Innovation and Knowledge Transfer in Romanian Universities

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Abstract

The present paper shows how the international productivity and competitiveness of a country depend on the rapid accumulation of knowledge based on the entrepreneurial innovative education and on the real transfer of the new technologies and positive experience. Although there is no explicit relationship between investments in education and the GDP variation the paper shows the existence of an influence of the education and scientific research on the economic growth of a country. We made a long term evolutionary analysis of the GDP and we showed that investments in education and research made four-five years ago are implicitly reflected in the GDP growth. By studying the investments evolution in education and research the paper demonstrates the existence of a similitude between the previous shape of the investments' curve in education and research and an ulterior shape of the GDP's curve.

Keywords: *Innovation, transfer of knowledge, technology transfer, academic entrepreneurship*

JEL classification: Q57

1. A factual and statistical analysis of the university system's evolution in Romania

The higher education system in Romania is going through a process of change. The new reformist tendencies have imposed the repositioning of higher education institutions in the social and economic environment. The requirement of higher education development stems from the fact that the economic development of a country is directly linked to the quality of its human capital.

Higher education in Romania has undergone major changes since 1990. First, the number of students has grown tremendously. In the period 1990-2010 their number increased from 164,507 to 999,523. There has been an increase of about 6 times. The number of higher education institutions has increased from

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56 universities (186 faculties in 1990) to 107 universities (with 629 faculties in 2010). The number of university teachers increased from 11,803 in 1990 to 27,765 in 2011, marking a growth of only 2.35 times compared with the 6 time increase in the number of students. This led to a degradation of the quality of education due to the increased ratio between the number of students and the number of teachers. After 1990 the first private universities emerged as an alternative to public education.

The material basis for higher education has extended, but not at the same pace with the increase in the number of students. If in 1990 Romanian universities had 933 amphitheaters, 2,361 seminar rooms and 3,994 laboratories in 2011 there were 3,160 amphitheaters, 4,316 seminar rooms and 9,456 laboratories. The result was an extensive development of higher education that cannot be maintained in the long term.

The increase in the number of students was not correlated with the increase in the number of university teachers, nor to the development of the material basis. Over the past four years there has already been a decline in the number of students compared to the peak reached in the 2008-2009 academic year, a decrease due to the fall in the number of high school graduates and to the effects of the economic crisis. For an intensive development of higher education, it is necessary to take serious measures for the transformation of universities, following the academic entrepreneurship path.

Among the various factors influencing the transition of universities in terms of their role, there are the changes the advanced economies have undergone towards knowledge-based innovative systems, open and more interactive. These changes have challenged universities to reorganize their research and innovation section, to assess their educational mission and methods, and to develop knowledge sharing. This process of transformation has been lately conceptualized in different ways, starting from the idea that it is a change in the "*social contract*" between the university and society, to the consideration that it a shift in the way of imparting knowledge (Martinelli, Meyer, Tunzelmann, 2008).

In comparison with the EU developed countries, Romania universities face many problems in terms of their transformation into entrepreneurial universities. There is an inadequate public funding of education and scientific research and most universities do not have their own income, which could supplement the government funds. The unavailability of adequate funds causes difficulties for universities in fulfilling their mission and objectives.

Thus, universities have difficulties in:

- education quality assurance;
- procurement of equipment and materials for research;
- ensuring modern information and communication technologies.

The future entrepreneurial changes in universities and the coalescence of the academic and economic world has been a subject of intense debate in recent years (Jain, 2009). These emerging forms should be studied for a deeper understanding of how to foreshadow their impact both on science and

entrepreneurship. In doing so, the old model of university researcher will be replaced by the model of academic (university) contractor, in which the university teacher is a researcher and an entrepreneur alike.

Why should we promote the entrepreneurial university? In order to answer this question it is necessary to show which is the finality of such an activity within the university. The entrepreneurial activity is intrinsically linked to intellectual property, through the development of inventions, of utility models or trademarks, of scientific or literary and artistic works. Therefore, this paper addresses the means used for upgrading the university by adapting knowledge, the results and capabilities obtained in university research centers in order to make them compatible with the socio-economic requirements.

