

RESEARCH-DEVELOPMENT AND INNOVATION IN ROMANIA BETWEEN REALITY AND IMPROVEMENT SOLUTIONS

Sandra TEODORESCU*

Mădălina TOCAN**

Oana CHINDRIȘ-VĂSIOIU***

Abstract

Research and innovation contribute to economic growth and, thus, to better living and working conditions in the European Union. For this reason, research and innovation are an important part of policies by which the European Commission seeks to stimulate employment, growth and investment.

Research and innovation provide us with the knowledge and solutions we need for urgent problems, such as epidemics or socio-economic crises, but also for long-term societal challenges, such as transport, climate change or energy.

For this reason, this paper attempts to present the current state of research and development in Romania and also to analyze the level of correlation between the activity of research and development and economic performance of Romania.

Key words: *research, development, innovation, economic growth, competitiveness.*

JEL classification: *E02, O32*

1. Introduction

The aim of this paper is to highlight the role of the research-development-innovation sector (hereinafter referred to as RDI) in Romania and to analyse the links between expenditures for this sector, RDI employees and the evolution of gross domestic product (hereinafter referred to as GDP). In this approach, we started from the idea that economic and social development does not come by itself, but is based on the fruit of the researchers' creative work. That is why scientific research is a very important element for the industrial development, evolution of transport, construction, agriculture and all the domains of activity within a society.

The specialized literature highlights the crucial role that science and technology play in solving the economic, social and environmental problems that determine the unsustainability of the current development model. Reducing the gaps between countries, eradicating poverty and a fair future for all people on the planet impose a new approach that integrates existing scientific knowledge with new ones, the scientists responsibility being to make the general public aware of its contribution to sustainable economic

growth, mitigation negative climate change, accelerating the depletion of resources, understanding demographic trends and sustainable development strategies¹.

The specialized literature mentions innovation as a way to achieve sustainable results, with the condition of an adequate process management of the evaluation and orientation of public and private actors towards technological innovation. Sustainable growth requires a new governance model focused on long-term goals and strategies which mediate conflicts between concerns about short-term profit growth and ensuring a balanced and healthy growth in the long term. Given that the innovation system has a visible international dimension, the absorption and use of new technologies existing worldwide and the management of specific "niche" technologies in the medium term could converge towards a long-term structural change, beneficial for sustainable growth. Arie Rip (2002) conceptualized the interaction between technology and society in terms of "co-evolution of societal and technological systems". The innovation system can speed up or slow down the achievement of sustainable development depending on the solidity of the interconnections and the existence of feedbacks between the technical-scientific and the social aspects².

* Associate Professor, PhD, Faculty of Economics and Business Administration, "Nicolae Titulescu" University of Bucharest (e-mail: sandra.teodorescu@univnt.ro).

** Associate Professor, PhD, Faculty of Financial Management, Ecological University of Bucharest, Scientific Researcher III, Institute of National Economy - Romanian Academy (e-mail: madalina.tocan@gmail.com).

*** PhD, Scientific Researcher III, Institute of National Economy - Romanian Academy (e-mail: oana.vasioiu@gmail.com).

¹ https://www.researchgate.net/profile/IoanFrancValeriu/publication/316038351_Sistemul_national_al_CDI_si_contributiile_sale_la_asigurarea_dezvoltarii_durabile/.

² Rip A., Science for the 21st century, in: Tindemans, P., Verrijn-Stuart, A., Visser, R. (Eds.), The Future of Science and the Humanities, Amsterdam University Press, Amsterdam, 2002, pp. 99-148.

2. Area of scientific research

Scientific research represents the search, production, promotion and application of the scientific research and scientific knowledge's, in order to solve theoretical and/ or practical problems. The principles of scientific knowledge are: logical consistency, objectivity, repeatability and social responsibility. Knowledge is usually expressed in sentences that are given a value of truth. Accidentally discovered or as a result of a search activity, the knowledge must then be organized in a structured system of scientific knowledge.

