However, assuming that the growth rate for this year is the average of the previous year and the next year (6.9%), the average growth rate for 2009–2017 was 3.33%, which is still well above the EU average (2.24 p.p.).

The correlation between the share of outlays for R&D in the GDP and the dynamics of economic development was statistically significant (–0.61), but increasing this share was accompanied by a decrease in the dynamics of development. It is a moderately strong relationship, which shows inefficient use of funds for development. The share of outlays for R&D in the GDP explains 38% of the dynamics of GDP growth. The share of outlays for development in the GDP over the entire study period did not exceed 2% and fluctuated from 1.05%–1.61%.

In the two other countries (Malta and Poland), the linear relationship between the share of outlays for development in the GDP and the dynamics of this indicator was statistically insignificant. This suggests that other factors had a greater impact on the dynamics of economic development. In Malta, the share of outlays for R&D in the GDP fluctuated from 0.52%–0.77%, and in Poland in a wider scope, from 0.66%–1.03%.

In other countries, the average share of development outlays in the GDP was lower than the EU average. Compared with the EU countries, a relatively high (> 1%) share of outlays for development in the GDP were observed in Portugal (1.38%), Luxembourg (1.37%), Italy (1.29%), Spain (1.27%), and Hungary (1.26%). In Luxembourg, the average rate of economic growth was higher than the EU average (2.04%), in Hungary it was 1.16%, in Spain it was significantly lower (0.22%), while Italy and Portugal had negative values (–0.43%, –0.07%).

In Spain and Hungary, the R&D outlays rate shows a statistically significant linear correlation with the GDP growth at –0.80 and 0.66, respectively. This means that in Spain, a higher share of outlays for development in the GDP was accompanied by a decrease in GDP growth, which suggests the inefficient use of these funds. In Hungary, financial resources were used more effectively than other countries. The rate of outlays for development explains the 65% volatility of GDP dynamics in Spain and 44% in Hungary. In Luxembourg, Portugal, and Italy, there was no linear, statistically significant relationship between the rate of R&D outlays and GDP dynamics.

In countries with a share of development outlays in the GDP below 1%, a statistically significant linear relationship between this indicator and GDP dynamics occurred in Bulgaria (0.72), Greece (0.82), and Cyprus (0.60). Apart from Cyprus (moderate dependence), these correlations were strong, and the rate of development outlays explained the changes in GDP dynamics of 36% in Cyprus, 52% in Bulgaria, and 68% in Greece. In these countries, R&D outlays positively impacted growth, although their average dynamics were low in Cyprus (0.11%), negative in Greece (–3.09%), and higher by only 0.3 pp. from the EU average in Bulgaria (1.46%), which most probably resulted from too-low shares of these outlays in the GDP

At a lower level of significance (0.1), the linear relationship between the rate of development outlays and GDP dynamics becomes statistically significant for Czech Republic (0.51%), Latvia (0.52%),

Luxembourg (–0.54%), and Slovakia (0.58%). In each of these countries, a moderate relationship was observed. The share of the outlays rate on development in the GDP explains the changes in the 26% GDP growth in the Czech Republic, 27% in Latvia, 29% in Luxembourg, and 34% in Slovakia. Outlays for development in these countries were not a significant stimulus for GDP growth, and only amounted to 1.43% (above the EU average), 0.68%, 2.04% (above the EU average), and 2.10% (above the EU average), respectively.

Investments in intellectual property products (IPP) as an economic growth factor

Data for investments in IPP from 2009–2018 is included in Tables 3 and 4.

