Mihaela Diaconu[1]

PERFORMANCE PARADIGMS IN INNOVATION ACTIVITY: THE CASE OF ROMANIA

The present paper has two objectives. Firstly, we highlight the capacity of the most important indicators to reflect the key dimensions of innovative processes. Secondly, as we focus on macro-economic indicators of innovation, our aim is to emphasize the factors that exercised the greatest influence on the innovative activity in Romania compared to the average EU-27. The results we reach testify that innovation in Romania remains weak in keeping with the input key indicators, especially R&D, in the enterprise sector and there are few signs of progress. The gap, compared to the EU 27 average, is due to the influences of sectoral composition of enterprises (structural effect), R&D intensity from each sector (intrinsic effect) and significant percentage of small and medium firms of all the enterprises that are not innovatively active (demographic effect).

Keywords: *invention; innovation; economic sectors; indicators; development.*

Міхаела Діакону

ПАРАДИГМИ РОЗВИТКУ ІННОВАЦІЙНОЇ ДІЯЛЬНОСТІ (ЗА ДАНИМИ РУМУНІЇ)

У статті, по-перше, відзначено основні показники інноваційних процесів, по-друге, продемонстровано основні чинники впливу на розвиток інноваційної діяльності в Румунії у порівнянні з країнами ЄС-27. Отримані результати свідчать, що інноваційна діяльність у Румунії відстає від індикаторів ЄС за вхідними показниками, особливо у сфері НДДКР і підприємництва. Відставання від ЄС пов'язане з галузевим поділом підприємств (структурний ефект), інтенсивністю НДДКР у кожній галузі (об'єктивний ефект) і значною часткою малих і середніх фірм серед підприємств, що не ведуть інноваційної діяльності (демографічний ефект).

Ключові слова: *винахід; інновація; галузь економіки; показники; розвиток.*

Михаэла Диакону

ПАРАДИГМЫ РАЗВИТИЯ ИННОВАЦИОННОЙ ДЕЯТЕЛЬНОСТИ (ПО ДАННЫМ РУМЫНИИ)

В статье, во-первых, отмечены основные показатели инновационных процессов, во-вторых, продемонстрированы основные факторы влияния на развитие инновационной деятельности в Румынии по сравнению со странами ЕС-27. Полученные результаты свидетельствуют, что инновационная деятельность в Румынии отстает от индикаторов ЕС по входящим показателям, особенно в сфере НИОКР и предпринимательстве. Отставание от ЕС связано с отраслевым делением предприятий (структурный эффект), интенсивностью НИОКР в каждой отрасли (объективный эффект) и значительной долей малых и средних фирм среди предприятий, не ведущих инновационной деятельности (демографический эффект).

Ключевые слова: *изобретение; инновация; отрасль экономики; показатели; развитие.*

1. Introduction. It is often argued that performance of innovative activity is not easily measured, adequate estimation indicators being necessary. Although this

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fact can be found in various aspects of innovative activity, we can assume that this does not exclude the usefulness of measuring some key dimensions in innovation processes and obtainable results, including in Romania, if the reduction of significant and persistent discrepancies of innovative activity over time compared to the average of the EU states is being taken into consideration.

Following the elements of input and output, in the literature there have been important contributions brought over time in terms of developing indicators, including at the level of national economies, which can allow for their comparability. In relation to innovation indicators, the present paper has two objectives. First of all, highlighting the capacity of the most important indicators in reflecting the key dimensions of innovation processes. Secondly, to emphasize the factors that exercise the greatest influence on the performances in innovative activity in Romania and the extent to which these have been reflected in innovation indicators, being a good fundament for subsequent more detailed analyses using the Community Innovation Survey (CIS) microaggregated data to appreciate innovation modes and performances achieved by enterprises according to their size class.

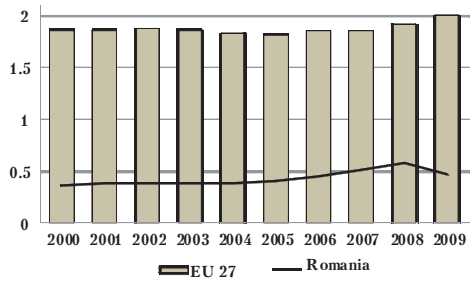
In this respect, we have proceeded to the analysis of innovation input indicators, represented by R&D expenditure included in every model of innovation and the new form of composite indicators used by the European Commission, outlining national innovation performance, in the case of Romania compared to the EU-27 average.

