

## **Research, Innovation and Development vs Regional Disparities across the European Union**

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**Abstract:** The paper achieves a complex analysis of the present developments in R&D and innovation processes across the EU28. A distinct part of the paper deals with the analysis of the R&D and innovation activities at NUTS 2 regional level. The latest official statistical data were used in order to build a regional database related to R&D and innovation processes. The statistical data were divided into two categories: R&D resources and R&D results, which were analysed using comparative analysis, cluster analysis and regression. The macro trends in R&D and innovation processes are compared to those at NUTS 2 level. A special chapter in the paper is focused on R&D and innovation processes across the Romanian regions. The conclusions of the analysis, supported by tables and pertinent diagrams, are not positive. The R&D and innovation processes lead to increasing disparities across the Member States and regions. Romanian regions, excepting Bucuresti-Ilfov are not able to eliminate the gap in R&D and innovation development on short and medium terms.

**Keywords:** gross domestic expenditure on R&D; human resources in R&D; employment in high-tech sectors; high-tech patent applications

**JEL Classification:** O1

### **1 Introduction**

There is no secret that R&D and innovation process become one of the most important supports for socio-economic development in modern economies. The importance of these processes is pointed out as a distinct goal of the Europe 2020 Strategy.

The “classic” gap between USA and Europe in R&D development has to be reduced if Europe wants to maintain its statue of main global economic actor.

There is a direct connection between the economic development and R&D and innovation development in the Member States. As a result, the first disparities

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between developed and less developed Member States result from the human and economic resources spent in R&D and innovation activities.

The above disparities become higher at NUTS 2 level. The most developed regions are in Sweden, Germany, Finland or UK. They achieved the best performances in R&D and innovation development processes. On the other hand, the Southern and Eastern NUTS 2 regions face to the worst performances in this domain.

## 2 Literature Review

There are a lot of scientific approaches on R&D across the EU28 and most of them are divergent. Some specialists consider that the recent economic crisis supported the increase of the divergent evolution in R&D in the Member States. In order to demonstrate this, they used sigma convergence indicator, which was able to point out the convergence/divergence process in R&D at regional level. Moreover, the European R&D system is not able respond adequately to the challenges of a sustainable development (Goschin, Z., Sandu, S. & Goschin G., 2014).

An interesting analysis covers the connection between R&D investment and marginal returns to labour. Using data from representative European companies, the paper quantifies the impact of the knowledge capital (R&D) intensity on the marginal returns to labour. The main conclusion of this study is that more knowledge intensive companies have an advantage in non-diminishing returns fast (Amoroso S., 2015).

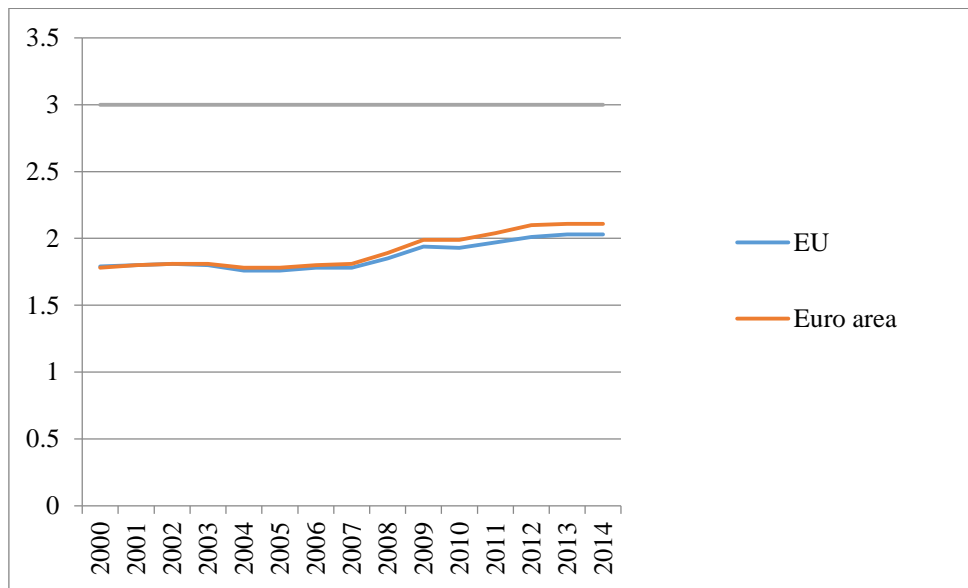
Using the EU Industrial R&D Investment Scoreboard which covers many top world R&D investors, other specialists realised a quantitative analysis in order to point out the relationship between the companies' production function and the innovation implications of production (Montresor S. & Vezzani A., 2015).

