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The Convergence Degree of Innovation Potential of Romanian Economy, by Comparison with the Developed Economies of the EU Member States

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In this paper we analyze the convergence degree of innovation potential of Romanian economy, by comparison with the developed economies of the economical and monetary union, on one hand, and with the last wave of integration countries – in most cases, economies in process of development, therefore with an economical development trajectory like our country – on the other hand. The European Innovation Scoreboard (EIS) is the instrument developed at the initiative of the European Commission, under the Lisbon Strategy, to evaluate and compare the innovation performance of the EU Member States. The EIS includes innovation indicators and trend analyses for the EU Member States, plus the two new Member States: Bulgaria and Romania, as well as for Croatia, Turkey, Iceland, Norway, Switzerland, the US and Japan. The Summary Innovation Index gives an "at a glance" overview of aggregate national innovation performance. It measures 5 key innovation dimensions: Innovation drivers, Knowledge creation, Diffusion, Applications and Intellectual property.

Key words: *innovation, Summary Innovation Index, research, knowledge creation*
JEL classification code: *O31*

The growth of Romania's productivity and competitiveness on the global markets have to be sustained by politics of easy firms' access to the research-development results, through: innovation and technological transfer; access to specialized services – as information, intellectual and industrial property – and participation to the international network; development of entrepreneurial culture and of innovation; growth of firm level research; strengthening connections between the business community and the one of education and research.

In USA and Japan the economical and research sectors are highly connected, but in EU there is *a real gap* between the economical sector and the one of applicative research. For our country, is a challenge to catch up the European developed economies, or even more than that, through a convergent economy, based on knowledge, and most important, able to generate knowledge. Therefore, the adoption of strategies which could stimulate new ideas and technologies represents an obligation for every European country.

The main reason of this research is the fact that process of knowledge creation is most rewarding in the present international economic context, characterized by global economy globalization. Any invention or innovation which could be brevetted is a competitive advantage on the global emergent markets, implying huge profitable effects.

Competitivity within the European Union is closely tied to its position in the domain of innovation and transmitting new technologies. For a better understanding of the factors that contribute to the success of innovation in the European Union we use the benchmarking as an instrument to identify the best methods. The method allows the appreciation of a country, region or enterprise's performances compared with its competitors.

As an answer to the challenge of the European Council in Lisbon, there have been used some of the performance indicators as reference points to provide the people who take decisions with relevant

information referring to each country's achievments in terms of innovation, business development and utilization of new technologies. The information related to the innovation activity made by EU enterprises is assured by a special statistic investigation/inquiry/survey: ***Community Innovation Survey*** *(CIS)*. The data and the information provided by this investigation are at the basis of the evaluation of the partial and synthetic innovation indicators.

The System of innovation indicators used by the EC countries and the candidate countries (*European Innovation Scoreboard* - EIS) is the main statistic instrument used by *European Trendchart on Innovation*, elaborated as a reply to the initiative from Lisbon in March 2000. It was implemented in 2001 and continuosly perfected, thus it became a main reference point for the decisions referring to innovation policies and economic analysts, as well. The number of the indicators used increased from 20 to 25, trying to find various aspects of the innovative process. These indicators are capitalized under different forms: individually, five synthetic indicators that cover the key dimensions of the innovation and a composite one that unites in a standard form all the partial indicators, offering a synthetic evaluation of the innovation that affords regional and international comparisons.

The elaboration of a complex system of innovation indicators has been a long process, developed in many stages.

The first step was the **indicator identification,** potentially relevant for the investment process, capable of directing the decisions making of economic policy according to the Lisabon objective. There has been elaborated a first list of 52 innovation indicators, selected in terms of relevance and data availability. These indicators have been organised in 5 blocs/bodies: innovation drivers (human resources), knowledge creation, innovation and entrepreneurship describe the input of the innovational process, while the applications and the intellectual property refer to output.

