

ECONOMIC GROWTH AND R&D EXPENDITURE IN ROMANIA. AN EMPIRICAL RESEARCH

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ABSTRACT

Research and Development (R&D) seems to be an important element in economic growth, provided it is coupled with several other factors. The benefits of R&D are quantifiable in the long run, as well as in the short run. R&D brings benefits not only at a local level, but also at a regional level, and if done right, it influences nearby countries or states. Private and public funding for R&D are different and bring in different results. As for the source of funding, it seems that government funding is less efficient, compared to private funding. Either way, R&D is beneficial for governments because they can exploit the research output. Higher education produces more R&D, if properly funded, and business enterprises can either exploit or grow around R&D and its output. The aim of this study is to investigate the relationship between the economic growth and the R&D Expenditure in Romania. We used the Johansen cointegration test, VECM model and Granger causality. The findings suggest that R&D Expenditure in the Business enterprise sector corrects the previous period disequilibrium faster than the other two variables, so 10% of this disequilibrium is corrected within the first year from R&D Expenditure in Business enterprise to GDP. In the short-run, the R&D Expenditure in the Business enterprise sector does not influence the GDP, while the other two variables, R&D Expenditure in the Higher Education sector and R&D Expenditure in the Government sector to GDP, influence the GDP in the short run.

KEYWORDS: *business, economic, education, government, growth, research and development.*

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1. INTRODUCTION

There is an important aspect related to Research and development (R&D) activities, which might be overlooked, but is implied in most studies. It appears that R&D expenditures led to positive outcomes for economic growth. Technological development and economic growth lead, inevitably, to higher employment capacity and import and export activities. This aspect of R&D is important because it is also connected to aspects such as positive outcomes for both long-term and short-term economic development. Countries that invest in R&D seem to have benefits, regardless of the time it takes for them to reap them. The only difference is that benefits are more stable and dependable in the long run, while they are weaker and less dependable in the short run.

Research and development (R&D) is the foundation for the development of knowledge, which leads to new products and technologies (Solow, 1956; OECD, 2012; Szarowská, 2017). R&D is not developed solely through private funding, but also through government spending, which can be divided into three main instruments. The first one is the government's own R&D process; the second is direct funding, while the third is indirect funding. If these types of funding are considered from the perspective of economic theory, there is no perfect type of spending or funding. Direct

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funding is mainly oriented towards long-term research, while the indirect one aims for applied research. Since R&D drives innovation, most EU countries have mechanisms to support it, through indirect or direct funding. The strategies they use aim at offering various incentives to companies and SMEs to aid them in supporting R&D. In this case, the aim is to reduce the costs of R&D for most firms, through the indirect fiscal incentives. Apparently, the best procedure is that which allows the decisions regarding R&D in the hands of these companies. They would be able to develop further, by investing in business R&D. However, due to various economic and social conditions, such as economic crisis and pandemics, governments are forced to reconsider public spending, which translates in less funding for R&D. Some governments managed to increase the public budget for this sector, by trying to prevent companies from reducing their R&D expenses. Despite best intentions, governments are forced to find new instruments for supporting and funding R&D (Szarowská, 2017). R&D at the company level, means innovation in a time of digital business and ever newer and more complex technological changes. This means that companies must take into consideration innovation, because this would reduce the risk of losing the business, customers, and even the market position (Cadaru & Badulescu, 2018)

Depending on models chosen there are various elements that drive economic growth. In the case of the neoclassical growth model (Solow, 1956), capital accumulation, population growth, and technology seem to be the most important economic growth factors. The Solow-Swan models (1956) argue that technology in more countries would improve over time, provided the ideas developed in one country are spread rapidly to others. The scale effect negatively influenced the first-generation R&D growth models because they argue that long-run growth rate increases with the size of the economy. The second-generation growth models, based on R&D, showed that public policy cannot influence the long-term growth rate. Even if public institutions are involved in R&D, it seems that private companies have a higher impact on growth. R&D investment in higher education also triggers innovation, which leads to growth. However, higher education R&D and innovation lead to growth only in strict dependence on the socioeconomic contexts of the regions in which they take place (Bilbao-Osorio & Rodrigues-Pose, 2004). Not all regions can invest sufficiently into R&D, to create a fast growth. In this context, there is yet another situation which seems contradictory. In effect, the less advanced EU regions have higher public R&D expenditures, which translates into higher GDP growth rate, because technological change has a positive effect on economic growth (Guadalupi et al., 2013).