2. Innovation indicators based on R&D expenditure. According to the Frascati Manual (OECD, 2002), R&D activities lead to acquisition of new knowledge as well as to their practical applicability, comprising the basic, applicable research and experimental development. Some activities with scientific or technological basis are distinct from R&D, as they are industrial associated with innovation through the acquisition of machinery, equipment and software, of external knowledge (patents, know-how etc.), of product design, of production testing or of personnel training. The expenses related to these inputs, together with those associated with R&D activities (internal and external) constitute innovation expenses.

The data regarding R&D expenditure represents only one of the innovation inputs. Nevertheless, considering R&D as an inchoate stage in the process of innovation objectively results from the connection between R&D and economic growth. R&D presents direct implications on companies or organisations that develop them (in-house), being generators of new/substantially improved products or processes and presenting indirect implications in supporting innovation. R&D activities are also associated with absorptive capacity of adapting the acquired technology, of diffusing outside innovative entities (Cohen and Levinthal, 1990), and with generating of positive externalities resulted from research performed by companies (organisations).

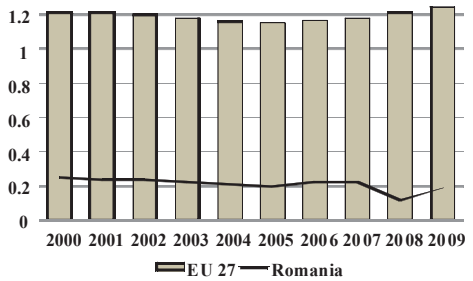
In fact, R&D-based models of growth attest a close correlation between R&D and technological innovation, according to Solow (1957) and Romer (1999). The Lisbon objective regarding the increase of R&D intensity to 3% at the level of the EU member states, from which 2/3 must be financed by the enterprises sector, was based on this. Nevertheless, the aggregate R&D intensity in different states or regions, as Moncada-Paterno-Castello and Smith (2009) note, is not only a matter of effort in R&D field, but is also it a combined result of strategies of enterprises, of their demography and a function of industrial structure and of macroeconomic dynamics.

The most used indicator in any of the innovation models is R&D intensity. At the industrial level, the ratio between R&D expenditure achieved in the business sector, BERD, and the added value or total production is used. At the national level, the total gross expenditure on research and development (GERD) indicator may be used, of the size of gross domestic product, GDP. R&D intensity is of importance from two points of view. Firstly, a significant dimension of GERD/GDP for a country reflects technological progress and the commitments in the area of creating of new knowledge. From this perspective, as we show in Figure 1, Romania is far behind the average of the EU member states, the stability in time of this gap being noticed.



Source Eurostat database

Figure 1. **GERD/GDP in Romania and EU 27**

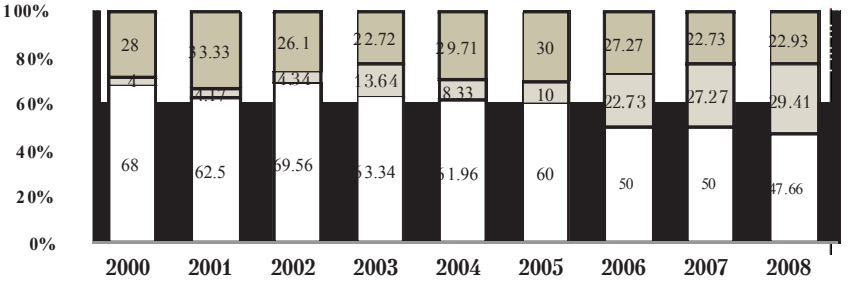


Source Eurostat database

Figure 2. **BERD/GDP in Romania and EU 27**

Although BERD/GDP holds the greatest percentage of GERD/GDP, a significant and unfavourable gap persists compared to the level of indicators for the EU 27 and this emphasises a reduced preoccupation of enterprises to adopt an innovation mode based on R&D, as we show in figure 2.