A distinct direction of analysis is the connection profit - investment in R&D. This analysis is made in the context of the distinction between uncertainty and risk. The authors develop Knight's approach related to the risky profit-maximizing scenario. They consider that R&D investments represent a main driver of the corporate profits (Amoroso S., Moncada-Paternò-Castello P. & Vezzani A., 2015).

The importance of the R&D in Europe led the European Commission to realize dedicated country's profiles for all Member States. According to this document, Romania faced to the challenge of improving policy coordination of R&I and upgrading the economy (European Commission, 2014).

### 3 Research, Development and Innovation across the European Union

According to Europe 2020 Strategy, the Member States succeeded in increasing permanently the gross domestic expenditure on R&D, even during the recent global crisis' period. The countries from Euro area achieved greater expenditure on R&D than EU average. Unfortunately, both regional economic entities are not still able to achieve the target of 3% of GDP for this type of expenditure (Eurostat, February 2016).

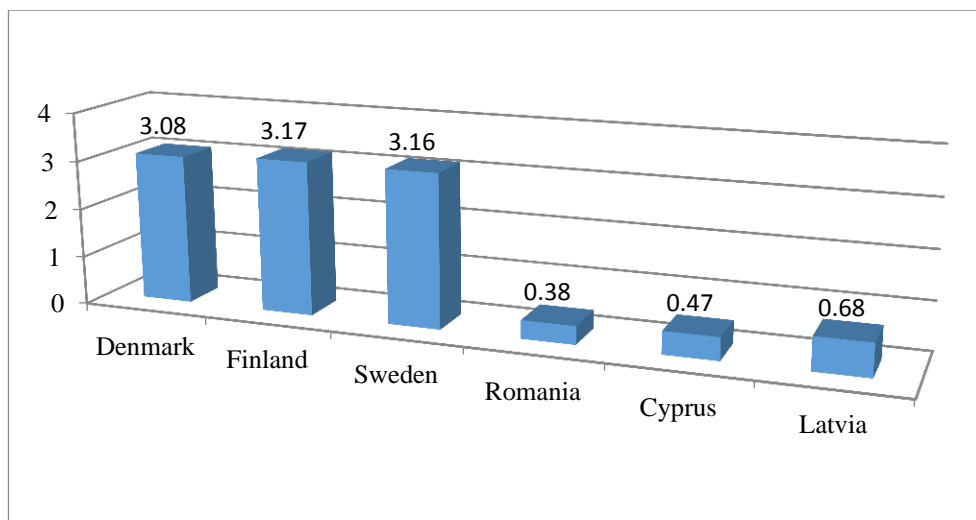


**Figure 1. Gross domestic expenditure on R&D (% of GDP)**

*Source: Personal Contribution*

According to Figure 1, a positive trend in R&D expenditure growth rate was realised by both regional entities during 2005-2014.

