

Research and development expenditures between discretionary costs and source for economic growth

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A*bstract:* At the microeconomic level, the research and development costs are included in a broader category known as "discretionary costs", i.e. they are not mandatory and occur as a result of managerial decisions. At the macroeconomic level, research and development spending stimulates innovation and contributes in this way to increase and diversify production, performance, productivity and economic efficiency. The Europe 2020 Strategy, based on the role of research and development expenses in the current period, has set a target on medium term for such expenditures: to rise up to 3% of GDP in the EU for 2020. The source of funding for research and development expenditures may be: state budget allocations to the government sector and higher education institutions and private funds allocated by corporate or nonprofit organizations. Our study aims to rank the impact of research activities undertaken by the government sector, higher education institutions and the private sector by GDP and gross private domestic investment and identify the most appropriate measures for achieving the Europe 2020 goals by Romania.

Keyword: research, development, discretionary costs, development technological innovation, social capability

JEL Classification: O32, O52, I25

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I. Introduction

Are research and development expenses really necessary? This should not remain just a rhetorical question. The answer is yes both for a country that feels a strong technological gap and a country that is close to the technological frontier. In the first case, research and development expenditures are required for taking technologies developed abroad, which are oriented towards the adaptation of productive apparatus and selection of the most appropriate technology, as well as penetrations in strategic areas (Alesina and Giavazzi, 2006), but as we approach the technological frontier and begin to achieve technological penetrations in top strategic domains new ways must be found to preserve our place in the club of developed economies. For Romania, a safe manner of departing from "periphery" (Dinu, 2007) is the capitalizing the potential of creativity, research and innovation through a coherent strategy in this area.

II. Literature review

At the microeconomic level, research-development expenses are considered "discretionary costs" along with the advertising and repairs and maintenance costs (Siegel, Dauber and Shim, 2008). They are defined as discretionary costs because the management of the company may give them up easily, on short term, and the savings made are helping to increase profits at the expense of future volume increases or productivity. As far as research-development expenditure are concerned Guy Serraf can be paraphrased that "rich companies do not make R&D because they are rich but are richer for doing R&D".

At the macroeconomic level, research on the impact of the R&D on economic growth emerged in the second half of the last century with the works of Schumpeter, Swan and Solow, according to the neoclassical theory of economic growth, the latest growth engine it represents the technological change. Until the 90s continued to be debated topic in economic literature inspired by Schumpeterian models based on innovation and "creative destruction".

In 1990 there Romer model that starts from three assumptions:

- economic growth is driven by technological progress and capital accumulation;
- technological advances result from deliberate activities undertaken by private agencies that respond to market challenges;
- knowledge of technology is a non-rivalrous input.

Sergerstrom (1990) also proposed a Schumpeterian model of the product life cycle in which innovation and technical progress plays a key role in renewing production.

Grossman and Helpman (1991) present a model for incorporating industrial innovation in economic growth in a global economy with emphasis on differences between developed countries and developing ones.

Aghion and Howitt (1992) propose a model based on "vertical innovation" in contrast to Romer's model that this "horizontal innovation" research is a replica Schumpeterian endogenous growth under uncertainty, concluding "growth results exclusively from technological progress, which in turn results from competition among research firms that generate innovations"¹.

Fagerberg (1994) believes that "catch-up" is possible in countries that have a strong "social capability" in investment, education and R&D.

Jones (1995) proposes a model that contradicts the "scale effects" of R&D highlighted by Romer's research (1990), Grossman and Helpman (1991) and Aghion and Howitt (1992) report that an increase in the level of resources devoted to R&D should increase the growth rate of the economy. The Jones demonstrates that "subsidies to R&D and to capital accumulation have no long growth effects"².

Cameron (1998) mentions three reasons for the innovative effort of firms and local organizations:

- to exploit the results of foreign research;
- to disseminate the results to the domestic economy;
- to play an important role in human capital improving.

Morales (2001) proposes an analysis in the context of an endogenous growth model with technological change in which private firms may invest both in applied and basic research.

Scotchmer (2004) provides a number of clarifications related to innovation economy in his "Innovation and Incentives".

Contributions of Romanian researchers include remarkable works published by Iancu (2003), Sandu (2003), Gheorghiu, Paslaru and Turlea (2004), Dinu (2007),

¹ Aghion, P.; Howitt, P., A Model of Growth through Creative Destruction, *Econometrica* 60, 337.

² Jones, C., R&D-Based Models of Economic Growth, *Journal of Political Economy* 103, 1995.

