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R&D EXPENDITURES: COMPARATIVE ANALYSIS BETWEEN SERBIA AND SELECTED COUNTRIES

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Abstract: *R&D expenditures are one of the key indicators of the success in innovation process. Successful transformation of R&D expenditures into some form of technological innovation creates a stable basis for sustainable profitability and competitive advantages of the company, which have a positive impact on the growth of the entire economy. Due to the role of R&D expenditures in achieving success at the country and firm level, the subject of research in this paper is a comparative analysis of R&D expenditures between Serbia and selected countries. The aim is to examine the situation in Serbian R&D area in the context of R&D expenditures, in comparison with, first of all, the countries from the environments of the Serbia, which are the EU members. The survey coveres the period 2008 – 2016. Results show that Serbia has a significantly higher GERD (%GDP) than all countries, except Slovenia and Hungary, while Croatia has insignificantly higher GERD then Serbia. All countries from the Serbian environment that are members of the EU have significantly higher BERD (%GDP) than Serbia, except Romania, which has insignificantly higher BERD than Serbia.*

Key words: *Research and Development, Gross expenditures on R&D, Busniess enterprise expenditures on R&D, Comparative analysis, Serbia, Bulgaria, Croatia, Hungary, Romania, Slovenia, North Macedonia.*

1. INTRODUCTION

In a difficult and lengthy development process of the Western Balkan countries, Serbia being one of them, little attention has been given to issues regarding R&D and innovations. The economic policy makers of these countries have been prioritising those usually unnecessary or the nuances of national economy specificities unadjustable to reform measures.

The marginalization of R&D in the transition period has had a negative impact on research capacities and the connection between science and economy, which has been severed completely.

In order for Serbia and other Western Balkan countries to achieve their main goal, which is to become a full member of the EU, they need to adjust their policy and the entire system to the EU standards. According to the new 2020 HORIZON program for 2014-2020, the strengthening of R&D and the innovation capabilities of Western Balkan countries is an important requirement for their enablement to abide and function in accordance with the EU standards and to take part in the European Research Area (WBR R&D Strategy), which could contribute to a re-update of issues regarding R&D and innovations in this part of Europe. One of the ways to revitalise and strengthen R&D capacity is to steadily and continously invest in R&D. It has been forseen by the EU Lisbon strategy in the year 2000, later on by The Europe 2020 Strategy, that the EU countries should increase expenditures for R&D by 2010, i.e. 2020, to 3% GDP, and 2/3, i.e. 2% GDP should be expenditures by the business sector.

It is important that each country and business sector recognise the importance of R&D independently from the EU requests for higher expenditures for R&D, as well as not to perceive those expenditures as expenses, but more of an investment which would secure a higher profit and a competitive advantage.

Various research have proven that higher expenditures for the R&D have positive implications on the country-level and firm-level.

A study conducted in 1979 has proven that R&D explain 75% of variances in the growth rate of factor productivity at country-level (Griliches, 1979). The expenditures for R&D which have resulted in technological innovations, be it by advancing the features of the existing product/process or launching a completely new product, it would have a positive reflection on profitability and the company's competitive advantage, not only in national, but also international framework (Lefebre et al, 1998). The competitiveness of a country in the world market will grow, which will obtain a higher inflow of foreign currency and with

that it will contribute to the balance of payments. Since export is one of GDP components, it can be said that the higher expenditures for R&D stimulate the economic growth of a country. In the last instance, those investments in R&D that have been successfully transformed in a form of technological innovation, primarily the launch of a new product, will generate new, better paid jobs for highly qualified workers (Harrison et al, 2008).

Increased investments in R&D on company level are key for strengthening the absorptive capacity of the entire country, i.e. the capabilities of a more efficient adaptation and applying foreign technology, as well as make a profit from spillover effects of FDI (WBR R&D Strategy; Bednyagin & Gnansounou, 2012).

Therefore, the increase of business, government and higher education sector investments in R&D will create positive spillover efects which will benefit the entire country.

