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Assessment of Research and Development Financing Based on the Strategies in EU: Case of Sweden, Slovakia and Romania

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Abstract: Research and development have been of interest to the European Union for a long time. This topic is also underlined in economic reform agendas and plans that have the form of strategies with clearly set targets. The article deals with the issue of financing R&D activities from the perspective of the share of expenditure to GDP, the total amount of funds spent on R&D, the share of expenditure per capita, and the structure of expenditure. The aim is to analyze and compare development in the field of R&D financing in selected countries of the European Union with emphasis on achieving the Europe 2020 target and to point out the expected development of the indicator for the first years of the validity of the 2030 Agenda for Sustainable Development. During the processing of the article, mathematical and statistical methods (regression and correlation analysis) were used in addition to standard logic methods intended for processing data and drawing conclusions (synthesis, induction). The final evaluates the achievement of the target in the field of R&D financing in accordance with the target of the Europe 2020 strategy and, using regression, predicts the development of the given indicator for coming years.

Keywords: research and development; Europe 2020; Agenda 2030; targets; prediction

Citation: Duľová Spišáková, E.; Gontkovičová, B.; Spišák, E. Assessment of Research and Development Financing Based on the Strategies in EU: Case of Sweden, Slovakia and Romania. *Sustainability* **2021**, *13*, 8628. https://doi.org/10.3390/su13158628

Academic Editor: Ladislav Mura

Received: 30 June 2021
Accepted: 30 July 2021
Published: 2 August 2021

1. Introduction

The role of innovation, research, and development as tools for the achievement of sustainable development and competitiveness is amplified by a highly competitive and knowledge-intensive global society. Innovation presents developing a new idea and its application and introduction into business practice, and it can help solve many critical problems, including social threats, and increase society's ability to act [1]. The starting point for this study is that the support of research and development (next R&D) is often crucial for allowing the future growth of the business because it leads to an increase of the knowledge, to an expansion of technology capacities and products, and to process innovation [2]. R&D becomes an engine for the economic growth of the world's industrial countries [3,4]. R&D represents systematic creative activity done in the area of science and technology with the purpose of increasing the level of knowledge [5] covering the needs of society [6] and its utilization.

The results of R&D and innovation are the driving force behind the current development of all areas of human activity. That is why it is very important to invest in these areas. For decades, the question of financing of R&D has been a topic of major interest for scholars, policy makers, and firms as innovators. The European Union also deals with the issue for a long time in order not to lag behind the USA and Southeast Asia in terms of technology. However, the EU groups countries with different technological advances. Therefore, the long-term intention of the EU is to compensate for differences between

individual member states also in technological sophistication, which is the result mainly of outputs in the field of R&D. It has been underlined in economic reform agendas and plans that have the form of strategies with clearly set targets, from the Lisbon strategy through Europe 2020 to Agenda 2030 [7–13], where progress in the field of R&D is one of the pillars of these agendas. While the results of the Lisbon strategy and Europe 2020 allow monitoring, comparison, and identification of the achieved changes of member states, Agenda 2030 presents the requirements for future progress. The EU has been confident that the increase in spending on R&D will generate a rise in innovations and make the EU a top global economic leader [14].

The paper is focused on the issue of R&D financing in selected countries and their final fulfillment or non-fulfillment of the Europe 2020 strategy's target. It analyzes and compares several indicators related to R&D. The first one is the total volume of expenditure on R&D. The value of this indicator depends on the country's size, and it is possible to assume that a larger country spends more expenditure in the monitored area. For this reason and the need for comparability, we will also focus on relative indicators, such as the share of R&D expenditure per capita in the country. Across the statistics on R&D expenditure, most of the attention is paid to the share of R&D expenditure in the country's GDP-GERD (Gross domestic expenditure on R&D), which is used to compare countries within several strategies and innovation rankings (scoreboards). The Europe 2020 strategy, but also the Global Innovation Index (GII) and Summary Innovation Index (SII), mention the need to finance R&D activities mainly from business enterprise sources, whereas only a small part should come from government sources. Therefore, in addition to the amount of R&D expenditure, it is necessary to examine their structures. The final part of the results will focus on the evaluation of the fulfillment of Europe 2020's target in the field of R&D and the prediction of the expected development of the monitored indicator until 2022, during the period of validity of the Agenda 2030 for Sustainable Development.

The aim of the article is to analyze and compare development in the field of R&D financing in selected countries of the European Union with emphasis on achieving the Europe 2020 target and to point out the expected development of the indicator for the first years of the validity of the Agenda 2030 for Sustainable Development.

The results contribute some findings concerning the non-fulfillment of the Europe 2020 strategy's target in the area of R&D financing not only in selected countries of the European Union and identify the current situation in the area as a starting point for the new Agenda 2030 for Sustainable Development. Timeliness and the need to research the issue are also confirmed by numerous studies carried out in recent years. Our ambition is to motivate further research to extend our study about the various options of R&D financing and convergence among EU member states.

2. Materials and Methods

Innovation, research, and development policy have been the cornerstones of several strategies supporting the competitiveness and future prosperity of the European Union and its member states. One of the pioneers was the Lisbon strategy, whose main target was to make Europe" the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion" [15]. It involved several targets, inter alia, creating an effective internal market, decreasing administrative burdens, improving human capital, and raising the level of the employment rate. These also included the aim of spending 3% of the EU's GDP in research and development (R&D), whereby private investment should account for two-thirds of the total by 2010.

The ways and means to achieve the objective in the field of R&D were initially defined in 2002 in the commission's communication "More research for Europe–Towards 3% of GDP", which led to the Action Plan "Investing in research" being adopted by the Commission in 2003 [16].

According to the European Commission, the failure of the Lisbon strategy was caused due to the conflicting priority areas and insufficient mutual cooperation between EU member states [12]. In addition, structural, and political differences among the member states should be held responsible for the divergence in results among countries as well as for the overall failure in reaching the 3% R&D target. The Lisbon strategy achieved relatively good progress in the macroeconomic areas, in GDP growth and employment rates specifically, unlike the developments in some of the microeconomic areas that were much more pessimistic. The performance with respect to R&D investment proved disappointing. The Lisbon strategy, despite all its weaknesses, proved itself as a useful instrument in promoting economic reforms [13].

Mentioned facts led the EC to decide on the adoption of the new Europe 2020 strategy for the 2010–2020 period. Its main priority has been to achieve sustainable, inclusive, and smart growth [17]. The strategy framework was designed to reach long-term economic growth while fighting the structural weaknesses in the European Union [18]. Its main aim was foremost the expansion of the economies of the member states of the European Union and an increase in employment. It was oriented toward the conquest of the economic crisis consequences that affected the economies of the member states and also the elimination of the weaknesses of the growth model.

Within this strategy, the European Union marked five quantitative and measurable targets in the area of R&D, employment, climate change, energy sustainability, education, fighting poverty, and social exclusion, which should have been fulfilled by the end of 2020 [17]. In this regard, seven main initiatives were set that should have been helping to fulfill the targets of the strategy Europe 2020. Between them was also the "Innovation Union" to improve framework conditions and access to finance for research and innovation so as to ensure that innovative ideas can be turned into products and services that create growth and jobs [17].