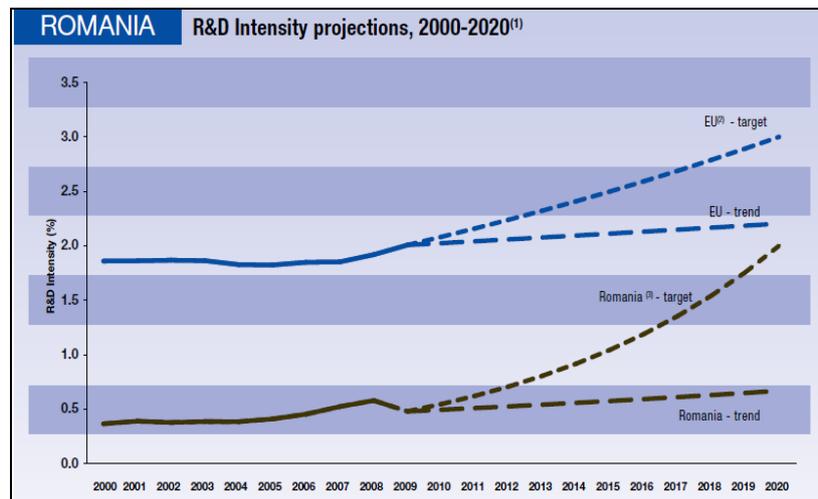
Zaman (2011) who have highlighted the role of research and development activities in Romania.

In conclusion the impact of research-development expenditure on economic growth at the macroeconomic level was highlighted by a several studies such as those undertaken by Romer (1990), Segerstrom (1990), Grossman and Helpman (1991), Aghion and Howitt (1992). On the other hand Jones (1995) considers the effects of scale of research-development expenditures are not certified by the results of an empirical study. A more nuanced view is brought up by Morales (2001), who concludes that basic research conducted in public institutions is positive, while the applied research performed mainly by the private sector has negative effects on economic growth, by differentiating the research-development expenditure performed in public institutions from those in the private sector.

III. Research and development expenditures in Romania from an European and global perspective

Government budget outlays on research and development (GBAORD) represented, in 2010, 0.76% of GDP in the EU compared to 1.09% in South Korea, 1.02% in the U.S. and 0.78% in Japan. Due to the tendency to reduce budget deficits, GBAORD fell to 0.73% of GDP or 92.308 million Euro in 2011. Romania is well below the EU average, with a 2011 a level of 0.26% of GDP or 353 million Euro. (Figure 1)

Figure 1 - R&D intensity projections 2000 – 2020



Source: European Commission – Innovation Union Competitiveness Report 2011

In the case of total research and development expenses (R&D expenditure), according to the Europe 2020 Strategy, the European average should reach 3% of GDP in 2020. In 2011 the EU average was 2.03% given that in 2009 Japan recorded 3.36%, U.S. 2.87%, and South Korea recorded 4% of GD, in 2010. In the European Union a group of countries already surpassed the target of 3% of GDP in 2011, namely Finland - 3.78% and Sweden - 3.37%. Romania recorded only 0.48% of GDP, more than half from budgetary allocations. The direct contribution of the 29.749 Romanian researchers to GDP was valued at 657 million Euro and allocated according to Table 1.

Table 1 - R&D expenditures by domain and type of research

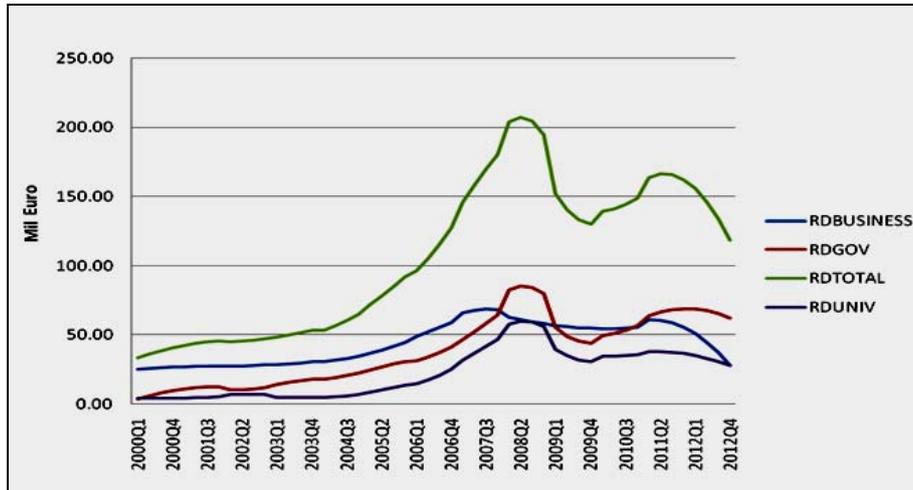
| Nr. | Domain | R&D expenditure – mil euro | Number of researchers | R&D expenditure/ researcher - euro |
|-----|---------------------------|----------------------------|-----------------------|------------------------------------|
| 1 | Business enterprise | 237 | 10.002 | 23695,30 |
| 2 | Government sector | 268 | 10.675 | 25105,40 |
| 3 | Higher education | 150 | 8.879 | 16893,00 |
| 4 | Private non-profit sector | 2 | 193 | 10362,70 |
| | TOTAL | 657 | 29.749 | 22084.80 |

Source: Own interpretation by www.cdi2020.ro/wp-content/uploads/2013/09

It can be seen that compared to the average intake of 22084, 80 euro per researcher - the government and the business sectors recorded values above average, while higher education and private non-profit organizations had a lower intake per capita. Compared to the European average of 98682.98 Euro (a total R&D expenditure of 256.587 millions Euro per 2.600.114 researchers), the productivity of R&D sector in Romania represents only 22.4%.

