THE DYNAMICS OF R&D HUMAN RESOURCES IN ROMANIA WITHIN THE EUROPEAN CONTEXT

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ABSTRACT

This study investigates the dynamics of R&D human resources in Romania and in EU. The general approach is focused on identifying what are the causes – especially the managerial ones – that determine a certain distribution of wealth among countries and a certain proactive – intensive response (mainly R&D activities) to the challenges implied by the shifting to the knowledge-based economy. The methods we used to tackle these issues comprised a study of the most influential trends regarding R&D human resources in Romania during a 8 year period (2003 - 2010) and cross-country research at EU level that focused on investigating the correlations between the economic development level and measures like: R&D personnel share in total employment and R&D labour cost by performance sectors (government sector and business enterprise sector). Also, we have enriched our endeavor by applying a previously developed methodology of ranking and grouping EU states as regard to the intensity of R&D activities, thus generating a conceptual and empirical platform for accomplishing synergy effects between several works that focus on various aspects of the Romania´s R&D specific within the European Union.

KEYWORDS: *R&D management, R&D personnel, European Union, Knowledge-based economy*

JEL CLASSIFICATION: *M50, O32, O47, O52*

1. INTRODUCTION

Knowledge has become one of the most influential factors as regard to competitiveness, productivity growth and economic development, thus being one of the main pillars that support shifting to the new economic paradigm – the knowledge-based economy. As the changes we are facing comport a systemic magnitude, the turbulence and uncertainty are increasing to such a high degree, that the short-term solutions are no more effective and acceptable, therefore a veritable response to these challenges is forced to address the structural aspects of the economic governance, both public and private. One of the definitions that addresses the issue of the new economy states that *"knowledge-based economy is characterized by the transformation of knowledge in raw material, capital, products, essential production factor for the economy, and by economic processes in which the generation, selling, acquisition, learning, stocking, developing, splitting and protection of the knowledge become predominant and decisive for long term profit gaining and sustainability assurance"* (Nicolescu, 2011). As R&D is one of the most important sources of marketable knowledge that could actually materialize in present and future added value, it is an imperative to foster these activities, especially in the private sector.

In order to make our point even more persuasive, EU´s strategic approach (EU 2020 Strategy) could be used as a proxy for this paradigm shift. Therefore, it aims for creating a smart, sustainable and inclusive economy, advancing at the same time 3 priorities, 5 objectives and 7 flagship initiatives, that are in a large extent linked to the issue of research and experimental development (2 out of 3 priorities – smart and sustainable economy, 2 out of 5 objectives – R&D and climate/energy, and 3

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out of 7 flagship initiatives – Innovation Union, Resource efficient Europe and An industrial policy for the globalization era).

As human resources is one of the most important element in fostering R&D, because of it is the source and resource for creativity and innovation at organizational level, this study will focus on the identification of the most relevant tendencies regarding R&D human resources in Romania during a 8 year period (2003 - 2010), both in an aggregate and structured (by performance sectors and types of personnel) perspective. Also, in order to ensure a better understanding, we put Romania in the context of the European Union, thus investigating the correlations between the economic development level (GDP per capita) and the following measures: (1) R&D personnel share in total employment and (2) R&D labour cost by performance sectors (government sector and business enterprise sector).

2. THEORETICAL FRAMEWORK

The literature that tackles the issue of R&D investments emphasizes that the importance of collaboration among organizations (Kesavayuth, 2012) and the size of the funds allocated for the project (Schwartz, 2012), is positively correlated with the success rate of the R&D project. In other words, there is a point in nurturing the collaborative behavior of organizations in the field of R&D activities, thus ensuring the critical mass needed for a professional risk management of the projects (a risk - reward ratio bearable). Also, in the context of the financial and economic crisis, the theoretical debate addressed the issue of efficiency in using governmental funds, therefore the attention was focused on the assumption whether *"public R&D subsidies crowd out private R&D investments"*, in the end concluding, based on empirical evidence, that the *"funded firms are significantly more R&D active than non-funded firms"* (Aerts, 2008).