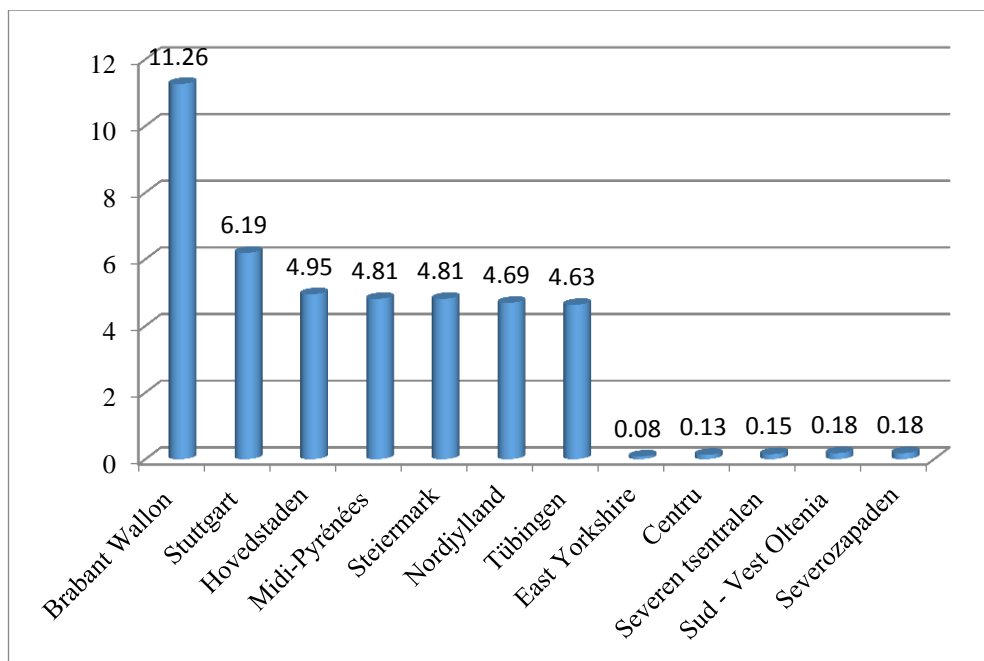
On the other hand, some Member States succeeded in achieving R&D expenditure growth rates in 2014: Denmark (3.08%), Finland (3.17%) and Sweden (3.16%). Unfortunately, there are other countries which faced to low rates, as: Romania (0.38%), Cyprus (0.47%) and Latvia (0.68%).



**Figure 2. Gross domestic expenditure on R&D – maximum and minimum levels (% of GDP)**

*Source: Personal Contribution*

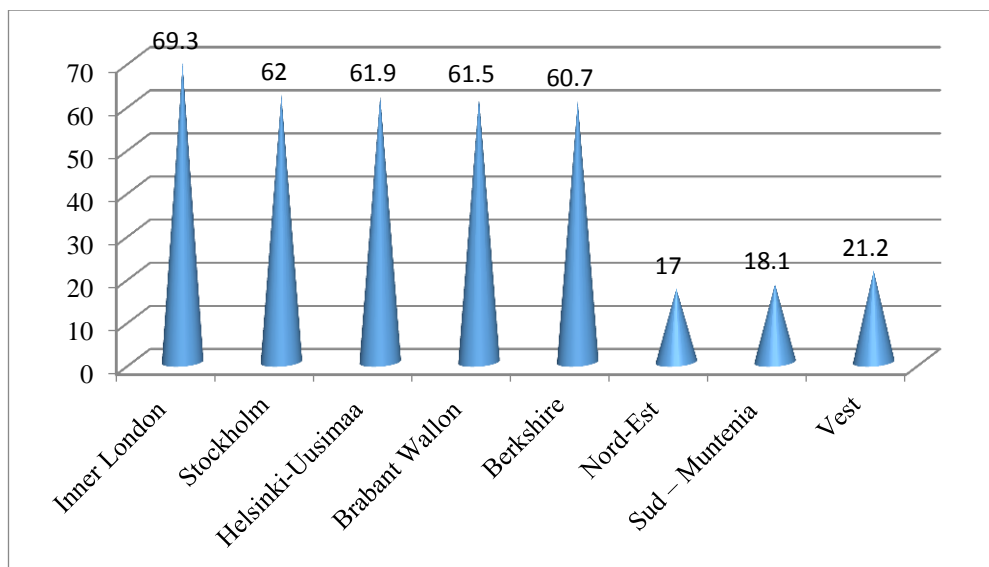
The same indicator leads to greatest disparities at regional level. Some regions achieved high R&D expenditure growth rates: Brabant Wallon (11.26%), Stuttgart (6.19), Hovedstaden (4.95%), Midi-Pyrénées (4.81%), Steiermark (4.81%), Nordjylland (4.69%) and Tübingen (4.63%). Other regions faced to low growth rates: East Yorkshire and Northern Lincolnshire (0.08%), Centru (0.13%), Severen tsentralen (0.15%), Sud - Vest Oltenia (0.18%) and Severozapaden (0.18%). The Romanian regions have no important achievements related to the R&D expenditure growth rates. Moreover, Centru faced to the second worth performance across the EU regions at this indicator (Eurostat, 10<sup>th</sup> of February 2016).