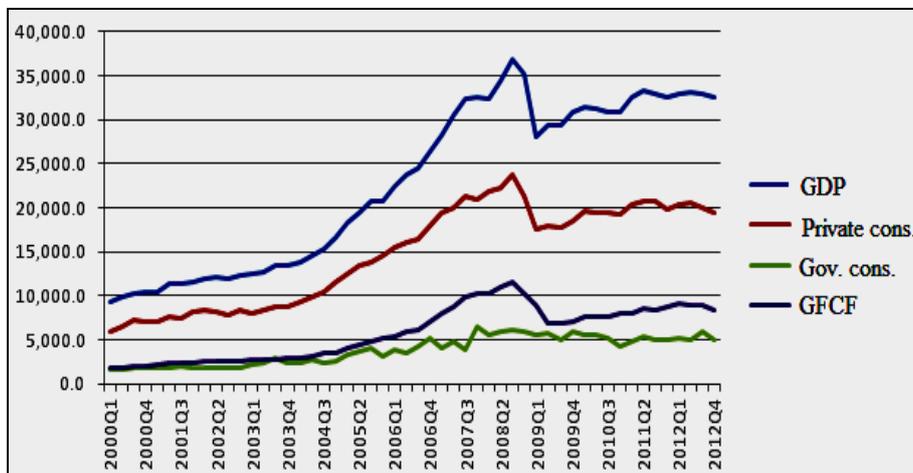
Figure 2 highlights the quarterly level for total expenditure during 2000-2012, made by the government sector, the business sector and universities.

Figure 2 - Evolution of research-development expenditure



Source: Own interpretation based on data from Eurostat and the National Institute of Statistics

Figure 3 - Evolution of GDP and main components between 2000 - 2012



Source: Own interpretation by data from Eurostat and National Institute of Statistics

Figure 3 captures the evolution of GDP and its main components in the period 2000-2012, the upward trend until 2008 and then a shock wave caused by the impact of the economic-financial crisis, followed by a slow growth starting with 2010. The first sign of the crisis was given by the gross fixed capital formation, which decreased by almost three quarters earlier, shown in the evolution chart, which reveals that it was not a crisis out of nowhere. Reduction in gross fixed capital formation, although not severe, emerged as a result of anticipating a restrictive economic climate for business.

It is obvious that the R&D total expenditure is mainly influenced by budgetary allocations which represent over 54% of the total and that the vision of "discretionary costs" specific to the business environment has made the private sector slowdown the growth rate of R&D expenditures by two quarters before the Romanian economy entered in recession.

IV. Empirical study on the impact of R&D expenditure on GDP and gross private domestic investment in Romania

IV.1. Research Methodology

Our study is based on the fact that research and development expenditures are funded from both public budget and private sources and that, in addition to the overall impact that R&D spending have on economic growth, it is useful to study the influence that research and development expenses exert when taken into account differentially, i.e. spending made by the government, expenditure by academic institutions as well as those made by businesses. In this article we performed an empirical study to identify the impact of R&D expenditures on GDP, consumption and gross private domestic investment in Romania. Depending on the results we aim to identify concrete measures for implementation of the national strategy on research, technological development and innovation for 2014-2020.

In this research we aimed to identify the impact of R&D expenditures on GDP, consumption and gross private domestic investment in Romania by using an unrestricted autoregression vector. In this regard, we used quarterly data taken from Eurostat reports, the variables being related to a period of study 2000: Q1 - 2012: Q4. Variables included are: GDP, private consumption, gross private domestic investment and total R&D expenditure and its components.

By using the impulse function related to the model of Autoregressive Vector (VAR), we have identified the effects of some components of R&D expenditures

in Romania on the size of gross domestic product and gross private domestic investment.

Our main purpose is to analyze the impact of research and development expenses over a period of 13 years, totaling 52 observations that we consider sufficient to express an opinion on the influence of R&D expenditure on GDP and investment.

IV.2. Data used

By using an impulse function we want to show the influence of exogenous variables on the evolution of GDP and investments. The variables are: GDP, private consumption, gross private domestic investment and total R&D expenditure and its components. Data were taken from the Eurostat website, which is seasonally adjusted and updated logarithmically and differentiated degree one.