The greatest BERD/GDP percentage comes from the manufacturing industry, as we reflect in Figure 3, even if its contributing part decreases over time, together with the increasing of R&D expenditure percentage in the service sectors and the quasi-constant maintenance of R&D in the other sectors (agriculture, extracting industry, constructions, production and distribution of electrical energy and water).

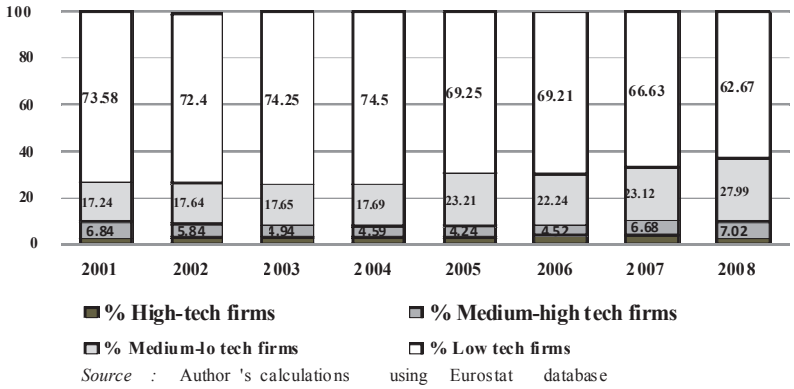


Source: Author's calculations using Eurostat database

Figure 3. **The sectoral contribution to the BERD/GDP in Romania**

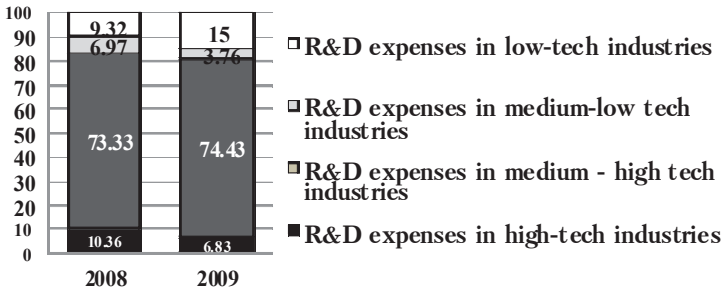
Using the OECD classification of the knowledge-intensive industrial sectors, it can be shown that R&D intensity varies considerably from one industry to another. A country or a region with industries characterised by a significant R&D intensity will naturally have a higher BERD/GDP ratio than a country with a majority representation of low-tech industries.

In Romania, as we depict in Figure 4, the percentage of enterprises of the manufacturing industry in the low-tech sectors is the highest; in 2008, 62.67% of the total enterprises carried out their activity in the low-tech sectors, the medium-low tech also had a significant representation, being reflected, however, by a more reduced proportion than those of the low-tech sectors (27.99% of the total of enterprises), followed by the medium-high tech (7.02% in 2008) and, finally, by the high-tech (2.32% in 2008). The evolution over time emphasises a decrease of the percentage of enterprises in the low-tech sectors in favour of those from the medium-low tech and the quasi-constant maintenance of the enterprises of knowledge-intensive sectors (medium-high tech and high-tech).



Source : Author 's calculations using Eurostat database

Figure 4. **Firms, contribution to the BERD/GDP in manufacturing industries**



Source: Author's calculations using Romanian Statistical Yearbook (2010)

Figure 5. **R&D expenditure percentage in manufacturing industries**

In manufacturing, R&D expenditure percentage (Figure 5) outlines that the sectors with the highest R&D of the total innovation expenditure are represented by the medium-high tech ones; R&D expenditure is concentrated in the manufacture of motor vehicles, trailers and semi-trailers, which contributes in 2008 41.94% of R&D expenditure related to the medium-high tech industry sectors and 26.38% of the total ones achieved by the enterprises, recording a significant growth in 2009, the percentages increasing up to 59.13% and 42.51% respectively. The second place in the hierarchy of R&D expenditure contributions of those in the medium-high tech group belongs to manufacturing of chemicals and chemical products with 25.45% and 16.10% of the total industrial ones in 2008, recording a decrease of the percentages in 2009 up to 20.33% and 14.62% respectively (author's calculations according to the

Romanian Statistical Yearbook, 2010, p. 396). As a result, we can assert that the reduced BERD/GDP dimension is a consequence of the sectoral composition influences (structural effect), as well as of R&D intensity from each sector (intrinsic effect). In this framework, although the number of enterprises in the medium-high tech sectors is more reduced than that from the low-tech sectors (according to Figure 4), the former present a significant contribution to R&D intensity in Romania (as Figure 5 shows).

