

## INNOVATIONS AND EVOLUTION OF SCIENTIFIC ACTIVITIES IN ROMANIA

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### ABSTRACT

*The scientific activities represent currently the support of innovations, which in turn contribute to a competitive advantage and thus to economic growth.*

*They help in the development of more efficient production processes and management methods, as well as in providing high quality products and services, thus having a significant contribution in economic growth and to increase the quality of life.*

*The analysis of their evolution provides useful information regarding the importance of innovation in Romania.*

*In this context, the aim of this paper is to highlight the extent to which the scientific activities were present in the national economy during 2008-2013 and this will be accomplished through relevant economic indicators, GDP and the employed population. In the last part of the study the previsions of both indicators for 2014-2016 period will be presented.*

**Keywords:** innovation, quality of life, competitiveness, development.

**JEL Classification:** R11, O32, O38, O40.

### Introduction

Since the early 90s, organizations tend to focus their activity on developing new products and services, this assuming often changes in the products and services already on the market. This new trend has begun to spread, the companies promising to become increasingly innovative.

In order to be successful, a company must therefore have the ability to innovate, to have a vision of the market or a specific image of products and services it wishes to develop. In the same time, the company must have the related technologies and the ability to attract human capital and investments (Susan E. Reid et. al., 2014).

On an intensely competitive market as the European one, the innovation is the main driver of competitiveness and thus the main driver of economic growth.

The companies that enjoy a rapid growth are those employing innovative solutions in their current work, a large part of their revenues being generated either by new products or services or by improved quality products (UEFISCDI).

Last but not least, a major role in increasing the quality of life is often assigned to innovations.

However, there are major differences between Romania and EU in innovation rates. But, as one can see in the following, the forecast for next year is a favorable one. The evolution of professional, scientific and technical activities will be analyzed using aggregate economic indicators, GDP and employed population.

According to CANE code, the professional, scientific and technical activities include scientific research and experimental development, scientific and technical education and formation, scientific and technical services etc.

### 1. The dynamic of professional, scientific and technical activities in Romania during 2008-2013

The analysed time frame is generally marked by strong fluctuations in the entire economy.

As the analysis revealed, the professional, scientific and technical services were characterized by a fluctuating evolution.

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At first glance, one can see that there has been an overall increasing trend of GDP, though there are two exceptions for 2009 and 2012.

In 2013 GDP registered the highest value of 41,8 billion ROL, increasing by 22 billion ROL compared to the base year 2008.

Expressed as current prices, GDP has recorded over time an average increase of 28,04 billion ROL.

However, in order to achieve more realistic results, GDP must be turned from current prices in constant prices, thus eliminating the impact of inflation.

To this end, IPC values presented in Romanian Statistical Yearbook will be used, data in the table below being calculated taking 2008 as the base period.

### GDP conversion from professional, scientific and technical activities from current prices in constant prices

Table 1

Years	GDP from PSTA* in current prices (bilions ROL)	Consumer price indices for services year 2008=1	GDP from PSTA in constant prices (bilions ROL)
2008	19,739	1	19,739
2009	20,142	1,09	18,479
2010	25,178	1,142	22,047
2011	31,443	1,193	26,356
2012	29,927	1,253	23,884
2013	41,814	1,293	32,338

Source: IS data processing, Romanian Statistical yearbooks from 2009-2014

\*Professional, scientific and technical activities

The new obtained data will be used in order to accurately determine the GDP evolution through dynamic factor index. Further the factors that led to these fluctuations will be determined.

### GDP evolution from the professional, scientific and technical activities (billions ROL constant prices)

Table 2

Years	GDP	$\Delta i/1$	$\Delta i/i-1$	$I i/1$	$I i/i-1$	$R i/1$	$R i/i-1$	$\bar{Y}$	$\bar{\Delta}$	$\bar{I}$	R
2008	19,739	0	0	1	-	0	-	23,807	2,519	1,103	0,103
2009	18,479	-1,26	-1,26	0,936	0,936	-0,063	-0,063				
2010	22,047	2,308	3,568	1,116	1,193	0,116	0,193				
2011	26,356	6,617	4,309	1,335	1,195	0,335	0,195				
2012	23,884	4,145	-2,472	1,209	0,906	0,209	-0,093				
2013	32,338	12,599	8,454	1,638	1,353	0,638	0,353				

Source: Table 1 data processing

Formula used for economic analysis:

