Role and Impact of Research & Development Activity on Economic Efficiency

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Abstract

Given the underfunding of research so far, we cannot say that everything that has been done already has to be blamed or ignored but for long time, both research institutes or private economic entities have been funded by the state without questioning the economic efficiency of the results. In the near future, the economic efficiency of RDI will be a much debated subject and at certain point new rules will need to be obeyed. Examples of institutional restructuring or a re-evaluation of the management system in RDI are now taking into consideration by numerous states. In this context, this article will analyze Romania's situation as a European country with its results and essentials. We also will analyze the European level of evolution and exigencies in matter of RDI, keeping in mind that cooperation between economic agents and public institutions of research will represent the next level of measuring some "good results".

Key words: scientific knowledge, scientific research, research and development, research programs
J.E.L. classification: I23, O3, D83

1. Introduction

After the international financial crisis, economic growth continues to be, an overriding goal of governmental strategies, both at the EU and international level. Considering that, in this new context of global competitiveness, technological progress is recognized as one of the key elements of a sustainable economic development, a central place in this equation is the RDI (Research, Development and Innovation) sector. The technological process has a great history in the development of human society. From the invention of the steam engine by Watt in 1788 to the construction of more powerful machines today, the RDI process never stopped having results (Hall, B. H., Lerner, J.: 2010).

At this point, everyone knows that supporting the RDI sector is achieved only through a mix of policies and tools that are complementary. Still many countries have difficulties in ensuring an optimal level of public funding the RDI sector. This is also the case of Romania that even a great amount of money goes into this sector, great results are ceasing to appear. One of the most common used policies to encourage the RDI is the involvement of the private sector in specific activities, both from the investment point of view or at an operational level. An effective and alike tool at the fingertips of states is the fiscal incentives that can be defined and implemented so as to successfully contribute to the above-mentioned objective.

We consider this analyze very important due to the serious imbalances recorded by Romania in terms of performance of RDI, especially in the context of regional competitiveness at the level of the European Union.

2. Theoretical background

The concept of scientific research is well-known and used as research and development (Chiesa, Manzini, Pizzuro). Lots of authors conducted numerous empirical studies to analyze RDI and the positive relationship between RDI and economic growth. (Ulku: 2004, Zachariadis: 2004, etc)

The engine of economic and social development for any country is represented by research, development and innovation sector (RDI). The common concern of all countries in matter of science and scientific research appears to be an acknowledgment of their role in ensuring human welfare and civilization (Plumb, Visan, Florescu: 2007).

The new scientific and technical revolution has fundamentally influenced the present era, a time characterized by rapid technology changes, by expanding automation and also by rapidly processing and transmitting information. From household to space, affecting all life, science and technology is growing at an exceptional rate. Some previously established laws may be contradicted by new scientific discoveries, such as atom indivisibility, species theory, etc. It reduces the time between a scientific discovery and its application in practice (Plumb, Visan, Florescu: 2007). For an efficient economic development, a process of continuous modernization is needed. This implies that along with the progress of nations, their competitive advantages are rising. Today, both competitiveness and the economy are not based only on primary production factors such as cheap labor or full access to natural resources but are increasingly based on innovation as a dominant source of competitive advantage, especially on the ability to deliver innovative products and services (Holzinger: 2011).

In order to achieve a level of higher education and scientific research at the European Union level, an acceleration of change in higher education is strongly needed. All of that in correlation with the European Union objectives in order to ensure the quality and visibility of the national RDI sector. The RDI activity is an important factor who contributes to economic and social development and an engine of economic and social progress; science and technology are basic components of modern life and directly help countries to achieve economic and social goals, to achieve sustainable development. Nowadays, in Romania are three RDI systems: the academic system (Romanian Academy and subordinated branch academies); the system of public institutes; the universities. Also, in the current national RDI sector there are other structures with RDI activities, such as:

- state-owned trading companies from former branch institutes;
- private equity companies;
- NGOs and private associations (Vacarel, Bistriceanu, Bercea: 2006).