The second step is the selection of final indicators so that to avoid redundancies and strongly correlated indicators. At this stage there has been made a statistic analysis of the relation among the five blocs of indicators and among the indicators in each bloc. The correlation matrix made for each bloc of indicators allowed the identification of indicators that had a strong correlation, and the statistic analysis of the main component was used to identify the key- factors in each group.

After the first two phases there remained 25 indicators. The selection was based on the following principles (Sandu, Steliana; Ioan-Franc, Valeriu; *Creativitatea şi inovarea – experienţe europene*, publicat în *Studii şi cercetări economice – vol. 44-45*, Academia Română, Institutul Naţional de Cercetări Economice, Centrul de Informare şi Documentare Economică, Bucureşti, colecţia 2007, p. 9):

- redundancy: if there are two or more indicators that offer similar information, we select only one;

- political impact: when two indicators are strongly correlated and offer an important political message, both indicators are selected ;

- availability: in many countries available indicators for many countries are preffered and those that can be obtained from the existent database;

- when two indicators are redundant, the one that is included in the previous lists is kept.

The database was completed with absent information using regression techniques.

It is possible to obtain a general view relating to the innovation evolution of each country by synthetising the partial indicators in a **summary innovation index**. It is much easier to analyze the variation of a synthetic indicator than to look for common tendencies of partial indicators' evolution. The synthetic indicator is useful for countries' hierarchy, discrepancies' evidence and in the decision making process. However, the construction of a synthetic indicator is not free of

difficulties, and the methodological problems that appear have to be solved accordingly to eliminate the danger of misinterpretation or results manipulation. The list of partially used indicators is frequently revised. For example, in the EIS 2005 list of partial indicators, the indicator "the penetration rate of simultaneous telecommunications" replaces "the access to Internet", the indicator "the weightings of innovative enterprises financed by public sources" replaces "direct expenses (research-development) of companies financed by public sources", and the indicator "national patents per a million citizens" disappears.

The reunion of partial indicators in a summary innovation index and subindexes corresponding to thematic groups presumes a calculation algorism that starts from standardizing the primary data. The primary indicators are represented in different unit measures (for example, % results on a million people) which do not permit their direct summing up. Bringing the primary indicators to a common measure unit is done by using **the minimum-maximum standardization method** that can be applied in two steps as it follows:

1. The standardized value is determined (between 0 and 1) of each primary indicator with the relation:

$$y_{ij} = \frac{x_{ij} - \min(x_j)}{\max(x_j) - \min(x_j)}$$

where: y_{ij} - standardized value of indicator ***j*** for country ***i***;

x_{ij} – value of indicator ***j*** for country ***i***;

2. The calculation of synthetic index as arithmetical mean (weighted or simple) of the standardized value of constitutive indicators:

$$I_i = \frac{\sum_{j=1}^{m} q_j y_{ij}}{\sum_{j=1}^{m} q_j}$$

where: I_i - innovation synthetic index for country ***i*;**

q_j - weight indicator ***j***.

In most of the cases, to simplify the partial indicators – that composes the summary index – receive equal weightings. In case of complementary indicators (for example when the data for innovative and noninnovative companies are available) weightings of sum 1 are used.

The European Innovation Scoreboard (EIS) covers the 27 EU Member States (Bulgaria and Romania joined the EU on 1 January 2007. However, the EU25 mean is used throughout this report to reflect average EU performance as all of the underlying analyses were performed in 2006 when only EU25 mean data was available from Eurostat and other data sources), Croatia and Turkey, the associate countries Iceland, Norway and Switzerland, as well as the US and Japan. The indicators of the EIS summarise the main elements of innovation performance.

The EIS 2006 almost fully adopts the 2005 methodology with the exception of some few changes, for example:

- Removal of the indicator measuring the share of university research and development expenditures financed by the business sector;
- The indicator on public research and development expenditures is now defined as the sum of government and university research and development expenditures only.

The groups of innovation indicators that form EIS (2006 variant) refer to two main themes: inputs and outputs. Innovation inputs (that include three dimensions) and outputs (two groups) will be presented briefly as it follows.

