

RESEARCH AND DEVELOPMENT EXPENDITURE AND THEIR IMPORTANCE FOR INNOVATION DEVELOPMENT

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Abstract

In an era of increasing globalization and digitization, innovation is becoming an increasingly important factor in determining the success of business. They provide companies with higher growth, increase efficiency, competitiveness and enable companies to create new markets. Especially in the current dynamically developing period, the need for innovation is even higher. This fact was also demonstrated by the current pandemic, during which companies were forced to react quickly and flexibly to changes in the market. Despite the fact that in Slovakia there is already support for innovative companies and efforts to create an innovation-friendly environment, the innovation performance of the Slovak Republic still lags behind other EU countries. The need to introduce innovations is necessary for Slovak small and medium-sized enterprises from the point of view of adaptation. And innovation would not arise without adequate research and development.

In the article, we will focus on the area of research and development and subsequently on the innovative activity of companies. We will evaluate the development of expenditures on research and development in the Slovak Republic in the period 2010-2019, describe human resources in research and development and assess the innovative activity of companies.

Keywords: research, development, innovation, employees, innovation activity, innovation performance

1 Introduction

The ability of the economy to adapt to current as well as expected technological changes is determined by many factors. One of the main ones we can consider its level of innovation. By the country's innovation level we understand a set of several factors: educated workforce, quality research and development, funding intensity, the share of intensely demanding industries in the structure of the economy, employment and the level of intellectual property production. Investment in research and development and innovation is essential for the long-term economic development and prosperity of EU countries. They boost economic growth, resource efficiency, job creation and labor productivity. The ambiguity and variability of the concept of innovation is also related to the innovation activity itself. Innovation can be the result of several years of innovation activity of the company, it can be the result of constant small, almost invisible changes in the product or process. It can also be the result of chance or a one-time idea. The purchase of machinery, equipment or licenses, training or changes in marketing can also be considered an innovation. All these activities can be performed externally, by purchase, or even internally in-house. However, the basic feature of the company's innovative activity is a high degree of uncertainty associated with innovation. [3] Innovation would not arise without adequate research and development. The relationship between R&D and innovation is very complex. Research, development and innovation are basic preconditions for growing the well-being of the population, maintaining a stable pace of economic growth and long-term competitiveness of economies.

Act no. 172/2005 Coll. on the organization and state support of research and development states that research "is a systematic creative activity carried out in the field of science and technology for the needs of society and for the development of knowledge" and "development is a systematic creative activity in the field of science and technology using or based on practical experience in creating or improving new materials, products, equipment, systems, methods and processes." [5]

Edquist (2011) emphasizes that R&D activities bring new knowledge, while R&D activities bring advanced products and processes. [2] Innovation determines a new way to improve, restore and change something. [4] It is also about the use of knowledge for the generation and practical application of a new idea that brings benefits. We can also understand innovation as a process of securing new, better capabilities or increased usefulness. The innovative environment connects the three inner parts of the regions - universities, financial institutions and geographical relations with the market. Close collaboration between leading companies, universities and research centers creates more efficient and innovative solutions. Innovation activities are the result of research and

development and are the driving force of the country. Innovation changes the existing state of the economy, acts as a basic factor in the society-wide production process moving to a new or newer stage of development. The importance of innovation needs to be emphasized, in particular in terms of its impact on guiding real economic policy towards new metas in society. Public investment in research and development plays an important role in the country's innovation. Countries spending more on public R&D spending tend to become more efficient and have a stronger knowledge base. The development of science, research and innovation of internationally comparable quality is important for the sustainability of economic development and long-term competitiveness.

2 Expenditures on research and development in the Slovak Republic

Slovakia is a country with a competitive technical background and a long tradition of industrial research and development. It has active research and development staff participating in top domestic and international projects, has an available engineering and scientific base, has a research and development network consisting of industrial research and development organizations, research institutes at technical and natural sciences, research institutes of the Slovak Academy Of Science and foreign research and development centers. This research and development base is also well connected with other interested institutions such as industry associations, clusters, agencies to support research, development and innovation, business innovation centers and incubators, science and technology parks, but also software development companies.