The structure by enterprises on size classes also exerts an impact, in our opinion, on the reduced level recorded by the BERD/GDP indicator and, implicitly, by the GERD/GDP ratio. In this sense, R&D intensity is affected by the pool of enterprises that are differentiated in their innovative efforts through R&D. At the EU average, the significant percentage of the total of enterprises is held by small and medium firms, as in Romania, but R&D intensity of the EU enterprises is higher, especially of those coming from the high-tech and medium high-tech sectors. In Romania, however, according to the CIS 2008 data for all the sectors, although small firms (with a number of employees from 10 to 49) held a significant percentage of the total number of enterprises, and R&D intensity of the innovative ones was higher (0.41% in 2008, Table 1) compared to the level of this indicator recorded by large enterprises (0.38% in 2008), the proportion of non-innovative small firms was higher. At the same time, R&D intensity computed as R&D expenditure/turnover ratio of all the enterprises was more reduced in the case of small enterprises (0.14% in 2008) than the level of the indicator relating to the firms (0.27% in 2008). This result was affected by more reduced number of small enterprises that innovate of the total ones related to the category - 29.85% compared to 58.90% of large enterprises (with more than 250 employees).

Table 1. **Indicators of innovation propensity of Romanian enterprises, by size class**

Indicators	Size class of enterprises		
	10-49	49-250	250+
Enterprises of the total, %	75.96%	19.50%	4.56%
Innovative enterprises in their class size, %	29.85%	40.85%	58.90%
R&D expenditures/T_i	0.41%	0.32%	0.38%
R&D machineries and equipment/T_i	1.99%	1.54%	2.44%
R&D expenditures of external knowledge/T_i	0.024%	0.053%	0.028%
Innovation expenditures (total)/T_i	2.43%	1.91%	2.84%
Research and development expenditures/T_t	0.14%	0.16%	0.27%
Innovation expenditures (total)/T_t	0.83%	0.99%	2.05%

Source: Author's calculation using Community Innovation Survey (CIS) 2008 for the period 2006-2008. Ti - turnover from innovative enterprises; Tt - total turnover of enterprises from a specified size class; R&D expenditures - intramural and extramural.

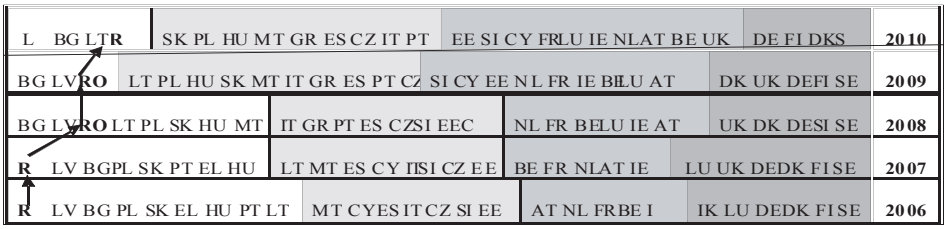
Taking a look at the results obtained from the CIS data we also notice that the acquisition of machineries, equipment and software plays an important role in innovation in all activity sectors, including the dominant low-tech. The greatest effort, in this respect, is recorded by large firms (equipment expenditure/T_i = 2.44%), where-

as small enterprises which get involved in the innovative activity make a greater effort in R&D direction ($R\&D/T_i$ = 0.41%). As a result, SMEs have the potential to increase R&D intensity, innovate and contribute with R&D investments to their growth. Unfortunately, from this point of view, Romanian SMEs tend to be less dynamic, and this phenomenon is more obvious in the knowledge-intensive sectors in Romanian economy.