The scientific research distinguishes between the fundamental research, applied research and research for development, innovation and technology transfer. The fundamental scientific research (theoretical or experimental, exploratory or strategic / oriented) means the search, production and dissemination of basic scientific knowledge. Knowledge which refers to rules and principles are the defining results of the fundamental research. As a general rule, they are expressed / submitted for academic debate in publications. Fundamental research can be exploratory (especially associated with theoretical problems) or strategic (especially associated with distal practical problems). Fundamental research also formulates and verifies hypotheses, models and theories on phenomena and processes of a theoretical or practical nature. Applied scientific research represents the incorporation of fundamental scientific knowledge and that empirically obtained into a finished product, process or service that can, in principle, have market value. In this case, the knowledge refers to the application to specific contexts of the knowledge resulting from the fundamental research. The results of applied scientific research are also disseminated through publications. Applied research can be translational (utilize the results of fundamental research to solve practical problems) or practical (seek solutions to well-defined practical problems).

If the knowledge is sufficiently proceduralized to express itself in completed products, technologies and services, we are talking about research and development, whose result is expressed in publications and / or patents and prototypes. The transformation of scientific knowledge from publications, patents and prototypes into products, economically and socio-culturally assimilated technologies and services represents innovation through knowledge transfer and dissemination, process in which scientific research and researchers are only a component alongside the socio-economic environment (*e.g.*: industry, users, policy makers, etc.). Thus, development and innovation

represents the process of bringing from the stage of product, technology or service obtained by applied research, directly or through technology transfer, to the level of entry into production to become a product, technology or service, respectively, a service with a market value.

Innovation is a fundamental mechanism of competitiveness and excellence. Innovations, as part of high-performance research, are understood in three directions: theoretical, methodological and practical. Innovation means the generation of new scientific constructs, methodologies, new creations and / or products / services / technologies, recognized and assimilated in the national and international scientific and socio-economic community, which set standards and / or change practices in the field.

Research- development and innovation play a key role in generating smart and sustainable growth and creating jobs. By producing new knowledge, research is essential for the development of new and innovative products, processes and services that increase productivity, industrial competitiveness and, ultimately, prosperity. The importance of productivity in stimulating sustainable growth and consolidating Europe's economic recovery has been widely recognized³. The increasing of the labor productivity depends on the ability of the economy to invest more in the available capital for each worker, namely to increase capital intensity, and to increase efficiency by combining factors of production, namely multifactorial productivity⁴. For countries with a high level of GDP per capita, RDI, skills and technological development have a fundamental importance for multifactorial productivity. For the emerging countries, it is also essential to start reducing the productivity gap. Along with better regulatory and institutional frameworks and efficient market functioning, RDI systems are a key to increasing the efficiency of a country's combined use of labor and capital. RDI systems are complex ecosystems that require several elements in order to function optimally. These elements include a solid public science base that produces high quality results, an intense participation of enterprises in innovation activities, fluid and abundant knowledge flows between RDI actors and good framework conditions for the development of innovation.

3. RDI sector in Romania

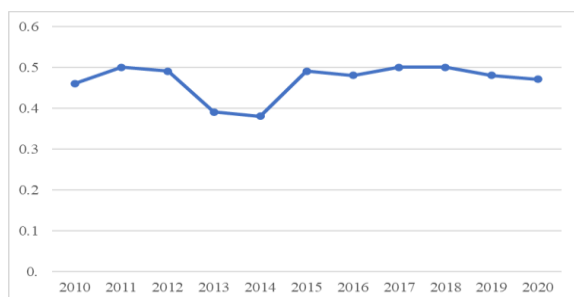
The most important premise of the RDI sector development, the engine of innovation in any economy, is the investments targeted to various relevant activities. According to the OECD, the expenditures on

³ OECD, The future of productivity, 2015.

⁴ Forumul Economic Mondial, Raportul privind competitivitatea globală 2016-2017, 2017.

RDI activities represent an indicator of a country's efforts to boost innovation⁵. These activities mainly cover three areas: fundamental research, applied research and experimental development. The indicator used to measure the intensity of specific activities is the total expenditure on research and development as a percentage of GDP. It represents a percentage of the expenditures made by all performance sectors of a country for research and development, relative to gross domestic product (GDP), and provides the level of financial resources allocated to research and development in a country's economy⁶. The indicator has the advantage of allowing comparisons between states, which is particularly important in the context of highlighting the role that RDI plays in the economic growth of nations. In this section, we will focus on the analysis of the Romanian RDI expenditures as a percentage of GDP in the last decade, adding some comments regarding the place occupied by Romania in the ranking of the European Union countries.

