



## TRENDS OF BUSINESS ENTERPRISE EXPENDITURE ON R&D BEFORE AND AFTER GLOBAL ECONOMIC CRISIS: EVIDENCE FROM SELECTED SEE COUNTRIES

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**Abstract:** *The latest economic crisis in 2008, with a source on the mortgage market of the USA, spilled, to a lesser or greater extent, over all European and non-European economies. One of the significant features of this crisis is reflected in the raising bank loans and tightening lending terms. State budget deficit in the conditions of the crisis imposes the need for fiscal consolidation, thus reducing the capacity of the state to provide financial support to the business sector. In this regard, these developments may have an adverse effect on the level of R&D expenditure of the business sector, which in turn leads to a decrease in quality or a complete suspension of R&D activities. Nevertheless, innovative companies willing to take the risk, as well as governments that have set the increase of expenditures on R&D as a strategic goal of their economic policies, can be taken as an explanation for unchanged or increased R&D expenditure in the time of crisis. Empirical research was conducted for the period 2004–2012 on a sample of 10 South-Eastern European (SEE) countries. The results of the survey show that the business sector had higher spending on R&D activities after the economic crisis, at the SEE region-level. At the country level, business sector in Austria, Bulgaria, Greece, Hungary, Serbia and Slovenia had higher R&D expenditures after 2008, while in Croatia, Romania, Slovakia and North Macedonia, there was no significant difference in the level of R&D expenditures before and after the crisis.*

**Key words:** *Business enterprise Expenditure on R&D, R&D intensity, global economic crisis, SEE.*

### 1. INTRODUCTION

According to the Frascati Manual, research and experimental development (R&D) includes “creative and systematic work undertaken in order to increase the stock of knowledge – including knowledge of humankind, culture and society – and to devise new applications of available knowledge.” There are three types of R&D: basic research, applied research and experimental development. Basic research is experimental or theoretical work undertaken to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view. Applied research is original investigation conducted in order to acquire new knowledge. It is, however, directed primarily towards a specific, practical aim or objective. Experimental development is systematic work, drawing on knowledge gained from research and practical experience and producing additional knowledge, which is directed towards producing new products or processes or towards improving existing products or processes (Frascati Manual, 2015).

From the economic point of view, R&D is a complex process composed of a series of activities aimed at creating a new, or modifying an existing product/service, with the aim of generating greater value added and ensuring sustainable economic welfare. In order to transfer R&D activities into some form of technological innovation, which will influence the improvement of all aspects of business, it is necessary that the dynamics of R&D activities is stable and immune to all disorders of internal and external character. In practice, this means that any adjustments to R&D activities, even if they have a short-term character, caused by certain economic or other disruptions, can jeopardize further expansion of the existing knowledge base (Borisova & Brown, 2013), but also reduce the positive effects on business performance in the long run. Additionally, disturbing the dynamics and flow of R&D activities will diminish the positive externalities of R&D and knowledge transfer, which further negatively affects the entire society.

In order to ensure the continuity and stability of R&D activities, one of the necessary prerequisites is the absence of a cyclical movement of R&D expenditures. This is a big challenge, especially for the private sector in developing countries (such as Serbia), which is relatively new and not competitive enough to possess the financial capacity sufficient not only for stable development, but also for initiating R&D

activities. In addition, the economic crisis further complicates the issue of business R&D expenditures on R&D. The main reason for that is that enterprises, as one of the mechanisms of reaction to the crisis conditions, apply a cost reduction strategy, including R&D expenditures.

Experiences from the past crises show that R&D expenditures had mainly pro-cyclical character (Sainsbury, 2007), that is, they converged with the level of output achieved. In contrast, there are also some attitudes in the literature that emphasize the anti-cyclical movement of R&D expenditures. These views are based on the fact that the decline in profitability in the time of the economic crisis puts a strong pressure on companies to focus their attention on the most productive activities. Canton & Uhlig (1999) state that opportunity costs of productivity growth are lower in the recession periods, which represents some sort of incentive to continue with higher spending on R&D in order to complete planned R&D activities, but also to start with new activities. Taking into account the general thesis that long-term investments should be counter-cyclical, and short-term pro-cyclical, providing R&D funds, even from bank loans, should not be a serious issue for firms. Nevertheless, the latest global economic crisis in 2008 with the epicenter in the US mortgage market has reflected on the raising of credit, hindering access to credit not only for SMEs, but also for larger companies. In addition, the need to harmonize public expenditures and public revenues in times of crisis reduces the capacity of the state in providing financial support to the private sector. On the basis of this, it could be concluded that the economic crisis increases the likelihood of withdrawal from the investment or, in turn, the reduction in the amount of funds that the companies, and thus the business sector as a whole, direct to R&D activities.