**Figure 3. Gross domestic expenditure on R&D in NUTS 2 regions– maximum and minimum values (% of GDP)**

*Source: Personal Contribution*

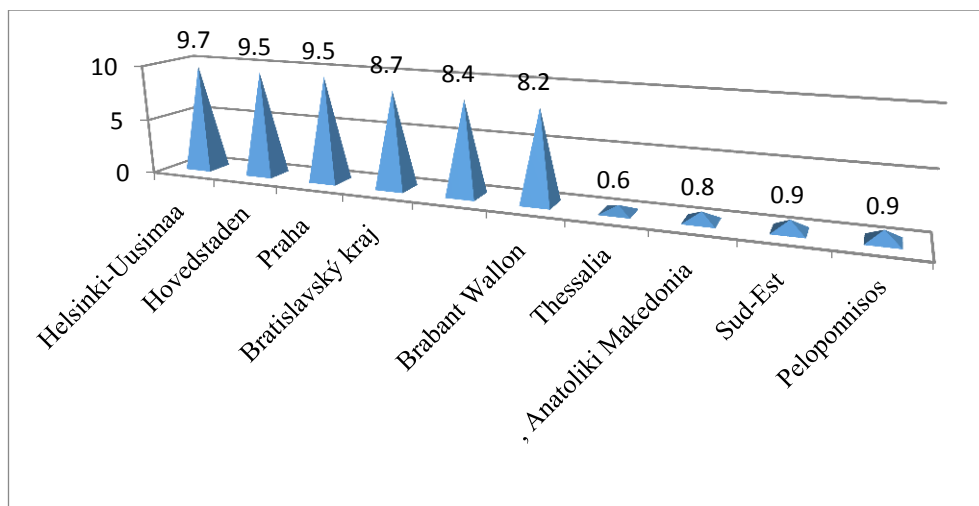
An interesting indicator is human resources in science and technology by NUTS 2 regions. It is quantified as % of active population (Eurostat, 2016). The greatest human resources in science and technology were placed in Inner London (69.3%), Stockholm (62.0%), Helsinki-Uusimaa (61.9%), Brabant Wallon (61.5%), Berkshire, Buckinghamshire and Oxfordshire (60.7%). At the opposite are the Romanian regions: Nord-Est (17.0%), Sud – Muntenia (18.1%) and Vest (21.2%).



**Figure 4. Human resources in R&D in NUTS 2 regions– maximum and minimum values (% of active population)**

*Source: Personal Contribution*

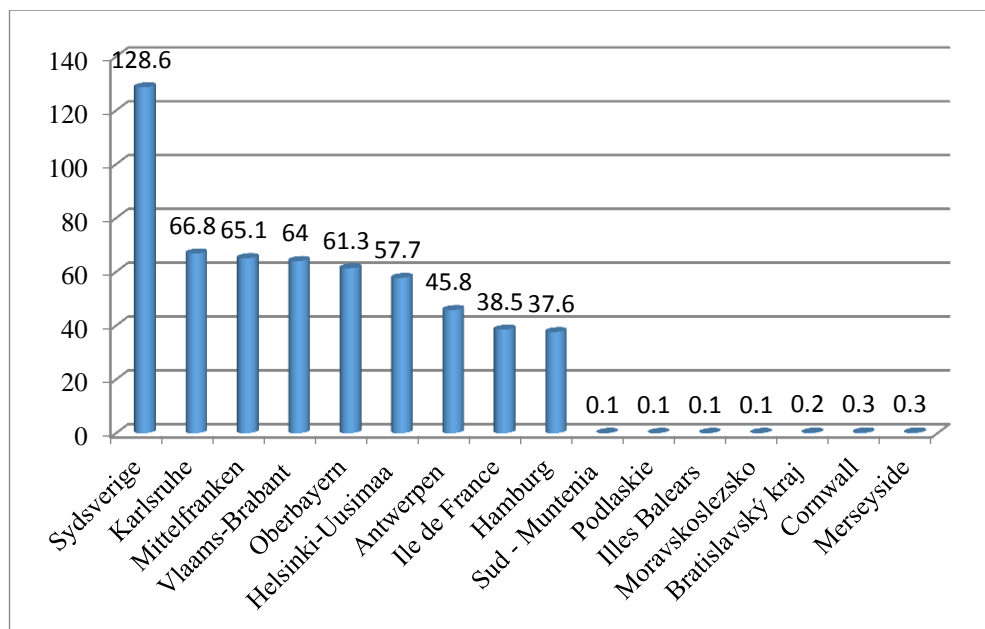
A more focused indicator is the employment in high-tech sectors by NUTS 2 regions. It is quantified as % of total employment (Eurostat, 11<sup>th</sup> of February, 2016). The European regions which realized the highest employment rates in high-tech sectors are the following: Helsinki-Uusimaa (9.7%), Hovedstaden (9.5%), Praha (9.5%), Bratislavský kraj (8.7%), Southern and Eastern Greece (8.4%) and Brabant Wallon (8.2%). The lowest performances were in: Thessalia (0.6%), Anatoliki Makedonia (0.8%), Sud-Est (0.9%) and Peloponnisos (0.9%).