Although Slovakia can still be considered an industrial and especially an automotive power, the main focus is increasingly on investment projects with higher added value and on activities with a significant degree of scientific and research potential. [10]

Table 1 Expenditure on research and development in the Slovak Republic in thousand. Euro [8]

Year	Expenditure on research and development			R&D expenditure per capita (Eur)	Share of R&D expenditure from GDP (in %)
	Together	Capital	Common		
2010	416 369	63 073	353 296	77,2	0,62
2011	468 439	94 799	373 641	86,9	0,66
2012	585 225	109 337	475 889	108,3	0,80
2013	610 876	97 300	513 576	112,9	0,82
2014	669 632	115 698	553 934	123,6	0,88
2015	927 272	374 186	553 086	171,0	1,18
2016	640 835	45 814	595 021	117,9	0,79
2017	748 955	72 776	676 179	137,6	0,88
2018	750 947	53 918	697 029	138,0	0,84
2019	776 590	36 117	740 472	142,50	0,83

Expenditures on science and research in Slovakia are constantly growing from 2010 to 2015, with a significant share during the entire analyzed period being current expenditures. The percentage share of R&D expenditure in GDP reached its maximum in 2015, namely 1.18% of GDP. The increase in the percentage of total R&D expenditures in 2015 was caused solely by capital expenditures, with significant drawing from the Structural Funds. In 2016, expenditures on research and development amounted to 640.8 mil. EUR, which represented 0.79% of HPD. In the following years, R&D spending increased again. Since 2018, the share of R&D expenditure in GDP has remained above 0.8%. In recent years, current expenditures have again been several times higher than capital expenditures. The maximum values from 2015 have not yet been exceeded. Slovakia is one of the countries in the EU with the lowest level of expenditure on research and development.

In Table 2 we see the evaluated structure of expenditures on research and development. In 2017, almost half of the expenditure was from state resources. Slovakia recorded a relatively positive development in the intensity of public expenditure on research and development. This fact can be attributed to drawing from the EU Structural Funds and the Cohesion Fund. However, the sustainability of public funding for research and development in the coming years is questionable. In the European context, the Slovak economy remains only a modest innovator with a relatively significant lag behind in a large part of the factors of innovative development. Since 2016, business resources have accounted for the largest share of funds spent on science and research. The interest of the business sector in the field of research and development is supported by the state through subsidies in the form of incentives for research and development. Foreign sources invested the most in research and development in 2015, when they were the main source of investment in research and development. Over the next two years, their share fell sharply.

Table 2 Structure of R&D expenditures (in %) [8]

Indicator		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
By sectors	Business enterprise sector	42,09	37,18	41,35	46,26	36,84	27,95	50,36	54,12	54,08	54,83
	State (government) sector	29,96	27,66	24,52	20,48	28,34	27,86	21,44	20,81	21,22	19,95
	State (government) sector	27,64	34,95	34,03	33,10	34,42	43,79	27,71	24,67	24,28	25,19
	Private non-profit sector	0,31	0,21	0,10	0,15	0,41	0,40	0,49	0,41	0,42	0,03
By source of funds	Business enterprise	35,06	33,85	37,71	40,19	32,21	25,06	46,22	35,50	48,85	46,76
	State (government)	49,57	49,75	41,57	38,90	41,38	31,94	40,99	49,03	38,01	40,45
	Other domestic	0,70	2,24	2,07	2,94	2,72	3,57	2,08	1,72	1,91	2,06
	Abroad	14,67	14,16	18,65	17,97	23,68	39,43	10,71	13,74	11,23	10,73
By field of science	Natural sciences	19,92	20,72	20,48	17,71	17,77	15,94	16,27	19,56	19,86	20,22
	Technological sciences	53,59	47,68	46,92	51,01	48,77	48,02	55,77	58,14	58,77	58,17
	Medical and pharmac. sciences	7,10	7,96	8,46	8,95	9,98	7,48	6,65	5,10	4,82	5,21
	Agricultural sciences	8,20	7,57	6,74	3,18	6,94	7,97	6,29	5,23	4,81	4,66
	Social sciences	6,99	8,46	7,44	7,50	10,34	17,14	9,91	7,21	6,51	6,08
	Humanities	4,21	7,62	9,96	11,65	6,21	3,45	5,12	4,77	5,22	5,66
By activity	Basic research	46,27	48,87	47,34	44,09	45,10	42,78	40,39	37,22	40,11	39,93
	Applied research	23,67	24,63	23,46	23,83	28,42	30,26	23,67	22,82	24,07	23,40
	Development	30,05	26,50	29,20	32,08	26,48	26,95	35,94	39,96	35,81	36,67

More than half of the expenditure is directed to technical sciences, less than 20% support natural sciences. Until 2016, the largest share of expenditures was spent on basic research. In 2017, a larger share went to the area of development. More than 20% is directed to applied research.