- **INPUT 1: innovation drivers**

This group of five indicators measures the structural conditions that assure the innovative potential using information related to the quality of work resources mainly:

1. science and engineering graduates per 1000 population between 20 and 29 years old;
2. population with higher education (any kind of posthighschool education), per 100 population between 25-64 years old;
3. broadband penetration rate: the extension rate of telecommunication lines (number of lines at 100 citizens);
4. participation in permanent education (life-long) learning (% people between 25-64 years old);
5. youth education attainment level (% people between 20-24 years who graduated at least highschool).

- **INPUT 2: knowledge creation**

The four indicators in this group measure the investments in human factor and in research – development activities, considered as key elements of the knowledge – based economy:

6. public research-development expenditures as percent of Gross Domestic Product (GDP);
7. business research-development expenditures as percent of Gross Domestic Product (GDP);
8. share of medium high-tech and high-tech research-development expenditures (% of manufacturing research-development expenditures);

9. share of enterprises that are financed for innovation and research-development from public sources;

- **INPUT 3: innovation and entrepreneurship**

This group of six indicators measures the efforts done for innovation at a microeconomic level.

10. sum of small and medium enterprises (SMEs) that have a domestic (in-house) innovation activity (% of the total number of SMEs);
11. innovative SMEs that cooperate with others for innovation (% in the total number of SMEs); SMEs prove a much more flexibility than the big companies, in all their activities, and by cooperating with other units they can become more powerful, having at the same time the advantage of reduced size and local presence. Industrial clusters are part of this category (for example technological parks) that create conditions for a mutual stimulation of ideas and knowledge;
12. innovation expenditures as percent of turnover; this indicator is calculated as a ratio between the sum of total innovation expenditure for enterprises (in-house research-development and outside the enterprise, product and process innovation, buying of patents and licenses, industrial design, innovation marketing etc.) in the total turnover (including the enterprises with no innovation activity);
13. early-stage venture capital (venture capital investment is defined as private equity raised for investment in companies), as percent of GDP ;
14. information and communication technology expenditures, as percent of GDP;
15. number of SMEs who introduced an organizational innovation in the total number of SMEs; the indicator refers to SMEs that use new or significantly improved knowledge management systems, a major change to the organization of work within the

enterprise, significant modifiactions in their relations with other firms or public institutions.

- **OUTPUT 1: applications**

The five indicators from this group measure the performance, expressed in terms of labour and business activities, and their value added in innovative sectors, mostly in high-tech domains:

16. the percent of employees in high-tech services (post and telecommunication, information technology – IT, research-development services) in the total workforce;
17. exports of high technology products, as a share of total value of exports;
18. sales of new products to the market (or significantly improved products), as percent of turnover;
19. sales of new products to the firm, but already on the market, as percent of turnover;
20. employment in medium-high and high-tech manufacturing, as percent of total workforce; this indicator refers to the activities in the following domains: chemicals, machinery, office and electrical equipment, telecommunications and related equipment, precision instruments, automobiles and other transport.

- **OUTPUT 2: intellectual property**

The following five indicators from this group measure the achieved results in terms of successful know-how.

21. number of patents applied for at the European Patent Office (EPO), per million population; high class patents comprise: computers and automatised equipment for business; genetic engineering and microorganisms; aviation; communication; semiconductor; laser;
22. number of patents granted by the US Patent and Trademark Office (USPTO) per million population;

23. number of triad patents (filed at the EPO, the Japanese Patent Office-JPO and the USPO) per million population;
24. number of new community trademarks per million population;
25. number of new community designs per million population.

The summary innovation index calculated as arithmetical mean of the standardized values of these partial indicators (according to the previous algortythm) permits the identification of relative places in innovation of the EU countries, and of candidate countries as well, those countries that joined in the last wave (figure no.1).