Still, in literature, an existence of a pronounced gap in expenditures for R&D between developed and developing countries is emphasized, as well as between business and public sector expenditures. For example, periphery EU countries give less attention to the activities of R&D as opposed to leading EU countries, one of the reasons given is a low degree of technological capacity, as well as that the number of larger companies interested and ready to invest a significant amount of money in R&D is low (Osorio & Rodriguez-Pose, 2004). As opposed to Serbia and the majority of developing countries in which GERD prevails over HERD and GOVERD, in developed countries, R&D activites have been dominantly supported by the private sector. Besides that, a high risk and a prolonged period of profitability of R&D are just some of the reasons why there were lower investments made by the business sector, especially in countries such as Serbia, in which 99,99% of companies in the non-financial sector make up SME, which are usually uninterested for the implementation of R&D activities, not only due to ignorance and lack of information, but also due to poor financial capability. For that reason, having in mind the use of intensifying R&D activity, countries have undertaken appropriate measures for the stimulation of companies, so that they would target more of their funds towards R&D. For example, Serbia has forseen certain incentives in the field of fiscal policy, such as: tax credits, a break for corporate revenue, grants, tax exemption etc.

Due to all of the abovementioned advantages which companies and countries could have from the increase of R&D expenditures, the subject of this paper is the comparative analysis of R&D expenditures between Serbia, as well as North Macedonia, a representative of the Western Balkans, and selected EU countries from its surroundings: Bulgaria, Croatia, Hungary, Romania, Slovenia. The aim of this research is to first identify the total expenditures and the expenditures of the business sector for R&D and second, to compare the results with the surrounding EU members in order to confirm where Serbia stands in the field of R&D as a candidate country.

2. RESEARCH METHODOLOGY

The subject of research in this paper is a comparative analysis of R&D expenditures between Serbia and selected countries. Based on a subject of a research paper, it is possible to distinguish two key objectives:

- Identifying potential differences in GERD (%GDP) between Serbia and selected countries and
- Identifying potential differences in BERD (%GDP) between Serbia and selected countries.

The measurement of GERD and BERD is based on the Frascati methodology for collecting data on R&D. The first version of the manual was created in 1963 in Frascati (Italy) by experts in R&D area from different countries. Frascati manual defines R&D as *"...creative and systematic work undertaken in order to increase the stock of knowledge – including knowledge of humankind, culture, society – and to devise new applications of available knowledge"* (OECD – Frascati manual 2015).

According to Frascati manual *"GERD is constructed by summing the intramural R&D expenditures totals for the four main sectors: Business enterprise, Government, Higher education, and Non-Profit"* and *"BERD represents the component of GERD incurred by units belonging to the Business enterprise sector. It is the measure of intramural R&D expenditures within the Business enterprise sector during a specific reference period"* (OECD – Frascati manual 2015). Prethodna istraživanja iz ove oblasti retko su se zasnivala na upotrebi apsolutnih vrednosti R&D expenditures,

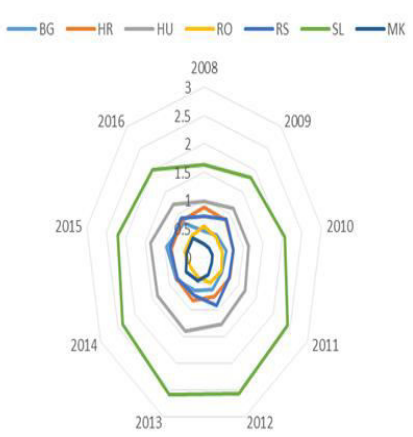
In this paper, GERD and BERD are measured as the GERD/GDP ratio and BERD/GDP ratio, which are then multiplied by 100, in order to determine the level of GERD and BERD compared to the level of GDP.

In addition to Serbia, the sample includes six other countries from its surroundings: Bulgaria, Croatia, Hungary, Romania, Slovenia, and North Macedonia. The original idea was to include all the countries of the Western Balkans, but this was not done due to poor reporting on R&D expenditure, which resulted in a lack of reliable data. Empirical research covers the period 2008 – 2016. Data on R&D expenditures are collected from the *UNESCO Institute for Statistics* website as a relevant and reliable source of secondary data.

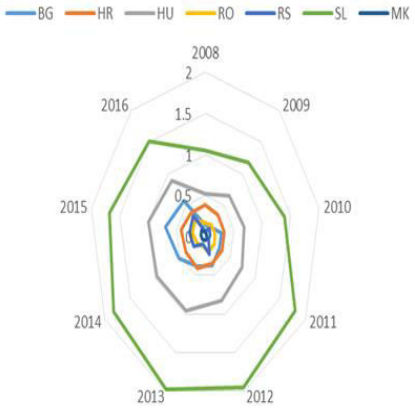
The sample is shown below in Table 1 and Spider graphs 1-2.

Table 1: Characteristics of the sample (2008 – 2016.)