Even if the structure of enterprises has known a dynamics in terms of increasing of the percentages of small firms, the entrepreneurial culture, the cost of patenting inventions, the difficulties in financing and the modest competences in R&D exert the unfavourable impact on R&D intensity compared to the EU 27. The disparities become explicable especially through technological specialization, therefore through the industrial structure, with the variable of R&D intensities from one industry to another and different proportions of entrepreneurial engagements, mainly held in low-tech sectors. In fact, the industrial composition presents significant effects on R&D intensity of each country. In Romania, however, the reduced R&D intensity is itself the cause of the weakness of enterprises' capacity to innovate. The reduction of R&D gap must be achieved by means of a supporting policy of innovation, which must not be a general one, but selective, with emphasis on high-tech industries, as a provider of technology and positive externalities in the economy.

3. New innovation indicators. In the last years efforts have been made in the direction of elaborating new indicators which preponderantly pursue, in a more direct way, the industrial innovative activity. The composite indicators have known an increasing use in order to appreciate the innovative performances at the aggregate level, concerning innovation as a process that is not carried out in isolation, but through continuous interactions with the environment. The composite indicators elaborated by the international organisations and associations, such as the World Bank, The World Economic Forum or the European Commission etc., which, depending on the aggregation methods used to construct various scoreboards, present the advantage of incorporation not only of certain aspects that characterise innovation or of preconditions necessary to innovate, but they are based on sub-indicators meant to characterise the favourable conditions to innovate, the innovative activity of business environment as well as the results obtained by the entire system of innovation. The scoreboards are used especially to serve the political class, constituting early warning signs on the potential problems at the national level. Scoreboards used for longer periods of time are also a source of information to politicians and public opinion on the relevant variations of strengths and weaknesses of national innovation.

In Europe, the most used composite indicator is the European Innovation Scoreboard (EIS) based on a set of sub-indicators that facilitate comparison of innovative activities performance between countries. According to EIS, in the interval 2006-2010 Romania was constantly situated, together with Bulgaria and Latvia, in the group of modest innovators (Figure 6), with an evolution that demonstrates that the recorded progress in the field of innovation has not been so important as to reverberate more favourably on the dimension of the composite index recording, for example, a level of 0.237 compared to 0.516 of the EU average in 2010.



Surce: European Commission (2010, 2009, 2008)

Figure 6. **EIS, 2006-2010**

The innovation enablers considered within the EIS dimension correspond to the input elements found outside the decision-making level of an enterprise. Education and training of personnel are of vital importance for creation and transfer of new knowledge and represent, at the same time, a determining factor of a society to innovate.

As we reflect in Table 2, the existing initial gap, especially in the field of tertiary education and doctoral studies, with the highest innovating potential, has been constantly reduced after 2007; however, there is still a statistically significant difference between the sub-indicators at the EU 27 average and those of Romania (reflected also in "human resources" of 0.38 for Romania, compared to the EU average of 0.6, which positions it on the last but one place in the EU in 2010). Nevertheless, training and increasing the number of professionals is particularly important both in terms of exploitation of indigenous capacity to innovate, as well as of increasing the capacity to absorb technologies. Accessing of knowledge requires absorptive capacities or "social capacities", which are essentially formed as technologically skilled workforce, in a climate of encouraging investments, of access to financing resources and of promoting instruments to facilitate diffusion of technologies in the context in which market forces are not adequate.

Table 2. **Innovation enablers in Romania and EU 27**

Indicator	2007		2008		2009		2010	
	RO	EU 27	RO	EU 27	RO	EU 27	RO	EU 27
Human resources								
New doctoral graduates	0.47	0.98	0.48	1.11	0.53	1.03	0.90	1.40
Population completed tertiary education	11.70	23.00	12.00	23.50	12.80	23.50	18.80	32.30
Youth - upper sec. level education	77.20	77.80	77.40	78.10	78.30	78.10	78.30	78.60
Finance and support								
GERD/GDP	0.17	0.65	0.31	0.65	0.41	0.64	0.29	0.78
Venture capital/GDP	0.004	0.053	0.0067	0.107	0.051	0.107	0.042	0.110

Sources: European Commission (2008-2011).

In the same framework, although the gap of "financing and support" sub-indicator of Romania compared to the EU average is not regarded as being as marked as the previous one, so that, from this perspective, it has been considered as a "relatively strong point" (the European Commission, 2011, p. 45), public R&D expenditure of GDP remains extremely low, like that of the venture capital participation.