Administration and inspection of the fulfillment of these targets are carried out annually by the synchronization of the economy and the budget policy [17]. The comparison and valuation of advances of EU member states in the implementation of the strategy are specifically difficult also in the context of sustainable development [19,20]. The targets of the strategy are interconnected, and they complement each other.

The position of research and development among the target and initiatives is shown in Figure 1.

The interconnectedness, validity, and relevance of defined targets have been the subject of several multidisciplinary discussions and research. For example, Nolan and Whelan state that employment growth does not always necessarily lead to a reduction in the number of people at risk of poverty [21]. The support of research and innovation on environmentally friendly, economically feasible, and socially acceptable technological and non-technological solutions are essential in the field of resource efficiency [22]. Colak and Ege, but also Leschke, Theodoropoulou, and Watt dealt with the issue of the feasibility regarding the achievement of the goals [11,23]. Roth and Thum pointed out that the goals in the field of education are very ambitious, and it is almost impossible to meet them in the given time horizon [24]. Nolan and Whelan conducted an analysis resulting in the fact that the poverty reduction target was not correctly formulated [21]. Fedajev et al. in their research indicated that relatively higher differences among the EU countries still exist in the development of renewable energy production and investments in research and development [8]. In these two areas, much less progress has been made in comparison to other targets of the strategy [25]. In addition, Ruser and Anheier pointed to insufficient efforts in investment in research and development and failure in the innovation process, which could be the source of generating smart growth [26]. Higher investments in R&D together with efficient use of resources scale up the competitiveness of the economy as well as the number of newly created jobs [27]. R&D is often examined only as one of the components of the comprehensive index for the evaluation of the Europe 2020 strategy (e.g., [10,11,18,25,28,29]). The results of Colak and Ege's research point out strong

leadership in Nordic EU countries in almost every study area, but especially in the field of R&D [11].

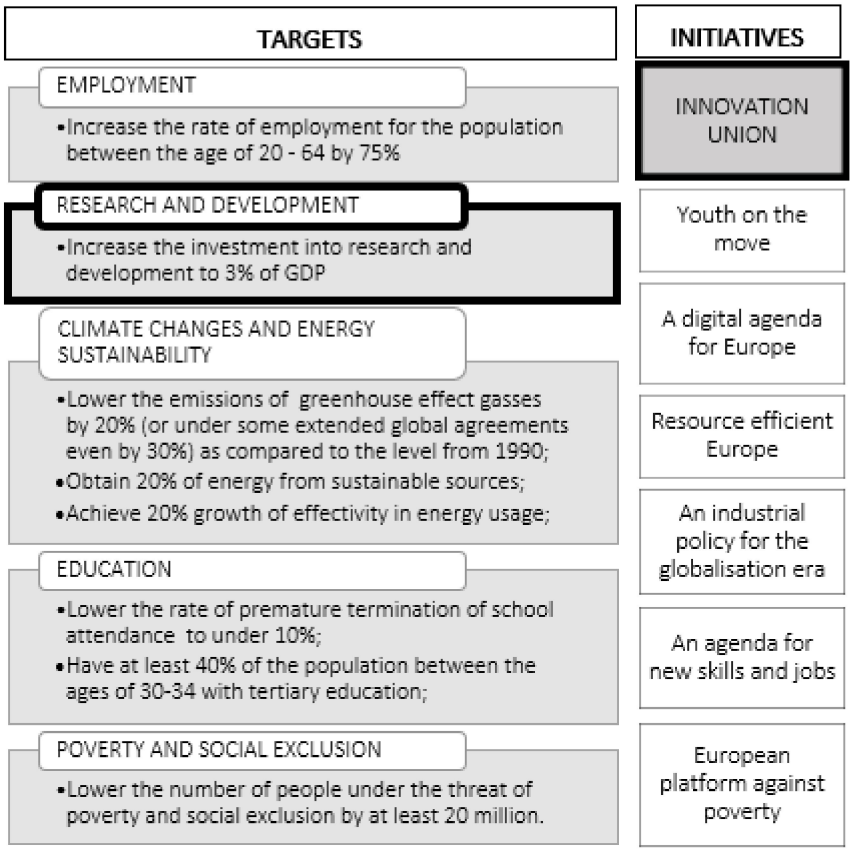

Figure 1. Targets and initiatives of the strategy Europe 2020. Source: It is our self elaboration according to the data from [17].

The Europe 2020 strategy followed the Lisbon strategy. The EC has not yet adopted a comprehensive strategy that follows up the Europe 2020 strategy. However, in 2015, the European Commission committed to Agenda 2030 and fulfilling the Sustainable Development Goals (SDGs). The targets of Europe 2020 were to some extent reflected in the targets of Agenda 2030 [7,25]. Among the 17 SDGs, there are goals corresponding to the five strategy targets, including the field of employment, poverty, education, R&D, and the environment. R&D is included in the ninth goal of Agenda 2030 named Industry, Innovation, and Infrastructure, which is oriented to building resilient infrastructure, promoting inclusive and sustainable industrialization, and fostering innovation [30]. Currently, the SDGs are an intrinsic part of the political program and lie at the heart of policymaking on internal and external action across all sectors. This commitment has even greater relevance considering the global COVID-19 pandemic by providing a positive impetus toward a more inclusive, sustainable, just, and resilient future for all [31].

R&D and innovation are an area that is currently undersized because of the COVID-19 crisis. The funding of R&D and innovation activities is now lagging far behind. At the same time, it is necessary to realize that R&D and innovation are crucial sources when it comes to restarting the economy and the activities of individual businesses, and they are also options for countries to assert themselves and succeed in strong competition not only in the domestic but also in the foreign market. Based on the mentioned reasons, it is necessary to monitor research and development funding, describe the fulfillment of the objectives of the 2020 strategy, and outline the future development.

Innovation performance and status of research and development of the countries can be evaluated and internationally compared based on the Global Innovation Index (GII) or Summary Innovation Index (SII). One of the important indicators in compiling the scoreboard based on SII and GII is R&D funding with a focus on private enterprise sources and public sources of funding. Therefore, in the selection of the research sample, it plays the role in placing countries within the European Innovation Scoreboard 2019 compiled based on SII 2019. One of the selected countries is Sweden, because it has long been at the top of the scoreboard, and the level of R&D funding in the country is several times higher than in other selected countries. This country belongs to the groups of innovation leaders in the EU. The second selected country is Romania, which has long been at the end of the scoreboard compiled according to the SII, which is also reflected in the data from the area of financing research, development, and innovation activities. This country is included in the group of modest innovators in the EU. The last selected country in the research sample is Slovakia, because it is our home country, and the aim is to compare its lag behind Sweden, which respectively progresses before Romania. This country is included in the group of moderate innovators in the EU [32].