GERD (%GDP)					
	Mean	**Std.dev.**	**Median**	**Min**	**Max**
Bulgaria	0.6478	0.16664	0.61	0.45	0.96
Croatia	0.8044	0.05126	0.81	0.74	0.88
Hungary	1.2244	0.13361	1.21	0.98	1.39
Romania	0.4644	0.05318	0.48	0.38	0.55
Serbia	0.8011	0.08207	0.77	0.71	0.91
Slovenia	2.1833	0.33260	2.20	1.63	2.58
North Macedonia	0.3367	0.12520	0.33	0.20	0.52
BERD (%GDP)					
	Mean	**Std.dev.**	**Median**	**Min**	**Max**
Bulgaria	0.3778	0.18999	0.37	0.14	0.70
Croatia	0.3711	0.03551	0.38	0.33	0.43
Hungary	0.8044	0.16667	0.83	0.52	1.00
Romania	0.1867	0.04123	0.18	0.12	0.27
Serbia	0.1689	0.09918	0.12	0.07	0.33
Slovenia	1.5967	0.33571	1.68	1.05	1.98
North Macedonia	0.0544	0.02297	0.04	0.03	0.10



Spider graph 1: GERD (%GDP) in 2008 – 2016.



Spider graph 2: BERD (%GDP) in 2008 – 2016.

In accordance with the subject and objectives of the research, the following hypotheses will be verified:

H_1: *There is a statistical significant difference in GERD (%GDP) between Serbia and selected countries.*

H_2: *There is a statistical significant difference in BERD (%GDP) between Serbia and selected countries.*

The truthfulness of the research hypotheses was verified using the T test of independent samples and its non-parametric alternative Mann-Whitney U test. Also, the arithmetic mean, standard deviation, median, minimum and maximum values for observing variables are calculated. The entire statistical data processing was performed in IBM SPSS v.23 and MS Excel.

3. RESULTS AND DISCUSSION

Table 2 shows the results of the T test and Mann-Whitney U test for GERD (%GDP). Following the results from normality tests, Mann-Whitney U test was applied for the analysis of GERD (%GDP) between Serbia and Romania, Serbia and Slovenia, Serbia and Northern Macedonia, while in other cases the T test was applied.The results of Mann-Whitney U test show that there is a statistically large and significant difference between Serbia (M=0.8011) and Romania (M=0.4644) in terms of GERD (Z=-3.580; sig=0.000; r = 0.84; U stat=0.000). Between Serbia (M=0.8011) and Slovenia (M=2.1833) there is a notably large difference in terms of GERD (%GDP) (Z=-3.578; sig=0.000; r = 0.84). There is a significantly large difference between Serbia (M=0.8011) and North Macedonia (M=0.3367), Z=-3.585; sig=0.000; r = 0.85. The Mann-Whitney U Statistic value in all three cases is 0.000, which implies that Serbia has had a greater GERD (%GDP) every year, compared to Romania and North Macedonia, i.e. Serbia has achieved a lower GERD (%GDP) than Slovenia.

It has been confirmed with the T test that there is a significantly large difference between Serbia (M=0.8011) and Bulgaria (M=0.6478) in terms of GERD (%GDP) in the observed period (F=3.557; Eta square=0.28; sig=0.025). On the other hand, there is a coincidental and extremely small difference, without any statistical significance (F=9.020; Eta square=6.63e-4; sig=0.919). Between Serbia and Hungary there is subdtantially large difference in GERD (%GDP) F=1.396; Eta square=0.80; sig=0.000.

Table 2: T test of independent samples and Mann-Whitney U test – GERD (%GDP)

	T test		***Mann-Whitney U test***			***Sig***	***Normality tests***	
	F	***Eta square***	***Z***	***r***	***Stat***		***Kolmog.-Smirn. Stat(p)***	***Shapiro-Wilk Stat(p)***
Serbia Bulgaria	3.557	0.28	–	–	–	0.025	0.128(0.200)	0.962(0.645)
Serbia Croatia	9.020	$6.63e^{-4}$	–	–	–	0.919	0.176(0.148)	0.914(0.101)
Serbia Hungary	1.396	0.80	–	–	–	0.000	0.164(0.200)	0.902(0.062)
Serbia Romania	–	–	-3.580	0.84	0.000	0.000	0.207(0.040)	0.890(0.039)
Serbia Slovenia	–	–	-3.578	0.84	0.000	0.000	0.282(0.001)	0.822(0.003)
Serbia North Macedonia	–	–	-3.585	0.85	0.000	0.000	0.206(0.041)	0.887(0.035)

Table 3 shows results from the T test and Mann-Whitney U test for BERD (%GDP). After carrying out normality tests, the T test was only applied only when comparing BERD between Serbia and Bulgaria, and between Serbia and Romania.