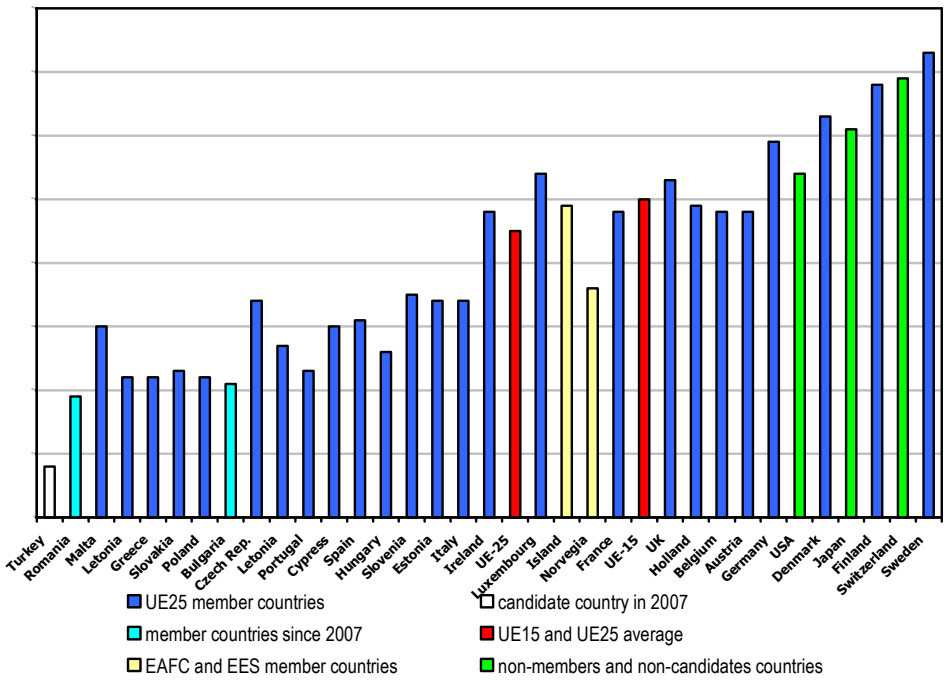

Figure 1. The Summary Innovation Index in 2006 in the EU countries and the candidate countries

(Source: *EUROSTAT, The European Innovation Scoreboard Indicators, and CIS 4*. Note: EAFC– European Free Trade Association; EES –Economic European Space/area).

Starting with the increase of the synthetic innovation indicator for each country, we can analyze the innovative performance that identifies four big groups of countries: *the innovation leaders*, that have an over average level of synthetic index, and a rapid growth as well; *the intermediary countries*, that have a reduced level (about the average) of synthetic index*; countries where the synthetic innovation index is increasing*, but its level is under average and *the group of countries under the average level of EU*, as level and the dynamic of the synthetic innovation index, as well.

Figure 2 shows the Summary Innovation Index on the vertical axis and the average growth rate of the Index on the horizontal axis. Countries above the horizontal dotted line currently have an innovation performance above that of the EU25. Countries to the right of the vertical dotted line had a faster average increase in the Index than the EU25.

Based on their Index score and the growth rate of the Index, the countries included in the analysis can be divided into four groups or clusters:

- Sweden, Switzerland, Finland, Denmark, Japan and Germany are the *innovation leaders*, with Index scores well above that of the EU25 and the other countries. The lead of the innovation leaders has been declining compared to the average of the EU25, with the exception of Denmark.
- The US, UK, Iceland, France, Netherlands, Belgium, Austria and Ireland are the *innovation followers*, with Index scores below those of the innovation leaders but above that of the EU25 and the other countries. The above EU25 average innovation performance of the innovation followers has been declining. Also, the gap of the innovation followers with the innovation leaders has on average slightly increased.

- Slovenia, Czech Republic, Lithuania, Portugal, Poland, Latvia, Greece and Bulgaria make up the group of *catching-up countries*, with Index scores well below that of the EU25 and the innovation leaders, but with faster than average innovation performance improvement.
- Estonia, Spain, Italy, Malta, Hungary, Croatia and Slovakia seem to be *trailing*, with Index scores well below that of the EU25 and the innovation leaders, and innovation performance growth which is either below or only just above that of the EU25.