Also, a lot of efforts were spent for researching the influence of the corporate governance on the propensity to perform R&D activities, both internally and externally. While it is common sense that the quality of the management is positively correlated to the organizations´ capacity to conduct R&D projects, the theoretical literature comes with empirical evidence, thus highlighting that in order to *"enhance companies' innovation and R&D capabilities, need to improve their corporate governance"* (Dong, 2010). One of the papers that studies the relationship between management and R&D intensity of organizations, advances the following findings: *"(1) the presence of CEO incentive schemes increases both corporate innovation effort and innovation performance; (2) sales-based performance measure in the incentive scheme, as compared with profit-based performance measure, is more conducive to firm innovation; and (3) CEO education level, professional background and political connection are positively associated with firm's innovation efforts"* (Lin, 2011). Other authors get a step forward and actually make proposals of measures that are aimed to foster the development of R&D capabilities: (1) improving the quality of corporate management in SMEs and (2) incentivizing the collaborative and cooperative behavior of organizations (Martinez-Roman, 2011). There are also papers that say the same thing in a more conceptualized manner, thus highlighting that *"the perspective on managing R&D processes has changed over the years, moving from a technology-centered model to a more interaction-focused view"* (Nobelius, 2004).

Also, it is important that we place this paper in the context of our previous works, as it comes to complement and deepen the analysis of the R&D activities at the European level. Therefore, a recent study of ours (Lavric, 2012) is underlying that at EU level, there are three groups of states, that differ one from another in terms of structure and intensity of R&D: (1) high R&D level (Finland, Sweden, Denmark, Germany and Austria); (2) medium R&D level (France, Slovenia, Belgium, Netherlands, Ireland, Great Britain, Estonia, Portugal, Czech Republic, Spain and Italy); and (3) low R&D level (Hungary, Lithuania, Poland, Malta, Slovakia, Bulgaria, Latvia, Cyprus and Romania). In this context, Romania, as a country with a low R&D level, in order to converge to the living standards of western economies, is doomed to foster private investments in applied research

and experimental development. In this context, *"an efficient incentive scheme for R&D activities in Romania could imply: a focus on R&D expenses, containing both capital and current expenses, a benefit in form of an additional deduction for eligible R&D expenses, a flat rate system and size differentiation"* (Popa et al., 2012). In terms of the highly important objectives for innovation, both in the European Union and Romania, there is a positive correlation between the size of organizations and the internationalization-related objectives: improving the quality of goods or services, the need to increase the range of goods or services and the entering new markets or increase the market share (Popa, Lavric, 2013). We also identified a correlation between the intensity of non-financial relative incentives and the per capita gross expenditure for R&D funded by private enterprises, therefore highlighting *"the great influence of the private sector in funding R&D on the perception of success in R&D projects, leading to a more creativity-oriented managerial approach in private organizations"* (Popa, Lavric, 2013). In order to shift the paradigm to the issue of the human resources, this finding suggests that *"the existence of a consistent base of employees that are willing, trained and capable of creative work, creates the premise for multiplying opportunities to invest in R&D"*.

3. METHODOLOGY

Our study is based on the statistical data series regarding R&D in the European Union, with an emphasis on Romania. The data sources used is the Science and technology database from Eurostat. The EU states that were investigated in this work the following: Bulgaria (BG), Czech Republic (CZ), Denmark (DK), Estonia (EE), Spain (ES), France (FR), Croatia (HR), Italy (IT), Latvia (LV), Lithuania (LT), Hungary (HU), Poland (PL), Portugal (PT), Romania (RO), Slovenia (SI), Slovakia (SK) and Finland (FI). The measures that are used in this paper are the following: number of R&D personnel, number of researchers, GDP per capita, total R&D expenses and R&D labour costs. Actually, the main issues that we study are the characteristics of human resources that are employed in research and development activities, as they are defined by the OECD methodologies (OECD, 2002) – the standard used by both Eurostat and the Romanian National Institute of Statistics. Therefore, the analysis and the results of this paper should be read and understood within the limits of the following conceptual framework:

- R&D (research and experimental development) *"comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications"*.
- R&D personnel – *"all persons employed directly on R&D should be counted, as well as those providing direct services such as R&D managers, administrators, and clerical staff."* It is composed of (1) researchers, (2) technicians and equivalent staff, and (3) other supporting staff.
- Researchers – *"professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems and also in the management of the projects concerned."*
- Technicians and equivalent staff – *"persons whose main tasks require technical knowledge and experience in one or more fields of engineering, physical and life sciences or social sciences and humanities. They participate in R&D by performing scientific and technical tasks involving the application of concepts and operational methods, normally under the supervision of researchers. Equivalent staff perform the corresponding R&D tasks under the supervision of researchers in the social sciences and humanities."*
- Other supporting staff – *"includes skilled and unskilled craftsmen, secretarial and clerical staff participating in R&D projects or directly associated with such projects."*

In investigating the R&D human resources in Romania, the approach we used was focused on identifying the main trends during a 8 year period (2003 - 2010), both in an aggregate and structured (by performance sectors and types of personnel) perspective. In order to examine the European context, we have studied the correlations between the economic development level

(GDP per capita) and the following measures: (1) R&D personnel share in total employment and (2) R&D labour cost by performance sectors (government sector and business enterprise sector). After analyzing the data, our study continues with the conclusions, formulating in the end some appropriate measures regarding R&D human resources that are to be taken in order to stimulate overall level of R&D activities through the private enterprise sectors.