Expenditures on R&D, and in general, the success of business operations in times of crisis cannot be generalized, but should be considered in the context of characteristics inherent to each company and country.

Companies that were not successful, innovation-oriented and ready to take the risks before the crisis, will achieve even worse results during and after the crisis, until they completely disappear from the market. In contrast, dynamic and innovative companies, with large investments in R&D activities, especially those with a higher risk, will be expanding regardless of the economic crisis. Examples from the practice show that some of these companies managed to adapt and benefit during the economic crisis. For example, a significant drop in passenger traffic in air travel was one of the consequences of the crisis in the 1990s. Some airlines have recognized this as a chance, and introduced low-cost airline flights, while others, due to poor adaptation and lack of innovation, have disappeared from the air traffic scene.

Taking into account the importance of R&D and innovation for the progress of enterprises and the economy as a whole, maintaining a stable level of R&D expenditures should be one of the strategic objectives of economic policy. Despite the numerous problems and difficulties that the state faces during and after the period of the economic crisis, part of the funds should be allocated to the financial support of the business sector in order to maintain the quality of R&D activities and ensure their successful completion, but also to initiate new ones.

The subject of the research in this paper is an analysis of the movement of expenditures for research and development of the business sector in the period before and after the global economic crisis in 2008, on the example of the selected SEE countries. The survey aims to determine whether the crisis has changed the trajectory of the business sector in the context of R&D expenditures, or whether stable or increased R&D expenditures have been used as a way to survive during and after the economic crisis. The empirical research covered the period from 2004 to 2012, with two separate intervals observed: the first interval before the crisis from 2004 to 2008, and the second interval after the crisis from 2008 to 2012.

## 2. RESEARCH METHODOLOGY

The aim of this paper is to examine the validity of the following hypotheses:

*H<sub>1</sub>: At the SEE region-level, R&D expenditure is higher after the economic crisis, compared to the level before the economic crisis.*

*H<sub>2</sub>: At country-level, R&D expenditure is higher after the economic crisis, compared to the level before the economic crisis.*

In order to test these hypotheses, an internationally accepted indicator developed by the OECD in the Frascati Manual was used: Business enterprise Expenditure on R&D (BERD). This indicator represents a component of Gross domestic expenditure on R&D (GERD) and includes the expenditure of the business sector for R&D (OECD Frascati Manual, 2015).

In order to make possible international comparisons, the ratio between the BERD indicator and the gross domestic product (GDP) was applied. The BERD variable (% GDP) indicates the intensity of the business sector expenditure for R&D and it is determined by the following formula:  $(BERD/GDP)*100$  (Frascati Manual, 2015).

Empirical research covers the period from 2004 to 2012. In order to test the research hypotheses, this period is divided into two intervals: the first interval from 2004 to 2008, indicates the period before the crisis, and the second interval from 2008 to 2012, marks the period after the economic crisis.

The sample includes 10 out of the 14 countries that belong to the SEE region: Austria, Bulgaria, Croatia, Greece, Hungary, Romania, Serbia, Slovakia, Slovenia and North Macedonia. The remaining countries are not included in the sample, as data on the amount of funds allocated by their business sectors to R&D are not available for all the years in the period that this study is dealing with. The basic characteristics of the sample are shown in Table 1.

The empirical part of the paper is based on UNESCO's secondary data, available in the *UNESCO Institute for Statistics*, in the *Science, Technology and Innovation* section. The complete processing of available data was realized using IBM SPSS v.23 and MS Excel.