Cyprus and Romania form a separate fifth cluster of fast growing, catching-up countries. Cyprus being one of the smallest EU countries and Romania starting from very low levels of innovation performance, this cluster is less robust than the other clusters, and is therefore not considered to be a real cluster. Luxembourg, Norway and Turkey do not fit into any of these groups.

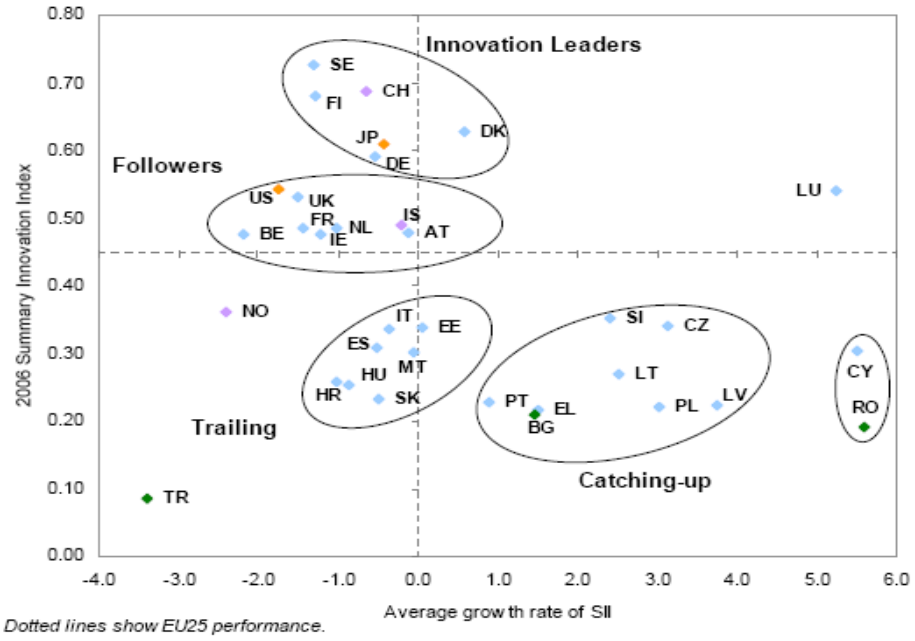

Figure 2. The Summary Innovation Index in 2006 and trends

(Source: *EUROSTAT, The European Innovation Scoreboard 2006, and Pro-INNO Europe*)

Current performance as measured by the Summary Innovation Index is shown on the vertical axis. Relative to EU25 growth performance of the Index is shown on the horizontal axis. This creates four quadrants: countries above both the average EU25 trend and the average EU25 Index are forging ahead from the EU25, countries below the average Index but with an above average trend performance are catching up, countries with a below average Index and a below average trend are falling behind, and countries with an above average Index and a below average trend maintain their lead but are growing at a slower rate.

Figure 2 suggests that there is a *process of convergence* in innovation performance in Europe: the catching-up countries are closing the gap with the EU25 and both the innovation leaders and followers are experiencing a relative decline in their innovation lead with the EU25.

This relative decline is a straightforward result of the rapid increases in innovation performance in the new member states.

The analysis can be studied thoroughly with the help of sub-indexes calculated on blocs of indicators for the year 2006. The figures below (Source: *EUROSTAT, The European Innovation Scoreboard 2006 – Pro INNO Metrics Europe)* show the ranking of countries for each of the 5 dimensions, from worst to best performer:

