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**CONTRIBUTION OF THE TERTIARY EDUCATION IN RESEARCH AREA**

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**Abstract:** *The authors present the results of a desk and direct observation research concerning the mission of the tertiary education in research area. The paper reveals the place and role of the universities in the development of the science, technologies, research and innovation, based on a statistical data analysis, between 2005 and 2010. The study encompasses both sides of the academic activities, i.e. research and education, focusing on the role in knowledge creation. The higher education institutions have a continuously enlarged and concrete involvement in research, innovation and knowledge transfer activities. Simultaneously the academic area has a major role in the people's education, contributing to the development of new competences and skills for a better knowledge management. Besides these strong points, the authors have identified also some weaknesses and possible improvements. The contribution of this paper consists in emphasising the role of the universities in the knowledge society and in suggesting improvements related to the academic research processes for increasing the universities role in the knowledge society.*

**Keywords:** *research and development, tertiary education, research indicators*

**I. TERTIARY EDUCATION IN THE KNOWLEDGE SOCIETY**

The 21 century demonstrates a major change in approaching the socio-economic development, based on knowledge intensive processes. In the new created context, knowledge becomes the major value and universities should re-define their role in order to better harnessing their potential as knowledge generators. Tertiary education institutions should act as drivers for education, research and innovation in the knowledge society. The general approach of the knowledge economy includes „first and foremost the growth and increasing proliferation of the production of knowledge-intensive products and services, i.e. this is the determining factor” (Bager, 2009, p.5). Consequently, the main pillars of the knowledge society, besides the technological infrastructure, are represented by the research, innovation and development processes, and also by the education and training activities. These new challenges require new competences for the human resources, centered on the continuously learning capacity and the innovative capacity. In addition, the tertiary education is actively involved in research and innovation, becoming, in the knowledge economy, a significant factor for the competitive sustainable development. In the actual context, the universities represent not only promoters of the research and innovation culture, but also active engines for the development of new solutions in the technological and socio-economic areas.

The paper is based on a desk research focused on statistical data analysis and interpretation. The analysis takes into consideration the European context and the specific Romanian tertiary education system position within the research and innovation area. For demonstrating the active involvement of the universities in research activities, a quantitative and qualitative analysis has been carried out. The main indicators analysed refer to the human resources involved in research and the expenditures related to specific research activities.

## II. DIRECT CONTRIBUTION OF THE UNIVERSITIES IN THE RESEARCH AREA

Due to the increased role of the research in the development, the set of indicators illustrating the evolution of the sciences, technologies and innovation has been enlarged, as it is presented in the Annex 1 (NIS, 2012). The paper addresses the main issues related to the mission of the universities related to the sciences and technologies development, as well as the contribution in innovation area. The European Commission (European Commission, 2010) has introduced a set of indicators for measuring the university-based research structured as:

- *input* indicators (quantification of the resources devoted to research - human, physical and financial);
- *process* indicators (illustration of the way how the research is conducted);
- *output* indicators (quantification of the research products);
- *outcome* (illustration of the level of performance);
- *impact and benefits* (reference to the contribution of the research outcomes for society, culture, the environment etc.).

The selection of the indicators is directly linked to the priorities of the development of the research activities. It should be stressed that there are no objective indicators, because in the most of the cases the indicators stand only as a proxy for the assessment of certain aspects related to the research infrastructure, concrete results or impact. The indicators facilitate also the ranking of the universities or of the universities-based research.

The paper is focused on the input indicators, analysing the situation in Romania and comparing the Romanian particular case with the other countries situation. The selection of the input indicators is significant for the Romanian level of development, as the infrastructure represents an issue to be solved for the further development of the research and innovation activities.