4. RESULTS

4.1. R&D human resources in Romania

Romania, as one of the EU member states with low R&D intensity, registered in 2010 a gross R&D expenditure, expressed as percentage of GDP, of 0,47%, while the EU average was 2,00% (4,3 times higher). In order to converge and even to catch-up, Romania has to put in practice programs that stimulate R&D activities on a competitive base, therefore, the private enterprises are the ones that should assume the initiative and leadership to research, develop and innovate. As a matter of fact, successful R&D involves inherently highly qualified, creative and motivated human resources. In the context on our research, the total number of R&D employees, the analyzed period (2003-2010) shows a decrease of almost 21%, from 33.077 to 26.171 persons (an average 3,29% annual decline rate). While someone could argue that it is the general trend in Romania that the number of employees (full time equivalent) is falling, there is a difference in terms of amplitude. Therefore, the total number of employees dropped by 3,33% over the analyzed 8 year period, from 4.384.275 to 4.238.133 persons in 2010 (an average 0,48% annual decline rate), thus being an almost 7 times smaller change. It is indeed true that, by considering the 2008 maximum in the number of employees (4.806.042 persons), the difference is only twice smaller. The gap in the dynamics of these trends materialize in a change in the share of R&D workers in the total, therefore, this proportion went from 0,75% in 2003, to 0,62% in 2010 (a decrease of 0,13 percentage points).

It is interesting that, although there was a consistent decrease in the number of total R&D employees, the number of researchers remained almost the same – dropping by just 1.185 persons, from 20.965 in 2003, to 19.780 persons in 2010 (an aggregate decrease of 5,65% over the analyzed 8 year period, respectively an average annual decline rate of 0,83%). The share of researches in the total number of employees almost stagnated at the level of 0,47%. In this context, the growth differential leads to consistent changes in the structure of R&D workers as regard to the type of employees. Therefore, the percentage in the total R&D workers of the employees that are engaged in the conception or creation of new knowledge, products, processes, methods and systems and also in the management of the projects concerned, increased by 12,20 p.p. (from 63,38% to 75,58%).

Regarding the structure by performance sectors (business enterprise sector, government sector, higher education sector and private non-profit sector) there has been a significant change during the analyzed period (Figure 1) even in terms of hierarchies. While in 2003 the largest share was registered in the business enterprise sector (51,22%), being followed by the government sector (28,40%), higher education field (19,76%) and the private non-profit sector (0,61%), in 2010 the changes encountered are massive and counterproductive: an increase of +14,83 p.p. in the higher education sector and +4,85 p.p. in the government sector, and a decrease of -19,62 p.p. in the business enterprise sector and -0,07 p.p. in the private non-profit sector. As the public sector comprises both the governmental and higher education sectors, this component went up from a share of 48,17% in 2003 to a level of 67,85% in 2010 (an increase of 19,69 p.p.), thus being in contrast with the private sector. The trend that is recorded in the last 8 years is quite a negative one, because our previous works (Lavric, 2012) emphasize that the economic development and wealth creation are positively correlated with the amount of gross R&D expenses, and, in order to stimulate the overall R&D activities, the prior actions must address the private sector. In these terms we could conclude that during the 2003-2010 Romania registered a negative evolution in the context of the need for real convergence to the EU development level.
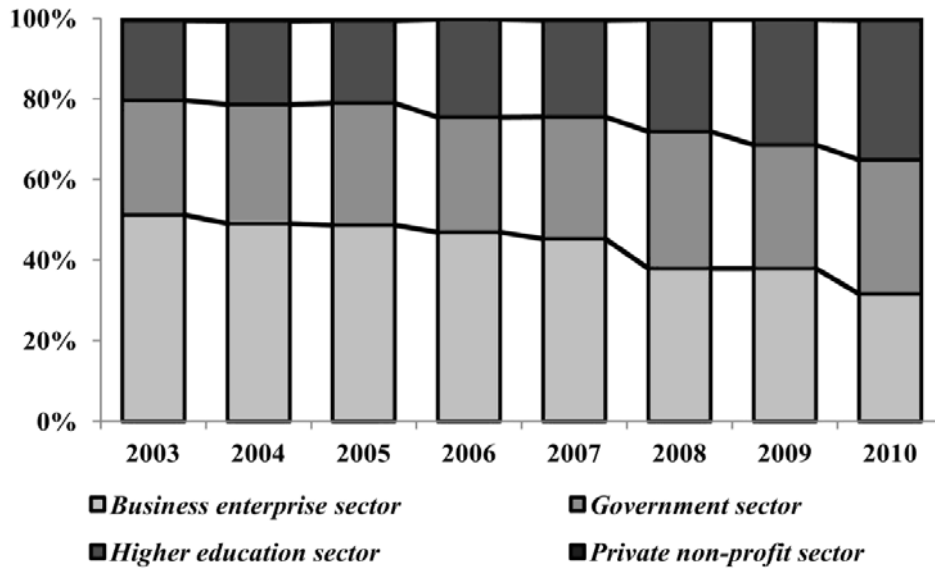
Figure 1. Romanian R&D human resources by performance sector
Source: own calculations based on Eurostat data