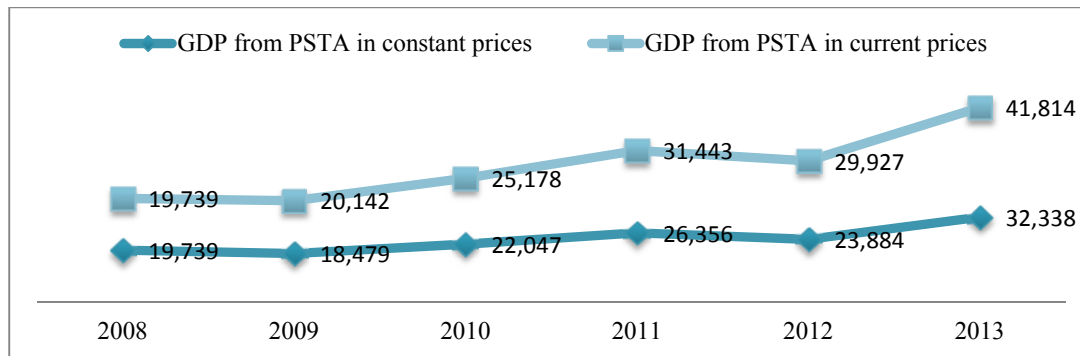
- Dynamic index calculated with fixed base:  $\Delta i/1=y_i-y_1$  (1)
- Dynamic index calculated with the base chained:  $\Delta i/i-1= y_i-y_{i-1}$  (2)
- Rate of increase (decrease) calculated with fixed base:  $I i/1= (y_i/ y_1)*100$  (3)
- Rate of increase (decrease) calculated with the base chained:  $I i/i-1 = (y_i/ y_{i-1})*100$  (4)
- Absolute value of a percentage of increase (decrease) with fixed base:  $R i/1= I i/1-100$  (5)
- Absolute value of a percentage of increase (decrease) with the base chained:  $R i/i-1 = I i/i-1 - 100$  (6)
- The average level of the time series:  $\bar{Y} = \Sigma y_i/n$  (7)
- The average level of the absolute change (increase or decrease):  $\bar{\Delta} = \Sigma \Delta i/i-1/(n-1)$  (8)
- The average index of dynamics:  $\bar{I} = (y_i/ y_1) 1/n-1*100$  (9)
- The average annual growth rate:  $R = I - 100$  (10)

Analyzing GDP at constant prices created in professional, scientific and technical activities, an average increase of 2,519 billion ROL from 2008-2014 can be seen.

In 2013 the rate of increase recorded the highest value, 1,64 billions, which indicates that there was a significant increase in that year compared to the base year.

Throughout the entire period there has been an average annual GDP of 23,8 billions ROL with an average annual increase of 10%.

The GDP evolution in the analyzed time frame and the difference between the current prices and constant prices can be tracked in the chart below.



**Figure 1 GDP evolution in professional, scientific and technical activities**

Source: Graph showing data from Table 3

Due to international and national economic conjuncture, similar dynamics on the *employed population* in PSTA was registered.

Regarding the employed population in professional, scientific and technical activities from 2008 and up to 2013, it grew on average by 5,2 thousand people yearly, with an average rate of growth of only 0,3%.

In comparison to GDP, employed population number grew from 2008 until 2011, followed in 2012 and 2013 with a slight decrease.

However in 2013 employed population in PSTA increased by 18% compared to 2008. In 2010 was obtained the largest rate of increase calculated with base chained, when employment rose 7,4 times compared with 2009.

**Evolution of employed population in PSTA during 2008-2013 (thousands pers.)**

**Table 3**

Years	EP*	$\Delta_{i/1}$	$\Delta_{i/i-1}$	$I_{i/1}$	$I_{i/i-1}$	$R_{i/1}$	$R_{i/i-1}$	$\bar{Y}$	$\bar{\Delta}$	$\bar{I}$	R
2008	140	0	0	1	-	0	-	158,5	5,2	1,034	0,034
2009	148	8	8	1,057	1,057	0,057	0,057				
2010	159	19	11	1,136	1,074	0,136	0,074				
2011	170	30	11	1,214	1,069	0,214	0,069				
2012	168	28	-2	1,2	0,989	0,2	-0,012				
2013	166	26	-2	1,186	0,988	0,186	-0,012				