IV.3. VAR Model

The VAR model used is an unrestricted VAR, since the variables are integrals of different orders. The Model proposed by us is original and observes the recommendations of Harvey¹, in 1990, because he was aware of the issues raised by the use of variables I (0) and I (1) in the same model.

$$Y_{1,t} = \alpha_1 + \Delta \sum_{j=1}^k \beta_{1,j} Y_{1,t-j} + \Delta \sum_{j=1}^k \delta_{1,j} C_{1,t-j} + \Delta \sum_{j=1}^k \mu_{1,j} I_{1,t-j} + \Delta \sum_{k=1}^k \pi_{1,j} RDtotal_{1,t-j} + u1_t \quad (1)$$

Where:

Y = gross domestic product;

C = private consumption;

I = gross private domestic investment;

$RDtotal$ = total research and development expenditure;

$$I_{1,t} = \alpha_2 + \Delta \sum_{j=1}^k \beta_{1,j} I_{1,t-j} + \alpha_1 + \Delta \sum_{j=1}^k \beta_{1,j} Y_{1,t-j} + \Delta \sum_{j=1}^k \delta_{1,j} C_{1,t-j} + \Delta \sum_{k=1}^k \pi_{1,j} RDtotal_{1,t-j} + u2_t \quad (2)$$

¹ Harvey, A. - The econometric analysis of time series, *The MIT Press, 2nd Edition, Cambridge, Mass., 1990*

Table 2 shows that VAR satisfies the stability condition.

Table 2 - VAR Stability Condition

| <i>Roots of Characteristic Polynomial</i> | |
|--|----------------|
| <i>Endogenous variables: DL_GDP DL_CONS DL_GFCF DL_RDTOTAL</i> | |
| <i>Exogenous variables: C</i> | |
| <i>Lag specification: 1 4</i> | |
| <i>Root</i> | <i>Modulus</i> |
| $0.207832 - 0.830017i$ | 0.855641 |
| $0.207832 + 0.830017i$ | 0.855641 |
| $0.757379 - 0.387049i$ | 0.850547 |
| $0.757379 + 0.387049i$ | 0.850547 |
| $-0.676109 - 0.486560i$ | 0.832985 |
| $-0.676109 + 0.486560i$ | 0.832985 |
| $0.794633 - 0.173299i$ | 0.813311 |
| $0.794633 + 0.173299i$ | 0.813311 |
| $-0.484189 - 0.635247i$ | 0.798735 |
| $-0.484189 + 0.635247i$ | 0.798735 |
| $-0.105311 - 0.727219i$ | 0.734804 |
| $-0.105311 + 0.727219i$ | 0.734804 |
| $-0.594270 - 0.219311i$ | 0.633446 |
| $-0.594270 + 0.219311i$ | 0.633446 |
| $0.306186 - 0.400258i$ | 0.503941 |
| $0.306186 + 0.400258i$ | 0.503941 |
| <i>No root lies outside the unit circle.</i> | |
| <i>VAR satisfies the stability condition.</i> | |

The model identified by us is further described. It should be highlighted that the model remained the same for all tests, the only change being the introduction of one of each category of R&D expenditure, i.e. the governmental one, the business environment's spending as well as that made by universities.

The number of lags chosen is 1 as shown in Table 3.

Table 3 - Selection of lag number

| <i>VAR Lag Order Selection Criteria</i> | | | | | | |
|--|-------------|-----------|------------|------------|------------|------------|
| <i>Endogenous variables: DL_GDP DL_CONS DL_GFCF DL_RDTOTAL</i> | | | | | | |
| <i>Exogenous variables: C</i> | | | | | | |
| <i>Sample: 2000Q1 2012Q4</i> | | | | | | |
| <i>Included observations: 47</i> | | | | | | |
| <i>Lag</i> | <i>LogL</i> | <i>LR</i> | <i>FPE</i> | <i>AIC</i> | <i>SC</i> | <i>HQ</i> |
| 0 | 351.351 | NA | 4.48E-12 | -14.78089 | -14.62343 | -14.72164 |
| 1 | 399.244 | 85.59590* | 1.16e-12* | -16.13804* | -15.35074* | -15.84178* |
| 2 | 409.6887 | 16.88944 | 1.49E-12 | -15.90165 | -14.48451 | -15.36837 |
| 3 | 425.3932 | 22.72135 | 1.57E-12 | -15.88907 | -13.8421 | -15.11878 |
| 4 | 440.6972 | 19.53697 | 1.75E-12 | -15.85945 | -13.18264 | -14.85215 |
| <i>* indicates lag order selected by the criterion</i> | | | | | | |
| <i>LR: sequential modified LR test statistic (each test at 5% level)</i> | | | | | | |
| <i>FPE: Final prediction error</i> | | | | | | |
| <i>AIC: Akaike information criterion</i> | | | | | | |
| <i>SC: Schwarz information criterion</i> | | | | | | |
| <i>HQ: Hannan-Quinn information criterion</i> | | | | | | |

It can be seen in Table 3 that the VAR meets the stability condition in this case.