The hypotheses were verified using the Wilcoxon rank test, nonparametric alternative to the t test of the paired samples. The Wilcoxon rank test is used for repeated measurements of the same variables in two different time periods, which is in line with the objectives of this paper. In the case of testing the first hypothesis, the decision on the application of the non-parametric test was made on the basis of the normality tests Kolmogorov-Smirnov and Shapiro-Wilk (Table 2). In the second case, when examining R&D expenditures of the business sector at the country-level before and after the economic crisis (Table 3), the normality tests do not provide useful information due to a rather small sample ( $n_{before} = 5$  and  $n_{after} = 5$ ). The decision to use nonparametric alternative to the t test of paired samples in this part of the study was made on the basis of the sample size rule, starting from the assumption that small samples are characterized by non normal distribution (Imam, Usman & Chiawa, 2014), as well as on histograms and Q-Q plot. In addition, the Exact significance test (IBM Knowledge Center) was used as an indicator of the significance level of the results obtained, compared to the Asymptotic significance test, which is more suitable for larger samples.

### 3. RESULTS AND DISCUSSION

Table 1 shows the arithmetic mean, standard deviation, median, minimum and maximum values for BERD (%GDP) at the country-level and SEE region-level, before and after economic crisis. These results will be used below to analyze the differences in the level of R&D expenditures before and after the crisis.

**Table 1:** BERD (%GDP) in SEE on a regional and country level before (2004-2008) and after (2008-2012) the economic crisis.

	Time	Mean	Std. dev.	Median	Min	Max
Austria	<i>Before</i>	1.6560	0.11502	1.66	1.47	1.78
	<i>After</i>	1.8620	0.11300	1.84	1.77	2.05
Bulgaria	<i>Before</i>	0.1180	0.01643	0.11	0.10	0.14
	<i>After</i>	0.2440	0.09762	0.28	0.14	0.37
Croatia	<i>Before</i>	0.3520	0.06181	0.35	0.27	0.43
	<i>After</i>	0.3480	0.02387	0.34	0.33	0.39
Greece	<i>Before</i>	0.1780	0.01924	0.17	0.16	0.21
	<i>After</i>	0.2320	0.01304	0.24	0.21	0.24
Hungary	<i>Before</i>	0.4440	0.06804	0.47	0.35	0.52
	<i>After</i>	0.6840	0.11459	0.68	0.52	0.83
Romania	<i>Before</i>	0.2020	0.01924	0.21	0.17	0.22
	<i>After</i>	0.18	0.00707	0.18	0.17	0.19
Serbia	<i>Before</i>	0.0460	0.01817	0.05	0.02	0.07
	<i>After</i>	0.1160	0.06693	0.09	0.07	0.23
Slovakia	<i>Before</i>	0.2180	0.03114	0.21	0.18	0.25
	<i>After</i>	0.2460	0.05595	0.25	0.19	0.33
Slovenia	<i>Before</i>	0.9140	0.08620	0.92	0.83	1.05
	<i>After</i>	1.4720	0.38861	1.40	1.05	1.95
North Macedonia	<i>Before</i>	0.0320	0.01924	0.03	0.01	0.06
	<i>After</i>	0.0420	0.01095	0.04	0.03	0.06
SEE-10	<i>Before</i>	0.4160	0.48768	0.21	0.01	1.78
	<i>After</i>	0.5426	0.61080	0.26	0.03	2.05

Source: Calculated by the authors.

Table 2 presents the results of the Wilcoxon rank test for the SEE region. The results show that, generally speaking, there is a statistically significant difference between the level of BERD (% GDP) at the SEE region level before and after the crisis ( $Z=-4.838$ ;  $\text{Sig}=0.000$ ). According to Cohen's guidelines for the effect size ( $r$ ): *large effect*=0.5 or greater; *medium effect*=between 0.3 and 0.5; *small effect*=between 0.1 and 0.3; in this case there is a large effect with  $r=0.48$ . From Table 1, it can be concluded that after the crisis, the business sector at the level of the SEE region had an average of 0.13 percentage points greater expenditures on R&D compared to the period before the economic crisis. Standard deviation is higher after the crisis, which points to greater imbalance in terms of funds, which the business sector at the level of SEE region was spending on R&D annually after the economic crisis.

**Table 2:** BERD (%GDP) in SEE region – before and after crisis.

	Z	r	Asymp. Sig.	Kolmog.-Smirn. Stat(p)	Shapiro-Wilk Stat(p)
SEE - 10	-4.838	0.48	0.000***	0.238 (0.000)	0.730 (0.000)
				0.299 (0.000)	0.730 (0.000)

\*\*\*Result is significant at the level of 1%.