4.2. R&D human resources in the European Union

At EU level, in terms of R&D human resources there are some interesting findings. For example, there is a positive correlation between the share of R&D personnel in the total number of employees and the level of GDP per capita (million Euros). If we compare the average values of these three categories, countries with high R&D level have a share of the R&D personnel in the total of 4,17%, that is 1,94 times larger than in the case of medium R&D group and 3,36 times larger as compared to the least developed countries. The correlation between these two indicators is presented in Figure 2, were we see that the relationship is really strong and consistent.
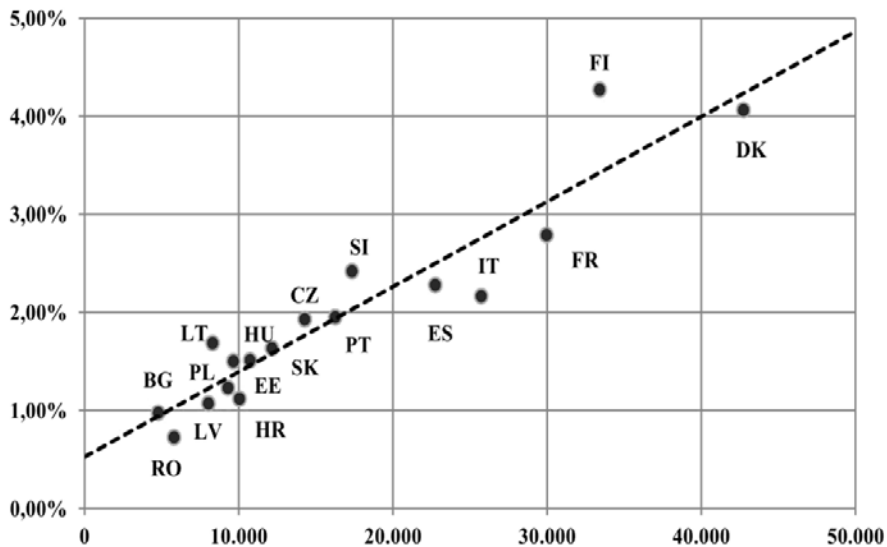

Figure 2. R&D personnel share in total employment and GDP per capita correlation in EU
Source: own calculations based on Eurostat data

Although the correlation does not necessarily imply causality, the relationship we have identified during our research is the result of a reciprocal influence of R&D activities intensity and the development level of countries (especially in economic terms). In this context, there arises a question regarding the proportionality of evolutions in terms of R&D personnel, R&D volume of

investments and GDP per capita. In order to do so, we will analyze the correlation between the costs of labour for R&D personnel and the GDP per capita as a genuine proxy for measuring the level of development o a certain economy. In tackling these issues with econometric tools, we identify a strong positive correlation between the average labour costs per employee (in R&D activities) and the per capita GDP (Euros). What is interesting about this relationship is that the average labour costs per employee increases faster than the development level. This evolution is relatively clear pictured by the coefficients resulted from an econometric regression, were the trend line has the following equation: $y = 2,03x - 4.708,1$; with an R^2 of $0,9513$.