When it comes to supporting R&D at a national level, the countries that are developed or the ones with large a population are able to support such investments. The issue is complicated by the fact that factor-driven and efficiency-driven countries do not have the possibility to invest heavily and strongly to support R&D. It is for this reason that these countries will not benefit from R&D benefits when it comes to GDP per capita. Neither will the human development index in these cases. Countries that are in the factor driven stage cannot efficiently manage the financial aid from international organizations. It is advisable to encourage these countries to channel their funds into those areas that would allow them to enter the next stage of development.

Economic growth is dependent on various factors, such as gross domestic expenditure on R&D, government researchers, and internet access. The latter is a positive factor, that contributes to economic growth, whereas the first two hinder it. The government can have a positive effect on economic growth, if it takes into consideration which are the most important and sought-after developments, invest in various ways that can lead to new innovations. Among such ways or strategies, it might consider recognizing the importance of R&D activities and invest in them, followed by an improvement in research quality, pushing a clear research agenda, coupled with encouraging high-quality R&D activities.

Thus, the aim of this study is to determine the short-run and the long-run relationship between the economic growth and the R&D Expenditure in the three sectors (Government, Higher Education and Business enterprise) in Romania, and also, we will test the evidence of the causality.

2. THEORETICAL FRAMEWORK

Scientific papers on R&D and innovation, and their role in socio-economic development are widespread. Economic growth is influenced by several factors, and, in the literature, there is evidence that R&D represents an important driver (Chun et al., 2014; Kaur and Sigh, 2016; Edquist and Henrekson, 2017; Hong, 2017; Nair et al., 2020; Romer, 1990). Kaur and Sigh (2016) analyzed the link between R&D expenditure and per-capita GDP using the data of 23 developing countries, between 1991 and 2010, and reported a significant impact of R&D expenditure on economic growth. Edquist and Henrekson (2017) highlighted in their research that, in the case of Sweden, R&D capital is associated with economic growth. Referring to OECD countries, for the period 1961-2018, Nair et al. (2020) analyzed the relationship between R&D, the development of ICT infrastructure and economic growth. They found that, in the long-term, R&D and ICT infrastructure development determine economic growth and that, in the short-run, inter-relationships between these indicators are also present. In a previous study, also at the level of OECD countries, Pessoa (2010) pointed out that the relationship between R&D and economic growth is different from one country to another and, in this context, highlighted the importance of country specific factors. Bayarcelik and Taşel (2012) demonstrated that, in the case of Turkey, R&D investment and the number of the employees in the R&D department significantly influence economic growth. Wang et al. (2013) analyzed the impact of R&D expenditures in the high-tech sector on economic growth, for 23 OECD countries and Taiwan, and revealed that high-tech R&D investment is most effective for countries with the highest per capita income.

Taking into consideration several developing and developed countries, Maneejuk and Yamaka (2020) pointed out that innovation is a key source of new technologies and engine-factor for economic growth. Also, according to Tuna, Kayacan and Bektaş (2015), it seems that there is no long-term relationship between R&D expenditures and economic growth and there is also no causality between them, based on the Granger Causality Test applied to certain economic contexts (Turkey between 1990-2003). The reason may be that some countries are in their developing stages, thus R&D expenditures will be higher and are also increasing. On that note, the R&D activities do need a longer period to generate benefits. The period can extend over two or three decades. It is therefore argued that countries that aim to invest in R&D, should do so on the long-term basis, taking into consideration both quality and quantity criteria.