As was mentioned above, the key factor of innovation development is the question of financing. The amount of expenditure on R&D activities can be followed using two summarizing indicators [33]. GERD—gross domestic expenditure on R&D—is the overall number of finances on R&D coming from a country's own or foreign sources during a certain period within the land area of that country. GNERD—gross national expenditure on R&D—is the overall number of finances of one country on R&D that happens abroad. The allocations of the funds to innovation and R&D are very important for successful regions [9]. For the purposes of the article, the financing of innovation activities in selected countries is observed through the GERD indicator.

During the processing of the article, mathematical and statistical methods (regression and correlation analysis) were used in addition to standard logic methods intended for processing data (methods of acquisition and data collection, analysis) and drawing conclusions (synthesis, induction).

Regression analysis was used to estimate the trends feature for predicting the expected development of the indicator expressing the share of expenditure on R&D of GDP in 2020. Among the many variants of functions, describing the present trend in the indicator was voted the best statistically significant model.

The coefficient of determination (R^2 or R-squared), F test, and the *p*-value were used for checking the suitability of the trend function. The statistical significance of individual regression coefficients is being assessed by *p*-value. R-squared is the proportion of the variance in the dependent variable that is predictable from the independent variable(s) and measures the strength of the relationship between the model and the dependent variable on a convenient 0–100% scale. At the same time, the overall F-test determines whether this relationship is statistically significant. If two or more tested models are statistically significant, the selection is based on a higher coefficient of determination.

The relationship between the resources that each sector spent on R&D was assessed through correlation analysis. Another used method was the comparative method–spatial comparison for comparison of selected indicators in Sweden, Romania, and Slovakia and trend comparison for examination of the development of the indicators over time.

All results of the analysis in the form of graphs and tables have been processed in Microsoft Office Excel. In the article, the latest available data published in the database of the EU statistical office Eurostat on the data 02.03.2021 was used [34].

3. Results

3.1. GERD in Selected Countries

An elementary indicator for evaluation of the level of research and development in the country is GERD. It expresses the share of gross domestic expenditure on R&D on the country's GDP and is used to monitor the fulfillment of one of the targets of the strategy

Europe 2020: to increase the expenditure on R&D in the European Union to 3% of GDP. It is also one of the targets of Agenda 2030. The target value is expressed as the average value for the union, while each member state has its own set target adjusted to its real chances and its current economic development. It is necessary to mention that this target was already set in the Lisbon strategy, which became invalid in 2010. By then, from the EU member states, only two countries attained the average target value of the union: Finland, with the indicator's value of 3.73% of GDP, and Sweden (3.22% of GDP). Just these two countries managed to complete the research power of South Korea (3.47% of GDP), Japan (3.25% of GDP), and other highly developed countries of the world. From the group of the other member states, the target value was close for Denmark (2.94% of GDP), Austria (2.74% of GDP), and Germany, whose GERD was 2.74% of GDP. Considering that most of the countries were not able to meet their target values, it was also necessary to set this target in the new ten-year strategy of Europe 2020.

This target of the strategy includes a partial target regarding the structure of the expenditure on R&D. According to this sub-target, one-third of expenditure should come from the government sector and two-thirds of expenditure on R&D activities should consist of expenditure from the business sector.

Based on the last available data from Eurostat, in 2019, the first five countries with the highest value of expenditure on R&D of GDP are Sweden, Austria, Germany, Denmark, and Belgium. On the other side, the lowest share on the expenditure on R&D of GDP in 2019 was recorded mostly among the southern states of the European Union, for example, Romania, Malta, Cyprus, and Latvia.

The size of the monitored indicator in the EU member states in 2009 and 2019 is in Figure 2, together with the target values for the individual countries. Six countries have the target of increasing their share of expenditure on R&D of GDP by 2020 at 3%; three countries (Finland, Sweden, and Austria) have set it even more than 3%. In 2019, Germany, Cyprus, and Greece reached and even exceeded the target value in the monitored area. In 2015, Slovakia was behind its target only by 0.02%; in 2019, it was 0.37%. On the contrary, Estonia, Romania, and Malta are the most behind their national target in R&D (Romania by 1.52%, Malta and Estonia by 1.39%). Significantly unfavorable indicator development can be observed in Finland, where the share of R&D expenditure on GDP is decreasing and the country is shifting and lagging behind the target value of 4% (in 2009 it was 3.73% and in 2019 2.79%).

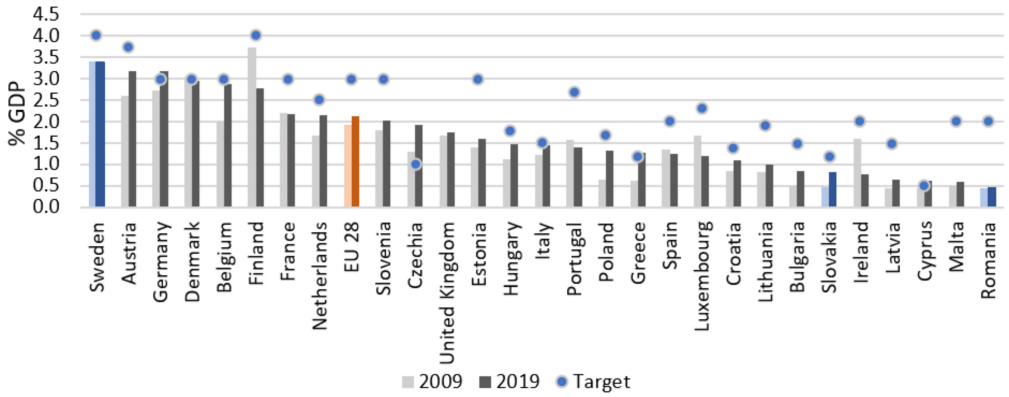

Figure 2. GERD in the member states of the EU in 2009 and 2019 compared to the target value. Source: Self elaboration based on the data from [34].

Not only in Finland, but also in seven other member states, the value of the monitored indicator dropped between 2009 and 2019. These are Sweden, Denmark, Finland, Portugal, France, Ireland, Spain, and Luxemburg. In the opposite case, the highest increase was in Poland (by 0.66%) and Greece (by 0.64%).

The development of the gross domestic expenditure on R&D activities of GDP in three selected countries (Sweden, Slovakia, and Romania) is in Figure 3a. The value of the monitored indicator in Slovakia and Romania is long term under the average of the European Union, which in 2019 was on the level of 2.14% of GDP. On the other hand, Sweden is a leader in this indicator for a long time with the value significantly exceeding the union average.