The results of the Mann-Whitney U test show that there is statistically significant and substantially large difference between Serbia (M=0.1689) and Croatia (M=0.3711) in terms of BERD (Z=-3.547; sig=0.000; r=0.84). Between Serbia (M=0.1689) and Hungary (M=0.8044), there is also a significantly large difference in terms of BERD (Z=-3.580; sig=0.000; r = 0.84). There is a statistically large difference between Serbia (M=0.1689) and Slovenia (M=1.5967), Z=-3.580; sig=0.000; r=0.84. Whilst comparing Serbia and North Macedonia, there is a significantly large difference in terms of BERD (%GDP) Z=-3.113; sig=0.002; r=0.73.

The value of Mann-Whitney U Statistic test when it comes to Serbia and Hungary, Serbia and Slovenia is 0.000 and it indicates that Serbia has not had a single year with a greater BERD (%GDP), compared to these two countries. On the other hand, the value of Mann-Whitney U Statistic between Serbia and Croatia, and between Serbia and North Macedonia, is 0.000 which implies that Serbia has had a greater BERD (%GDP) every year, compared to these two countries.

The T test confirmed that there is a significantly large difference between Serbia (M=0.1689) and Bulgaria (M=0.3778) in terms of BERD (%GDP) in the observed period (F=2.693; Eta square=0.35; sig=0.010). Between Serbia (M=0.1689) and Romania (M=0.1867) there is no statistically relevant difference (F=15.956; Eta square=0.02; sig=0.626).

Table 3: T test of independent samples and Mann-Whitney U test – BERD (%GDP)

	T test		***Mann-Whitney U test***			***Sig***	***Normality tests***	
	F	***Eta square***	***Z***	***r***	***Stat***		***Kolmog.-Smirn. Stat(p)***	***Shapiro-Wilk Stat(p)***
Serbia Bulgaria	2.693	0.35	–	–	–	0.010	0.152(0.200)	0.908(0.080)
Serbia Croatia	–	–	-3.547	0.84	0.000	0.000	0.238(0.008)	0.867(0.016)
Serbia Hungary	–	–	-3.580	0.84	0.000	0.000	0.171(0.172)	0.876(0.022)*
Serbia Romania	15.956	0.02	–	–	–	0.626	0.115(0.200)	0.964(0.679)
Serbia Slovenia	–	–	-3.580	0.84	0.000	0.000	0.263(0.002)	0.822(0.003)
Serbia North Macedonia	–	–	-3.113	0.73	0.000	0.002	0.273(0.001)	0.785(0.001)

*Decision is based on the histogram and Q-Q plot. Also, Shapiro-Wilk has a greater power to explain data distribution.

Serbia had a greater GERD (%GDP) every year for the period of 2008-2016 compared to Romania, and the best results were achieved in 2012, when GERD reached 0.91% GDP. In 2016, Serbia allocated 0.89% GDP to R&D, whilst Romania allocated a mere 0.48%. Serbia's average GERD was 0.80%, whilst Romania had a 0.46% GDP. On the other hand, Serbia and Romania had similar values in the previous period, so the difference between average allocated funds for R&D was a mere 0.02 percentage points. An average BERD of Romania was insignificantly greater than that of Serbia.

Slovenia is the only country from the sample which has allocated an average of more than 2% GDP to GERD, which is above the average of EU-28. Slovenia's GERD had an average of 1.38 percentage points more than Serbia's GERD. In 2016, Slovenia had a GERD of 2% GDP, and it reached a peak in 2013 with 2.58% GDP. There is a similar situation when comparing Serbia's and Slovenia's BERD. The business sector in Slovenia allocated an average of 1.60% GDP to R&D, whilst Serbia's BERD was in average lower for 1.43 percentage points. The business sector in Slovenia is surely more active in comparison to other sectors in terms of expenditures on R&D, which together allocate an average of 0.59% GDP.

Following Slovenia, the next country according to the height of GERD is Hungary, which GERD was an average of 1.22% GDP. Compared to Serbia, Hungary had a greater GERD in each year, and for the overall period Hungary had an average GERD of 0.42 percentage points more than Serbia. The business sector of Hungary allocates more for R&D in comparison to the Serbia's business sector. In 2016, Hungary's BERD was 0.89% GDP, which is 0.56 percentage points higher than Serbia's BERD. As with GERD, Hungary had a greater BERD than Serbia, where the average value of BERD was 0.80% GDP, which is 0.64 percentage points higher than in Serbia.