Since R&D activities are considered to be the driving force of economic growth in endogenous growth models, they are receiving new impetus and importance in the context of the recent decades, because the argument seems to be that any resources allocated to R&D, would inevitably lead to economic growth, but only in the long run. Overall, the countries that are developed, benefit most from R&D activities, because they can afford to invest more resources. These countries also have high income levels. Technological developments are linked to innovation and R&D activities, in such a way that they contribute to the economic growth. In the context of developing countries (e.g., Turkey) R&D grows from funding recipient, into fundamental element of economic sustainability. Therefore, R&D activities must increase. R&D generates technological development, and, in turn, it drives efficiency and an increase in competitiveness (Bozkurt, 2015). In this context, R&D investments would allow a country to be free from economic dependency, and it would also allow it to develop its own technologies.

The increase of R&D activities takes place by increasing the collaboration between industry and higher education, a leaner and more meaningful collaboration within the industries, a higher

investment in human capital, and incentives for companies and organizations. These are the elements that are invested in R&D; therefore, they must be helped to develop further.

Regarding China, Xiong et al. (2020) revealed that R&D investment is related to R&D output and economic growth mainly in non-state sectors and non-peripheral regions. Considering European Union's regions, Rodriguez-Pose and Crescenzi (2008), empirically studied the role played by R&D and innovation on economic development, underlining also the importance of proximity for the transmission of economically productive knowledge. Anousheh et al. (2018) evaluated the effect of agricultural R&D on regional economic growth and included in their study EU-28 regions, from 1995 to 2014. They considered business enterprise R&D, government R&D and higher education R&D and investigated the effects of spatial spillover. The researchers noticed that positive spillovers are stronger in the business enterprise sector. Armeanu et al. (2018) also reported that total expenditure on R&D is positively related with real GDP growth in EU-28 countries. Banelienė and Melnikas (2020) focused in their study on European Union countries also and demonstrated that R&D expenditure has a positive impact on economic growth. Also, researchers found that the impact is much higher in well-developed EU economies. Considering several Central and Eastern European countries, Szarowská (2018) investigated the effect of R&D expenditure on economic growth, by components, i.e., business R&D, government R&D and higher education R&D expenditure. Overall, it was found that there is a significant positive effect of R&D expenditure on economic growth and the analysis by components revealed that government R&D expenditure has the strongest influence on economic performance, followed by business R&D expenditure, while the influence of higher education R&D expenditure is insignificant.

Hong (2017) analyzed the causal relationship between R&D investment and economic growth referring to Korea's ICT industry and observed a bidirectional Granger causality between the two variables. He went further with the analysis and separated R&D investments into public and private. The results showed that the relationship between private R&D investment and economic growth is stronger. The role of private R&D investment appears to be important when it comes to the drivers of economic growth, as highlighted by other researchers too. For example, regarding the US business enterprise sector, Chun et al. (2014) demonstrated that an increased technological diversity attracts more private R&D investments, and this will further lead to long-run economic growth. Thus, R&D seems to be an element that has positive outcomes at a national level, even for countries such as the US. The positive outcomes are related to firm and industry level as well. R&D has a positive effect also on the State Gross Domestic Product on the long run, thus proving that there is a link between R&D investment and a certain state's economic growth. As for the R&D positive spillovers, it seems that for the US, for every dollar invested in R&D in one state's GDP, it creates almost 5\$ of GDP for the other states. As for the spill overs, for every dollar invested in R&D in one state, it has a marginal average return of 11% in another state.

R&D elasticity is an important factor, since it seems that levels of human capital and development influence the impact. Therefore, in the context of the US, economic growth is dependent on R&D spending in any state since all neighboring states reap the benefits. It follows that a coordinated R&D spending, coupled with incentives in a region, which has more states, would lead to an economic growth for the entire region (Blanco et al., 2013). Falk (2007) found that the ratio of business enterprises' R&D expenditures to GDP and the share of R&D investment in the high-tech sector have strong long-term positive effects on GDP per capita and GDP per hour worked. As we can observe from analyzing the results of above-mentioned studies (Falk, 2007; Wang et al., 2013; Hong, 2017) the R&D investment in high-tech sector represent a key factor that drives economic growth.