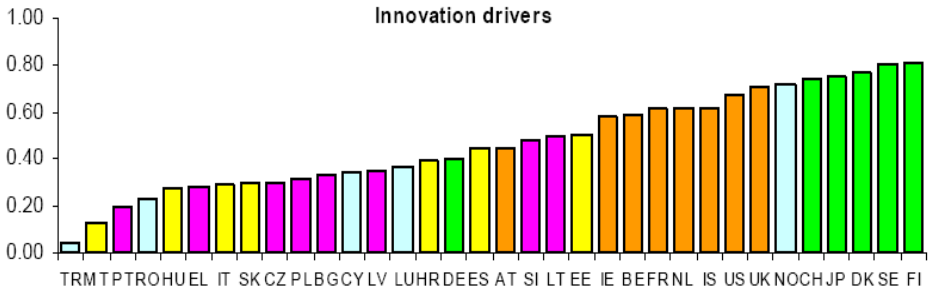

Figure 3. The synthetic index of Innovation drivers in 2006

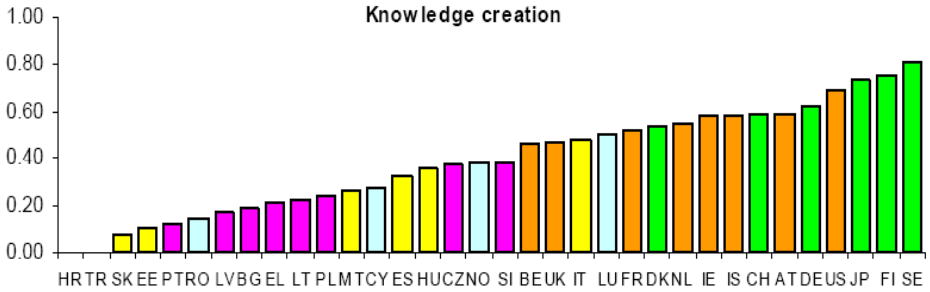

Figure 4. The synthetic index of Knowledge creation in 2006

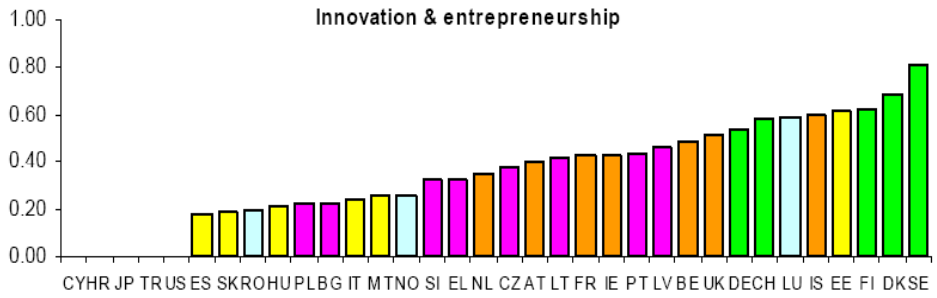

Figure 5. The synthetic Innovation and entrepreneurship index in 2006

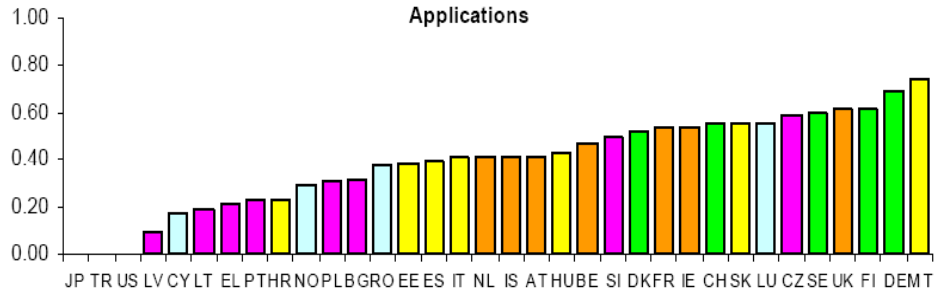

Figure 6. The synthetic index of innovation Applications in 2006

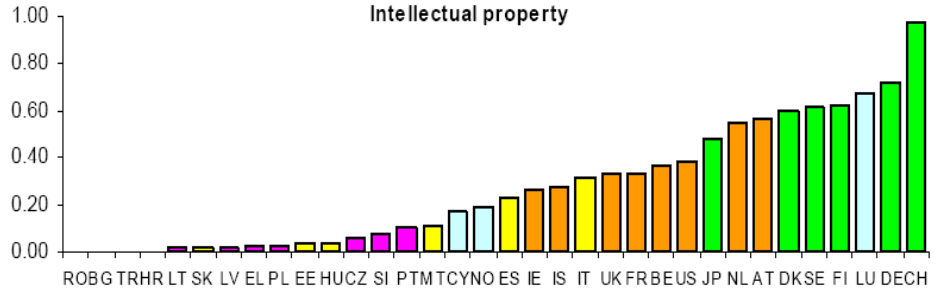

Figure 7. The synthetic index of Intellectual property in 2006

Abbreviations used in graphs:

- **EU – European Union**: AT-Austria; BE-Belgium; DK-Denmark; DE-Germany; EL-Greece; ES-Spain; FI-Finland; FR-

France; IE-Ireland; IT-Italy; LU-Luxembourg; NL-Holland; PT-Portugal; SE-Sweden; UK-England;

- **ACC – The countries that became members of the EU in 2004 :** CZ-Czech Republic; EE-Estonia; CY-Cypress; LV-Letonia; LT-Lithuain; HU-Hungary; MT-Malta; PL-Poland; SL-Slovenia; SK-Slovakia;

- **ACC I – The countries that became EU members in 2007:** BG-Bulgaria; RO-Romania;

- **CC** – Candidate country: TR-Turkey;

- **Other countries**: IS-Island; NO-Norvegia; US-USA; JP-Japan; CH-Switzerland; HR-Croatia.

The analysis of innovation subindexes allows the identification of weak points of the member countries. It has been demonstrated that the resources for the support of less performant areas of innovation are more beneficial compared to the use of the same resources for stronger domains. This suggests that a balanced policy, which supports the harmonious development of all innovation domains is more efficient.

Generally, there is a concordance between the place of a country in the hierarchy based on the summary index and the place it has according to the subindex values. There are some significant exceptions. Germany and Austria are performing relatively worse in Innovation drivers, the Netherlands in Innovation and entrpreneurship, and the Netherlands, Austria and Iceland in Applications. Of the stagnating countries, Estonia is among the best performers in Innovation and entrepreneurship and Malta in Applications.