2. Analysis of investments in education and research

The international productivity and competitiveness of a country depend on the rapid accumulation of knowledge and the effective transfer of technologies and good experience. Peters L. Daniels tried to find a dependence between the expenditure of scientific research, technological development and innovation (RDI), and the variation of world exports (Peters, 1977)

According to the conclusions of this study, which were developed based on the statistical data between 1978-1988, it is shown that *there is not an explicit relationship between RDI expenditure and GDP variation.*

The dimensionless indices of GDP and RDI variation are defined as follows:

$$\partial_{GDP} = [\ (GDP)_f - (GDP)_i\ ] /(GDP)_i$$
$$\partial_{RDI} = [\ (RDI)_f - (RDI)_i] / (RDI)_i$$

the indices have the meaning:

i – *at the beginning of the test period*;

f – *at the end of the test period*.

With the help of these relationships and the statistical data[1], [2] we calculate the variations in GDP and RDI between 1987-1997 for a group of ten countries, including Romania.

Figure 1 shows the variation in GDP, variation correlated with RDI expenditure in these countries during a decade (1987-1997).

After a period of 10 years, for the group of strongly industrialized countries (USA, France, England, Italy) it is found that, although the allocations for the RDI (% of GDP) fell, the GDP increased, its index of variation having values lower than 0.3. For Germany, although the allocations for the RDI fell more sharply, the GDP

[1] *** Main Science and Technology Indicators, OECD1998

[2] *** National Science Board, Science & Engineering Indicators – 1998, Arlington, VA: National Science Foundation, 1998 (NSB 98 – 1), SUA.

increased significantly, its index of variation being ∂_{GDP} = 0.5. Instead, the RDI expenses for Japan and Canada rose, while the GDP also increased, the ∂ being 0.34 for Japan, 0.25 for Canada respectively. More obvious is the case of New Zealand, which for an ∂_{RDI} = 0.38 has a correspond of ∂_{GDP} = 0.73, so a fairly important GDP growth. South Korea presents an ∂_{RDI} = 1.2, that is a large increase in the RDI expenditure, which corresponds to an ∂_{DGP} = 1.16, which means a high increase in GDP. As far as Romania is concerned, the index variation of the RDI has a value of ∂_{RDI} = 0.54 which corresponds to an ∂_{GDP} = - 0.46. These variations show that if the RDI costs have fallen sharply, the Romanian GDP has fallen sharply, too. Based on these calculations and observations, we can estimate that there is not an explicit dependency relationship between the RDI expenditure and the GDP variation, which means that we should also take into consideration other factors of influence.