Following Romania, Bulgaria, as a member of the EU, has the lowest result when it comes to GERD. In 2016, GERD in Bulgaria was 0.78% GDP, which was a decline of 0.18 percentage points compared to the previous year, and 0.33 percentage points lower than in 2008. Bulgaria allocated an average of 0.65% GDP for GERD, which is 0.15 percentage points less than the GERD in Serbia. BERD in Bulgaria was greater than in Serbia through the entire period. An average BERD in Bulgaria amounts to 0.38% GDP and is 0.21 percentage points higher than the BERD in Serbia.

Croatian had a GERD of 0.85% GDP in 2016, which is 0.04 percentage points less than Serbia's GERD. It can be noted that the differences in the height of GERD between Serbia and Croatia are insignificant, ranging from 0 to 0.17 percentage points. The average GERD in Croatia was 0.8044% GDP, which is a mere 0.003 percentage points higher than the GERD of Serbia in the same period. As is the case with other countries of the EU from the sample, Croatia also has a greater BERD than Serbia. Croatia had an average BERD of 0.37%, which is 0.22 percentage points higher than Serbia. Each year in question, Croatia allocated more funds than Serbia, ranging from 0.05 till 0.38 percentage points. Only in 2016 did Serbia manage to reach the BERD of Croatia, however, still falling behind for 0.05 percentage points.

Serbia has clearly outshined Macedonia when it comes to GERD. Macedonia allocated 0.43% GDP to R&D in 2016, which is 0.46 percentage points lower than Serbia. Macedonia had a GERD of 0.34% GDP in the given period, which is 0.46 percentage points less than Serbia. The business sector of Macedonia achieved significantly poor results by allocating an average of 0.05% GDP to R&D in a span of nine years, which is 0.12 percentage points lower than the business sector of Serbia. Exceedingly large differences in BERD were noticed in the period of 2014-2016 and they range from 0.17 to 0.23 percentage points, which is an upshot of increasing expenditures of the business sector of Serbia for R&D.

4. CONCLUSION

According to the economic theory, knowledge and technological changes have been characterized as the main initiators of sustainable economic development. R&D is treated as one of the sources of technological changes, which on the other hand lead to acquiring new knowledge, then by comercializing the newly acquired knowledge, the positive effects on performances on micro- and macro-level are brought about. Accordingly, there is a need for increasing R&D expenditures, since it is one of the prerequisities, not only for progress, but also survival in the era of knowledge, especially for developing countries, which have to begin with reviving and then increasing the strength of research developing capacities.

In recent years, Serbia has acknowledged the importance of R&D, which can be seen from a slight increase of GERD to 0.89% GDP in the year 2016, for 0.18 of percentage points more than in 2008, but also from a significant increase of BERD from 0.07% GDP in 2008, to 0.33% GDP in 2016. Based on these results, the research hypotheses $\boldsymbol{H_1}$ and $\boldsymbol{H_2}$ are mostly confirmed. In the period of 2008-2016, there were significant differences in the height of GERD and BERD, with the exception of Croatia, which had an insignificantly greater GERD than Serbia, and Romania, which had a mere 0.02 percentage points of a

greater BERD. Serbia has a significantly greater GERD than Bulgaria, Romania and Macedonia. On the other hand, Serbia has a lower BERD as oppposed to all the countries from the sample, except for Macedonia. The results indicate that the Government and Higher education sector in Serbia is more active in the amount of R&D expenditures, since they allocated 0.63% GDP, for 0.46 percentage points more than the Business sector. In more developed EU countries, such as Slovenia and Hungary, the Business sector allocates significantly more funds to R&D as opposed to other sectors.

Although the GERD level in Serbia is relatively greater as opposed to other countries in the region, especially EU countries (Bulgaria, Croatia, Romania), there is a significant lag when it comes to expenditures on R&D by the Business sector. Since the private sector is an initiator and the carrier of advanced economy development, a country needs to find ways to engage the business sector in the domain of R&D and innovations. A country should focus on promoting the role of R&D and innovations, so as to strengthen the company's competitive advantage, and then to strengthen and encourage the private sector to make larger investments in R&D activity, by using certain financial stimuli, such as subsidies and tax reliefs. Providing a regulatory administrative relaxing work environment could additionally encourage the business sector to increase R&D expenditures, even in higher risk R&D activities.

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