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Human Resources in Science and Technology: a European Perspective

Raluca Mazilescu, Petru Mazilescu

Institute of National Economy, Romanian Academy, Calea 13 Septembrie no. 13, Bucharest
e-mail: ralucamazilescu@gmail.com, petrumazilescu@yahoo.com

Abstract

Science and technology plays a crucial role in resolving the economic, social and environmental problems that make current development paths unsustainable, but they are not sufficient to ensure economic growth, competitiveness and job creation. R&D and other S&T activities are not possible without human resources. If the R&D expenditure target of 3 % of GDP is to be achieved, ensuring there are sufficient human resources for research is a preliminary step in the right direction.

Key words: *Research&Development, Science&Technology, Human Resources in Science and Technology*

Introduction

Sustainable development is probably the most daunting challenge that humanity has ever faced, and achieving it requires that the fundamental issues be addressed at local, regional and global levels. At all scales, the role of science and technology is crucial; scientific knowledge and appropriate technologies are central to resolving the economic, social and environmental problems that make current development paths unsustainable.

Implementing Agenda 21 during the next decade and beyond is based on progress made during the past ten years in generating knowledge targeted to sustainable development objectives and in developing cleaner and more affordable technologies (1). However, enhancing the S&T community's capacity to contribute to sustainable development will require significant changes.

Knowledge - Engine for Productivity and Long-Term Economic Growth

Economic performance is determined by a variety of macroeconomic policies and structural conditions, and thus differs significantly across regions and countries. Stability-oriented macroeconomic policies (e.g. inflation, fiscal policy), trade policy, financial market conditions and labour market institutions impact heavily on the framework conditions that nurture higher growth regimes in a sustainable manner.

In the long run, however, the economic performance of countries is also strongly determined by knowledge-related factors (e.g. technical change and human capital), in particular R&D and technological innovation. More generally, the contribution of knowledge investments and activities to employment, productivity and economic growth has been emphasized in many studies[1].

The relationship between investment in knowledge and performance is complex and non-linear. An important source of diversity between industrialised economies relates to the respective roles of the main actors (i.e. firms, universities, and government and other public research institutions) in the process of knowledge production, diffusion and utilisation, as well as to the forms, quality, and intensity of their interactions. These actors are influenced by a variety of factors that exhibit some degree of country specificity: industry structure, the education and training system, the human resources and labour market, the financial system, etc.

Analysing all the different institutions in a country that individually and jointly contribute to the production, diffusion and utilisation of knowledge, it is possible to identify the main building blocks of an STI system (2). In this system, science, technology/innovation and industry are central but not sufficient to ensure economic growth, competitiveness and job creation. The education and training system, human resources and the labour market, and the financial system – all have a substantial impact on the performance of 'Science-Technology-Industry'. From this perspective, the performance of an economy depends not only on how the individual institutions perform in isolation, but also on how they interact with each other as elements of a collective system of knowledge creation, diffusion and use, and on their interplay with other institutions.

Such interactions between policies and, above all, the need for better coherence between them, both at the Member State and European levels, have been stressed since the re-launch of the Lisbon Strategy in the "Integrated Guidelines for Growth and Jobs (2005-2008)" dealing with macroeconomic, microeconomic and employment issues as proposed by the European Commission in the framework of the revised Lisbon Strategy adopted by the Council of Ministers (3).

While the policy challenge of implementing Lisbon-driven reforms remains a serious one for a large number of EU Member States, the expected gains are considerable. For instance, a recent CBS study estimates that the introduction of five key measures of the Lisbon Strategy (i.e. the Services Directive, reduction of the administrative burden, improving human capital, 3% R&D target, increase in the employment rate) can boost the EU's economic and employment growth rates by at least 0.8 % per year for more than a decade (4).