Table 4 - Results of LM autocorrelation test

| <i>VAR Residual Serial Correlation LM Tests</i> | | |
|--|----------------|-------------|
| <i>Null Hypothesis: no serial correlation at lag order h</i> | | |
| <i>Sample: 2000Q1 2012Q4</i> | | |
| <i>Included observations: 50</i> | | |
| <i>Lags</i> | <i>LM-Stat</i> | <i>Prob</i> |
| 1 | 28.30148 | 0.029 |
| 2 | 24.30919 | 0.083 |
| 3 | 21.87083 | 0.147 |
| 4 | 20.30711 | 0.206 |
| 5 | 10.69312 | 0.828 |
| 6 | 9.458272 | 0.893 |
| <i>Probs from chi-square with 16 df.</i> | | |

In Table 4, it can also be seen that for a lag the model respects the autocorrelation condition, the null hypothesis being refuted, although an increase in probability can be noticed for the number of higher lags.

In table 5 it can be observed the model passes the test of heteroscedasticity.

Table 5 - Results of de heteroscedasticity test

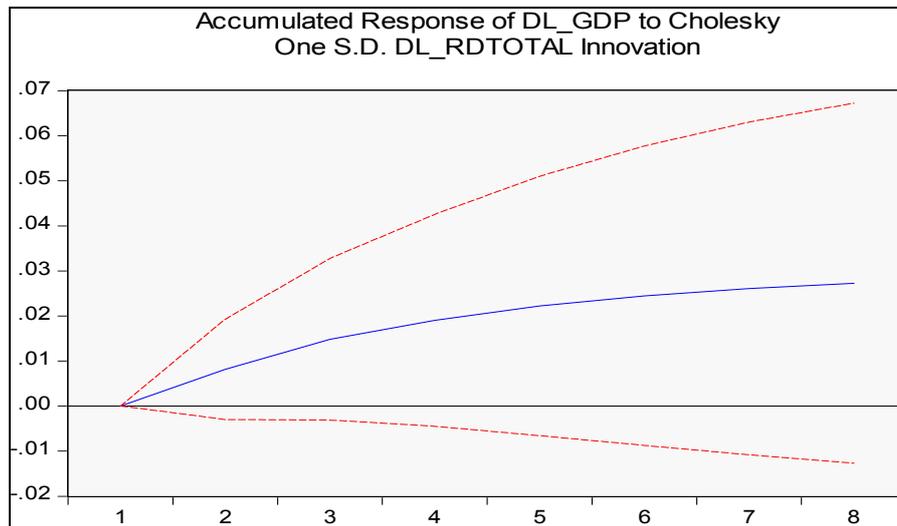
| <i>VAR Residual Heteroskedasticity Tests</i> | | |
|--|-----------|--------------|
| <i>Sample: 2000Q1 2012Q4</i> | | |
| <i>Included observations: 50</i> | | |
| <i>Joint test:</i> | | |
| <i>Chi-sq</i> | <i>df</i> | <i>Prob.</i> |
| 129.8092 | 80 | 0.0004 |

IV.4. Total R&D Impact

The impact of different variables on GDP and gross private domestic investment over time can be observed by using impulse functions specific for the VAR methodology

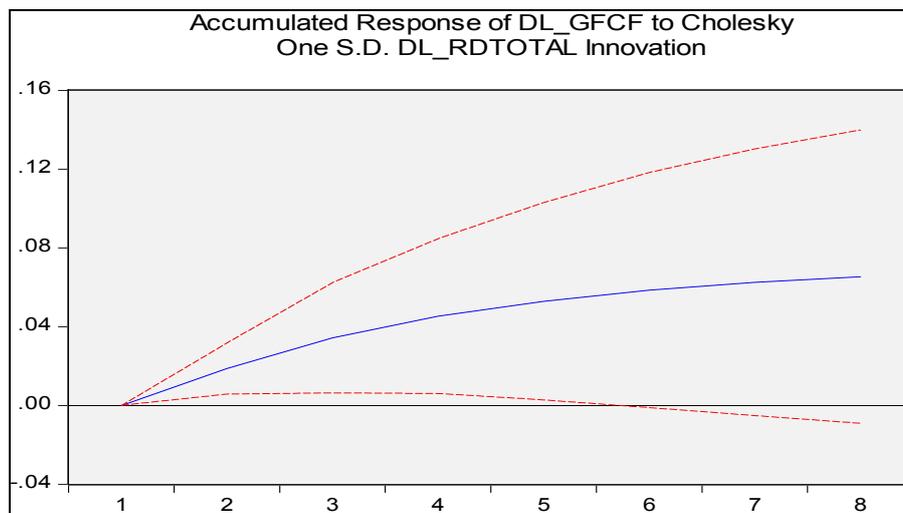
Thus, in Chart 1, the impact of total R&D expenditure on GDP is positive and on an upward trend over the period of observation of eight quarters.