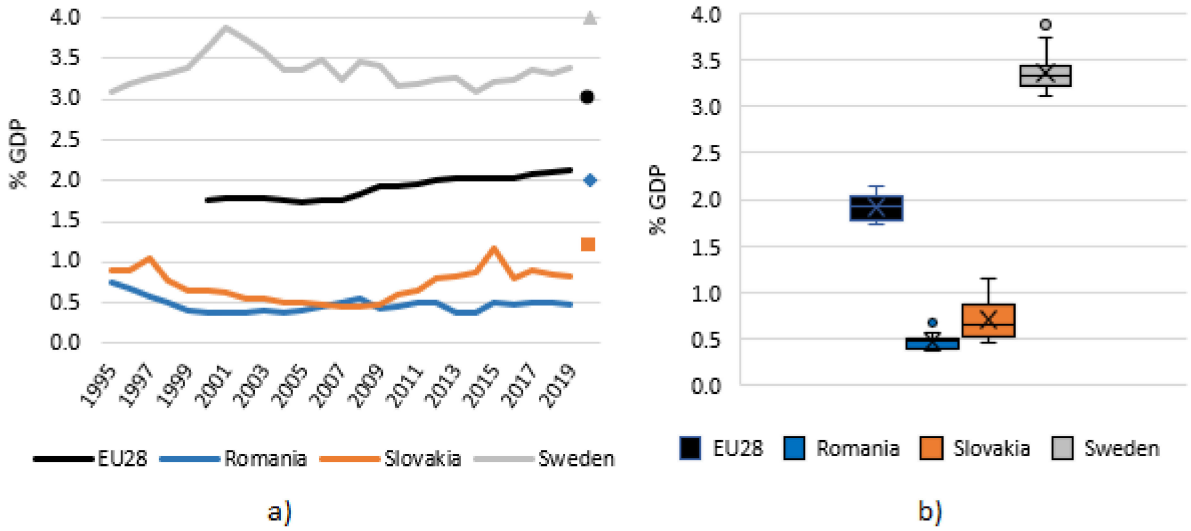

Figure 3. (**a**) Development of GERD in 1995–2019 and their targets (percentage GDP); (**b**) box plot for the share of GERD (% of GDP). Source: Self elaboration based on the data from [34]. Note: Description of box plot: Top of upper whisker - Maximum value of the sample; Top of box - 75th percentile of the sample; Line through the box - Median of the sample; Bottom of the box - 25th percentile of the sample; Bottom of the lower whisker - Minimum of the sample; × markers - Mean of the sample; o markers—Outlier.

Table 1 contains basic descriptive statistics of the monitored indicator for the period of 25 years for all three compared countries. It has the corresponding box plot (Figure 3b) based on which it can be stated that the lowest variability of an indicator's changes is in Romania with also the lowest average value. The highest variability of the indicator's changes is in Slovakia.

Table 1. Descriptive statistic for the share of GERD.

	EU	RO	SK	SE
Mean	1.9125	0.4748	0.71	3.354
Standard Error	0.0308	0.0185	0.0392	0.0378
Median	1.925	0.48	0.66	3.325
Mode	1.77	0.5	0.89	3.36
Standard Deviation	0.1379	0.0927	0.1961	0.1890
Sample Variance	0.0190	0.0086	0.0384	0.0357
Kurtosis	−1.6108	2.9073	−0.5175	1.2088
Skewness	0.1482	1.4917	0.4238	1.1165
Range	0.4	0.39	0.71	0.77
Minimum	1.74	0.37	0.45	3.1
Maximum	2.14	0.76	1.16	3.87
Count	20	25	25	25
Confidence Level (95.0%)	0.0645	0.0382	0.0809	0.0780

Source: Self elaboration.

The economic crisis as the consequence of the mortgage crisis in the USA influenced most European countries in a very negative way. Its impact was demonstrated by a fall in elementary macroeconomic indicators. The level of the financing R&D activities in Slovakia was the lowest in comparison with the other two countries even though their amount was raised 5.6 times during 1995–2019 (Figure 4). The exception was three years (2013–2015), during which more funds were spent on R&D in Slovakia than in Romania. Even though in the other two countries the volume of expenditures increased from year to year, in Slovakia, there was a significant decrease in support for R&D activities between 2015 and 2016 (decrease from 927 million € to 640 million € in 2016). This was due to a significant year-on-year decrease in the use of financial resources from the European Union funds under the Operational Program Research and Innovation.

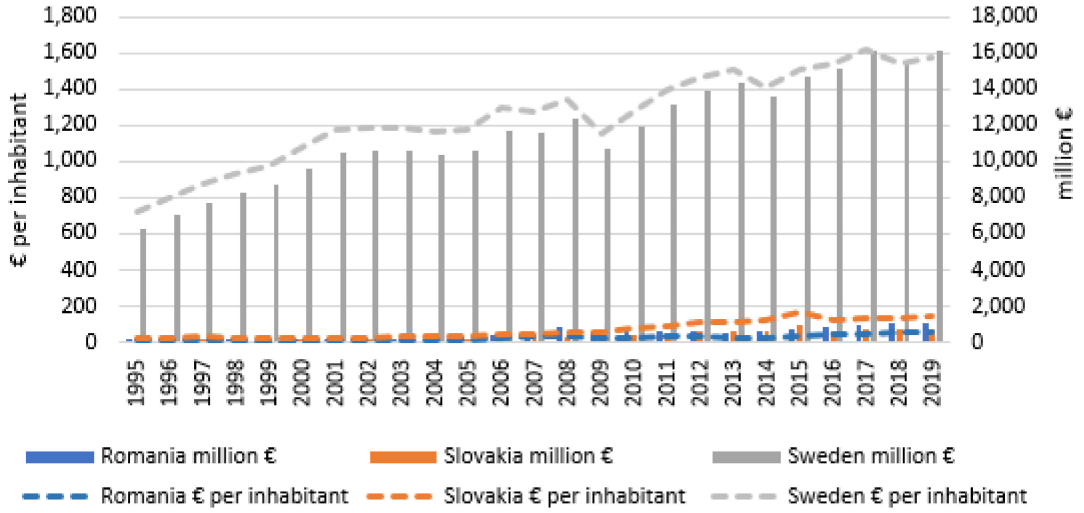

Figure 4. Development of expenditure on R&D in 1995–2019 (in million €, in € per inhabitant). Source: Self elaboration based on the data from [34].

Over the period of 20 years, R&D expenditure in Romania increased almost fivefold, from 216.18 million € in 1995 to 1067.44 million € in 2019. Similar to Slovakia, in Romania, there was a significant year-on-year decrease in expenditure between 2008 and 2009 by almost 250 million € in between 2012 and 2013 by almost 90 million €. This country attains the lower average value but not the lower spread of indicator changes (Table 1, Figure 5a). Sweden invests in R&D activities a several times higher number of financial resources than the other two countries. The total amount rose from 6324.86 million € in 1995 to 16,154 million € in 2019, and the share of these expenditures was 4.6% (in Slovakia only 0.22% and in Romania 0.30%) of total expenditures on R&D activities in the European Union. For comparison, the highest share of expenditure on total expenditures on R&D activities in the European Union is reported in Germany (31.1%), France (15%), and the United Kingdom (12.6%).