The innovation indicators elaborated by EUROSTAT are used by the Romanian statistics. In figure 8 the relative place of Romania is presented (% in the average level EU-25) in 2005, referring

to the innovation indicators, the indicators referring to SMEs have an important place.

Romania's place is not favorable compared to the average of EU referring to SMEs innovative capacity. The only indicators Romania is superior to the average is the SMEs weightings that introduce the nontechnological progress and the new products for the market, as weightings in the turnover, while at the expenses weightings with communications technology in the GDP exceeds the average level slowly.

There is a rising tendency of the disparity/difference at indicators «weightings in GDP of direct expenses of the companies» and « patents request».

On the other hand, there is a favourable trend of reducing the disparities at the rapid rising indicators than the EU average: the employees' weightings in top domains, the number of the graduates, the weightings of research-development public expenses in GDP, etc.

The synthetic innovation index and the partial innovation indicators in Romania compared to the EU average level presents Romania in an unfavorable place referring to innovation capavity. However, Romania is among the groups that are in a process of disparity recovery confronted by the EU average level. This position illustrates, on one hand, the tendency of economic rise mostly based on cheap labour hand, and on the other hand, the low level of the infrastructure and of innovational mechanisms that are in a primary stage of development.

Most of the partial innovation indicators present a reduced tendency of disparities. Except the expences for information technology and communications, tertiary education, direct expenses of companies and EPO patents, which are on an unfavorable trend.