Source: NIS data processing, Romanian Statistical yearbooks from 2009-2014

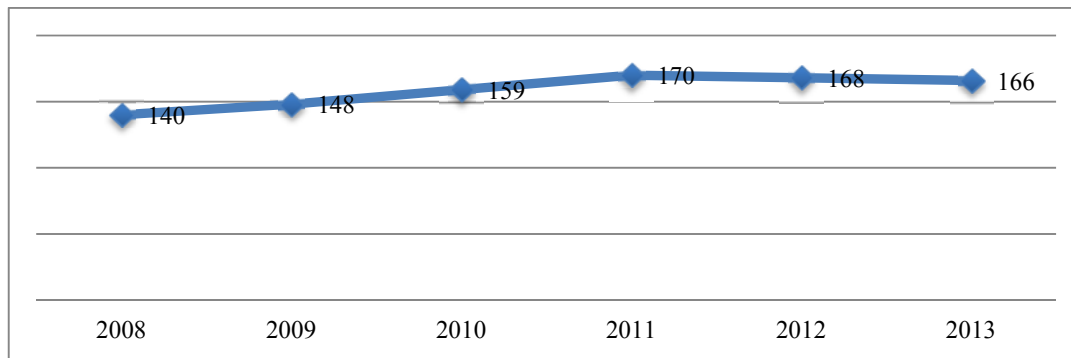
\*Employed population

At this moment, the service sector owns the largest share of the employed population (42.6%), followed by industry (26.6%) and agriculture (24.2%). In the past, this sector has recorded period of decline due to the global economic crisis, but now it has a positive evolution.

Other causes that could determine such development could be: the reduction of the average age of retirement (by early retirement) and the increase of the number of people following a higher education institution which prolong their period of inactivity (ADR CENTER).

These oscillations can be caused also by: seasonal work (e.g. education), opening/closing of scientific institutions, retraining, or penetration of technology.

An even clearer picture of the evolution of employed population in professional, scientific and technical activities is provided in the chart below.



**Figure 2 Evolution of employed population in PSTA**

Source: Graph showing data from Table 4

The economic development requires, among others, a process of continuous modernization. As nations develop, they progress on their competitive advantage and also on the specific modalities of competition. Innovation is the main way to achieve this competitive advantage.

In the Global Competitiveness Report 2014-2015 prepared by the World Economic Forum, Romania ranks 59 among the most competitive countries in Europe being among the backwards, although it climbed 17 places in the rankings compared to 2013-2014. Basically, Europe is facing a low competitiveness in the South and Central part (Portugal, Italy, Bulgaria, Romania and Greece), while the North remains the most competitive (World Economic Forum).

A strong economy manages to achieve competitive advantage through increased investment in the innovation support activities and also in the work force. Certainly, in order to achieve a strong economy, efforts must be done to increase the innovation process.

## 2. Prospects for professional, scientific and technical activities for 2014-2016

In order to forecast GDP created in professional, scientific and technical activities, but also the employed population, The Average Index of Dynamics Method and The Average Level of the Absolute Change Method will be used. The method that will yield the lowest value for the coefficient of variation ( $v$ ) will be used for forecasting.

However, before that will be followed the extent to which the employed population in professional, scientific and technical activities influences GDP created in services. In order to determine this, the Spearman and Kendall correlation coefficients will be calculated at regional level for 2011.

The obtained data will be just for guidance, as there may be new factors that can influence the evolution of these indicators.

### Calculation of Spearman correlation coefficient

**Table 4**

Macroregion	EP in PSTA (thousands pers.)	GDP – Professional, scientific and technical activities, activities of administrative services and support services. (ROL billion, current prices)	R <sub>x</sub>	R <sub>y</sub>	D <sup>2</sup>
Macroregion 1 (NV-Center)	34	4,362	2	2	0
Macroregion 2 (NE-SE)	27	3,782	4	3	1
Macroregion 3 (Sud Muntenia, Bucharest- Ilfov)	79	19,837	1	1	0
Macroregion 4 (Sud-Vest Oltenia, Vest)	30	3,069	3	4	1
Total	170	31,050			2

Source: NIS, data processing Romanian Statistical yearbook for 2012

After processing the Spearman correlation coefficient, a value of 0,8 was obtained, which means that there is a strong and direct relationship between the two indicators. As such, the change of the EP value influences in the same direction the GDP created in professional, scientific and technical activities. Therefore, given the strong connection between employed population and GDP, measures should be taken for GDP growth both through employed and unemployed people training, in order to improve the management quality in the field. Below there is the necessary calculation formula.

$$SP = 1 - 6 \cdot \sum d^2 / n(n^2 - 1) \quad (11)$$

Calculating the Kendall correlation coefficient insures that the results prior obtained are reliable.