**Figure 5. Employment in high-tech sectors by NUTS 2 regions – maximum and minimum values (% of active population)**

*Source: Personal Contribution*

The results of the R&D activities are the high-tech patent applications to the European patent office (EPO). This indicator is related to every million inhabitants at regional level (Eurostat, 12<sup>th</sup> of February, 2016). The greatest performances were achieved in: Sydsverige (128.6), Karlsruhe (66.8), Mittelfranken (65.1), Vlaams-Brabant (64.0), Oberbayern (61.3), Helsinki-Uusimaa (57.7), Antwerpen (45.8), Île de France (38.5) and Hamburg (37.6). Other regions faced to lowest number of patent applications: Sud - Muntenia (0.1), Podlaskie (0.1), Illes Balears ( 0.1), Moravskoslezsko (0.1), Zachodniopomorskie (0.2), Cornwall and Isles of Scilly (0.3) and Merseyside (0.3).

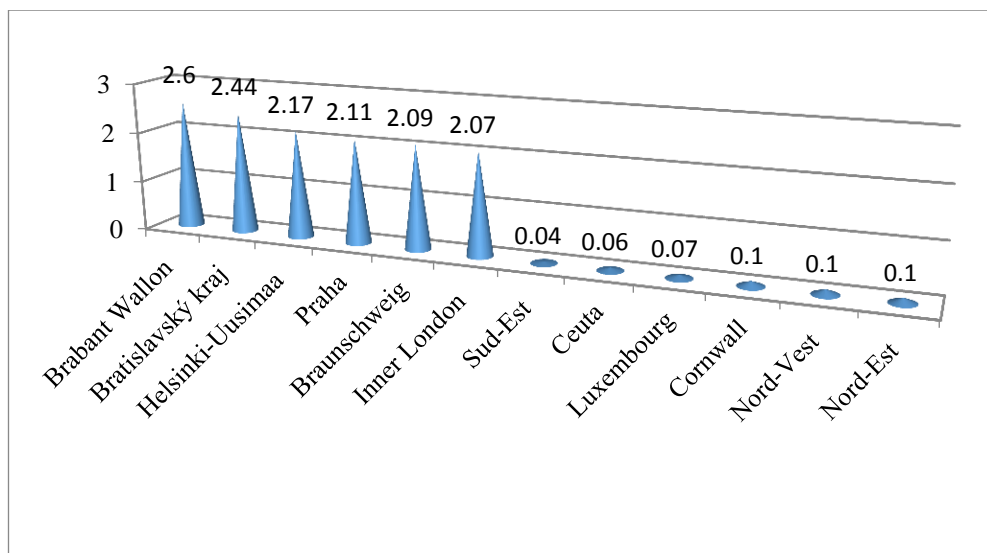


**Figure 6. High-tech patent applications by NUTS 2 regions – maximum and minimum values (no. to every million inhabitants)**

*Source: Personal Contribution*

The last representative analysed indicator is researchers as % of total employment (Eurostat, 13<sup>th</sup> of February 2016). The regions which achieved the best performances are: Brabant Wallon (2.6%), Bratislavský kraj (2.44%), Helsinki-Uusimaa (2.17%), Praha (2.11%), Braunschweig (2.09%) and Inner London (2.07%). The worst researches rates were realized in: Sud-Est (0.04%), Ciudad Autónoma de Ceuta (0.06%), Luxembourg (0.07%), Cornwall and Isles of Scilly (0.1%), Nord-Vest (0.1%) and Nord-Est (0.1%).