### 2.1. Human Resources in Research and Development Activities

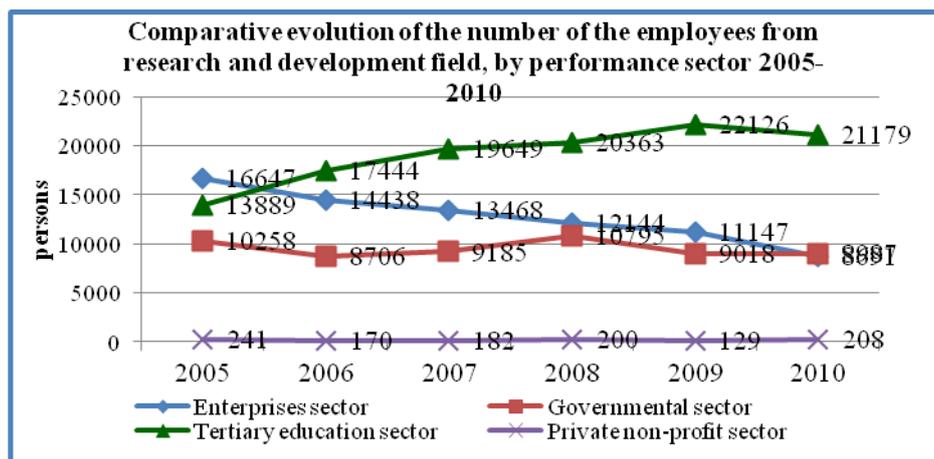
An important indicator taken into consideration is represented by the level and the dynamics of the employees from research-development activity, by sector of performance. This indicator illustrates the distribution of the research activities by sectors and the capacity of each sector to have a relevant contribution in research, innovation and development activities (table 1).

**Table 1. Level and dynamics of the employees in research and development activities by sectors of performance, 2005 - 2010**

Sector	Employees (number) - end of year						Variation 2010/2005%	
	2005	2006	2007	2008	2009	2010	Absolute (no. of persons)	Relative (%)
	<b>Total</b>	<b>41035</b>	<b>40758</b>	<b>42484</b>	<b>43502</b>	<b>42420</b>	<b>39065</b>	<b>-1970</b>
<i>Enterprises sector</i>	16647	14438	13468	12144	11147	8691	-7956	-47,79
<i>Government sector</i>	10258	8706	9185	10795	9018	8987	-1271	-12,39
<b><i>Tertiary education sector</i></b>	<b>13889</b>	<b>17444</b>	<b>19649</b>	<b>20363</b>	<b>22126</b>	<b>21179</b>	<b>7290</b>	<b>52,49</b>
<i>Private non-profit sector</i>	241	170	182	200	129	208	-33	-13,69

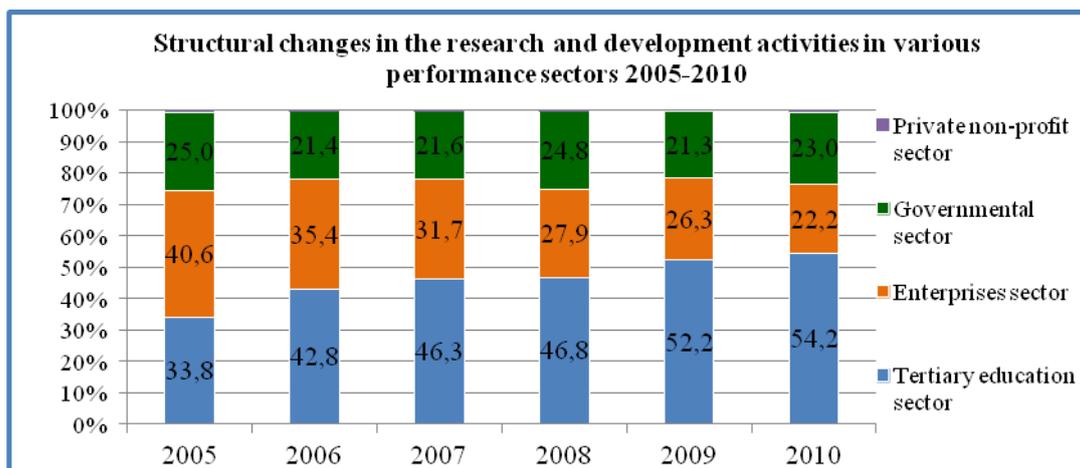
Data source: Data processed from Romanian Statistics Yearbook 2011, National Institute of Statistics, Bucharest

According to the statistical data and to the dynamic analysis, it has been noticed that the number of the employees in the research field has decreased during 2005 – 2010, with around 2000 persons, representing 4,8%. This decrease represents the consequence of the diminished number of researchers and other employees in the research area: approximately 8000 persons (-47,79%) from the enterprises sector, 1271 persons (-12,39%) from the governmental sector and 33 persons (-13,69%) from the non-profit sector.



**Figure 1.** Comparative evolution of the number of employees in the research area

The only sector that has increased the number of the employees in the research and development area during the period analysed is represented by the tertiary education, as it is illustrated in the figure 1. In this sector, the number of the researchers has increased in 2010 with 7290 persons, representing over 50% compared with 2005. This phenomenon demonstrates the increased role of the universities in the research field.