The absolute amount of investment in Slovakia was changing from the start of the independent republic. In addition, the indicator value for the share of GERD to GDP was changing. In 1993, the indicator's value achieved 1.38% GDP, which represented the highest value from the division of Czechoslovakia until now. In those days, the size of the investment was 157.14 million €. The relative indicator reached its lowest value in 2007 at the onset of the mortgage crisis in the USA: 0.45% of GDP. A moderate increase happened up to the year 2015 when the R&D activates started to be considered as one of the decisive solutions to the ongoing economic crisis. Except for the growing expenditure from the state budget for the support of such activities, the finances from the structural funds of the European Union were being intensively used, which had a positive effect on its increase to 1.17% of GDP (in 2015). Due to the inconsistent use of EU funds in the

current programming period, the indicator has declined in recent years, and the country moves away from the target value of 1.2% of GDP. Despite these facts, our country cannot approach the results of comparable countries—for example, Denmark, whose number of inhabitants is almost identical to Slovakia. It also has a negative impact on another indicator expressing the expenditure on R&D activities per capita (Figure 4).

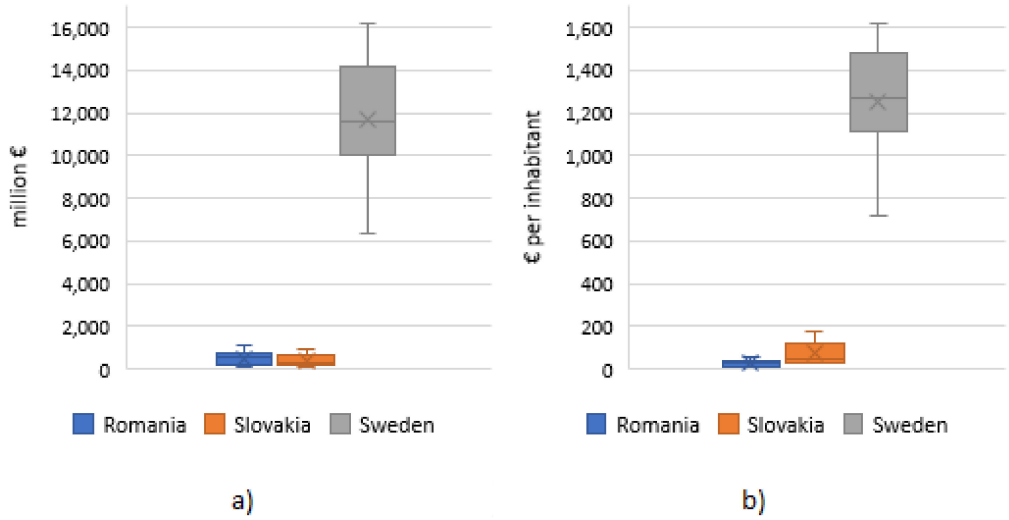

Figure 5. Box plot for expenditure on R&D in compared countries (**a**) in million €; (**b**) in € per inhabitant. Source: Self elaboration.

The indicator expressing the amount of expenditure on R&D activities per inhabitant is more important than the total amount of expenditures (Figure 4). From the group of monitored countries, Romania reported the lowest R&D expenditure per inhabitant during the whole period. In 1995, it was only 9.5 € (in 1999 even 6 €) per inhabitant. The value of this indicator rose 5.8 times to 55 € per inhabitant in 2019 (Figure 5b, Table 2b). Despite this increase, expenditure represents only 8% of average R&D expenditure in the European Union (685.7 € per inhabitant in 2019).

Similar to Romania, also in Slovakia, the value of expenditure per inhabitant rose more than five times from 25.8 € in 1995 to 142.5 € in 2019. The highest value was recorded in 2015 (171 € per inhabitant). Sweden is the country with the highest expenditures on R&D activities per inhabitant in the European Union. Although their value has only doubled over the last 25 years, they represent 230% of the average expenditure per inhabitant in the European Union, 1579.1 € in 2019. The maximum value was reached in 2016 (Table 2b).

Except for Sweden, the high value of the monitored indicator in comparison to the average value for the European Union also shows in Denmark (228.7%), Austria (208.9%), and Germany (192.4%).

3.2. Structure of Expenditure on R&D by the Source of Funds

Expenditure on R&D activities comes from various sources. The expenditure of the business and government sector is among the most important and is also connected with the partial target of the strategy Europe 2020 in R&D. According to the partial target of the strategy, two-thirds of the expenditure should be contributed from private business sources and the remaining one-third should be contributed from the government. Some additional sectors for financing, supporting, and organizing R&D activities are the university sector, private nonprofit sector, and the foreign sector.

Table 2. Descriptive statistics for the indicator of expenditure on R&D (**a**) in million €; (**b**) in € per inhabitant.

(a)	RO	SK	SE
Mean	470.185	359.22	11,203.339
Standard Error	57.7484	49.0631	610.1278
Median	444.098	216.562	10,682.826
Standard Deviation	300.0695	254.9392	3170.3168
Sample Variance	90,041.704	64,993.978	10,050,909
Kurtosis	−1.0258	−0.7651	−0.8440
Skewness	0.5305	0.8487	−0.1604
Range	933.101	809.927	10,781.437
Minimum	134.341	117.345	5372.91
Maximum	1067.442	927.272	16,154.347
Count	25	25	25
Confidence Level (95.0%)	118.7035	100.8506	1254.1356
(b)	**RO**	**SK**	**SE**
Mean	22.9852	66.4519	1201.9259
Standard Error	3.0101	9.0105	55.8698
Median	20.9	40.3	1186.3
Standard Deviation	15.6407	46.8199	290.3080
Sample Variance	244.63208	2192.1041	84,278.752
Kurtosis	−0.9093	−0.7698	−0.6469
Skewness	0.5829	0.8438	−0.5128
Range	49	149	996.9
Minimum	6	22	618.1
Maximum	55	171	1615
Count	25	25	25
Confidence Level (95.0%)	6.1873	18.5213	114.8420

Source: Self elaboration.

Public spending on R&D is much more effective in countries with "high institutional quality" [35]. The business enterprises sector and higher education sector are the most significant; they should be preferred in the countries with lower performance [36].

In 2018 (last available data), only Germany fulfilled this partial target from all the member states of the European Union. A model for European countries should be China, South Korea, and Japan, where the business sector funds more than 76% of the mentioned activities.

The furthest from the target is Latvia, where financing comes predominantly from abroad (41.5% of all GERD) and the government sector (34.3% of all GERD). Financing from the business sector is insufficient (22.3% of all the GERD). It is interesting to observe the distribution of sources of funding for R&D activities in one of the non-member countries, Serbia. In this country, 43.1% of funds come from the government sector, 25.3% come from the higher education sector, 21.6% come from abroad, and 10% come from the business enterprise sector.

Figure 6 points to the partial target of the strategy in three monitored countries during the year 2018. Based on available statistical data, we can state that all three countries predominantly finance R&D from the business enterprise sector. However, Slovakia achieved the worst results, where 48.8% of total GERD comes from the business sector, 38% comes from the government sector, 11.2% comes from abroad, and 1.7% comes from the higher education sector. In Sweden, almost 60% of resources come from the business enterprise sector, 26.9% come from the government sector, 10% come from abroad, and 3.3% come from the private nonprofit sector. The structure of financial resources in Romania is similar to Sweden: 57.1% of funds come from the business enterprise sector, 33.3% come from the government sector, and 9% come from abroad.