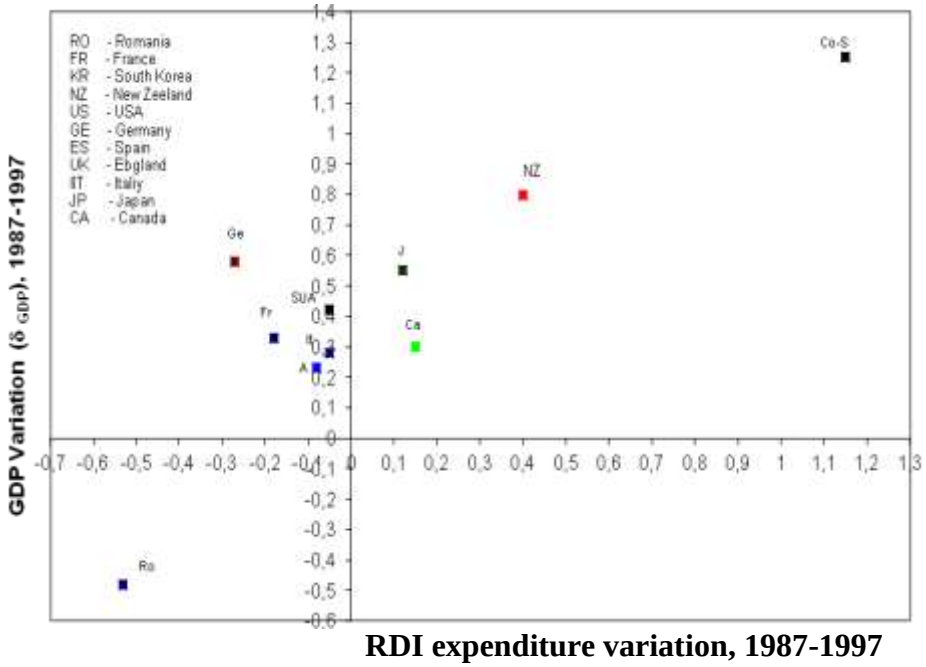


Figure 1 GDP variation in correlation with RDI expenditure

Such an influencing factor could be the *social capital*. As a social influencing factor, it suggests that its ownership and efficient exploitation depend greatly on the set of common values and sociability. Other factors that influence the GDP could also be identified with a view to finding the explicit dependency relationship, a relationship in which the investment in RDI has a significant percentage. It requires in-depth research because innovation as a process is more than a means to redress the problems of transition and development, through the balance of payments. With a first approximation, we can assess that *the mere investment in RDI does not automatically solve the problem of raising the GDP*.

This should be associated with capital investment, innovative capacity and other factors of influence.

The innovative productivity index is defined by the relationship:

$$\partial_i = (E_1 - E_0) / (E_1 + E_0)$$

where: E_1 – represents the expenditure for a researcher, lei / researcher.

E_0 – represents the expenditure for a patent lei / certificate.

The values of the innovative productivity index have been calculated for a group of seven countries, including Romania. These calculated values are plotted in Figs: 2a, 2b and 2c.

Figures 2a, 2b and 2c shows the trends, in time, of the the following parameters of development by means of the RDI:

- GDP per capita, considered as a welfare indicator.
- RDI expenditure.
- Innovative productivity index.

It can be noticed that for countries with high levels of GDP per capita, correlated with RDI expenditures, there are corresponding values of ∂_i closer to zero.

Typically, the $E_0 \geq E_1$ and, therefore, the ideal case is given by $E_0 = E_1$, in which case $\partial_i = 0$.

Thus, the USA, which has the highest GDP per capita and allocates high RDI expenditure, achieves an innovative productivity index with values ranging from - 0.77, to - 0.83, while South Korea achieves ∂i = - 0.19 ..... - 0.5.

Romania achieves ∂i closer to the value "-1" ($E_1 = 0 \rightarrow \partial i = -1$), which means a very low innovative productivity, reflected in a modest GDP per capita, ranging between 1120 - 1346 USD per capita.

We can make similar observations for the other surveyed countries.

It is obvious that innovative productivity index shows values closer to zero, the more the RDI expenditure / researcher decrease, and the more the RDI expenditure RDI / patent fall. In other words, the stimulation of the human factor, associated with corresponding scientific and technical facilities results in increased income per capita, therefore in an increased GDP. For these countries, and generally, even if the number of analysis parameters has increased (∂_i, RDI expenses, no. of people, no. of researchers, no. of patents, GDP) the dependency relationship with the GDP remains subsequently implicit. This means noticing the "presence" of other factors, behind these figures and curves. These factors, which are more of socio-cultural nature, should be deeply studied, and, for countries which are in transition, this research represents both an important scientific and pragmatic stake. In order to understand the functional connection between the parameters that are associated with the creation of a nation's welfare, it is necessary to study further the influence of innovative productivity and of the RDI expenditure on the GDP evolution. Although all they manage is to point out an

implicit dependence, the results obtained show that in the context of the action of some socio-cultural factors, the innovative productivity and the RDI expenditure influence, to a large extent, the variation in GDP.

This aspect indicates that research work still needs to be carried out, and this should be rooted in the Romanian reality, in the psycho-sociology of the Romanian people, in order to define transition as a complex phenomenon, both from an innovative and socio-cultural pint of view.