The average share of investments in IPP in the European Union during the analyzed period was 3.3%, with an average GDP growth of 1.36%. The highest average share of investments in IPP in GDP during the examined period occurred in Ireland, which had an average growth rate of 5.49%. However, one should remember the unusual GDP growth dynamics in 2015, which overstated this indicator. However, if using the GDP growth rate of 6.9% for 2015 (the average for 2014 and 2016), then the growth rate for the entire period was 3.67%, which is still well above the EU average (2.38 p,p.). However, there was no statistically significant linear correlation between IPP investment rate and GDP dynamics (Table 4), which indicates that other factors more strongly impacted economic growth. From 2016–2017, the share of investments in IPP in

Table 3. The rate of outlays for IPP in European Union countries and the average GDP growth from 2009–2018 (%) (calculations based on (Eurostat, 2019))

GEO/TIME	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Average rate of outlays for IPP	Average GDP growth
Belgium	3.6	3.6	3.8	3.9	3.9	4.3	4.8	4.3	4.4	4.5	4.1	1.02
Bulgaria	1.4	1.3	1.3	1.2	1.4	1.4	1.5	1.6	2.2	2.2	1.6	1.62
Czech Republic	3.3	3.0	3.3	3.6	3.6	3.6	3.9	4.0	4.0	4.1	3.6	1.58
Denmark	5.1	5.1	4.9	4.9	4.8	5.0	5.0	5.5	5.2	5.4	5.1	0.94
Germany	3.5	3.4	3.5	3.5	3.5	3.6	3.7	3.8	3.8	3.7	3.6	1.29
Estonia	2.0	2.1	2.2	2.5	2.5	2.4	2.3	2.4	2.5	2.7	2.4	1.85
Ireland	5.0	5.2	4.5	6.4	5.4	6.1	12.7	22.2	18.6	8.4	9.5	5.49
Greece	1.7	1.9	1.6	1.5	1.6	1.6	1.8	1.7	1.7	1.7	1.7	–2.59
Spain	2.4	2.6	2.7	2.9	2.9	3.0	3.0	3.0	3.0	2.9	2.8	0.46
France	4.7	4.8	4.8	5.0	5.0	5.1	5.1	5.3	5.5	5.7	5.1	0.91
Croatia	:	:	:	:	:	:	:	:	:	:	:	–0.06
Italy	2.6	2.6	2.5	2.6	2.7	2.7	2.9	2.9	2.9	2.9	2.7	–0.3
Cyprus	1.0	1.0	:	:	:	:	:	:	:	:	:	0.49
Latvia	1.5	1.6	1.6	1.5	1.8	1.7	1.7	1.6	1.9	1.8	1.7	1.09
Lithuania	1.9	1.9	1.7	1.7	1.5	1.7	1.8	2.1	2.3	2.4	1.9	1.56
Luxembourg	1.3	1.4	1.2	1.3	1.4	1.6	1.7	1.6	1.7	1.6	1.5	2.1
Hungary	2.8	2.5	2.5	2.6	3.1	2.8	3.2	2.6	2.6	2.9	2.8	1.53
Malta	2.5	2.9	2.6	2.9	2.8	3.3	3.0	3.0	3.0	2.9	2.9	4.77
Netherlands	4.0	4.1	4.2	4.2	4.9	4.3	7.6	4.6	4.6	4.5	4.7	0.93
Austria	4.0	4.0	4.3	4.4	4.8	4.7	4.8	4.9	5.0	5.1	4.6	1.07
Poland	1.4	1.3	1.2	1.3	1.3	1.4	1.4	1.4	1.5	1.5	1.4	3.45
Portugal	2.7	2.6	2.7	2.7	2.6	2.6	2.5	2.5	2.6	2.6	2.6	0.15
Romania	1.8	2.0	2.1	1.4	1.7	2.0	1.8	1.6	1.3	:	1.7	2.14
Slovenia	2.9	3.2	3.1	3.1	3.1	3.0	3.0	2.9	3.0	3.1	3.0	0.8
Slovakia	1.7	2.9	1.8	1.7	2.1	1.6	1.8	1.5	1.4	1.5	1.8	2.3
Finland	5.3	5.3	4.9	4.7	4.6	4.6	4.3	4.2	4.1	4.1	4.6	0.28
Sweden	6.4	6.2	6.4	6.1	6.3	6.6	6.6	6.2	6.2	6.7	6.4	1.86
United Kingdom	3.3	3.4	3.3	3.3	3.4	3.3	3.1	3.1	3.1	3.1	3.2	1.27
Average											**3.3**	**1.36**