In 2008, Radu, Badea, Mocuta are stating in their book that "the Romanian RDI system cannot ensure the promotion of industrial development due to its weaknesses", among which we quote the most important:

- very low RDI spending;
- the total or almost total absence of R & D in the business sector;
- the weakness of RDI institutes;
- the attitude and mentality of researchers, who are more self concerned with their career;
- a lack of adequate incentives for RDI;
- a shallow capitalization of RDI results;
- poor endowment of RDI activity;
- a lack of a regular analysis of the real correlation between the needs of the Romanian society and the priority programs as a research direction within the National Program of RDI;
- discouragement of inventive activities by applying excessive fees in relation to inventor's income.

The requested objectives are part of the preoccupations for a thorough investigation of the contribution of national and non-Romanian programs to the financing of R & D activity, as well as the implications of this funding for the national economy.

Following (next table) we analyzed the world wide literature in the field and find that various authors have had made complex researches since 1997.

Table no. 1: Literature review of RDI efficiency

Authors	Data Sets	Methodology	Specification	Key results
Sharma and Thomas, (2008)	UNESCO Institute of Statistics data base, SCI Expanded data base of the web of science, WIPO Statistics data base	DEA approach with constant (CRS) as well as variable returns to scale (VRS).	Inputs: R&D expenditures, researchers, gross domestic product, population Output: patents granted, publications counts	Japan, Republic of Korea, China lie on the efficiency frontier with CRS, Japan, Republic of Korea, China, India, Slovenia and Hungary are found to be efficient with VRS
Wang and Huang, (2007)	WIPO Statistics data, MSTI data base, SCI expanded data base	DEA approach (VRS) and second stage Tobit Regression, Three stage approach according to Fried et al. (1999)	Inputs: R&D net capital stock, researchers, technicians, Output: patents granted, publications counts Environmental Variables: like the enrollment rate of tertiary education, the PC density and the English proficiency	About half of the countries are efficient in their R&D activities, higher education can explain variations in R&D input slacks, increasing returns to scale for two thirds of the countries
Wang, (2007)	WIPO Statistics data, MSTI data base, SCI expanded data base, World development indicators, economic freedom index	Stochastic frontier analysis (SFA), Battese and Coelli (1992, 1995) specification	Inputs: R&D net capital stock, researchers, technicians, Output: patents granted, publications counts Environmental Variables: the PC density, economic freedom index, percentage of R&D performed by the government	External factors affect R&D achievements, PC density and economic freedom index have a significant impact on efficiency differences
Rousseau and Rousseau, (1998)	EPO Patents, Science citation index, UNITED NATIONS, Statistical Yearbook,	DEA approach with CRS, different output and input weights	Inputs: GDP, active population and R&D expenditure Outputs: publications and patents	Switzerland was in 1993 the most efficient and effective country of Europe, closely followed by the Netherlands.
Rousseau and Rousseau, (1997)	EPO Patents, Science citation index, UNITED NATIONS, Statistical Yearbook,	DEA approach with CRS	Inputs : GDP, active population and R&D expenditure Outputs: publications and patents	DEA can be used as a tool to construct performance indicators for governments.

Source: A.Cullmann, J. Schmidt-Ehmcke, P. Zloczysti, *Innovation, R&D Efficiency and the Impact of the Regulatory Environment – A Two Stage Semi-Parametric DEA Approach*

Over the years, scientific research has been subject of debate, but by analyzing all the above research we can conclude that each research process contains several essential steps in order to make a real contribution to the theoretical progress and to facilitate a better understanding of the phenomena studied both by specialists in the field and by the general public.

3. Objective of the study

The main objective of our research is the identification and presentation of optimal financing solutions for the R & D activity, which in the current economic and financial context will ensure the efficiency of its activity and thus the achievement of a sustainable economic development. By using an appropriate methodology of scientific research and a systemic approach, we considered the following objectives specific:
    • establishing the place and role of RDI activity in the economy;
    • permanent connection between the information of the R&D activity and the implementation of its results in the economy;
    • revealing the contribution of information from the research-development activity in terms of efficiency indicators.
   • presenting the main modalities and sources of financing the R & D activity;

• presentation of analyzes, studies and examples for each of the financing modalities presented;
• presenting a case study whose results highlight the importance and efficiency of R & D activity;
• formulating conclusions and proposals based on the results of the scientific research carried out.