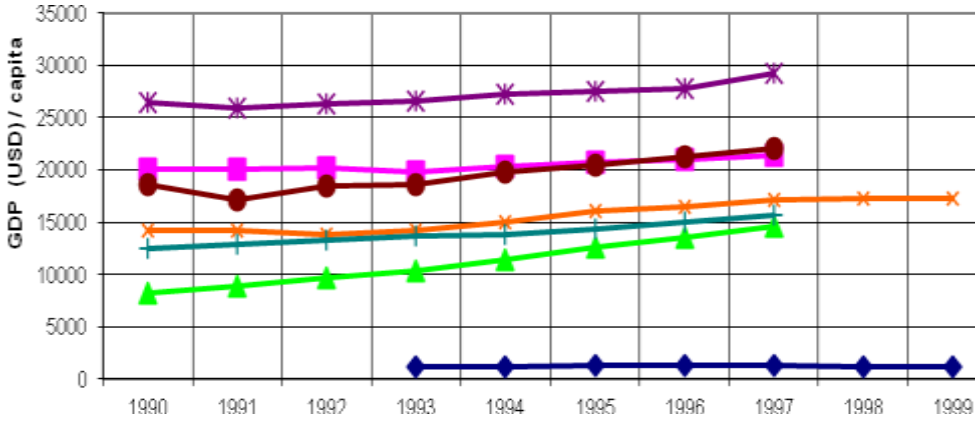


Figure 2 a. of GDP evolution / capita

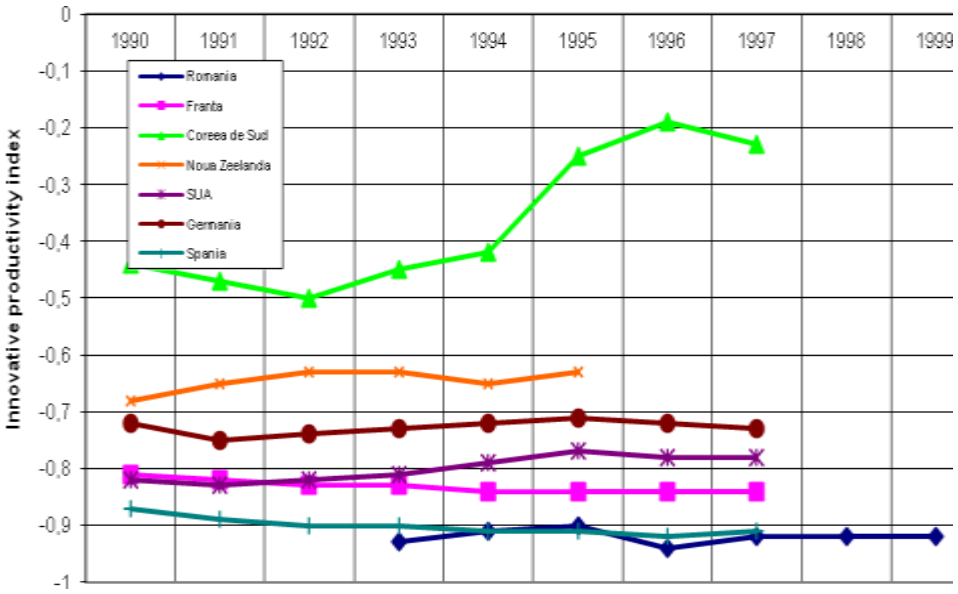


Figure 2 b. RDI expenditure

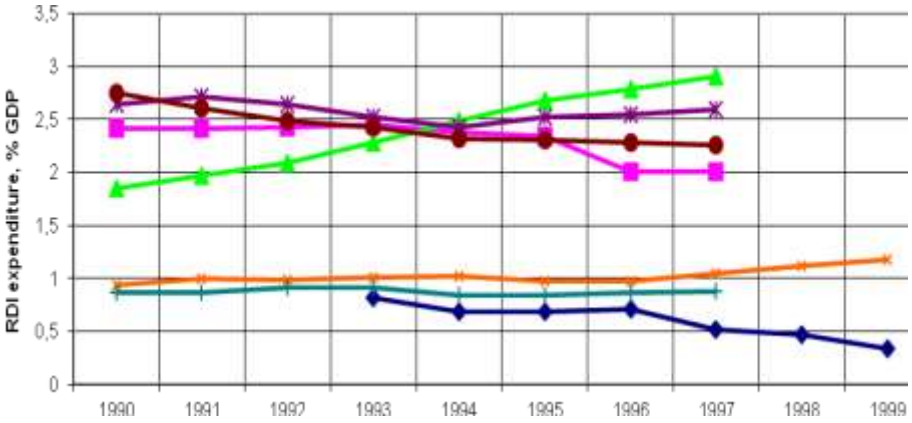


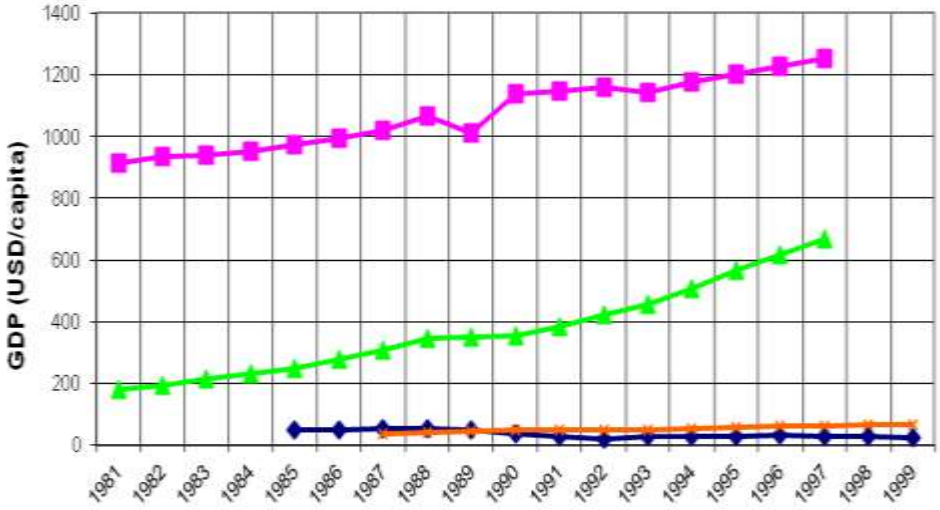
Figure 2 c. Innovative productivity index

The results of this research could ensure Romania's success in the developing and transition process by leading the society to an innovative and adaptive culture, able to support emerging technology and breakthroughs corresponding to a rapid growth of the Romanian competitiveness. The analysis of the evolution, over long periods, of the Gross Domestic Product (GDP) shows that the investments in RDI, about 4 -5 years earlier, are implicitly reflected in the GDP growth. By studying the evolution of these two parameters on a group of four countries, including *Romania*[1],[2] (Fig. 3), a similarity can be noticed between the previous trend of the RDI and the subsequent trend of the GDP. In the period 1981 - 1986, South Korea incurred RDI expenses amounting to USD 12.9 billion, which led, in combination with other factors, to a GDP growth of 1.2 times, in 1990, compared to 1986. The same phenomenon can be noticed on the