Despite the increasing involvement of venture capital in the East European countries, including Romania, especially in the field of communications, computer and electronic products manufacturing (EVCA, 2010, p. 25), the dimension of this financing modality of enterprises, that is vital to innovate, remains insignificant. In general, markets of venture capital have known expansion in the countries in which there has been performed a transition from traditional sectors to manufacturing industry and knowledge-intense services and where there are close connections between universities, research institutes and business environment. Government agencies and institutional investors (especially collective and pension funds) are the ones that participate in financing of various R&D objectives of enterprises in the East European countries, including Romania. Being on the market of venture capital, the latter ones have, however, a longer investment horizon than other groups of investors. Due to the conservative attitudes in the investment field, institutional investors still play a minor role in the venture capital, outmatching the supply of financial resources of banks (EVCA, 2010, p. 7).

Increasing the supply of venture capital is a necessary but not sufficient condition for growing the number of companies engaged in innovations. Besides the entrepreneurial culture, an attitude of risk-taking and the existence of opportunities for small enterprises of getting outside the business at the secondary markets are necessary. A reduced level of financing from venture capital, as in the case of Romania, reflects a lack of financial resources and of enterprises benefitting from these funds.

The enterprise activity outlined by the EIS comprises a series of sub-indicators that analyse the investments of enterprises in R&D and non-R&D field, cooperation and entrepreneurship, as well as the intermediary outputs from innovative activities (Table 3). By the "firm's investments", Romania is situated on a position closer to the EU 27. Nevertheless, the BERD/GDP, which reflects the involvement of enterprises in innovative, creative activities through R&D, remains extremely modest. Contrary to this, the non-R&D expenditure achieved by Romanian enterprises are close to the EU 27 (or even outmatch the average in 2008-2010), emphasizing that development of absorbing capacity, which is inclusively achieved through research efforts, is at least as important for industrial competitiveness in order to reduce such a persistent gap over time compared to the EU 27 in innovation.

Table 3. **The enterprise innovation activity in Romania and EU 27**

Indicator	2007		2008		2009		2010	
	RO	EU 27	RO	EU 27	RO	EU 27	RO	EU 27
Firm's investments								
BERD/GDP	0.20	1.17	0.22	1.17	0.18	1.19	0.19	1.25
Non-RD innovation expenditure/GDP	1.02	1.02	1.08	1.03	1.08	1.03	1.36	0.71
Linkages & entrepreneurship								
SMEs innovating in-house	13.40	21.60	17.90	30.00	17.90	30.00	16.66	30.31
Innovative SMEs collab. with others	2.80	9.10	2.90	9.50	2.90	9.50	2.27	11.18

The End of *Table 3*

Public-private co-publications	n.a.	n.a.	3.10	31.40	4.10	36.10	6.30	36.2
Intellectual assets								
EPO patent application	0.26	4.71	0.26	4.76	0.30	4.20	0.15	4.00

Sources: European Commission (2008-2011).

The data show that more than 1/2 of the EU enterprises do not carry out intramural or in-house R&D activities, as is the case of enterprises in Romania, also consequently characterised by a more reduced collaboration, inclusively mirrored through the much modest number of publications compared to the EU 27. Such non-R&D innovative activities include the acquisition of technological equipment and computers in order to produce or implement new products or processes, the acquisition of rights of using inventions, of know-how, factory brands or software, training for personnel, or introduction of marketing or organisational innovations. It is obvious that, being possibly found far from the frontier of technological knowledge, Romanian firms can innovate and progress by adopting and adapting the existing technologies, appearing as necessities when applications submitted by enterprises for patenting of inventions, for brands, models or the EU drawings are noticed as being the lowest among the EU member states.

The output indicators of innovation activity, as EIS denote, regarding innovative enterprises and economic effects (Table 4) reflect the typology and the innovation modes adopted by enterprises. In this respect, if the percentage of enterprises that introduced marketing and organisational innovations is close to the EU 27, the proportion of small and medium-sized enterprises that have introduced technological innovations (of product and process) is much more reduced.