Chart 1 - Impact of total R&D expenditure on GDP



The impact of total R&D expenditure on the fixed capital formation is presented in Chart 2, which is positive and significant and on the rise over the observation period of eight quarters.

*Chart 2 -Impact of total R&D expenditures
over gross fix capital formation*



The impact of total R&D expenditure on GDP and GFCF shown in Charts 1 and 2 shows that there is a strong link, with a strong continuity feature, between the total R&D expenditure and the GDP, and GFCF respectively, which confirms the researches done by Romer (1990), Segerstrom (1990), Grossman and Helpman (1991), Aghion and Howitt (1992) while being in contradiction with the results of Jones (1995). Comparing the trend of total R&D with the one recorded by the economic growth during the same period, we find that an increase in GDP corresponds to an increase in total R&D and, when the economic cycle enters the descending stage, the total R&D begins to decline, with the observation that the private sector began to reduce R&D costs before entering into recession.

Chart 3 - Impact of R&D expenditures made by the business environment on GDP

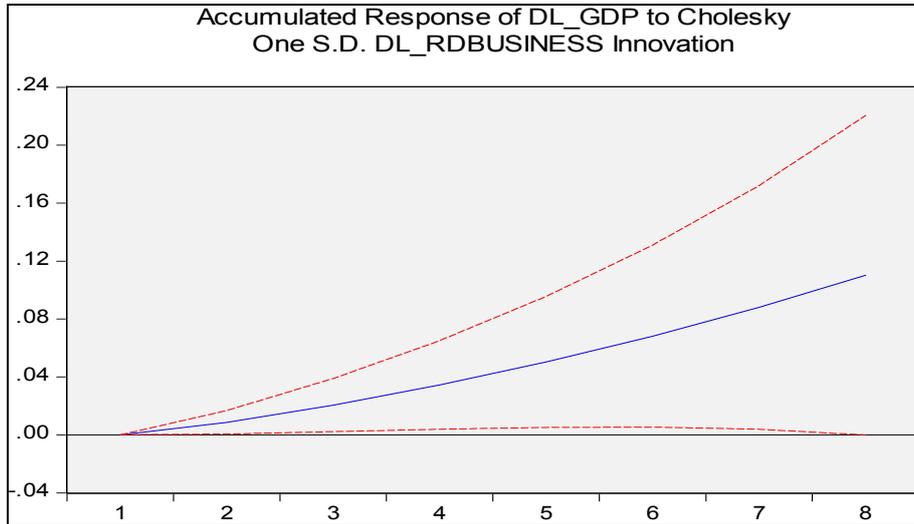


Chart 3 shows the slow progress in the first three quarters of R&D expenditure impact, followed by an accelerated evolution in the next five quarters.

Chart 4 - Impact of R&D expenditures made by government on GDP

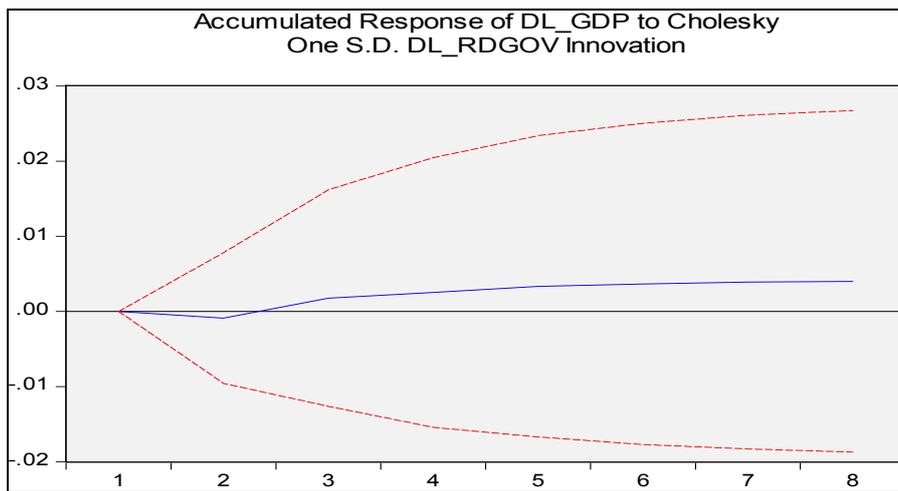


Chart 4 shows a strong impact of R&D expenditure in the first three quarters and a linear trend in the next five quarters.