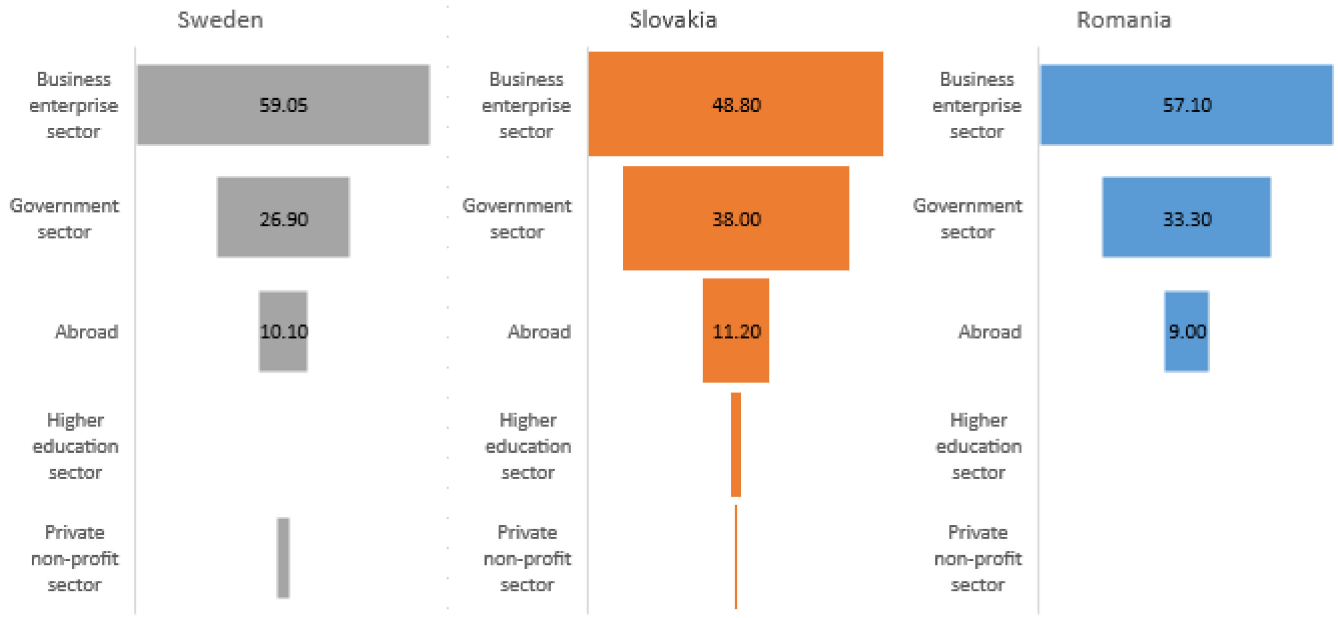

Figure 6. Structure of the GERD in 2018. Source: Self elaboration based on the data from [34].

In all three countries, foreign resources have played an important role in recent years, mainly from European Union funds, which have a positive impact on countries' innovative, scientific research activities. Their higher share of total GERD was in 2015: in Slovakia, it was 39.4%, in Romania, it was 19.2%, and it was 6.7% in Sweden.

Based on the results of the analysis, it can be stated that Slovakia is furthest from meeting the partial target focused on the structure of R&D expenditures according to funding sources.

Within this part, attention was also paid to monitoring the correlation between individual sources of funding in the three countries. In the case of Romania, it is not possible to observe a positive correlation between variables, i.e., different areas of R&D funding (Table 3). Only between the business enterprise sector and government sector is a strong negative correlation. In Slovakia, the expenditure from abroad strongly influences the expenditure on R&D by higher education sectors with the probability of 86.09%. As in the previous two countries, the negative correlation dominates also in Sweden between the business enterprise sector and other sectors. Strong negative correlation is monitored between the business enterprise sector and government sector as well as the business enterprise sector and abroad. With the probability, 82.7% increasing expenditure in the government sector has a positive impact on the financing of R&D activities in the higher education sector.

Based on the results of the previous analysis, we concluded that none of the three monitored countries reached the target of funding for research and development set in the strategy Europe 2020 by 2019. Therefore, the final part of the contribution will deal with the expected development of the indicator expressing the share of R&D expenditure in the GDP of specific countries to assess whether these countries will succeed in achieving the set goal in the next three years.

The current trend of the development of the indicator expressing the share of R&D expenditure in GDP in Slovakia, Sweden, and Romania can be described by several functions (Table 4). To select the most appropriate and accurate trend, it is necessary to monitor the determination coefficient (R^2) but also the *p*-value and the F test result, which must be less than 0.05 (Tables 5 and 6).

Table 3. Correlation between funding of R&D by the sectors.

RO	*BES*	*GS*	*HES*	*PNPS*	*A*
BES	1				
GS	−0.854	1			
HES	0.199	−0.081	1		
PNPS	−0.201	0.159	−0.338	1	
A	−0.091	−0.427	−0.407	0.097	1
SE	*BES*	*GS*	*HES*	*PNPS*	*A*
BES	1				
GS	−0.916	1			
HES	−0.849	0.827	1		
PNPS	−0.385	0.519	0.203	1	
A	−0.911	0.673	0.715	0.117	1
SK	*BES*	*GS*	*HES*	*PNPS*	*A*
BES	1				
GS	−0.523	1			
HES	−0.567	−0.301	1		
PNPS	−0.453	0.095	0.279	1	
A	−0.772	−0.137	0.861	0.449	1

(Explanatory note: BES—business enterprise sector, GS—government sector, HES—higher education sector, PNPS—private non-profit sector, A— abroad) Source: Self elaboration.

Table 4. Expected development of the expenditure on R&D (% of GDP).

	Trend	**Function**	**R^2**
Sweden	Linear	$y = -0.0226x + 3.6169$	0.457
	Exponential	$y = 3.6128e^{-0.007x}$	0.497
	Logarithmic	$y = -0.189\ln(x) + 3.780$	0.606
	Polynomial 2nd degree	$\mathbf{y = 0.0035x^2 - 0.0965x + 3.8877}$	**0.75**
	Polynomial 3rd degree	$y = 0.0001x^3 - 0.0005x^2 - 0.0623x + 3.8208$	0.759
Slovakia	**Linear**	$\mathbf{y = 0.0233x + 0.4303}$	**0.512**
	Exponential	$y = 0.459e^{0.0332x}$	0.541
	Polynomial 2nd degree	$y = 0.0018x^2 - 0.0153x + 0.5717$	0.596
	Polynomial 3rd degree	$y = -0.0006x^3 + 0.0202x^2 - 0.1736x + 0.8819$	0.809
Romania	Linear	$y = 0.0052x + 0.3939$	0.312
	Logarithmic	$\mathbf{y = 0.042\ln(x) + 0.3593}$	**0.388**
	Polynomial 2nd degree	$y = -0.0005x^2 + 0.0156x + 0.3558$	0.387
	Polynomial 3rd degree	$y = 9 \times 10^{-5}x^3 - 0.0033x^2 + 0.0394x + 0.3091$	0.447

Source: Self elaboration.