It seems that, if we analyze separately the private and public R&D investment, there is a difference between the contribution of these categories of investments to the economic growth. Therefore, private R&D investment is seen as having a stronger influence on economic growth compared to public R&D investment. There are studies that reveal the fact that public R&D investment is not

efficient when it comes to determining economic growth. For instance, by considering several European countries, Moutinho et al. (2015) showed that Governmental R&D investment does not have any statistically significant impact on economic growth. They drew attention to the fact that more public and private R&D investment is, obviously, a necessary condition for sustainable development, but in order to prove its effectiveness, it must be complemented by other policy measures. Regarding Central and Eastern European Countries (CEE), Pop Silaghi et al. (2014) revealed a statistically significant impact of R&D business on economic growth while the impact of public R&D is not significant. Interestingly, when including human capital, the contribution of business R&D decreases, but it still remains significant when it comes to economic growth. On the other hand, Goel et al. (2008) highlighted the greater importance of federal R&D compared to non-federal R&D in determining U.S. economic growth.

R&D in the Romanian higher education context is a problematic issue. The Romanian educational system has decried the lack of sufficient public funding throughout the years. The trend is changing and the educational system seems to receive increasingly more funding. At the level of 2012, 6% of the GDP should have been given to the educational system, as provided in the Romanian Law of Education, while R&D would have gotten at least 1%. It was observed that as funding increased, so did the research output. According to Vlăsceanu and Hâncean (2015), the 2011 Law of Education should have brought in significant benefits for the Romanian education, and part of the development in R&D was possible because of this law. Even if government funds for the educational system are lower than needed, there is a need for a high-quality research output, which would be facilitated by proper funding and a clear delineation between teaching, engagement in research, and dealing with administrative responsibilities. At an organizational level, there is a need for a stable connection between research production and transfer. Organizations could be more involved in research per se, as well as a refining of the political and managerial context, in order to promote research development and output. The clear academic mission helps the institutions focus their efforts, coupled with transparency and social responsibility. At a national level and government level, policy makers may be involved in clearer, transparency policies, engaging as active partners in the higher education environment, so that the research production would happen locally, then at a regional level, and also at an international level (Ion, Iucu, 2015).

3. EMPIRICAL RESULTS AND DISCUSSION

This research aims to investigate the short and long-run relationship between the economic growth and the R&D expenditure from Romania. To determine this relationship, we used the annual time series data from Eurostat during the period 1993-2019. The statistical indicators underlying this analysis are: Gross Domestic Product (GDP), R&D expenditure in the Higher Education sector, R&D expenditure in the Government sector, and R&D expenditure in the Business enterprise sector. In Table 1 we present the descriptive statistics for the dataset used.

According to the results presented in Table 1, we can argue that all the variables are positively skewed. Three of the variables, namely GDP, R&D Expenditure in the Higher Education sector and R&D Expenditure in the Business enterprise sector have a moderately high kurtosis, while the R&D Expenditure in Government sector have a small kurtosis. In the case of this study, for an easier interpretation of the coefficients, the variables considered are transformed by using the natural logarithm. The coefficients of the logarithmic function will be interpreted as elasticities that show a percentage variation in an exogenous variable, considering a 1% change of an endogenous variable. To test the short and long run relationship between GDP and the R&D Expenditure (R&D Higher Education sector, R&D Government, R&D Business enterprise sector), and also the causal relationship between these variables, we state the following hypothesis:

H1: There is either a short or a long-run relationship, or both, between GDP and R&D Expenditure in Romania.

H2: There is either a unidirectional or a bidirectional relationship between GDP and R&D Expenditure in Romania.

Table 1. Descriptive statistics of variables

	Variables			
	Gross Domestic Product (Current prices)	R&D Expenditure in Higher Education sector (Million euro)	R&D Expenditure in Government sector (Million euro)	R&D Expenditure in Business enterprise sector (Million euro)
	GDP	RDE	RDG	RDB
Mean	98,843.35	159,34	72.53	236,66
Median	97,215.6	143,64	78.67	171,01
Maximum	222,997.6	339,31	233,53	616.96
Minimum	28,589.8	24.93	3.69	99.93
Std. dev.	62,011.24	117,87	63.40	148,98
Skewness	0.35	0.16	0.60	1.61
Kurtosis	-1.18	-1.74	-0.37	1.74
Observations	27	27	27	27

Source: Eurostat database (2021a, 2021b)

The first step in investigating the relationship and the causality between the variables GDP, R&D expenditure in the Higher Education sector, R&D expenditure in Government, R&D Expenditure in the Business enterprise sector, consists of testing the stationarity by using the unit root test (Augmented Dickey Fuller test) and also the determination of the number of lags underlying these tests. The number of lags will be selected based on the Akaike information criterion, Schwarz information criterion and Hannan-Quinn information criterion. Since there is at least one unit root, the model is not stationary and passes the cointegration tests. Since the variables are cointegrated, the most suitable model is VECM (Vector Error Correction Model), it also explains the causality test.