**Figure 2.** Structural changes concerning the number of researchers and employees in the research activities

It should be highlighted that the private enterprises sector owned, in 2005, more than 40% of the total number of the researchers in Romania, meanwhile the tertiary education sector had only 33,8% from the total number of researchers. The situation changed in 2010, when the researchers employed in universities represented more than 54%, since the researchers in the enterprises sector represented only 22% and the researcher employed in the governmental sector represented 23% (figure 2).

The positive evolution of the research activities in the tertiary education institutions in Romania is due to the efforts of the universities to be better positioned in the world tertiary education top, where the scoring includes the universities' contribution in the research field. It is well known that the tertiary education system has its own research institutes and centers, which become more and more powerful. In Romania, in particular, the integration in the European Union has created favourable conditions for financing the research activities and to join international research and universities networks (European Research Area and European Higher Education Area). The educational policies in Romania played also a major part, especially through the introduction of the quality evaluation in the education system and the development of a hierarchy of the universities. The development of various criteria for the evolution in the education career and also the regulations for the doctoral studies have

stimulated also the research activities in the academic area. In this perspective, the academic system represents a generator of ideas and good practices emerging from research processes, the doctoral research having a significant contribution (Davis, H., 2006).

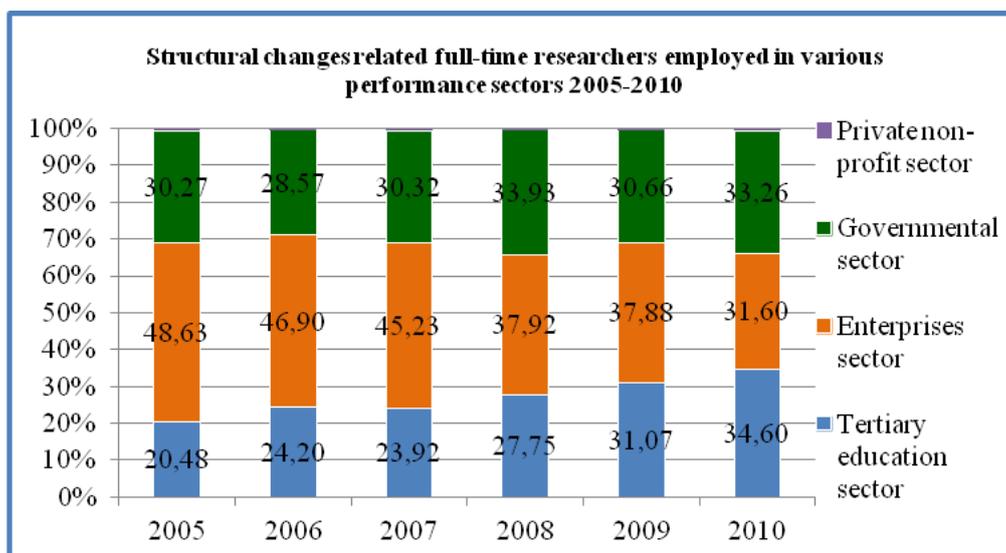
A more precise evaluation of the researchers' involvement in various sectors could be carried out by analysing the number of the full time employees in the research activities. In this case, the statistical data shows a worse situation. As the data demonstrates (table 2), the number of persons full time employed in the research activities decreased with more than 21%, representing more than 7000 persons.

**Table 2. Number of employees, in full-time equivalent, activating in research activities, in various performance sectors 2005-2010**

Sector	<i>No. of employees in full-time equivalent</i>						Changes 2010/2005%	
	2005	2006	2007	2008	2009	2010	Absolute values (no. of persons)	Relative values (%)
	<i>Total</i>	33222	29340	28977	30390	28398	26171	-7051
<i>Enterprises sector</i>	16157	13761	13107	11525	10758	8271	-7886	-48,8
<i>Government sector</i>	10055	8381	8786	10312	8708	8704	-1351	-13,4
<i>Tertiary education sector</i>	<b>6803</b>	<b>7101</b>	<b>6931</b>	<b>8433</b>	<b>8824</b>	<b>9054</b>	<b>2251</b>	<b>33,1</b>
<i>Private non-profit sector</i>	207	97	153	120	108	142	-65	-31,4

Data source: Data processed from Romanian Statistics Yearbook 2011, National Institute of Statistics, Bucharest

During 2005 and 2010, the enterprises sector lost 7886 full-time researchers; the governmental sector lost 1351 researchers and the non-profit sector, only 65 persons employed in research. Although the tertiary education sector had an increase in the number of full-time researchers (2551 persons), this positive trend does not compensate the decrease in the other sectors. Unfortunately, the data demonstrate that in the sectors creating gross added value in research the research activities are dramatically diminished. The structural changes concerning the number of full-time researchers during the same period (2005-2010) are illustrated in the figure 3.