Table 4. Pearson's correlation coefficient (r) and coefficient of determination (R^2) for GDP dynamics and the outlays rate for IPP in European Union countries in 2009–2018 (calculations based on (Eurostat, 2019))

GEO/TIME	Average rate of outlays for IPP	r	R^2	Level of significance 0.05	Level of significance 0.1
Belgium	4.1	0.38	14%	insignificant	insignificant
Bulgaria	1.6	0.53	28%	insignificant	significant
Czech Republic	3.6	0.49	24%	insignificant	significant
Denmark	5.1	0.17	3%	insignificant	insignificant
Germany	3.6	0.13	2%	insignificant	insignificant
Estonia	2.4	0.56	32%	significant	significant
Ireland	9.5	0.36	13%	insignificant	insignificant
Greece	1.7	0.24	6%	insignificant	insignificant
Spain	2.8	0.68	47%	significant	significant
France	5.1	0.44	19%	insignificant	insignificant
Croatia	:	:	:	:	:
Italy	2.7	0.47	22%	insignificant	significant
Cyprus	:	:	:	:	:
Latvia	1.7	0.49	24%	insignificant	significant
Lithuania	1.9	-0.03	0%	insignificant	insignificant
Luxembourg	1.5	0.40	16%	insignificant	insignificant
Hungary	2.8	0.19	4%	insignificant	insignificant
Malta	2.9	0.84	70%	significant	significant
Netherlands	4.7	0.30	9%	insignificant	insignificant
Austria	4.6	0.49	24%	insignificant	significant
Poland	1.4	0.33	11%	insignificant	insignificant
Portugal	2.6	–0.79	62%	significant	significant
Romania*	1.7	–0.47	22%	insignificant	insignificant
Slovenia	3.0	0.16	2%	insignificant	insignificant
Slovakia	1.8	0.20	4%	insignificant	insignificant
Finland	4.6	–0.49	24%	insignificant	significant
Sweden	6.4	0.09	1%	insignificant	insignificant
United Kingdom	3.2	–0.15	2%	insignificant	insignificant

* Calculations for 2009–2017.

Ireland had high values of 22.2% and 18.6%, while in the remaining years it significantly fluctuated from 5.0%–12.7%.

Other countries with a high average share of investments in IPP in their GDP are Sweden (6.4%), Denmark (5.1%), and France (5.1). The average GDP growth rate in these countries were 1.86%, 0.94%, and 0.91%, respectively, which are all below the EU average, except for Sweden. The correlation between the rate of outlays for IPP and the GDP dynamics is, however, statistically insignificant, which means that other factors have a stronger impact on economic growth. In Sweden, the share of investment in IPP in the GDP was nearly constant at 6.1%–6.7%, while in Denmark, it ranged from 4.8%–5.5% and in France from 4.7%–5.7%.

The average share of investments in IPP in the GDP above 4% occurred in the Netherlands (4.7%), Austria (4.6%), Finland (4.6%), and Belgium (4.1%). In all these countries, the average GDP growth rate was below the EU average: in the Netherlands 0.93%, Austria 1.07%, Finland 0.28%, and Belgium 1.02%. The Pearson's coefficient indicates that in these countries, the linear correlation between the studied values was statistically insignificant, so there was no direct relationship between the share of outlays for IPP in the GDP and economic growth dynamics. Only in Austria and Finland, did the Pearson coefficient indicate a linear relationship between the variables tested. At a level of significance of 0.1, the dependence was moderate

In Belgium, the IPP investment rate fluctuated during 2009–2013 from 3.6%–3.9%, while from 2014–2018 it fluctuated from 4.3%–4.8% and was therefore relatively stable. In Austria, the IPP investment rate fluctuated from 4.0%–5.1%, in Finland

from 4.1%–5.3%, and in the Netherlands from 4.0%–4.9%, except for a one-off increase to 7.6% in 2015.