Table 1. R&D human resources by performance sectors and intensity of R&D

R&D INTENSITY	HIGH R&D INTENSITY	MEDIUM R&D INTENSITY	LOW R&D INTENSITY
2010	**Denmark, Finland**	**Czech Republic, Estonia, Spain, France, Italy, Portugal, Slovenia**	**Bulgaria, Latvia, Lithuania, Hungary, Poland, Romania, Slovakia, Croatia**
GDP per capita (euro)	**38.062**	**19.570**	**8.499**
R&D personnel / Total number of employees	**4,17%**	**2,15%**	**1,24%**
Labour costs / Total R&D expenses			
Total	55,07%	53,25%	49,20%
Government sector	63,18%	54,03%	57,46%
Business enterprise sector	53,49%	48,90%	41,45%
Labour costs / Total R&D personnel			
Total	69.244	36.474	11.979
Government sector	62.145	34.507	13.573
Business enterprise sector	77.384	40.797	16.869

Source: own calculations based on Eurostat data

In this context it is important to identify what are most influential causes of this trend, therefore we should perform an in-depth analysis of these issues. One could argue that the main cause is the marginal increase of labour costs (by incrementally employing people, the marginal amount of resources put in place in order to pay the salaries is higher than the previous average), but in the same time, the economic common sense suggests that the most competitive researches will be employed the first, thus receiving a larger remuneration. It is clear that this argument is quite contradictory, showing among others the level of complexity implied by these phenomena. Still, the most consistent and credible cause consists in the following evolution – as the development level of a country is higher, the social and economic status of R&D personnel (mainly researches) increases, while the vice-versa is also valid – a higher status of R&D employees determines a more intense economic development. Exactly this cause shows that the cultural specific and the core values the people share are very important for developing the R&D potential, and as a result, for increasing the GDP per capita. Also, there is competition among EU member states, thus the most potent countries can afford to pay higher wages and bear larger projects. In other words, there is a brain drain phenomena, the states with low and medium R&D intensity being the most affected on long and medium term:

- On medium term, as researchers leave the country, the potential added value that the society could have benefited from is gone, although it has invested resources in educating them. Also, in a globalised competitive environment, the damage we are talking about has a cumulative effect (competitiveness deterioration comes along with the strengthening of the opponents).
- On long term, the research community is left without the most talented and bright human resources. Making a long story short, the generations to come are widowed of successful domestic models, bright teachers and powerful colleagues.

Another finding illustrated in Figure 3 consists in the following: the slope of the regression equation is larger in the case of the business enterprise sector (red line), as compared to the governmental sector (blue line). In other words, the private sector puts in place more resources for human resources, mainly because of the following elements:

a) The business enterprise sector performs in a larger extent experimental development activities and applied research, therefore, the time and efforts allocated until the market implementation and monetization of new products and services are smaller.

b) The resources the business enterprise sector can assign to R&D projects is larger, therefore there is a gap in terms of economical/financial capacities (it is also a result of the previous point).

c) The nature of R&D projects is more complex in the business enterprise sector, therefore the experience, knowledge, skills and abilities required of researchers are broader and more diverse, therefore there is a qualitatively difference in terms of supply on the labour market for R&D personnel.

d) There are managerial premises from the private sector that are in a larger extent favorable for a more efficient and effective use of human resources.

e) R&D personnel from the governmental sector benefits from higher job stability, therefore, it compensates a potential monetary benefit.
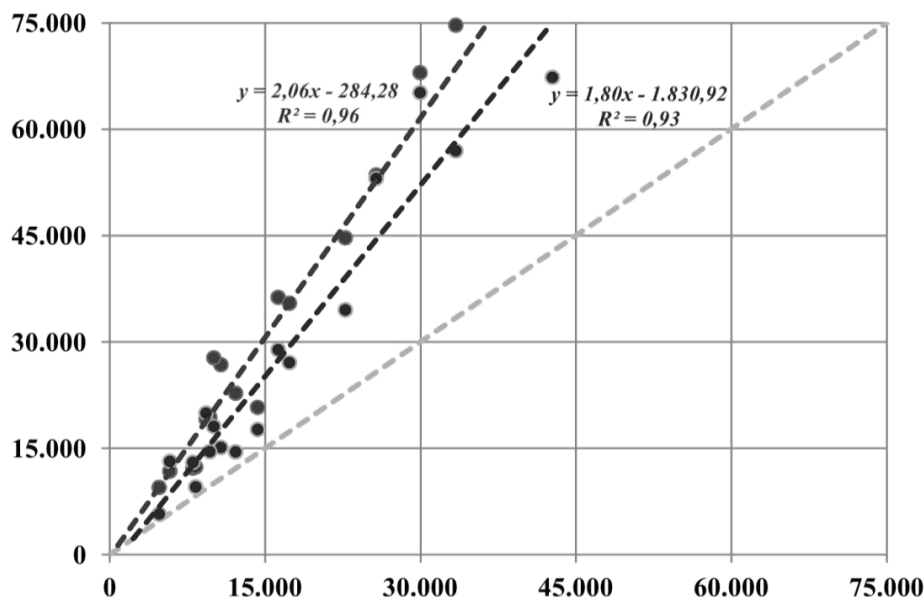