**Figure 7 Researchers by NUTS 2 regions – maximum and minimum values (% of total employment)**

*Source: Personal Contribution*

First intermediate conclusions support the idea that there are huge differences between the European regions related to R&D development. The most developed Member States achieved better performances, while the new Member States (Romania, Bulgaria) face to the worst. The Czech Republic seems to have a positive trend in this domain.

#### **4 A Cluster Approach to the Romanian Regions under R&D Analysis**

The Romanian regions have no positive achievements in connection to R&D development. Almost all the above indicators pointed out worst performances for these regions. But the comparative analysis is not enough in order to obtain a scientific point of view. As a result, a cluster approach can be usefully.

The above six indicators can be divided into two categories. The first one is R&D resources and covers gross domestic expenditure on R&D, human resources in R&D and employment in high-tech sectors. The second entity is focused on R&D results and covers high-tech patent applications and researchers as a result of the human capital's improvement.

The analysis points out at least two aspects: the R&D disparities across the Romanian regions and the R&D disparities between Romanian and the most developed European regions, as well.

The volume of analysed data was big and the analysis faced to difficulties in operating official statistical indicators. The newest official dates allow building the following database (see Table 1).

**Table 1 R&D representative indicators**

Region/ Indicator	NV (1)	Centru (2)	NE (3)	SE (4)	S (5)	Bucu- resti- Ilfov (6)	SV (7)	V (8)	Brabant Wallon (9)	Hel- sinki (10)
Gross domestic expenditure	0.32	0.13	0.30	0.07	0.35	0.79	0.18	0.26	11.26	3.98
Human resources	22.2	26.0	17.0	20.5	18.1	48.1	20.6	21.2	61.5	61.9
Employment In high-tech	2.4	1.9	1.2	0.9	1.1	6.8	1.2	5.4	8.2	9.7
High-tech patents	0.73	0.98	0.40	0.26	0.10	2.09	0.37	1.12	38.44	57.70
Researchers	0.10	0.13	0.10	0.04	0.13	0.88	0.13	0.20	2.60	2.17

According to Table 1, the Romanian NUTS 2 regions are analysed together to two developed European regions: Brabant – Wallon and Helsinki.

The R&D resources are analysed using Nearest Neighbor Analysis (NNA). The three R&D resources were presented using a three dimensional space (see Figure 8).

The Romanian region Centru (2) faced to the worst two from all three R&D resources. All Romanian regions were not able to obtain high performances related to R&D resources, excepting Bucuresti-Ilfov (6), which have better results but not well enough. On the other hand, there are huge differences between Romanian regions' performances and the two representative European regions.