Therefore, to identify a long-run relationship between two or more variables it is important to test the stationarity of these time series. The results of the unit root test for the variable GDP, R&D expenditure in the Higher Education sector, R&D expenditure in Government, R&D Expenditure in the Business enterprise sector, expressed in natural log, are provided in Table 2.

According to the results, we can say that at the level, the null hypothesis cannot be rejected for any of the 4 variables. Therefore, the 4 variables are not stationary at the level. To the stationary we applied the difference of order I. The results show that all four series integrated in order I are stationary and do not have a unit root for 5% significance level. In other words, the variables are stationary in the first order I (1) for 5% significance level.

In case that the series of data are not stationary at the level, they can be cointegrated, i.e., we can say that there is at least one linear combination between them that is stationary. Given that the analyzed series are not stationary at the level, the cointegration condition is accepted. The concept of cointegration was first introduced by Granger and developed by Engle and Granger. They defined the long-term relationships between the elements of a time series vector as the existence of a linear combination of vector elements that appear to be stationary (Engle and Granger, 1987).

Johansen and Juselius (1990) also derived a procedure that exceeded the limit of univariate cointegration. In the present study, we will use the methodology proposed by Johansen and Juselius (1990), according to which the null hypothesis of non-cointegration will be tested. Thus, to

determine the number of cointegration relations we will use the LR tests (probability ratio), namely (Johansen and Juselius, 1990) the Trace test (LRmax) and the maximum Eigenvalue test.

Table 2. The unit root test

	Log values			
	GDP (p-value)	R&D Expenditure in Higher education (p-value)	R&D Expenditure in Government (p-value)	R&D Expenditure in Business enterprise (p-value)
ADF - level	-0.2379 (0.9215)	-1.3938 (0.5696)	-0.6617 (0.8395)	0.4529 (0.9814)
ADF - 1st diff	-3.6899 (0.0108)	-4.7560 (0.0009)	-5.8882 (0.0001)	-3.6645 (0.0114)
The order of integration for 5% level of significance	I(1)	I(1)	I(1)	I(1)

Notes: The optimum lag length selected based on Akaike, Schwarz and Hannan-Quinn info Criterion is 1 for all the variables.

Source: Author's calculation using Eviews 9

In Table 3 we presented the number of cointegration relationships among the variables. The results show that there is at least one cointegration relationship between the variables, the statistic value < the critic value, both for the first test and for the second test in case of the variables GDP and R&D Expenditure in Government sector. For the other variables, we found at least one cointegration relationship between GDP and R&D Expenditure in Higher education sector, respectively GDP and R&D Expenditure in Business enterprise sector, only in case of the Trace test. Engle and Granger (1987) argue that if there is cointegration between two series, there is a long-run effect that obstruct the two series from moving away from each other. So, there is a force of equilibrium that holds the two series moving together in the long-run (Engle & Granger, 1987).

Table 3. The Cointegration Tests

Variables	Hypothesized No. of CE(s)	Trace statistic	Max-Eigen statistic	Critical Value	
				Trace	Max- Eigen
GDP / R&D Higher education	r=0	15.24**	9.33	12.53	11.44
GDP / R&D Government	r≤1	5.91	5.91	6.51	6.51
GDP / R&D Business enterprise	r=0	21.90*	18.07*	18.39	17.14
	r≤1	3.82	3.82	3.84	3.84
	r=0	18.15*	12.35	17.98	13.90
	r≤1	5.79	5.79	7.55	7.55

Note: * denotes significant at 10% significance level, ** denotes significant at 5% significance level. Lags=1. r denotes the number of cointegrated vectors.