**Figure 3.** Structural changes concerning the number of full-time researchers

The share of the number of full-time researchers in the tertiary education sector increased from about 20% in 2005 at 34,6% in 2010, since the share representing the researchers full-time employed in the enterprises sector has decreased from over 48% in 2005, to 31,6% in 2010.

The results of the desk research revealed a positive evolution of the number of the researchers employed in the tertiary education sector. This trend has increased the premises of the fundamental research, but in the same time, the support for the applied research, innovation and development activities became weaker by reducing the research activities in the enterprises sector.

## 2.2. Expenditures in Research and Development Activities

Interesting trends have been noticed in the international research space, i.e. the expenditures in the research and development area have increased significantly in the last decade, at the global level. The USA has registered an increase of 45%. Asian share in the world research and development expenditures increased from 27% in 2002, to 32% in 2007. The main contribution to the Asian evolution regarding research and development is due to China, India and South Korea (UNESCO, 2010). Despite the significant efforts, Europe is lagging behind regarding the investments in the research and development area.

The situation in Romania shows a lower share of expenditures in the research sector. A positive aspect consists in the dynamics observed related to the expenditures registered in the research, innovation and development field. From this perspective the increase is more than 100% in the analysed period of time (2005-2010), as it is illustrated in the table 3.

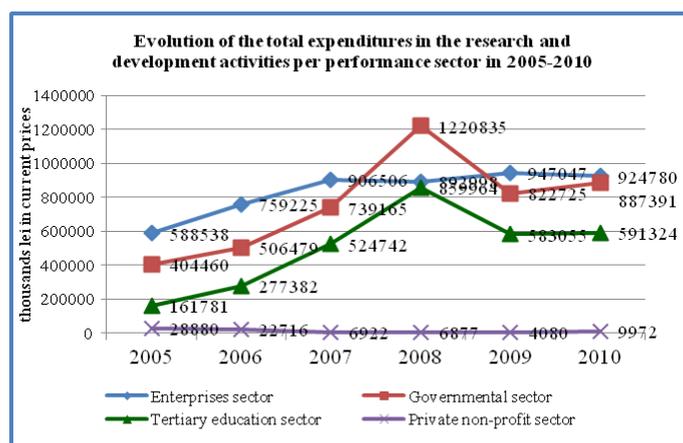
**Table 3. Current expenditures evolution in the research and development activities by performance sectors in 2005-2010**

*thousands lei in current prices*

Sector	2005	2006	2007	2008	2009	2010	Changes 2010/2005 (%)	
							Absolute values (thousand lei)	Relative values (%)
<b>Total expenditure</b>	1183659	1565802	2177335	2980674	2356907	2413467	1229808	103,9
<i>Enterprises sector</i>	588538	759225	906506	892998	947047	924780	336242	57,1
<i>Government sector</i>	404460	506479	739165	1220835	822725	887391	482931	119,4
<i>Tertiary education sector</i>	161781	277382	524742	859964	583055	591324	429543	265,5
<i>Private non-profit sector</i>	28880	22716	6922	6877	4080	9972	-18908	-65,5
<b>Current expenditure</b>	<b>1040367</b>	<b>1319247</b>	<b>1742744</b>	<b>2513439</b>	<b>2077224</b>	<b>2045132</b>	<b>1004765</b>	<b>96,6</b>
<i>Enterprises sector</i>	525019	649238	737979	767604	830476	757366	232347	44,3
<i>Government sector</i>	368150	435009	614560	1055808	745425	787571	419421	113,9
<i>Tertiary education sector</i>	120751	212373	383305	684048	497338	490740	369989	306,4
<i>Private non-profit sector</i>	26447	22627	6900	5979	3985	9455	-16992	-64,2
<b>Investments</b>	<b>143292</b>	<b>246555</b>	<b>434591</b>	<b>467235</b>	<b>279683</b>	<b>368335</b>	<b>225043</b>	<b>157,1</b>
<i>Enterprises sector</i>	63519	109987	168527	125394	116571	167414	103895	163,6
<i>Government sector</i>	36310	71470	124605	165027	77300	99820	63510	174,9
<i>Tertiary education sector</i>	41030	65009	141437	175916	85717	100584	59554	145,1
<i>Private non-profit sector</i>	2433	89	22	898	95	517	-1916	-78,8

*Data source: Data processed from Romanian Statistics Yearbook 2011, National Institute of Statistics, Bucharest*

The main contribution to increasing the total research expenditures is due to the tertiary education (3,6 increase in 2010 compared to 2005) and the governmental sector (2,19 increase in 2010 compared to 2005). The ascendant evolution of the expenditure indicator in the sectors analysed is illustrated in the figure 4.