From the beginning, the present paper wanted to be a qualitative research but during our investigation, the necessity of expanding research with quantitative elements increased significantly. This will increase the relevance of the research findings and at the same time will eliminate the subjective factors, proved to be more and more stringent.

The motivation for choosing such a research theme is doubled justified. On one hand, the arguments set out in our scientific approach regarding the importance of R & D activity, with a particular emphasis on the current context of harmonization of its approach at EU level, and on the other hand the special importance to be given to its financing, which has also undergone several milestones in recent years to achieve convergence towards international standards, notably through the EU's 1-7 Framework Programs. (Tanislav, Oachesu, Popescu: 2017)

As is showed in the following figure the RDI efficiency is based on his inputs and outputs. The data resulted must be measured in publications with impact, brevets and citations.

Figure no. 1: The RDI inputs and outputs
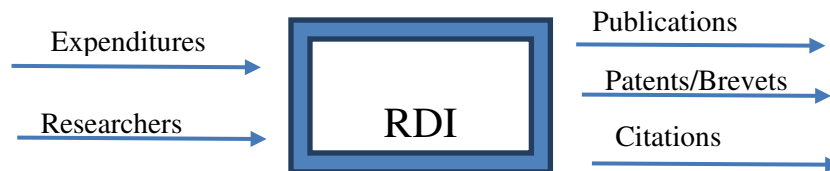

Source: author's own realization

"Knowledge" and "discovery" have laid the foundations of scientific research and those of future scientific fields. There are stages that build through evolution, the history of knowledge and scientific research: the sentimental stage that produced the faith; the rational stage that produced philosophy, and the experimental stage that produced the science itself (1).

4. The Romanian RDI sector and the European exigencies

Over the past 28 years Romania's research and development activity has been seen as a real "Cinderella" of the national economy because either it has been allocated insufficient funds or, when it has received a higher amount of funds, the budget rectifications have taken significant amounts of money from the research budget.

In 2015 the R & D expenditures were on average at the value of 2.03% of GDP, slightly decreasing compared to 2014 (2.04%). As is showed in the following figure Romania is at the bottom of the ranking with a 0,49%. Thus, the target of 3% of GDP set by the Union Europe within the Europe 2020 strategy remains a challenge that still requires engagement by the Member States.

Figure no. 2: Total expenditure for research and development activity % of GDP in 2015
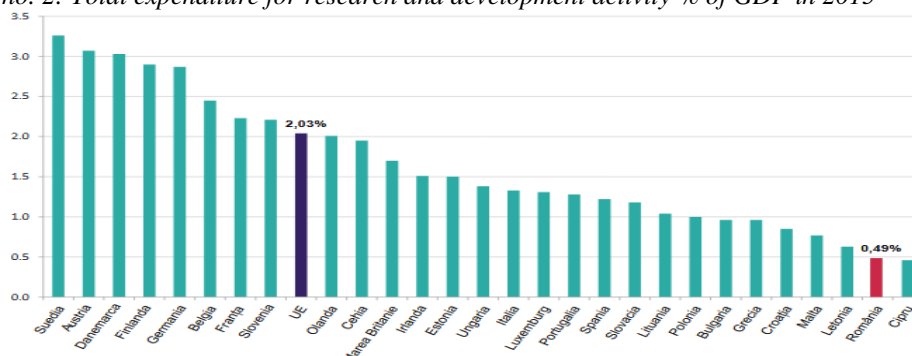
Source: Eurostat data

We analyzed the gross domestic expenditures on research and development, at the European level, to show that Romania is one of the countries that is using its RDI resources inefficiently and will probably be penalized with a growth discount. (Table 2)