Figure 1 – RDI expenditures as a % GDP in Romania



Source: authors' processing according to Eurostat data, <https://ec.europa.eu/eurostat/data/database>

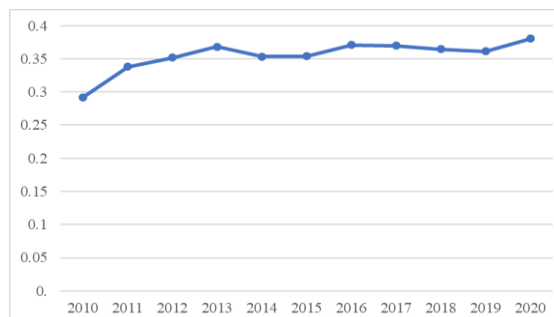
Last year, Romania recorded the lowest share of RDI expenditures as a percentage in GDP in the last six years, according to Eurostat data. Our country ranks last in the EU with a percentage of only 0.47%. In order to have a better picture, it is worth mentioning that the value of RDI expenditures in 2020 was below the post-accession level of 0.55%, recorded in 2008 and from the Eurostat data series, the highest level for our country was recorded in 1995 (0.75% of GDP)⁷.

A particularly relevant indicator of the research-development-innovation sector is represented by the number of employees assigned to these types of activities, starting from the premise that researchers represent the backbone of this sector. Researchers are

those professionals involved in designing and creating new knowledge, products, processes, methods and systems, being directly involved in management processes⁸.

There are important studies that have tested a positive correlation between the number of researchers in the RDI area and the growth rate of innovative results, but also a reverse determination, in the sense that investment in innovation leads, in addition to increasing productivity, to a significant increase in employment⁹. According to the European Commission, the share of researchers in the total number of employees is an indicator of the economy structure, as well as its degree of development, being strongly correlated with the production of innovative results at the national level. Thus, the countries with high shares of RDI expenditures in GDP also tend to be leaders in innovation¹⁰.

Figure 2 – RDI employees in total active population Romania



Source: authors' processing according to Eurostat data, <https://ec.europa.eu/eurostat/data/database>

Over the last decade, the RDI workforce has had a slightly upward trend of only 0.07% (from 0.29% in 2010 to 0.38% in 2020). It is important to point out that Romania also ranks last in the European Union in terms of full-time research personnel. We specify that it were analyzed the persons employed full time in the RDI sector.

4. The analysis of the relationship between RDI and Romania's economic growth

Starting from the models of endogenous economic growth, in this last part of the paper, we intend to analyse the correlation between the evolution of Romania's GDP, expenditures and the number of

⁵ OECD, Science and Technology, OECD Factbook 2016.

⁶ www.insse.ro.

⁷ <https://ec.europa.eu/eurostat/data/database>.

⁸ Griffith, R., Redding, S., & Van Reenen, J., *Mapping the two faces of R&D: Productivity growth in a panel of OECD industries*, Review of economics and statistics, 86(4), 883-895, 2004, p.22.

⁹ Pianta, M., *New technology and Jobs*. In J. Michie, and J.G. Smith, *Globalization, Growth and Governance: Creating an Innovative Economy*, Oxford University Press, United States, 1998.

¹⁰ European Commission, *Science, Research and Innovation performance of the EU*, 2016.

employees from the RDI sector. Romer mathematically formalized the idea that knowledge leads to continuous economic growth, which marked a new theoretical approach to the analysis of economic growth factors, the so-called endogenous growth¹¹. In Romer's model, the growth is based on the results of research and development, embodied in technological change, which companies use to maximize profits. In this regard, a Romer point out that technology is different from all other goods, as it is uncompetitive and is a partially an exclusive good. Endogenous growth models, based on research and development, in a way follow Schumpeter's idea of the importance of creating organized knowledge in generating economic growth¹². The basis of these approaches is based on the idea of creative destruction¹³. What motivates individuals to engage in research and development is their perception that such activity will provide additional profit¹⁴.