#### Calculation of Kendall correlation coefficient

Table 5

Macroregion	EP in PSTA (thousands pers.)	GDP – Professional, scientific and technical activities, activities of administrative services and support services.(ROL billion, current prices)	Ry	Pi	Qi	S
Macroregion 3 (Sud Muntenia, București - Ilfov)	79	19,837	1	3	0	3
Macroregion 1 (NV-Centru)	34	4,362	2	2	0	2
Macroregion 4 (Sud-Vest Oltenia, Vest)	30	3,069	4	0	1	-1
Macroregion 2 (NE-SE)	27	3,782	3	0	0	0
Total	170	31,050		5	1	4

Source: NIS, Romanian Statistical yearbook for 2012

$$K = 2 \cdot S / n(n-1) \quad (12)$$

$$S = \sum P_i - \sum Q_i \quad (12)$$

The calculations yield a coefficient equal to 0,66 which confirms the hypothesis according to which the contribution of professional, scientific and technical activities depends on the status of employed population in this area which contributes to this development and being also in the same time its own effect.

#### 2.1. Forecast of GDP created in professional, scientific and technical activities

Given the fact that there is a strong and direct relationship between the two indicators, they can be forecasted in the following.

- a) The Average Index of Dynamics Method

#### Calculation by the Average Index of Dynamics Method

Table 6

Years	GDP (ROL billion, current prices)	t <sub>i</sub>		$\hat{y}_i = y_1 \cdot \bar{I}^{t_i}$	$(y_i - \hat{y}_i)^2$
2008	19,739	0		19,739	0
2009	18,479	1		21,772	10,843
2010	22,047	2		24,015	3,873
2011	26,356	3		26,488	0,017
2012	23,884	4		29,216	28,430
2013	32,338	5		32,338	0
Total					43,163

Source: Table 3 data processing

In order to calculate the results the following formulas are needed:

$$\text{Standard Deviation: } \sigma = \sqrt{\sum (y_i - \hat{y}_i)^2 / n} \quad (13);$$

$$\text{The coefficient of variation: } V = (A/Y) * 100 \quad (14).$$

Applying the above formulas, the following results are obtained:

$$\text{Standard Deviation, } \sigma = 2,682$$

$$\text{The coefficient of variation, } v = 11,26\%$$

b) The Average Level of the Absolute Change Method

#### Calculation by the Average Level of the Absolute Change Method

Table 7

Years	GDP (ROL billion, current prices)	$t_i$	$\hat{y}_i = y_1 + \bar{\Delta} * t_i$	$(y_i - \hat{y}_i)^2$
2008	19,739	0	19,739	0
2009	18,479	1	22,258	14,280
2010	22,047	2	24,777	7,452
2011	26,356	3	27,296	0,883
2012	23,884	4	29,815	35,176
2013	32,338	5	32,338	0
Total				57,791

Source: Table.3 data processing

After processing the information from the table, a Standard Deviation ( $\sigma$ ) of 3,103 and a coefficient of variation ( $v$ ) of 13,03 % are obtained.

The lowest value for the coefficient of variation was obtained through the use of The Average Index of Dynamics Method. Therefore, this method will be used further for forecasting.

#### Forecast of GDP created in professional, scientific and technical activities

Table 8

Years	$t_i$	$\hat{y}_i = y_1 * \bar{I}^{t_i}$
2014	6	35,54498
2015	7	39,20611
2016	8	43,24434

According to the trend characterizing the data series, the tendency which is observed after the forecast is a favorable one for professional, scientific and technical activities. The technical field has started to be fairly appreciated by students from Romania and in the same time the labor offer in this area has begun to be increasingly higher.