The evolution of main partial innovation indicators shows:

- positive tendencies for permanent education, research-development of public expenses (relating to the governamental

decision to rise to 1% the weightings in the GIP of research-development public funds), *high-tech* EPO and USPTO patents;

- moderate rising tendencies in the number of university graduates;
- worsening tendencies for the EPO patents and the companies research expenses (related to the reduced innovational potential of companies, the strong tendency to import equipment and technologies from abroad, the reduced request for domestic research-development and the orientation mostly to commerce and services).

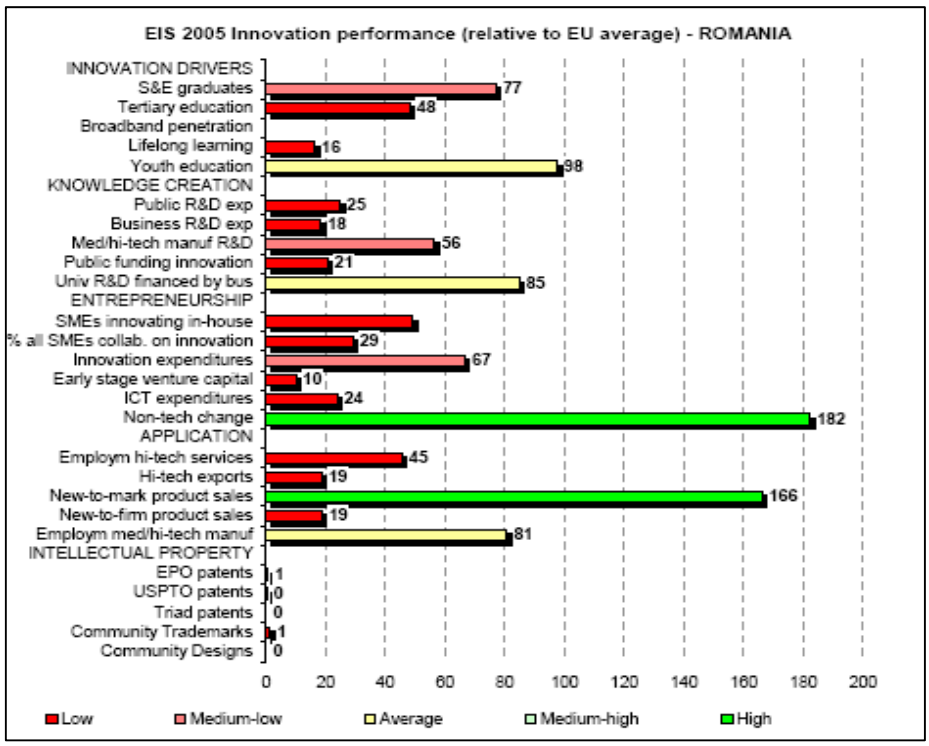

Figure 8. Romania's place in EU referring to partial innovation indicators

(Source: *EUROSTAT, New Cronos,* CIS 3 and Pro INNO Europe, Country Report-Romania)

The innovative profile of Romanian firms is still very low: over 80% of non-innovator firms, next to approximately 10% of intermittent innovator firms and a small percentage of strategic innovator, adopter and modifier firms. Innovative firms account for less than a fifth of the country's total number of active firms and workforce, and for about 42% of the total turnover of active firms. Innovative firms are predominantly SMEs (83,4%) and operate mainly in industry (73%), while the rest are active in services (trade, real estate, transport and communications). This situation is to a large extent the result of a very low level of public funding of innovation, with only 10% of innovative firms receiving funding, and very low levels of innovation expenditures, which don't exceed 3% of innovative firms' turnover. Although significant progress has been made in order to foster the weak innovation culture in the country, further measures are needed to increase application of research – develipment results by business and to turn innovation into a driver of national competitiveness.

The distribution of innovative companies on regions points out that many of them are in Bucharest. These indicators show a reduced innovative capacity, explained by the insufficient development of innovative infrastructure and of diffusion instruments, which slows the rhythm of economic development considerably. Although progress towards innovational system consolidation has been made, firm methods are needed to amplify the research-development results application and transformation of the innovational process in a motor of national competitivity.

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