$y = 2,06x - 284,28$
$R^2 = 0,96$

$y = 1,80x - 1.830,92$
$R^2 = 0,93$

**Figure 3. R&D labour cost by performance sectors and
GDP per capita correlation in EU**

Source: own calculations based on Eurostat data

Also, there are only 3 countries in which the R&D labour costs per capita in the governmental sector are larger than in the private one (business enterprise sector). The countries we talk about are Latvia, Poland and Romania. It is not surprising that these states are part of the third category,

characterized by a low intensity of R&D and among the lowest GDP per capita in the European Union. This finding suggests that there is a problem in the private sector, because the results these countries encounter are not an effect of an extremely competitive R&D projects performed in governmental institutions.

5. CONCLUSIONS

As Romania is lagging in terms of economic development in the EU context, there is a consistent and explicit need for convergence in order to ensure cohesion among member states. In order to do so, supporting R&D activities has to be a priority for policy makers, as there is empirical evidence that the economic development and wealth creation are positively correlated with the amount of R&D investments. Therefore, it is a must to support R&D activities on a competitive base, thus placing private enterprises in "pole position", as they are the ones that should assume the initiative and leadership to research, develop and innovate. In order to do so, the issue of human resources should be tackled with special interest, as it is one of the key elements of the creative and innovative behavior in organizations.

AT EU level there is a positive correlation between the share of R&D personnel in the total number of employees and the level of GDP per capita. In this context, Romania registered a counterproductive trend during the analyzed, when the share of R&D workers in the total went from 0,75% in 2003, to 0,62% in 2010 (a decrease of 0,13 p.p.). Putting it more concisely, this trend widened the gap between the development of Romania and the EU average, being in this sense divergent (as opposed to the need for real and nominal convergence).

We have also identified a strong positive correlation between the average labour costs per employee (in R&D activities) and the per capita GDP. As the average labour costs per employee increases faster than the development level, there is a point in stating that: as the development level raises, the socio-economic status of R&D personnel increases, while the vice-versa is also valid – a higher status of R&D employees determines a more intense economic development. Also, there is an objective competition among EU member states, therefore the more powerful a country is, the more possibilities it has to attract the most brilliant researchers and to access the most complex and profitable R&D projects. The effect of these challenges is a brain drain phenomenon that affects (especially on long and medium term) mainly the states with low and medium R&D intensity.

Another finding this paper brings to your attention is the fact that the slope of the trend line is larger in the case of the business enterprise sector, as compared to the governmental sector. This gap implies some of the following argumentation: (1) private sector runs R&D projects that are potentially more profitable and take less time; (2) enterprises have a larger financial capacity to dislocate resources for R&D activities; (3) the profile of needed human resources for R&D projects performed in the private sector is more complex and rare; (4) the management in the business enterprise sector is more efficient and effective in using resources; and (5) the job stability from the governmental sector has an informal monetary equivalent substitute in the private sector.

Considering the above mentioned facts, we have to recognize that the challenges we are facing are of a systemic magnitude. The turbulence and uncertainty are constantly increasing to such a high degree, that the short-term solutions are no more effective and acceptable, while a veritable response is forced to address the structural aspects of the economic governance. In the context of free completion among the member states on the labour market, the issue of R&D human resources transposes as one of the most complex problems, because, on one hand, collaboration, cooperation and multiculturalism are fostering the innovative processes, but on the other hand, the distribution of benefits and added value is distributed unequally and in a certain sense inequitably, due to the brain drain phenomena. As the institutional framework of EU is not allowing imposing barriers on labour markets, it is the mainly the managerial creativity and perseverance that could at least slow down the trends we have discussed in this paper.

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