Chart 5 - Impact of R&D expenditures made by universities on GDP

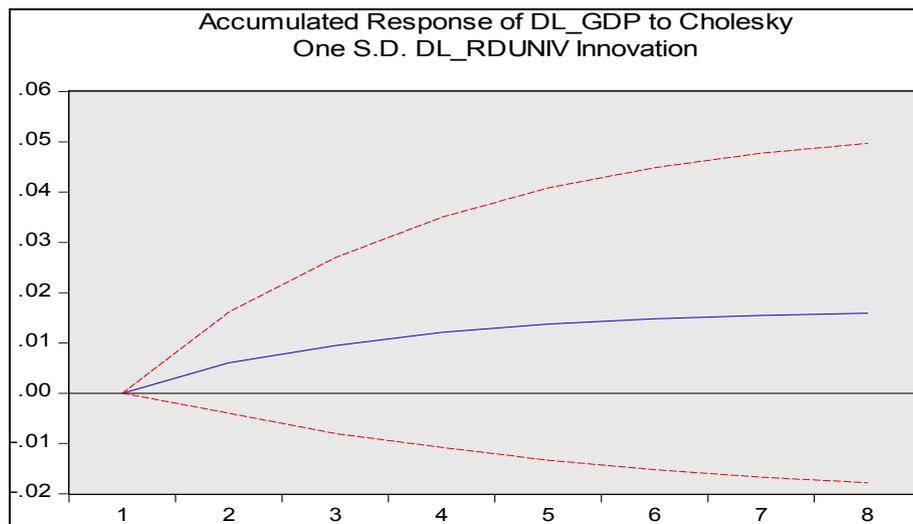


Chart 5 shows that the impact of academic research on the GDP follows a closer projection from the government-funded research environment at the private environment.

The impact of R&D expenditure made by private businesses, government sources and academia on GDP is presented in chart 3, 4 and 5 and confirms a closed link, with a strong continuity feature, for all three funding sources while indicating that growth is slower in the first three quarters for business environment and then accelerates, and in the case of government spending and academic sources the response to impulse is faster but with a lower growth after six quarters, which implies continuity in financing R&D expenditures.

IV.5. GFCF response to an increase in expenditure on R & D

The pattern chosen by us implies a positive and sustainable relationship between the expenditures and development research level and gross fixed capital formation, given that gross fixed capital formation influences the level or potential GDP for the next period.

Chart 6 - Impact of R&D expenditures made by the business environment on GFCF

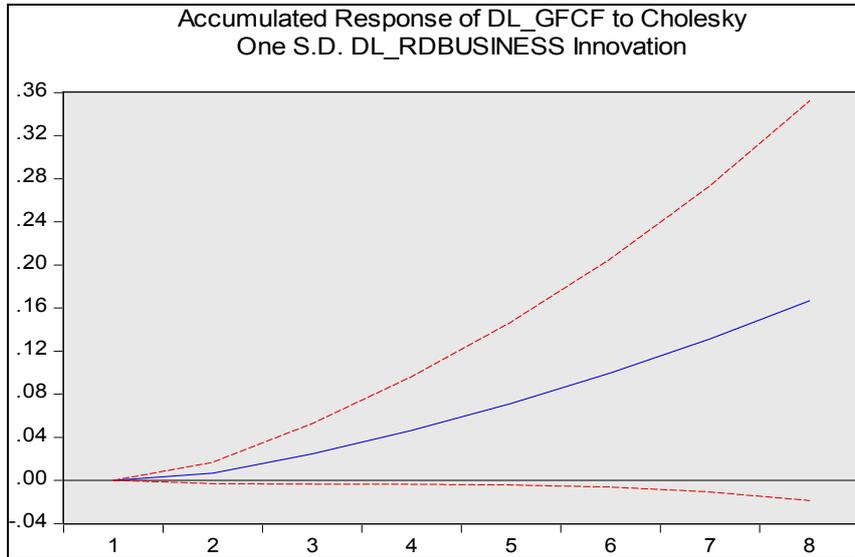


Chart 6 shows a slow progress in the first three quarters followed by an accelerated evolution in the next five quarters.