## 2.2 Forecast of employed population in professional, scientific and technical activities

a) The Average Index of Dynamics Method

#### Calculation by the Average Index of Dynamic Method

Table 9

Years	EP in PSTA (thousands pers.)	$t_i$	$\hat{y}_i = y_1 * \bar{I}^{t_i}$	$(y_i - \hat{y}_i)^2$
2008	140	0	140	0
2009	148	1	144,76	10,497
2010	159	2	149,66	87,235
2011	170	3	154,7	234,09
2012	168	4	160,03	63,52
2013	166	5	166	0
Total				395,342

Source: Table.3 data processing

Standard Deviation:  $\sigma = 8.117$

The coefficient of variation:  $v = 5.12\%$

b) The Average Level of the Absolute Change Method

**Calculation by the Average Level of the Absolute Change Method**

**Table 10**

Years	EP in PSTA (thousands pers.)	$t_i$	$\hat{y}_i = y_1 + \bar{\Delta} * t_i$	$(y_i - \hat{y}_i)^2$
2008	140	0	140	0
2009	148	1	145.2	7.84
2010	159	2	150.4	73.96
2011	170	3	155.6	207.36
2012	168	4	160.8	51.84
2013	166	5	166	0
Total				341

Source: Table.3 data processing

Standard Deviation:  $\sigma = 7.53$

The coefficient of variation:  $v = 4.75$

The lowest correlation coefficient value was obtained by The Average Level of the Absolute Change Method and it will be used for forecasting.

**Forecast of employed population in professional, scientific and technical activities**

**Table 11**

Years	$t_i$	$\hat{y}_i = y_1 + \bar{\Delta} * t_i$
2014	6	171,2
2015	7	176,4
2016	8	181,6

If the GDP created in professional, scientific and technical activities, the evolution is likely to be favorable, the same can be said about employed population, which will continue to grow over the years. This result can be justified also due to the number of total population that is continuously growing.

So far the two indicators did not registered a spectacular growth in the analyzed time frame despite the fact that this type of activities is very beneficial to the economy. Information and Communication Technology (ICT) is closely related to the development of PSTA. Due to this reason, the table below illustrates to what extent the Romanian companies make available the computers to their employees.

**PC availability in Romanian enterprises**

**Table 12**

Indicator	2011 (%)	2012 (%)
The weight of enterprises that used PC in active enterprises	82,1	85
The weight of enterprises with Internet connection in active enterprises	80	81,8
The weight of employees that use PC in active employees	40,6	38,7
The weight of employees that use PC with Internet connection in active employees	36,5	34,8

Source: Source: NIS, Statistical yearbook for Romania, 2013

Regarding the weight of enterprises that used PC and also Internet connection, it seems that it was an increase from one year to another. Instead, the share of employees that use the PC and the Internet connection dropped, probably due to their orientation for jobs that do not involve office job.

**The number of internet users worldwide, in 2013, number/1.000 inhabitants**

**Table 13**

Country	Internet Users
Romania	498
Norway	951
Sweden	948
Denmark	946
Netherlands	940
Finland	915

Source: Data processing from Statistical yearbook for Romania, 2013

According to the ranking made by NIS, Norway is the most "connected" country in the world, the ranking being completed by Sweden, Denmark, the Netherlands and Finland.

Romania is 58 in the world ranking that includes 166 countries, because we are "downgraded" at the penetration rate. We are the second last country in Europe in terms of penetration rate of Internet services after Romania being only Ukraine, with a percentage of 34,1%. On the other hand, Ukraine is in the top ten as the number of Internet users in Europe, with 15,3 million people.

### Conclusions

There are activity sectors where innovation is the only way to ensure the survival of a company on the market and it does not represent a way to secure a privileged position. The computer industry where the innovation rate knows very high values can be mentioned here. On the contrary, in other sectors the degree of innovation is traditionally very low, the firms seeking other means to achieve the economic competitiveness.

Through significant research and development expenses, most companies rely on innovation. In this case the economic dimension and the financial potential of the firm are often decisive. Also, the internal structure of the company, the organization of the work is not a negligible support of innovative processes (Popa Ion, 2005).

One study that included the questioning of more than 500 small, medium and large companies (worldwide) operating in most sectors and industries, reveals the importance they attach to scientific activities (Barry Jaruzelski et.al., 2014).

So it turned out that the sales of average companies are not so influenced by innovation while for large firms the innovation activity has a significant impact in terms of sales volume. Also, the innovation contributes to the rapid development especially for small and relatively new companies on the market, which are investing more in product or process innovation than the ones present on the market from a longer period of time. Currently 58% of research and development expenses goes to the renewal of existing products and only 14% goes to the development of radical innovations.

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