The neoclassical growth theory is based primarily on Robert Solow's model, developed in the mid-1950s¹⁵. Solow concluded that about 50% of historical growth in the industrialized countries could not be attributed to the increasing use of physical capital and labour, but to the third factor, the so-called residual¹⁶. The residue includes all intangible growth factors, such as the development of existing means of production and the creation of new means of production, changes in employee education and expertise, research and development, changes in organization and production methods.

Defining contextual indicators and models applied

According to previous studies, research and development expenditures and the number of employees in the RDI sector are the tools used to measure the intensity of innovation. In this context, these parameters will be used to test the hypothetical model.

To analyse the impact of RDI sector on Romania's GDP, research was conducted using the Eurostat data and a statistical method (multiple regression).

The purpose of multiple regression is to highlight the relationship between a dependent variable (endogenous) and a set of independent variables (exogenous, predictors). The function between Y (the dependent variable) and X (the p -dimensional covariate) relies on a finite number of parameters to be

estimated. The most popular parametric regression model is the linear regression model

$$Y = \alpha + \sum_{j=1}^p \beta_j X_j + \varepsilon,$$

where $\beta_j \in \mathbb{R}$, $j = 1, \dots, p$ are the parameters to be estimated and ε is a random error term.

To interpret correctly the parameters, we use logs for variables, i.e. log-log multiple regression model. Both the dependent variable and independent variables are log-transformed variables. The interpretation is given as an expected percentage change in Y when X increases by some percentage.

For the analysis of data to be further developed, we get the following general linear model:

$$\text{Log GDP}_t = \alpha + \beta_1 \text{LogExp}_t + \beta_2 \text{LogEmployee}_t + \varepsilon,$$

where t is time in years.

The specific, RDI indicators we analysed are the predictors, i.e.:

- Exp_t : is the RDI expenditure in Romania.
- Employee_t : is the number of employees in RDI in Romania,

and GDP_t , is the gross domestic product (GDP) in Romania, is the dependent variable.

After plotting the correlation matrix we can see whether multi-collinearity occurs between the variables. The analysis of the sample correlation presented below clearly illustrates there is no multi-collinearity. So, between the RDI expenditure in Romania and the number of employees in RDI departments in Romania the correlation coefficient is $r_{\text{Exp};\text{Empl}} = -0,19$, so the model is correctly fitted and, respectively, the strong relationship between GDP and the two of indicators ($r_{\text{GDP};\text{Exp}} = 0,9832$ and respectively, $r_{\text{GDP};\text{Empl}} = 0,9832$) allows the estimation of a significant linear model.

Estimation of Regression Equation

Based on statistical data for 2000-2020 log-log regression equations showing the relationship between GDP and each predictor were developed, illustrating strong correlations, along with the analysis and the regression model.

¹¹ Romer, P., *Growth based on increasing returns due to specialization*. American Economic Review, 77, 1987.

¹² Schumpeter, J., *Capitalism, socialism, and democracy*. New York, NY: Harper, 1932.

¹³ Ayres, R., & Warr, B., *The economic growth engine – how energy and work drive material prosperity*. Cheltenham: Edward Elgar Publishing, 2009.

¹⁴ Ruttan, V., *Social science knowledge and economic development – an institutional design perspective*. Ann Arbor: University of Michigan Press, 2004.

¹⁵ Solow, R., *A contribution to the theory of economic growth*. Quarterly Journal of Economics, 70, 65–94.10.2307/1884513, 1956.

¹⁶ Solow, R., *Technical change and aggregate production function*. Review of Economics and Statistics, 39, 312–320.10.2307/1926047, 1957.