3 Research and development personnel

An important factor in research and development is human resources, which increase technological progress, scientific knowledge, improve the quality of life, and contribute to European competitiveness and the prosperity of European citizens. The lack of qualified employees is a common barrier, especially in small and medium-sized enterprises. On the one hand, it is related to the demography and educational structure of graduates. But the shortage of skilled workers often has regional dependence. In those locations where there are plenty of job opportunities, such employees are usually concentrated who bring innovative ideas to the company. Small businesses, even if they acquire such employees, may have problems with the evaluation and career growth of quality and innovative employees.

Table 3 Research and development personnel [8]

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
R&D personnel - total	28128	28596	28880	27823	28825	28752	33252	33467	35770	36309

The number of employees in the field of research and development in Slovakia increases slightly during the analyzed period, while it is obvious that the largest share is made up of researchers.

Table 4 R&D employees by fields of science [9]

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Natural sciences	5 046	4 873	5 178	4 896	5 048	4 730	4 712	4 889	5 863	6 172
Technological sciences	9 807	10 166	10 081	9 790	10 042	10 669	10 850	11 838	12 366	12 773
Medical and pharmaceutical sciences	3 590	3 544	3 641	3 280	3 259	3 292	3 402	2 974	2 889	3 019
Agricultural sciences	1 888	1 856	1 723	1 125	1 599	1 842	1 801	1 752	1 742	1 672
Social sciences	4 802	4 896	4 814	5 175	4 836	4 612	4 867	4 906	4 823	4 584
Humanities	2995	3 261	3 443	3 557	4 041	3 607	4 039	3 425	3 582	3 569

The field of research and development is highly dependent on human potential and knowledge, more than any other field. In the field of research and development, it is necessary to support the development of intangible capital - people and their ideas, knowledge, and to link it to real tangible outputs and research results. The number of R&D employees available to the national economy thus becomes the main measure of the country's research and development potential.

Table 5 Structure of R&D employees (in %) [8]

Indicator		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
R&D employees by occupation	Researchers	85,50	86,41	86,80	87,84	87,01	84,85	83,41	82,79	82,35	81,57
	Technicians and equivalent staff	10,10	9,38	9,53	8,72	8,93	9,89	10,42	11,78	11,87	12,67
	Supporting staff	4,40	4,21	3,66	3,44	4,06	5,26	6,16	5,43	5,78	5,75
R&D employees by qualification	Graduates from universities and higher qualified people	89,19	90,13	90,44	91,86	91,12	89,03	89,65	89,35	88,96	88,97
	Bachelor degree	2,51	2,15	1,24	0,96	1,29	1,73	1,54	1,36	1,88	2,13
	Master degree	40,18	40,99	40,82	41,23	39,87	38,82	40,08	39,88	40,72	41,72
	Doctoral degree (Ph.D., Dr., Professor, Associate prof.)	46,51	46,99	48,38	49,67	49,96	48,48	48,02	48,11	46,36	45,12
	Short-cycle tertiary education	1,13	1,27	0,98	0,82	1,25	0,87	1,72	1,38	1,80	1,74
	Secondary education	9,23	8,22	8,22	6,96	7,41	9,63	8,28	8,95	8,97	9,03
	Basic education	0,44	0,37	0,35	0,36	0,22	0,47	0,35	0,32	0,27	0,26

As many as almost 90% of R&D employees are employees with a university degree of the 2nd and 3rd degree. They are the R&D staff, researchers and innovation creators. In relation to individual scientific disciplines, the largest share has long been represented by employees in the field of technical sciences, followed by employees in the field of natural sciences.

4 Inovačná aktivita podnikov

Every enterprise that wants to be competitive in today's globalized market needs to innovate. The share of enterprises with innovation activity from all enterprises operating in Slovakia is 30%, while the share of their expenditures on innovations increased compared to previous years and in 2018 it represents more than 2% of total revenues.

Table 6 Enterprises with innovation activity [8]

		2018	2016	2014	2012	2010
Share of enterprises with innovation activity	of enterprises in industry and selected services	30,5	30,7	31,8	34,0	35,6
	small enterprises (10-49 employees)	25,8	24,6	28,5	29,8	29,3
	medium enterprises (50-249 employees)	39,1	42,7	37,9	40,0	43,6
	large enterprises (250 and more employees)	61,1	60,1	54,7	62,1	65,1
Share of innovation expenditure	in total turnover in %	2,3	1,6	1,3	1,8	1,2
Structure of innovation expenditure in %	Intramural R&D	23,4	22,4	21,8	12,9	17,1
	Extramural R&D	14,1	7,8	10,6	20,8	7,7
	Acquisition of machinery, equipment, software and buildings	42,5	63,6	41,4	62,8	71,6
	Acquisition of other external knowledge	-	3,2	16,6	1,8	3,6
	Market introduction and other preparations	-	-	-	-	-
	Expenditures on other innovation activities	-	3,1	9,6	1,6	-
	Expenditures on own personnel working on innovation	9,2	.	.	.	.
	Expenditures on services and materials for innovation	10,8	.	.	.	.