Source: Author's calculation using Eviews 9

For both hypotheses mentioned above, we developed two models. In the first model, we considered the GDP variable as dependent and R&D Expenditure independent, while in the second model we considered the R&D Expenditure variables as dependent and GDP variable as independent. Therefore, to identify a possible long-run relationship between the GDP and the R&D Expenditure

in the three sectors, we will continue to apply the Johansen co-integration test. Starting from the results obtained from the Johansen-Juselius cointegration tests, we can decide if the application of the VECM model is the most appropriate method for each model. After we normalized the cointegrating vector to estimate the error correction model (ECM) of the dynamic structure, we had (Andrei & Bourbonnais, 2017, Begu et al., 2019):

$$y_t = \alpha_1 + \beta_1 x_t + \varepsilon_t \quad (1)$$

where:

y_t – the exogen variable,

x_t – the endogen variable,

α_1 - the constant,

β_1 - the coefficient of the endogen variable,

ε_t - the random variable.

Starting from the above equation, we can obtain the error correction term:

$$EC_t = y_t - \alpha_1 - \beta_1 x_t \quad (2)$$

So, the equation becomes:

$$\Delta y_t = a_0 + \delta EC_{t-1} + \sum a_{1j} \Delta y_{t-j} + \sum a_{2j} \Delta x_{t-j} + u_t \quad (3)$$

According to Greene (2011), the size of the coefficient δ shows the speed of adjustment towards equilibrium, and for these models to be validated this adjustment coefficient δ should be negative.

Table 4. VECM - Long-run and Short-run estimation

Causality direction	Error correction term (ECT) (<i>t</i> -statistics)	Short-run Coefficient (<i>t</i> -statistics)	Lag coefficient (<i>t</i> -statistics)
GDP → RDE	-0.001911 (-0.59)	-0.08348 (-0.97)	0.685374 (2.38)
RDE → GDP	-0.062815 (-1.32)	2.348908 (2.59)	-0.347942 (-1.31)
GDP → RDG	0.013736 (2.37)	-0.083250 (-0.94)	0.412129 (1.66)
RDG → GDP	-0.019227 (-0.81)	1.169047 (1.75)	-0.419094 (-1.76)
GDP → RDB	0.053359 (2.72)	0.182842 (1.51)	0.124637 (0.55)
RDB → GDP	-0.107131 (-1.50)	-0.157731 (-0.37)	0.335904 (1.47)

Source: Author's calculation using Eviews 9

The results presented in Table 4 show that the causal effect of the R&D Expenditure in the Higher Education sector and the R&D Expenditure in Business enterprise sector on the GDP is significant in the long run, the estimated adjusted coefficients are statistically significant and relevant (as $|t\text{-statistic}| > 1.31$). The negative sign of these coefficients indicates that between the mention variables exist a long-run equilibrium. In case of the causal effect of the R&D Expenditure in Government on the GDP, we can see that we have also a negative sign, but the coefficient is not statistically significant because $|t\text{-statistics}| < 1.31$. According to the results we can affirm also that the R&D Expenditure in the Business enterprise sector corrects the previous period disequilibrium faster than the other two variables (10% of this disequilibrium is corrected between

1st year from R&D Expenditure in Business enterprise to GDP). Regarding the long-term causal effect of the GDP variable on the R&D Expenditure in the three sectors variables, we observe that only in the case of the R&D Expenditure in the Higher Education sector we have a negative value of the coefficient, but this is not significant ($|t\text{-statistics}| < 1.31$). In case of the other two variables, we found a significant coefficient, but because the coefficient is positive, we can affirm that the effect of GDP on these two R&D Expenditure variables is not relevant in the long run. The short-run coefficients indicate convergence and significant results only from the R&D Expenditure in the Higher Education sector and R&D Expenditure in Government sector to GDP, while in case of the R&D Expenditure in the Business enterprise sector, the coefficient is not significant. We can also affirm that, of the three categories of R&D Expenditure, the R&D Expenditure in the Higher Education sector have the highest influence on the short-run.