Table no. 2: Gross domestic expenditures on research and development

Country Name	2010	2011	2012	2013	2014	2015
France	2,17344	2,18988	2,22579	2,23406	2,23919	2,23135
Romania	0,45196	0,49324	0,48281	0,38694	0,38258	0,48765
Finland	3,72797	3,63639	3,41594	3,29266	3,17663	2,90474

Source: Analyses after http://ec.europa.eu/eurostat/statistics-explained/index.php/R_%26Dexpenditure

As it is showed in the following figure Romania has a very low percent and mainly this is due to the low capital and current expenditures in the four main sectors: Business enterprise, Government, Higher education and Private non-profit.

Figure no. 3: Gross domestic expenditures on research and development
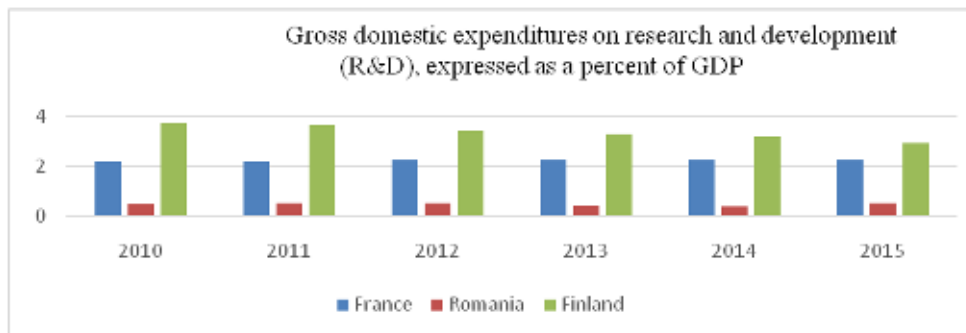
Source: Analyses after http://ec.europa.eu/eurostat/statistics-explained/index.php/R_%26Dexpenditure

It is therefore noted that among EU Member States, Romania allocates resources far below the European average, ranking very close to the last place of the rankings. The situation is more worrying at the EU level because in most countries there is an increase in investment over the period 2007- 2014, while in Romania is decreasing. In this context, the target of 2% of GDP assumed by Romania for expenditures of RDI within the Europe 2020 Strategy seems impossible to be achieved in view of the current rhythm.

Referring now to the situation of Romania, the state with the highest economic growth in recent years at the EU level, and taking into account the primordial role which technological progress is playing in the context of national economies competitiveness at regional level, it is difficult to understand how national policies are currently acting for development of the RDI sector.

This observation must also be interpreted in the context in which the RDI sector is perceived as fueling the sustainable economic growth, in contrast to other less-"healthy" long-term developmental incentives such as consumption.

5. Conclusions

The aim of the reform of the national RDI system is to restructure the connections between science, technology, economy and civil society so as to leave the market to decide on the primary distribution of RDI and to speed up the marketing of results scientific and technological developments. The long term objectives should be:

1. Changing the organizational structure of the national RDI system: a solution could be the re-establishment of ANCS (National Authority for Scientific Research and Innovation).
2. Crossing the RDI themes from the traditional (flawed) model to the emerging model, which calls for transdisciplinary and strategic relevance.
3. Multiplying the funding resources for RDI and improving the financing system: finding new resources and better involvement of the private sector in financing RDI.
4. Changing management system for RDI institutions.
5. Stimulating the formation and functioning of new research organizations (with public or

private capital).
6. Changing the system for evaluating research results.
7. Improving the communication and dissemination system of research results.
8. Stopping the migration / emigration flow of RDI specialists.
9. New instruments to stimulate private investment in this area, either direct (in the form of grants, loans or public procurement) or indirect (such as tax incentives).

Changing the organizational structure of the national RDI system is based on a structural vision that simplifies the components of the system, correlates them efficiently and provides reduced expenditures.One of the disastrous consequences of the economic crisis in Romania was the diminishing of funding for research and development field. Unfortunately this is seen in all the statistics made by Eurostat.

6. Acknowledgement

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