An average IPP investment rate above 3.3% (EU average), was recorded in the Czech Republic (3.6%) and Germany (3.6%). In the United Kingdom and Slovenia, the average rates were slightly below the EU average, at 3.2% and 3.0%, respectively. The Pearson's coefficient indicated that in these countries, the linear correlation between the studied values was statistically insignificant, which means that other factors had stronger impacts on the growth. Only in the Czech Republic and Austria did the Pearson coefficient indicate a moderate relationship between the variables tested, but at a significance level of 0.1.

In countries with the highest average GDP growth rate, Malta (4.77%) and Poland (3.45%), the average IPP investment rates were 2.9% and 1.4%, respectively, which were below the EU average. In Poland, the correlation between the IPP investment rate and GDP dynamics turned out to be statistically insignificant, which suggests that other factors more strongly influenced the dynamics of economic development. In the case of Malta, the correlation was strongly statistically significant (0.84), which means that increasing outlays for IPP was accompanied by an increase in the GDP growth. The outlays rate for IPP explains the 70% volatility of the GDP dynamics. The examined outlays were an important growth factor and were used more effectively compared with other European countries.

In other countries, the average IPP investment rate was below the EU average, and levels above 2% were achieved in Spain (2.8%), Hungary (2.8%), Italy (2.7%), Portugal (2.6%), and Estonia (2.4%). In Spain, Estonia, and Portugal, the linear relationship between the IPP investment rate and GDP dynamics was statistically significant. In Spain and Estonia, this was a moderate level, respectively at 0.68 and 0.56, and the investment rate under investigation explains the 47% volatility of GDP growth in Spain and 32% for Estonia. In these countries, outlays for IPP positively impacted growth, although its average rate was low. In Estonia, it was 1.85% (0.49 p.p. above the EU average), 0.46% in Spain, and 0.15% in Portugal, which most probably resulted from too few outlays in the GDP.

In Portugal, there was a strong negative relationship (–0.79), which means that increasing the share of outlays for IPP in the GDP was accompanied by a decrease in its dynamics. We can draw conclusions about the inefficient use of outlays. The rate of these outlays explains the 62% volatility in the GDP dynamics. In Italy, the Pearson's coefficient showed a statistically significant linear relationship between the analyzed variables at a significance level of 0.1. For Croatia and Cyprus, there is a lack of complete data on the outlays rate for IPP during the studied period.

In Bulgaria and Latvia, the Pearson's coefficient showed a linear, statistically significant relationship between the share of investments in IPP in GDP and the dynamics of GDP, but at a significance level of 0.1. In both countries, the correlation was moderate.

Conclusions

A higher than average share of outlays for R&D in European Union countries did not significantly accelerate the pace of economic growth in any country. Countries with a significant share of R&D outlays in their GDP mostly showed a low or slightly above EU average economic growth rates. Countries with an average growth rate showed a low share of outlays for R&D in their GDP. In most countries, there was no statistically significant linear relationship between the studied factors. Thus, hypothesis 1 was rejected.

The same trends were observed for outlays for IPP. Higher than average shares of these outlays in the GDP did not significantly accelerate the pace of economic growth in any country. Countries with a significant share of outlays for IPP in their GDP mostly showed a low or slightly above-average rate of economic growth. Countries with high average economic growth dynamics showed a low share of these outlays in their GDP. In most countries, there was no statistically significant linear relationship between the studied factors. Thus, hypothesis 2 was also rejected.

This analysis considered only quantitative relationships between the examined indicators. In-depth research into the impact of outlays for R&D and IPP on economic growth must include a number of other factors, including: spending efficiency of these funds, compliance of their expenditure with market needs, potential of the R&D sector, level of cooperation between this sector and industry, and state policy conductive to innovative research. Factors directly affecting GDP growth should also be taken into account.

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