Source: Calculated by the authors.

The differences in the BERD level (% of GDP) before and after the economic crisis, at country-level, are shown in Table 3. At the significance level of 10%, it is found that there is a statistically significant difference in expenditures on R&D of business sector in the following countries: Austria, Bulgaria, Greece, Hungary, Serbia, Slovenia. On the other hand, there is no statistically significant difference in Croatia, Romania, Slovakia, and North Macedonia. The results by countries are analyzed in the following paragraphs.

**Austria.** There is a statistically significant (at the level of 10%) and a large difference in the level of BERD before and after the crisis ( $Z=-2.023$ ; exact sig.=0.063;  $r=0.64$ ). In the period after the economic crisis, the R&D expenditure of the business sector increased to an average of 1.86% GDP, which is 0.21 percentage points more than in the period 2004-2008. The amount of BERD was more balanced in the post-crisis period (std.dev = 0.11300).

**Bulgaria.** There is a statistically significant (at the level of 10%) and a large difference in the level of BERD (% GDP) before and after the crisis ( $Z=-2.023$ ; exact sig.=0.063;  $r=0.64$ ). Compared to average BERD, which before the crisis amounted to 0.12% GDP, after the crisis, the business sector significantly increased R&D expenditures to 0.24% GDP. In the case of Bulgaria, there was a higher variation in the level of BERD in the years after the economic crisis (std. dev. = 0.09762).

**Croatia.** The difference in the amount of BERD (%GDP) is insignificant and quite small in the period before (2004 – 2008) and after the economic crisis (2008 – 2012). ( $Z=-0.135$ ;  $r=0.04$ ; exact sig.=1.000). In the post-crisis period, BERD (%GDP) was on average less than only 0.004 percentage points compared to the pre-crisis period. Higher unevenness in the level of R&D expenditures is present in years before the economic crisis (std.dev.=0.06181).

**Greece.** BERD (% GDP) significantly differs (at the level of 10%) before and after the economic crisis ( $Z=-2.041$ ;  $r=0.65$ ; exact sig.=0.063). BERD (% GDP) has increased from an average of 0.18% GDP before the crisis, to 0.23% GDP after the economic crisis. In addition, the variability in the amount of R&D expenditures is somewhat smaller in the years after the economic crisis (std.dev. = 0.01304), unlike the pre-crisis period (std.dev. = 0.01924).

**Hungary.** There is a significant, at the level of 10%, and a large difference in the level of BERD (% GDP) before and after the economic crisis ( $Z=-2.023$ ;  $r=0.64$ ; exact sig.=0.063). From the average value of 0.44% GDP in the period 2004-2008, BERD increased by 0.24 percentage points in the period 2008-2012 and amounted to 0.68% GDP. After the crisis, there were more pronounced variations (std.dev. = 0.11459) annually in the level of BERD compared to the pre-crisis period (std.dev. = 0.06804).

**Romania.** The difference between BERD (% GDP) before and after the crisis cannot be characterized as significant ( $Z=-1.633$ ;  $r=0.52$ ; exact sig.=0.188). On average, after the crisis, the business sector had only 0.02 percentage points lower R&D expenditures compared to the period before crisis. There is also considerable stability in the level of R&D expenditures before (std.dev = 0.01924) and after the crisis (std.dev = 0.00707).

**Serbia.** Expenditures on R&D of the business sector differ, at the significance level of 10%, before and after the crisis ( $Z = -2.023$ ;  $r = 0.64$ ; exact sig. = 0.063). After the crisis, BERD was 0.12% of GDP, on average, and before the crisis 0.05% of GDP. In the post-crisis period, there is a somewhat higher variation at the level of BERD (std.dev. = 0.06693), unlike the period 2004-2008 (std.dev. = 0.01817).

**Slovakia.** There is no statistically significant difference in the level of BERD before and after the economic crisis ( $Z=-0.813$ ;  $r=0.26$ ; exact sig.=0.500). Before the crisis, BERD amounted to an average of 0.22% GDP, and in the post-crisis period, 0.25% GDP. Business sector R&D expenditures were relatively stable, i.e. they wasn't a significant fluctuation over the entire period (std.dev.bef = 0.03114; std.dev.aft = 0.05595).