**Figure 4.** Dynamics of the total expenditure in the research per sector between 2005 and 2010

It is also interesting to highlight the share of the investments in research. In this case, the enterprises sector and the government sector have the main contribution, i.e. 163,6% and 174,9%. In the tertiary sector, the current expenditure increase is more significant than the investments in research, which demonstrates that the contribution of the universities is predominant in the theoretical field and less significant in the applied research.

Per total, the structure of the research expenditures shows a positive evolution, consisting in the increase of the investments share in the total expenditure from 12,11% in 2005 to 15,26% in 2010, which is correlated with the dynamics of the investments, representing an increase of 157,1% in 2010 compared with the base year.

The allocation of funds for investing in research remains limited and lower as expected, especially for achieving the main goals of the 2020 European Strategy. In Romania, as well as in other European countries, in order to avoid to jeopardize the main development goals for the 2020 horizon, the EU and the member countries should re-think the public spending on knowledge, i.e. the investments in research and innovation and also in tertiary education (Ritzen, J., Soete, L., 2011).

The correlation between the two indicators, i.e. the number of researchers and the expenditures in the research area could be analysed through the indicator distribution of the costs per employee. The efficiency of the research activities could be revealed calculating the distribution of the expenditures in the research area per researcher full-time employed, as it is presented in the table 4.

**Table 4. The expenditure per capita in research area in 2005-2010**

*Lei/ Employees (number of persons in full-time equivalent)*

Sector	2005	2006	2007	2008	2009	2010	Changes 2010/2005 (%)	
							Absolute values (lei/person)	Relative values (%)
<b>Total</b>	35629	53367	75140	98081	82996	92219	<b>56590</b>	<b>158,8</b>
<i>Enterprises sector</i>	36426	55172	69162	77484	88032	111810	<b>75384</b>	<b>206,9</b>
<i>Government sector</i>	40225	60432	84130	118390	94479	101952	<b>61727</b>	<b>153,5</b>
<b><i>Tertiary education sector</i></b>	23781	39062	75709	101976	66076	65311	<b>41530</b>	<b>174,6</b>
<i>Private non-profit sector</i>	139517	234186	45242	57308	37778	70225	<b>-69292</b>	<b>-49,7</b>

*Data source: Data processed from Romanian Statistics Yearbook 2011, National Institute of Statistics, Bucharest*

Analysing the dynamics of the expenditures distributed per researcher, it should be emphasised that only in the private non-profit sector it has been noticed a negative evolution, demonstrating a positive trend for increasing the efficiency. The evolution of the efficiency, measured through the indicator expenditures per capita is illustrated in the figure 5.

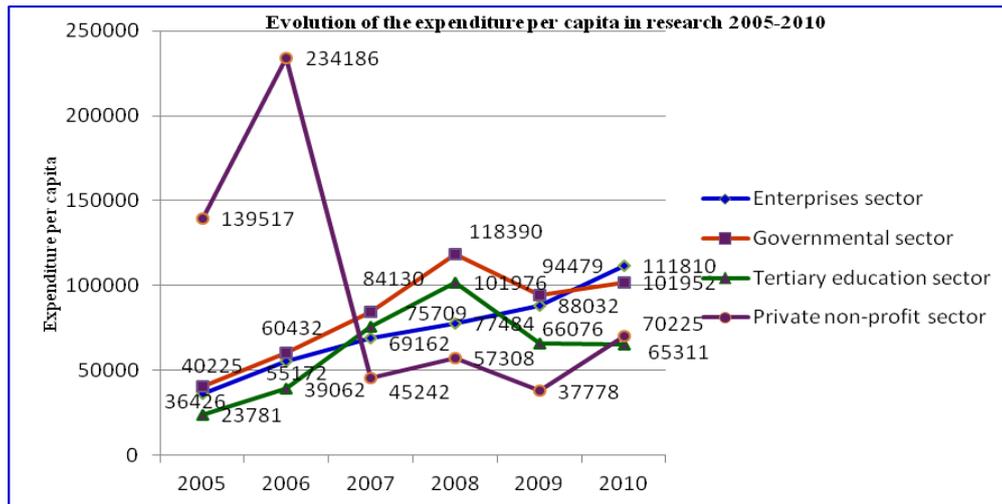


Figure 5. Efficiency evolution measured through the indicator expenditure per capita in research area

In the other cases, despite the decrease related to the number of researchers, the level of the expenditure has increased and also the expenditures per capita (e.g.: in the enterprises sector, the expenditure per researcher full-time employed, has increased with more than 200%; in the governmental sector, with more than 150% and in the tertiary education, with more than 170%).