Table 5. Estimated parameters for regression models.

Testing Results	**SE**	**SK**	**RO**
Correlation coefficient	0.865844	0.715603	0.62276
Coefficient of determination	0.749686	0.512088	0.38783
Adjusted coefficient of determination	0.720238	0.484982	0.35382
Standard variable	0.104599	0.138288	0.04420
Number of measurements	20	20	20
F test	7.71×10^{-6}	0.000389	0.00336

Source: Self elaboration.

Table 6. Estimated parameters for regression models.

		Coefficients	Standard Variable	*p*-Value	Lower 95%	Upper 95%
SE	Intercept	3.887684	0.077819	6.9×10^{-20}	3.7235	4.051869
	X Variable 1	−0.09646	0.017067	2.87×10^{-5}	−0.13247	−0.06045
	X Variable 2	0.003517	0.000789	0.000348	0.001851	0.005182
SK	Intercept	0.430263	0.064239	2.79×10^{-6}	0.295302	0.565224
	X Variable 1	0.023308	0.005363	0.000389	0.012042	0.034575
RO	Intercept	0.359303	0.028202	1.91×10^{-10}	0.300053	0.418554
	X Variable 1	1.000899	0.296392	0.003359	0.378202	1.623596

Source: Self elaboration.

In the case of Sweden and Slovakia, we selected functions with a coefficient of determination higher than 40% to describe the current trend of R&D expenditure. Romania is a specific case where only the development described by the polynomial function of third degree can occur with a probability of 44.7%; in other cases, the coefficient of determination is less than 0.4.

The current development of the share of expenditure on R&D of GDP in Sweden can be described by several functions. If we use the logarithmic function, the value of the indicator should decrease from 3.39% in 2019 to 3.19% GDP in 2022. Such a development would cause the country to move away from the target of 4%. A similar situation occurs if the current development is described by the polynomial function of the third range. The value of the indicator should have increased with the probability of 75.6% in 2020 by only 3.34%. Based on the results of testing, the most appropriate function describing the indicator's development in Sweden is the polynomial function of the second degree. The *p*-value for the constant is $6.9 \times 10^{-20} < 0.05$, while for the regression coefficients, it is $2.87 \times 10^{-5} < 0.05$ and $0.000348 < 0.05$, which proves the statistical importance of the constant and the regression coefficients. The result of the F test $7.71 \times 10^{-6} < 0.05$ proves the statistical importance of the estimated model (Tables 5 and 6). Such a development of the monitored indicator can be expected in the future with a probability of 74.97%.

The current trend of the development of the indicator expressing the share of R&D expenditures in the country's GDP can be described in several functions also in the case of Slovakia (Table 4). If the current development of expenditures were to follow in the future according to the exponential trend, the monitored indicator would increase with the probability of 54% to 0.98% GDP. Conversely, if the previous development was to follow the polynomial function of the second degree, the country would move near to the target value of 1.2% GDP and the value of the indicator would be 1.172% GDP with the probability of 59.5%. The future development of the indicator, which would be governed by a polynomial function of the third degree, can be considered the least desirable. In this case, the value of the indicator would fall significantly to the level of 0.27% of GDP by 2022.

To select a suitable development trend, in addition to the determination coefficient (R^2), the *p*-value and the F test result must be monitored (Tables 5 and 6). Based on the test results, the linear function whose *p*-value for the constant is $2.79 \times 10^{-6} < 0.05$ is the most appropriate function describing the development of the indicator so far, indicating the statistical significance of the constant. The *p*-value for the regression coefficient is $0.000389 < 0.05$, which also confirms its statistical significance. The F test result is $0.000389 < 0.05$, indicating that the selected model is statistically significant. The probability that the indicator will follow this trend in the future is only 51.21%.

As already mentioned, the supposed development in Romania according to the selected trends will occur in the future with a very low probability. Of the three selected countries, Romania is furthest from its target of 2% GDP, and based on the present development, the country is not able to approach this level by 2022. If the developments in the coming years were guided by a polynomial function of the second degree, the share of

R&D expenditure in GDP would probably fall to 0.45% GDP with the probability of almost 40%. On the contrary, the greatest increase (though insufficient) would be observed in the case of a development driven by a polynomial function of the third degree. In this case, the indicator would increase to 0.56% of GDP by 2022.

Based on the results of testing, the current and future expected development is described with the best accuracy by the logarithmic function. In this case, the *p*-value for the constant is $1.91 \times 10^{-10} < 0.05$, and the coefficient for the regression is $0.003359 < 0.05$, which proves the statistical importance of the constant and also the regression coefficient. The result of the F test $0003359 < 0.05$ proves the statistical importance of the estimated model (Tables 5 and 6). The probability with which the monitored indicator will follow this trend in the future is only 38.78%.

Based on the above results, we can evaluate the state of fulfillment of the target of the strategy Europe 2020 in R&D by 2020 and assess whether the target values have become a reality or a fiction in all three monitored countries. Official statistics from Eurostat point to the fact that none of the three countries reached the national target in 2019. Therefore, based on the above (statistically significant) trends, we tried to estimate the future values of the indicator expressing the share of R&D expenditure in the country's GDP until 2022 (Table 7, Figure 7).

Table 7. Expected values of expenditure on R&D by 2020 (percentage of GDP).

	2020	2021	2022	Target
Sweden	3.40	3.46	3.52	4.00
Slovakia	0.92	0.94	0.97	1.20
Romania	0.487	0.489	0.491	2.00

Source: Self elaboration.

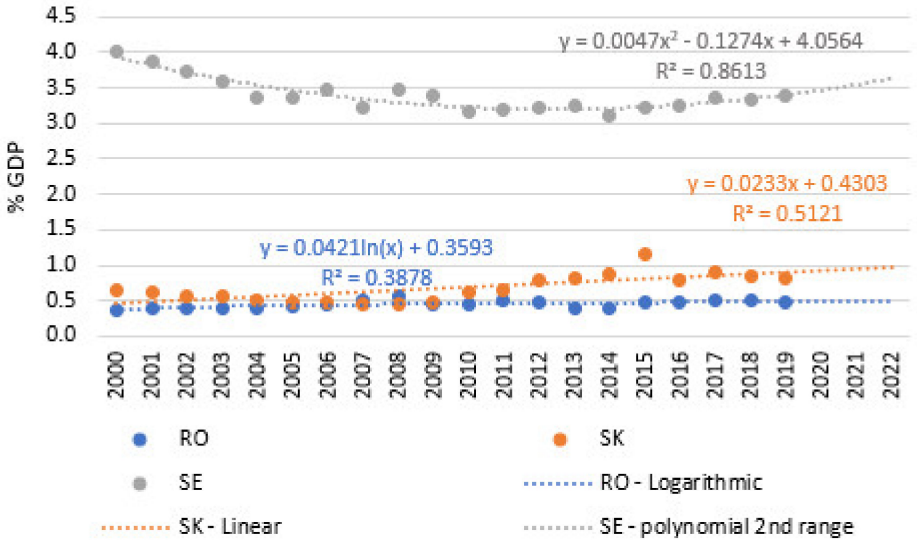

Figure 7. Expected development of the share of the expenditure on R&D of GDP by 2020. Source: Self elaboration.