**Slovenia.** There is a significant, at the level of 10%, and large difference in the level of BERD before and after the crisis ( $Z=-2.023$ ;  $r=0.64$ ; exact sig.=0.063). R&D expenditures of the business sector increased by an average of 0.56 percentage points compared to the pre-crisis period, with significantly higher variability in the level of assets that the business sector spending for R&D (std.dev.=0.38861).

**North Macedonia.** There is a random, moderate, but insignificant difference in the level of BERD before and after the crisis ( $Z = -0.736$ ;  $r = 0.23$ ; exact sig. = 0.625). After the crisis, the BERD increased, but only 0.01 percentage points. After the economic crisis, expenditure on R&D was less variable (std.dev = 0.01095), although it is characterized by the entire period 2004-2012 (std.dev.bef = 0.01924).

**Table 3:** Country-level difference in BERD (%GDP) before and after crisis.

	<b>Z</b>	<b>r</b>	<b>Asymp. Sig.</b>	<b>Exact Sig.</b>
Austria	-2.023	0.64	0.043	0.063*
Bulgaria	-2.023	0.64	0.043	0.063*
Croatia	-0.135	0.04	0.893	1.000
Greece	-2.041	0.65	0.041	0.063*
Hungary	-2.023	0.64	0.043	0.063*
Romania	-1.633	0.52	0.102	0.188
Serbia	-2.023	0.64	0.043	0.063*
Slovakia	-0.813	0.26	0.416	0.500
Slovenia	-2.023	0.64	0.043	0.063*
North Macedonia	-0.736	0.23	0.461	0.625

\*Results are significant at the level of 10%.

Source: Calculated by the authors.

#### 4. CONCLUSION

The survey showed that there were significant differences in business sector R&D expenditures at the SEE region level, before and after the economic crisis. The business sector, observed at the SEE region level, increased post-crisis BERD (% GDP) by 0.13 percentage points. Accordingly, the first hypothesis ( $H_1$ ) can be confirmed. However, when the survey was conducted at the country-level, different trends of BERD (% GDP) were observed from country to country. Austria, Bulgaria, Greece, Hungary, Serbia and Slovenia are countries with significant differences (at the level of 10%) in R&D expenditures of the business sector before the crisis (2004-2008) and in the years after the economic crisis (2008-2012). The results show that R&D expenditures of the business sector of the aforementioned countries were higher after the economic crisis compared to the years before the crisis. By contrast, the business sector in Croatia, Romania, Slovakia, and North Macedonia is characterized by insignificant differences in the level of R&D expenditures before and after the crisis. In Croatia and Romania, after the crisis, BERD decreased by only 0.004, or by 0.02 percentage points, respectively. The business sector in Slovakia and North Macedonia had a slightly higher level of R&D expenditures in the years after the crisis. After the crisis, in Slovakia BERD (% GDP) was higher by 0.03, and in Croatia only by 0.01 percentage points. The obtained results imply that the hypothesis  $H_2$  can only be partially accepted.

The reasons for such results can be found in the analysis of the motives of business entities for investing in R&D in the conditions of the economic crisis. Namely, innovative enterprises and supporting government sector in certain countries such as Austria, Bulgaria, and Slovenia have contributed to the growth of BERD.

Despite a stable level of R&D business sector expenditures, in transition economies (North Macedonia and Serbia), there is an extremely low level of BERD. This is certainly a signal for economic policy makers to include incentives for improving business investment in R&D in the set of economic measures. Moreover, there is a need to increase the level and efficiency of business expenditures on R&D that can be applied in

the manufacturing industry which is considered as a main driver of economic development and structural changes (Štrbac, 2018).

Despite the significant results achieved by this research, there are certain limitations. The size of the sample in which the differences in BERD were analyzed before and after the crisis at the country level is rather small, which puts in doubt the reliability of the results obtained. The disadvantage is also reflected in the fact that only the movement of BERD is considered. In the next research, the analysis should be completed with other components of GERD, and GERD as a whole. In addition, certain dependent variables at the company level, but also at country level, should be included, which, with the application of an adequate quantitative methodology, would provide a more complete picture of the relations between the trends in R&D and the selected performance indicators in times of crisis. In this way, a more thorough conclusion could be drawn about the importance of stable growth of R&D expenditures for survival, but also prosperity, both in crisis and regular conditions.

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