Table 4. **Output of innovation activity in Romania and EU 27**

Indicator	2007		2008		2009		2010	
	RO	EU 27	RO	EU 27	RO	EU 27	RO	EU 27
Innovators								
SMEs with product or process innovations	11.18	33.25	19.40	33.70	19.40	33.70	18.03	34.18
SMEs with marketing and organizational innovations	13.04	39.25	35.40	40.00	35.40	40.00	25.80	39.09
Economic effects								
Employment in knowledge-intensive activities	5.67	6.63	5.66	6.69	5.66	6.25	6.16	13.03
Medium and high-tech product exports	n.a.	n.a.	37.50	48.10	44.10	48.20	50.14	47.36
High-tech product exports	3.50	16.10	5.4	15.4	8.2	16.9	n.a.	n.a.
Sales of new to market and new to firm innovations	16.60	13.50	18.54	14.88	18.54	14.88	14.87	13.36

Sources: European Commission (2008-2011).

The economic effects incorporated into the EIS dimension include, however, the entire sector of enterprises, framework in which there can also be observed positive aspects related to the number of employees from the knowledge-intensive sectors, with a slight increase in Romania, being close to the EU 27, as well as a percentage of the exports of products manufactured in the high-tech and medium-tech sectors of the total of exports that outmatch the EU 27. The latter ones are due, in fact, to the exports of products from the medium-high tech sectors which thus appear much higher than in the EU 27, the high-tech ones being found lower than in the EU 27 average.

Another aspect that appears to be favourable to Romania refers to the proportion of turnover corresponding to new to a market and new to a firm innovations, being constantly over the EU 27 in the interval 2007-2010. However, including this sub-indicator in the EIS for the achievement of comparisons between states we consider being not as appropriate as would be, for example, the use of this one depending on the size class of enterprises within the same country, leading to possible interpretation errors as a result of the fact that it only refers to the local market of the enterprise. The size of this EIS sub-indicator incorporates the level of R&D expenditure achieved in-house by firms, but refers inclusively to the innovations developed by other companies that operate at different markets (local, national or international). For this reason, a sub-indicator more appropriate to highlight the innovative performances in terms of output may be the one which takes into account the proportion of innovative enterprises of the total, but which operates at the international markets as well, or the turnover of products that are new to the local and simultaneously new to other markets.

4. Conclusions. The importance of R&D expenditure as the main indicator of innovation is well justified, as we have shown, and in this respect, Romania is situated far below the level recorded by the EU 27. This gap is due, to a great extent, to R&D expenses made in the sector of enterprises that we found being also at a statistically significant unfavourable and persistent difference from the EU 27. The imperative of increasing R&D expenditure can be observed as a result of reduced performances obtained from innovation in Romania.

The largest proportion of R&D expenditure performed by the business sector derives from the medium-high tech industries. The industrial structure in Romania therefore, exerts an influence over R&D intensity. Undoubtedly, innovation in these sectors is particularly important in the economy, generating positive externalities to other industries, services, or to households. However, R&D intensity in these sectors is much lower than that at the level of the EU average, and this intrinsic effect is accompanied by a reduced proportion of enterprises that activate in these sectors as well as in knowledge-intensive areas; the significant proportion of the total enterprises is held by those from the low-tech sectors and especially by the SMEs that are not innovatively active. The SMEs which innovate, in all the economy sectors, engage themselves in R&D effort of their turnover more intensively compared to the large enterprises and these, on their turn, allow an increased volume of innovation expenditure, but are focused more on the acquisition of technologies. These facts need to be taken into account in appreciating the performances of firms depending on their size class, particularly useful for policy-makers in supporting innovation.

The orientation of innovation in Romania, by stimulating the enterprises to engage themselves more in research, must be able to attenuate the considerable vulnerabilities that hinder the economic development based on knowledge: the concentration of economic and creative capacities in several sectors and, as a result, their dependence on the imports of technologies, on the external resources of knowledge and insufficient funding from venture capital resources. The boost of innovation and the tracing of an ascending trend of the innovation performance indicators in Romania are imperative, so the conditions, in this direction, with the passing of time, become more and more severe, with growing demands regarding technological capacities and necessary innovative efforts. Institutional instruments conceived to support linkages with the technological frontier or with different markets and users may present in Romania effects of diminishing the disadvantages compared to the more advanced states on the way of innovation.

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