Table 1 presents regression results. Based on regression results, the explanatory power of the model is highly significant $R^2 = 0.98$ and there is no multi-collinearity.

| Regression Statistics | |
|-----------------------|----------|
| Multiple R | 0,992006 |
| R Square | 0,984076 |
| Adjusted R Square | 0,982307 |
| Standard Error | 0,031274 |
| Observations | 21 |

Table 1 – Regression Results

| | Coefficients | Standard Error | t Stat | P-value | Lower 95% | Upper 95% |
|------------------------|--------------|----------------|----------|-----------|-----------|-----------|
| Intercept | 1,159575 | 1,213769 | 0,95535 | 0,3520561 | -1,39046 | 3,70961 |
| Log Cheltuieli C-D | 0,855726 | 0,026882 | 31,83262 | 2,81E-17 | 0,799249 | 0,912203 |
| Log Forta de munca C-D | 0,351578 | 0,264075 | 1,331354 | 0,1996893 | -0,20322 | 0,90638 |

$$\text{LogGDP}_t = 1.145162 + 0.855726 * \text{LogExp}_t + 0.351578 * \text{Employee} + \varepsilon$$

Figure 3 presents the regression of the logarithm of the RDI Employees on the log of GDP.

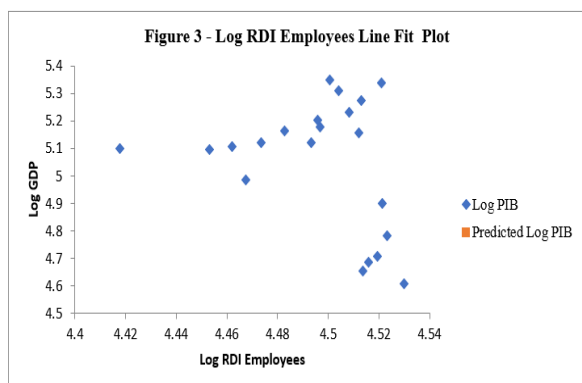
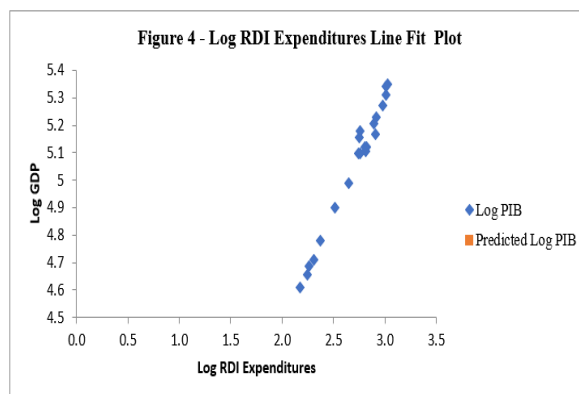


Figure 4 presents the regression of the log of the RDI Expenditures on the log of GDP.



5. Conclusions

Starting from the endogenous growth models, the aim of the paper was to examine the effects of RDI expenditures and the number of employees in the RDI sector on Romania's economic growth.

The working hypothesis was whether the investment in research and development in the period 2000-2020 in Romania had a positive effect on economic growth. To this end, we constructed a multiple regression model, in which the dependent variable was the economic growth rate, and the independent variables were research and development expenditures as a and the number of employees in the RDI sector.

The result of the regression model shows that there is a positive and significant relationship between the RDI expenditures, number of employees and growth rate of GDP. For this reason, it should be taking into consideration the fact that emerging economies, such as Romania, in order to obtain economic growth, should increase their research and development activities. The experience of developed countries has shown that countries that are leaders in innovation and research and development have higher economic growth than other non-leading economies.

The re-launch of research and innovation depends decisively on the public investments in research and development, a chapter in which Romania ranks last in the European Union. Romania reaffirms strategic option to increase public RDI spending to reach 1% of GDP by 2027. Public investment in RDI will support private sector innovation drive through a wide range of private-public partnerships, attracting and training talent, cross-sectorial mobility, developing the technology transfer capacity of public research organizations and engaging enterprises in addressing societal challenges.

Increasing the competitiveness of the Romanian economy through innovation can also be achieved by

supporting the performance of economic agents and increasing their competitiveness based on innovation. This involves developing the ability of companies to absorb state-of-the-art technology, to adapt these technologies to the needs of the markets they serve, and to develop, in turn, technologies or services that allow them to progress in value chains.

As future research we intend to perform a more complex correlation analysis, using a large number of variables that characterize the RDI system in Romania, with a view to identify the most important factors which influence the economic growth.

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