The Granger causality test shows that there is an evidence of long-run Granger causality running from: R&D Expenditure in Higher Education sector to GDP, and R&D Expenditure in Government sector to GDP. Regarding the evidence of a short-run unidirectional causal relationship, the results show that there are three, namely: from R&D Expenditure in the Higher Education to GDP, from R&D Expenditure in Government sector to GDP, and from GDP to R&D Expenditure in the Business enterprise sector. We did not find a short-run bidirectional causal relationship between the studied variables.

To determine if the proposed models are valid, we checked also the quality of the residue, namely: the autocorrelation, the homoscedasticity, and the normal distribution. The results of these three residual tests are presented in the Table 5.

Table 5. The residual tests

Models based on causality direction	Autocorrelation LM	White	Jarque-Bera
	Test	heteroskedasticity	
	H ₀ – no serial correlation (p-value)	H ₀ – the errors are homoscedastic (p-value)	H ₀ – the errors are normally distributed (p-value)
GDP → RDE	5.5147 (0.23)	20.2547 (0.31)	4.3460 (0.11)
RDE → GDP	4.5123 (0.34)	18.7631 (0.40)	0.5220 (0.77)
GDP → RDG	1.8615 (0.76)	19.4545 (0.36)	2.8336 (0.24)
RDG → GDP	1.8615 (0.76)	29.9726 (0.31)	3.4446 (0.17)
GDP → RDB	1.1102 (0.89)	18.4929 (0.42)	0.6514 (0.72)
RDB → GDP	2.5245 (0.64)	12.6017 (0.81)	7.8990 (0.019)

Source: Author's calculation using Eviews 9

The results presented in Table 5 show that the values of these probabilities are higher than the 5% threshold (p-value = 0.05), we can affirm that the null hypothesis is accepted. So, the representation of the residue of the estimated models was correct in most of the cases. In case of the last model that had R&D Expenditure in the Business enterprises sector as dependent variable, the normality of the residual is not verified. According to the results, we can affirm that the null hypothesis is accepted for all these three residual tests, except for the latest model, therefore, the correct representation of the residue of the estimated models is validated.

4. CONCLUSIONS

Research and Development (R&D) is a beneficial factor of economic growth, because either in the long run or the short run, it seems to have positive outcomes. Since the R&D results can be put into production, companies and firms can develop or they can be created for a specific output, which translates into higher employment capacity and higher import/export activities. The advice for R&D investment is that it should be made specifically for the long run because it is more stable and dependable. As for the source of funding, it appears that private funding is more efficient than government funding. Companies and firms are left to decide for themselves which R&D decisions need to be implemented and what kind of products they aim to produce, in accordance with various market strategies. The economic environment can be affected by various issues, such as economic crisis and various pandemics or natural disasters. The severity of the events can be so strong that it forces governments to redirect funding away from R&D and focus on more urgent matters. Since R&D depends on socio-economic contexts, countries that are factor- or efficiency-driven cannot invest heavily in R&D, but their efforts should be oriented towards the next stage of their development.

For R&D activities to be efficient, there is a need for a clear government agenda, which would translate in simplifying procedures for the economic environment and allowing it to prosper. Investing in R&D is to be seen as an obligation, rather than an option, if conditions are proper and the country has reached a development stage that would allow it to enter such ventures. High quality research is also a priority, since the results are to be picked up by various companies and firms, that would turn it into products.

In the case of Romania, we found that R&D Expenditure in the Business enterprise sector corrects the previous period disequilibrium faster than the R&D Expenditure in the Higher Education sector and R&D Expenditure in Government sector. So, 10% of this disequilibrium is corrected within the first year from R&D Expenditure in the Business enterprise to GDP, while in case of the R&D Expenditure in Higher Education sector, only 6% of this disequilibrium is corrected within the first year from R&D Expenditure in the Higher Education sector to GDP. The short-run coefficients indicate a significant result only from the R&D Expenditure in Higher Education sector and R&D Expenditure in Government sector to GDP, while in case of the R&D Expenditure in the Business enterprise sector, the coefficient is not significant. Thus, we can conclude that in the long run, R&D Expenditure in the Business enterprise sector has a higher impact on the economic growth and the R&D Expenditure in the Higher Education sector and R&D Expenditure in the Government sector have an influence on the economic growth only in the short run.

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