other segments of the curve corresponding to 4 -5 years' periods. *France*, in the same period, allocated USD 121.9 billion for the RDI. In the next period, this had, in 1990, a GDP which was is 1.14 times higher than in 1986. Also, New Zealand that had allocated USD 1.91 billion for the period 1987-1991, achieved a GDP growth which was 1.2 times higher in 1996 compared to 1991. In the case of Romania the reverse phenomenon can be noticed. Thus, it had allocated USD 1.5 billion for the RDI in the period 1989-1993, corresponding, in 1998, to a GDP which was almost equal to that from 1993. The same phenomenon, much worse, was repeated between 1993 and 1997, resulting in an even sharper decrease in the GDP, to a crash quote, as a result of an inadequate policy of a continuous decline in the RDI investments. As far as Romania is concerned, its welfare fell drastically during the analyzed period, while increasing in the countries that constantly invested in the

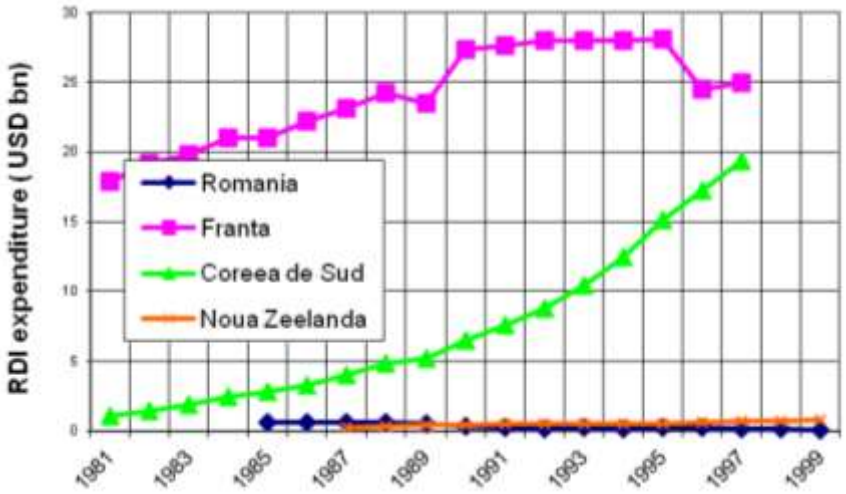
[1] *** Main Science and Technology Indicators, OECD1998

[2] *** National Science Board, Science & Engineering Indicators – 1998, Arlington, VA: National Science Foundation, 1998 (NSB 98 – 1), SUA.