The analysis of the structure of expenditures on innovation activities of enterprises shows that the majority of expenditures were spent on the procurement of machinery, equipment, software and buildings (more than 60%),

22% of expenditures on innovation are directed to internal research and development. If we look at the breakdown of companies by size, of the total number of enterprises in Slovakia, up to 99% are small and medium-sized enterprises. But as far as innovation activity is concerned, of the small enterprises, only 24% are engaged in innovation activities, of the medium-sized enterprises it is already more - 42%. Large enterprises have the smallest representation among enterprises in Slovakia, but up to 60% of them invest in innovative activities. This confirms the fact that R&D is a costly activity and there is a significant relationship between the size of the enterprise and the intensity of R&D expenditure. [1] Business R&D spending appears to be too low to significantly increase innovation performance. Overall, R&D is one of the smallest in the EU and focuses on medium- to high-tech manufacturing in areas dominated by multinational companies. [10]

Table 7 Share of the innovative enterprises cooperating in innovations with be specified type of partner [8]

Kind of partners at co-operation	2018	2016	2014	2012	2010
Other enterprises within the enterprise group	13,4	14,5	14,5	13,1	15,2
Suppliers of materials, components or software	23,6	23,4	25,2	17,6	25,5
Clients or customers	23,2	20,2	18,3	19,4	21,7
Competitors and other firms from the same industry	8,0	6,0	4,3	7,1	17,6
Consultants, commercial labs or private R&D institute	11,7	15,1	9,7	7,3	11,9
Universities and other higher education institutions	10,3	8,7	8,1	7,4	10,8
Government or public research institutes	3,2	2,8	3,8	3,1	7,1
Other enterprises	6,8	.	.	.	.
Non-profit organisations	3,0	.	.	.	.

Enterprises with innovation activity cooperate in innovation mainly with suppliers of equipment, materials, components and software and with customers (more than 23% of companies). Another important type of innovation partner are companies within the group of companies, consultants and scientific research institutions. In 2018, the share of companies using cooperation with universities and higher education institutions increased. This is closely linked to the fact that most R&D staff are university-educated staff and confirms the importance of human resources in effective R&D and the subsequent creation of innovations.

5 Conclusion

Slovakia is highly dependent on EU funding for research and development. In order to increase productivity and maintain the convergence process in Slovakia, permanent investments in research and development, digital and transport infrastructure and energy efficiency are needed. Effective spending policies in support of R&D by the state and multinational companies have a positive effect on the growth of innovation performance of countries and their regions. They stimulate the growth of the business environment, with the aim of increasing investment in research and development, but also other drivers of innovation who invest in this area and are active in it. Innovation helps any entity to reach a higher level, both qualitatively and quantitatively, and thus helps it to maintain and develop its competitiveness.

Slovakia is one of the countries with a low share of R&D funding in GDP. During the entire analyzed period, R&D expenditure was less than 0.9% of GDP, with the exception of 2015, when Slovakia reached its maximum and the share of R&D expenditure reached 1.18% of GDP. Over the last three years, the share of R&D expenditure in GDP has stabilized at more than 0.8%. As part of the Europe 2020 Strategy, Slovakia has set a goal of putting one percent of GDP on science and research. This goal can be achieved if the business sector is more involved in research and development.

An important factor in the implementation of research and development is human resources and their level of education. Most R&D employees who are the creators of innovation are employees with a university degree. It is universities and other higher education institutions that are important partners in companies with innovative activity. Universities provide companies with a basis for research and development, which is then transformed into an economy in the form of innovation.

Increasing expenditures in the field of research and development in Slovakia should also be helped by the Government-approved Economic Policy Strategy with a view to 2030, the aim of which is to gradually move closer to the knowledge economies within the EU. One of the recommendations speaks of a gradual increase in R&D expenditure by 2030 so that the level of the top five EU countries is reached in terms of the share of R&D expenditure in GDP. One of the main support instruments is to be various tax breaks. The tax advantage stimulates companies to spend on domestic research and development. In the last year, the amount of the possible deduction of R&D expenditure, which is an effective tool for financing innovation, has been increased. It is an indirect support for research and development, which is provided to the company through a tax relief from expenses

incurred for development and research activities. At present, mainly companies that hire young R&D workers and companies that increase funding for their research activities are supported.

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