If the current development of the share of expenditure on R&D of the GDP in Sweden were to be guided by the polynomial function of the second degree, the country would not reach the target by 2022. The value of the indicator will be 3.52% GDP. The situation is similar in Slovakia. If Slovakia would be guided by the linear function, the country would not reach its target of the strategy in 2022 with a probability of 51.21%. In addition, Romania would not achieve its national target by 2020, and it will continue to lag significantly behind the target value of 2% GDP (Table 7).

4. Discussion and Conclusions

The financing of R&D as a basis for innovative business activities and increasing the innovation performance of countries is an important indicator of the European Innovation Scoreboard constructed based on SII. The research sample was created based on the European Innovation Scoreboard 2019 and consisted of Sweden as an innovation leader, Romania as a modest innovator, and Slovakia as a moderate innovator.

The issue of the expenditure on R&D can be studied from several perspectives, so we tried to overcome this obstacle with complementary analyses based on GERD and its structure, the total volume of expenditure on R&D, and in terms of per capita. Based on the performed analyses, it can be stated that the absolute number of investments in R&D are increasing in all three states, but the relative values expressed in relation to GDP have decreased in recent years and move away from the required target value. Sweden achieved the best results in all monitored indicators throughout the period. In recent years, Romania has reported a larger total amount of R&D expenditure than Slovakia, but when calculated per capita, this expenditure is lower. In all three countries, R&D activities are financed mainly from the business enterprise sector. These countries also received a relatively large part of their resources from abroad.

From the results of predictions of the expected development of the share of R&D expenditure in GDP shown in Figure 7 and Table 7, it is clear that the situation will not improve in 2022. The countries such as Slovakia and Romania do not have a chance to achieve the target until the end of the validity of Agenda 2030 for Sustainable Development. In accordance with the results obtained in this article, several studies by authors Goschin, Sandu, Goschin; Rus; Diaconu, and Huňady have pointed to the low convergence of the Romanian R&D system with the European one [37–40]. The competent authorities of these countries must seriously address this situation in the coming years so they would not just become assembly factories with cheap labor force for the world's advanced economies. The necessity is a revision of the EU R&D policies [41] and the opportunity is funding from EU funds and Horizon Europe [42] to support R&D, the use of which has decreased significantly in recent years (which resulted from long-term monitoring of the structure of R&D expenditure).

Kasprzyk and Wojnar also point out the target of the strategy Europe 2020 and the large differences in the financing of R&D activities between Romania and Sweden, which are subsequently transferred to innovation activity [43].

The problem with the fulfillment of the target value has not only three selected countries but also most member states of the European Union because of large differences in GERD [14]. Papageorgiou, Anastasiou, and Liargovas also drew attention to this problem and pointed to moving away from the target values [44]. In this regard, some European countries have adjusted their innovation systems to facilitate and support R&D and innovation activities [45]. This successful model can be found in Scandinavia [14]. The system of innovation support in Sweden is considered as one of the best in Europe and together with Germany, Austria and Finland experienced the highest R&D expenditure in the business enterprise sector in the EU [40].

The target was transformed into the new Agenda 2030 for Sustainable Development as the ninth objective entitled Industry, Innovation, and Infrastructure, and its partial objective 9.5 also deals with the issue of R&D funding from private and public sources. Therefore, the issue of the future fulfillment of this sub-objective, together with its other areas, by strengthening the technological base in selected sectors, supporting innovation and innovation activities, and increasing the number of R&D workers per million people by 2030, it may be the subject of further research related to Agenda 2030 and its objectives. The results of the analysis can be used in the development and updating of the EU innovation policies, where R&D remains a significant impulse.

Research, development, and innovation are clearly an area that is currently largely undersized due to the COVID-19 crisis. Although based on results, all three countries finance R&D predominantly from the business enterprise sector, the level of corporate

R&D expenditures by European firms is lower compared to US enterprises [46]. Funds from the state budgets of the member states devote a large part of their resources mainly to various subsidies and benefits provided to businesses and households, which is why funding for R&D activities is currently lagging far behind. Even in this pandemic situation, states must think about current and future developments, not just immediate consumption. It is necessary to realize that research and development are one of the important ways to restart the economy, the activities of individual businesses, and how to succeed in strong competition not only in the domestic market but also in foreign markets. On the other hand, governments could have tendencies to prefer providing R&D subsidies to larger companies. These have already achieved better results in the field of innovation, so the concentration of R&D among market leaders is increasing and form barriers to entry for small and medium enterprises [47]. Generally, SMEs have a problem with finding resources in terms of funds, people, knowledge, and other factors needed for innovation and R&D [48–50]. Based on the reasons above, it will be necessary to monitor the area of R&D funding, the structure of their resources, as well as to analyze and compare the size of funds used to support these areas from the business enterprise sources, public (government) sources, or foreign sources in the coming years with Agenda 2030.

The findings of this study have to be seen in the light of some limitations. The first is the fact that despite the findings of the analysis and formulated recommendations, we do not have the competence to make decisions at the highest level that would support R&D activities. Only the specific authorities in the state have this power (to take and implement a decision), which can consider our article as one of the sources dealing with the issue of insufficient R&D funding. The second limitation concerns the timing of the study caused by the current pandemic situation (mentioned above). Most countries spend a lot of money fighting a pandemic. This leaves significantly fewer resources not only in the state budget but also in the budget of business entities to support R&D activities in individual countries. Therefore, it is questionable how the current situation will be reflected in the future development of the indicator expressing the share of R&D expenditure in GDP.

The contribution of the article is an analysis, comparison of countries, and prediction of expected development in the field of R&D financing with an emphasis on failure to meet the Europe 2020 target. The qualitative case-by-case analysis of EU member states in the field of R&D financing can also provide relevant and expanding outcomes for this field of research. Further research could be focused on other analyses of the current state in the field of R&D focusing on the objectives of Agenda 2030 for Sustainable Development, which could be the basis for informing the public but also state authorities in the state in the monitored area.

Author Contributions: Conceptualization, E.D.S., B.G. and E.S.; methodology, B.G.; validation, E.D.S., B.G. and E.S.; formal analysis, E.D.S., B.G.; investigation, E.D.S., B.G. and E.S.; resources, E.D.S., B.G.; data curation, E.D.S. and B.G.; writing—original draft preparation, E.D.S., B.G. and E.S.; writing—review and editing, E.D.S., B.G. and E.S.; visualization, B.G.; supervision, E.D.S.; project administration, E.S.; funding acquisition, E.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by VEGA 1/0384/20.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data is contained within the article.

Conflicts of Interest: The authors declare no conflict of interest.

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