RDI (Fig. 4). Compared to 1989, in Romania the GDP per capita fell by half in 1999, which explains the high rate of poverty today. In a period of 10 years, from 1987 to 1997, in France the GDP per capita increased by 17%, while in South Korea doubled, and in New Zealand it grew 1.5 times.



a)



b)

Figure 3 (a and b) GDP evolution in correlation with RDI expenditure evolution

Figure 4 GDP evolution/ capita

3. Mechanisms of entrepreneurial university for innovation by means of intellectual property valorization

According to this paper, the innovative-entrepreneurial university aims at the valorization of intellectual property, which means all the entrepreneurial activities and initiatives that lead to increasing the value of the research results and the overall knowledge produced by the university. Specifically, the valorization of intellectual property involves the entrepreneurial means used to tailor knowledge, the results and capabilities obtained in the research centers in order to make them compatible with the socio-economic requirements. The generally known academic entrepreneurship presents in detail all the possible trajectories of knowledge production and the functions of the entrepreneurial university (Figure 5).

The mechanisms of intellectual property entrepreneurial valorization are those operations that ensure the dissemination of a particular technology from the supplier to the customer. In general, these processes can be financial, technological or human. They consist of various procedures, from active forms, such as interpersonal communication to passive ones like reading a technical magazine.

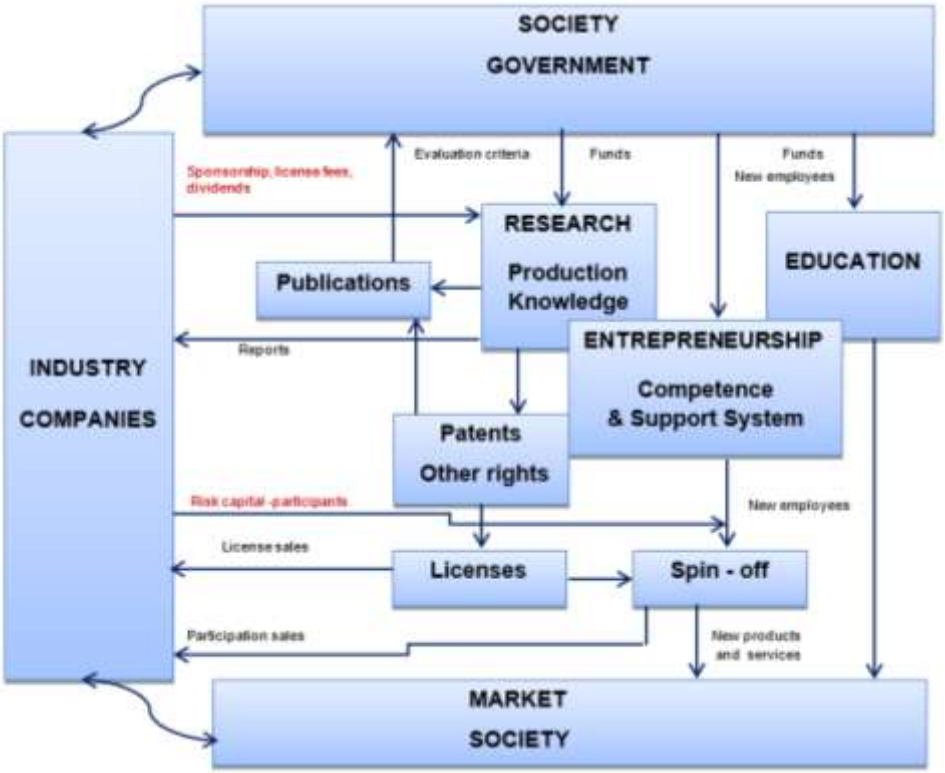


Figure 5 Academic entrepreneurship

The mechanisms for intellectual property valorization can be divided into seven categories, as shown in Table no. 1.