Another important indicator is represented by the share of research expenditures in GDP, as a main factor for the development of the research activities (figure 6).

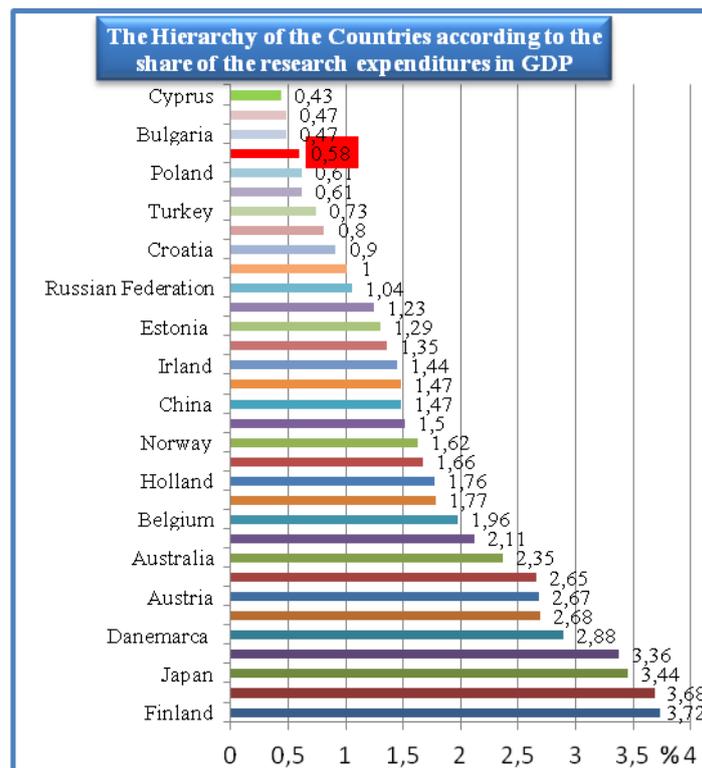


Figure 6. The ranking of the countries according to the research expenditures

A hierarchy of the countries related to the research and development capacity has positioned Romania on the level 22 from 33 world states concerning the number of researchers equivalent full-time. The hierarchical list based on the share of the expenditure for research and development in the GDP, shows that Romania is positioned on the 30 place, having a better position only compared with Slovakia, Bulgaria and Cyprus. (Figure 6). It should be also emphasised that Finland is placed on the

first position concerning the research activities. The very good positioning of Finland in the hierarchical list related to the research activities is correlated with the fact that Finland has the greater number of persons who had been attended the tertiary education and also with the fact that Finnish universities have occupied an outstanding position in the hierarchy of the universities.

Concerning the results of the research, the academic area aims at making visible its effort and the main indicator considered in the tertiary education is represented by the number of scientific papers included in the Thompson Reuters index of the scientific research papers. The global academic market is more and more competitive not only concerning the education processes, but also regarding the research activities. The facilities for the international recognition of the research results and their publishing enable the wide access to knowledge and new technologies, diminishing the space and financial barriers.

### III. CONCLUSIONS

Among the major changes in the research area, the increased role of the tertiary education should be considered one of the most important mutations. Within the academic space, there are also important changes, especially related to the position of the countries and universities on a global perspective. The traditional leaders in research faced in the last years a significant competition from China, India and Brazil. The number of scientific published papers from China and Brazil has doubled during the last six years.

The culture of the academic excellence and cutting-edge research is not only the privilege of certain countries, being available for interested tertiary education institutions which intend to evolve positively in the knowledge society.

The ranking of the universities and the research activities will be more and more significant for the sustainable development of the countries. Consequently, the national and regional policies should be focused on supporting the development of the universities and the research processes within the academic area as the main development factor.

Besides the benefits in quantitative terms, the contribution of the universities is very important for the personal development, creating people's new competences in order to cope with technological changes and to have a pro-active attitude for continuous learning. The main result of the research consists in a better repositioning of the universities in the socio-economic landscape.

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