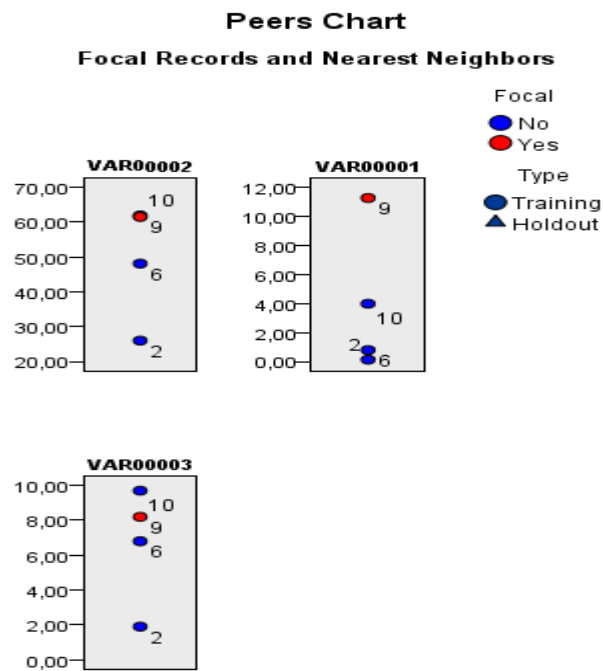
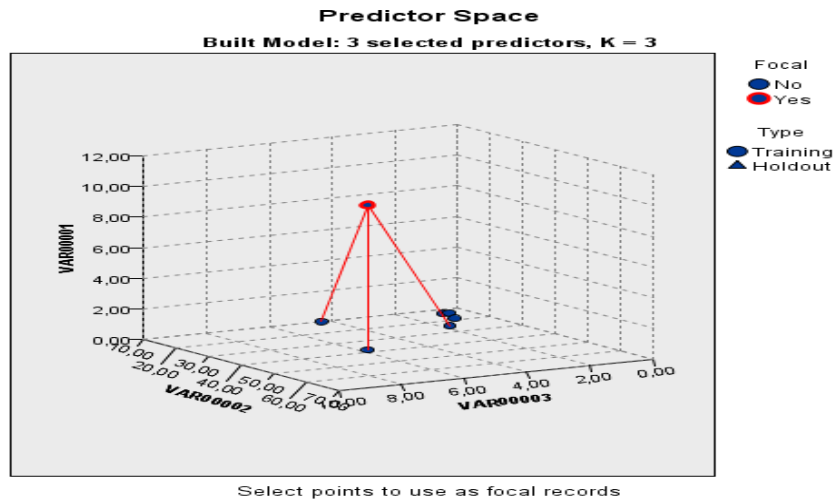
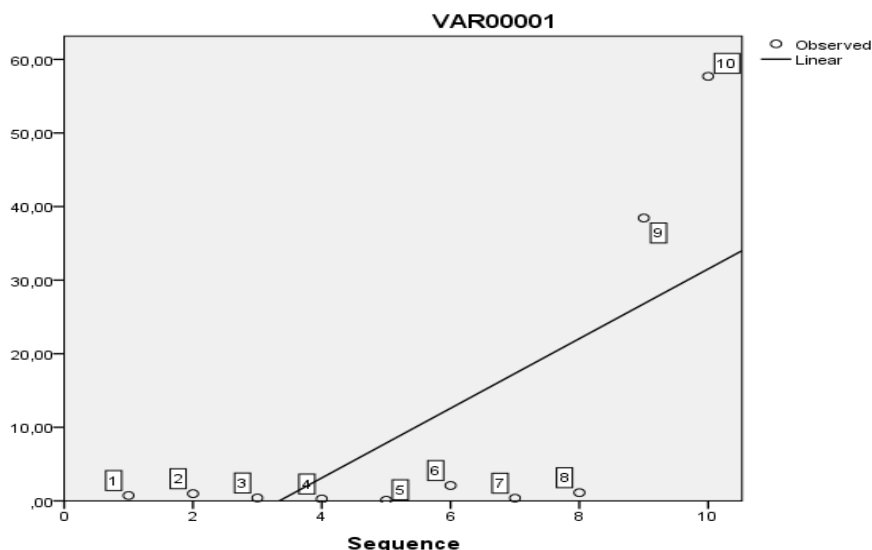


Figure 8. R&D resources by NUTS 2 regions (case study)

Source: Personal Contribution using IBM-SPSS software

In order to analyse the R&D results regression can be usefully. Under ANOVA conditions, both result variables lead to the following diagram:



**Figure 9. R&D results by NUTS 2 regions (case study)**

*Source: Personal Contribution using IBM-SPSS software*

According to Figure 8, all Romanian regions are far away from the European developed regions. Moreover, there are high differences which cannot be eliminated on short and medium terms.

## 5 Conclusions

An important target of the Europe 2020 Strategy covers R&D activities' development. Unfortunately, R&D activities support the increase of the disparities across the Member States. Moreover, these disparities are greater at regional levels.

The regions from the Northern EU achieved better performances in R&D and innovation than those from the Southern EU. Some capital regions, as Prague and Helsinki, have good achievements, as well. On the other hand, regions from Bulgaria and Romania face to worst R&D and innovation performances.

Romanian regions are far away from the EU average in R&D and innovation activities, excepting Bucuresti-Ilfov. The gap between the most developed R&D regions and the Romanian regions is too great to be eliminating on short or medium terms.

The cluster and regression analysis in the paper lead to the conclusion that two distinct clusters can be built in Romania: first cluster covers Bucuresti-Ifov, and the second one, which is far away from the first, covers the other seven NUTS 2 regions.

As a result, a new economic and political approach is needed in order to restart the R&D and innovation processes in the Romanian regions.

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