The technologies which are the object of intellectual property entrepreneurial valorization are embedded in patents, utility models, designs, trademarks, know-how, including information and technology, technological services, technological support and other protection rights for chips and software. Changing the structure and functions of universities has become a crucial necessity in transforming the knowledge flow into new sources of industrial innovation (Chang, ş.a. 2006). In order to provide economic benefits, various organizational forms of universities have emerged, which include business organizations such as intellectual property offices, technology transfer, licensing, incubation facilities and spin-offs ones.

Table 1 Mechanism for intellectual property entrepreneurial valorisation

No.	Category	Sub - category
1.	Advisory groups	*Final user reviewer groups*
		Technical reviewer groups
2.	Collaboration with cost participation	*Industrial consortia*
		Research-development in partnership
		Demonstrative projects
		User's facilities
3.	Collaboration without cost participation	*Research-development contracts*
4.	Staff exchange	*Works for third parties*
		Advisory staff
		Invited staff
		Staff transfer
5.	Licensing / spin off	*Licensing*
		Spin off Companies
		Scientific and technological parks
		Business technology incubators
6.	Information active dissemination	*Brokerage companies*
		Conferences, seminars, workshops
		Technology information centers
		Education
7.	Information passive dissemination	*Postal mail, including e-mail*
		Technical reports
		Journal articles
		Video-recordings
		Electronic bulletins

Conclusions

Basically, universities are required to fulfill the mission of education, research and services. The purpose and function of the university have always been to produce knowledge and wealth for the benefit of the public. This model has evolved towards the one that regards the university as a major player in the economic development.

The innovative-entrepreneurial university must demonstrate the social and economic benefits of their research, with a view to participating in competitions for the various funding sources available. More than ever, innovative-entrepreneurial universities are turning to the management, patenting and valorisation of intellectual property developed in the university campus. Thus, by maintaining their basic functions of education and theoretical development, many universities have started to increase the attention they attach to the function of creating welfare, not only for the society in general, but also in particular, for generating revenues for the respective universities.

References

1. Azagra-Caro, J.,M., *Faculty support for the objectives of university–industry relations versus degree of R&D cooperation: The importance of regional absorptive capacity,* RESEARCH POLICY 35, 2006
2. Chang, Y.,C., "Managing academic innovation in Taiwan: Towards a scientific–economic framework", *Technological Forecasting & Social Change* 73, 2006.
3. Griffin, T., "Evaluating QFD´s Use in Firms as a Process for Developing products", *The Journal of Product Innovation Management* 9 (3), 1992.
4. Jain, S. and so on, "Academics or Entrepreneurs? Investigating Role Identity Modification Of University Scientists Involved in Commercialization Activity", *Research Policy* 38, 2009.
5. Markma N, G., D., "Entrepreneurship and university-based technology transfer", *Journal of Business Venturing* 20, 2005.
6. Martinelli, Arianna, Meyer, Martin, Tunzelmann, von Nick, "Becoming an entrepreneurial university? A case study of knowledge exchange relationships and faculty attitudes in a medium-sized, research-oriented university", *Journal Technol Transfer*, 33, 2008.
7. Năstase, I., G., *Scientific research, tehnological development and innovation in the security system.* AGIR Publishing House, Bucharest, 2012.
8. Peters, L., Daniels, "Translating National R & D Investment into Trade Succes: An exploration into some dynamic linkages", *Science and Public Policy*, Vol. 24, aprilie 1977.
9. Youtie, Jan, Shapira, Philip, "Building an innovation hub: A case study of the transformation of university roles in regional technological and economic development", *Research Policy* 37, 2008.
10. *** *Main Science and Technology Indicators*, OECD1998.
11. *** *Guidelines on Developing Intellectual Property Policy*, World Intellectual Property Organization (WIPO), Publication No. 848(E), 2001.
12. ****National Science Board, Science & Engineering Indicators* 1998, Arlington, VA: National Science Foundation, SUA, 1998.
13. ****Statistical Yearbook of Romania*, ISR, 2010.