Chart 7 - Impact of R&D expenditures made by government on GFCF

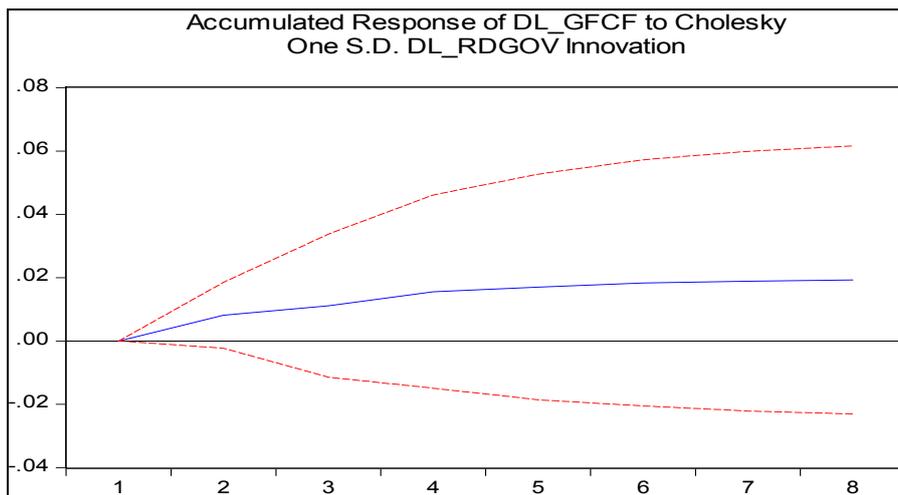


Chart 7 shows a strong impact in the first three quarters and a slow progress in the next period.

Chart 8 - Impact of R&D expenditures made by universities on GFCF

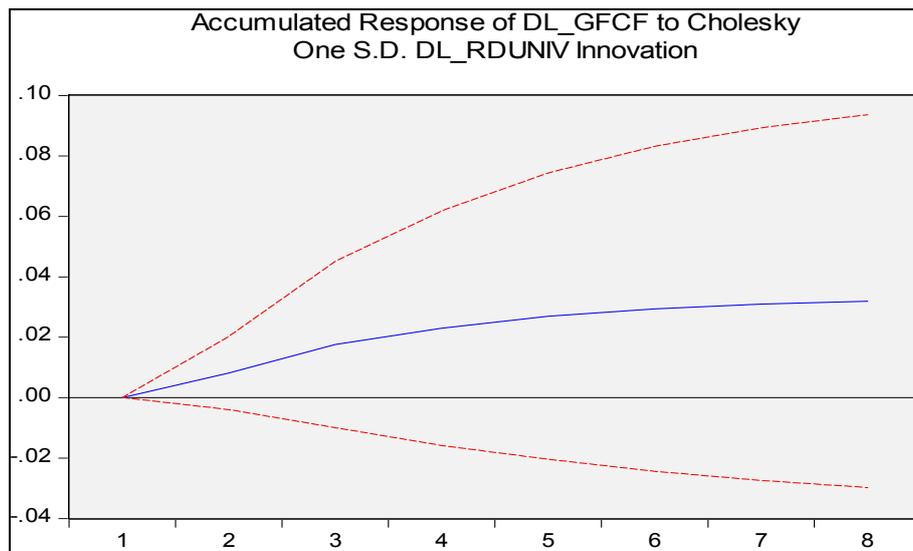


Chart 8 shows that the academic research impact on the GFCF follows a closer path to the governmental environment.

Charts 6, 7 and 8 show the impact of R&D expenditure made by the business environment, government sources and academia on GFCF and confirms a stable and strong connection for all three funding sources indicating that the growth is slower in the first three quarters for the business environment and then accelerates, while government sources' response to impulse is faster but with a slowdown from the fourth quarter while for the academic structures the impact on GFCF is moderate in the first three quarters but afterwards remains high.

V. Conclusions

Our results confirm a strong and stable relationship between R&D expenditures, GDP and GFCF. That is why public policies should be consistent and long lasting, unlike the tendencies in other developed countries; in Romania the volume of R & D expenditures, as well as the number of scientific personnel have

declined especially over the crisis period. On the other hand the contribution of economic private sector to R&D expenditures decreased, whereas in developed countries the private sector has a greater importance in R&D funding.

One of the most difficult problems in the R&D sector is generated by the fact that a good part of the national economy is under the control of subsidiaries and affiliates of foreign companies (multinationals), which are not interested in developing research projects in Romania. Their research usually is carried out by the parent company abroad, respecting the principle of discretionary costs.

Monitoring the R&D expenditures made by the government, private and the academic sectors indicates that the government is contributing with over 50% to the total R&D expenses. It is desirable to change the proportion in which the research sectors participate in R&D spending in Romania since our study reveals a greater impact of the R&D expenditure made by the private sector on GDP and GFCF, which leads to different conclusions from those reached by Morales (2001). In our opinion, in a country situated on the technological frontier and aiming to get "out of the periphery", the private sector can better use technology and knowledge transfer and therefore the results can be highlighted by the growth of GDP and GFCF. Bringing closer the university research to the needs for knowledge and technology felt by the private sector can contribute to raising public and private funds used to capitalize on the development and training potential. During the period 2005-2011 the growth rate of research - development personnel was negative (-2%). The number of researchers decreased both naturally (through retirement) and due to economic reasons (poor financial motivation), small salaries for junior researchers and elimination of PhD benefits for all employees.

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