R&D Intensity

Within EU-27 R&D and R&D investment hold an important place in the overall policy agendas. Under the influence of the Lisbon Strategy (2000), the Barcelona '3%' objective (2002) for more investment in research in Europe (with increased private sector funding) and the renewed Lisbon Strategy (2005), R&D is increasingly considered a key source for sustaining economic growth and welfare. Member States are developing commonly shared R&D policy objectives. Recently, and consequent to the renewed Lisbon Strategy of mid-2005, 26 Member States[2] have set targets for their R&D intensities (i.e. R&D expenditure as percentage of GDP – each target is not necessarily 3%) for 2010 or other years.

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[1] For instance, according to the European Commission (1), a substantial increase in knowledge investment (R&D and education) could boost potential EU growth rates by between one half and three quarters of a percentage point annually over a 5-10 years horizon. Regarding the US, the knowledge-based economy appears to be more fully entrenched, with studies suggesting that investments in R&D and education can explain almost as much as 75% of the US productivity growth rate over the period 1950-2003. The differences in EU-US productivity patterns are fundamentally driven by the superiority of the US in terms of its capacity to produce and absorb new technologies, in particular Information and Communication Technologies.

[2] Bulgaria is the only Member State which does not have a target.

The volume of financial resources allocated to R&D is an indicator of the level of commitment to the production and exploitation of new knowledge, as well as an indirect measure of a country's innovation capacity.

Fig. **1** illustrates the hierarchy of EU Member States according to the share of R&D expenditure as a percentage of GDP.

Recent evidence on trends up to 2006 shows that the EU is not yet on track to meet these targets. Only a small number of Member States (Finland, Sweden, Germany, Austria and Denmark) have over recent years experienced rates of growth which, if they are maintained, would be sufficient to advance these countries significantly towards their targets.

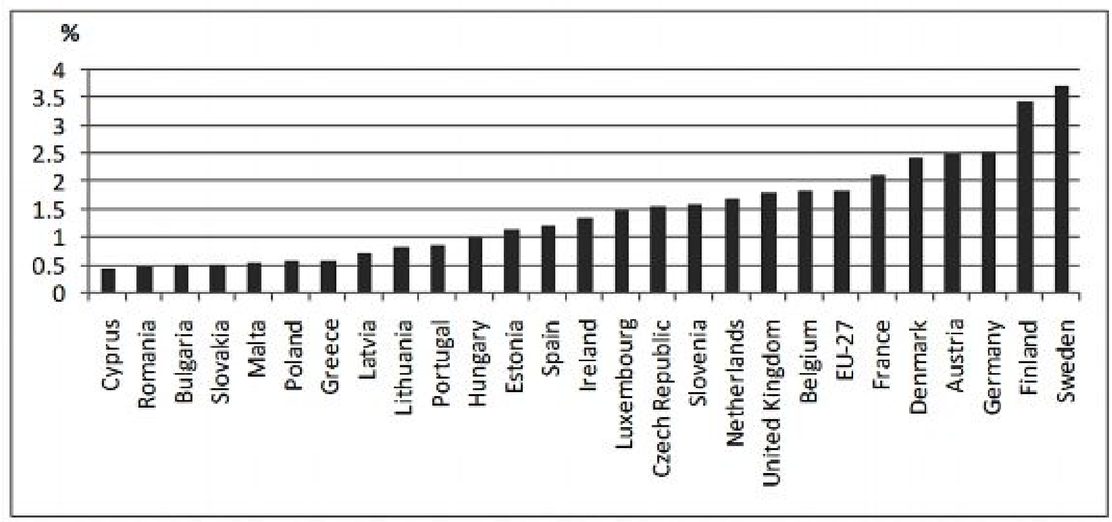

Fig. 1. R&D expenditure as percentage of GDP, 2006, %

Source: Eurostat online database.

In 2006 some of the Member States recorded a share of R&D expenditure in GDP bigger than 2000 level (for example, Estonia: +86 percentage points, Cyprus: +75, Latvia: +59 percentage points). Romania has experienced an increase of R&D intensity of more than 21 percentage points between 2000 and 2006 (5). On the other hand, Member States like United Kingdom, Belgium, Bulgaria, Netherlands or Luxembourg have diminished this share over the past seven years (UK: -3,8 percentage points, Belgium and Bulgaria: -7 percentage points etc.).

Turning to the aggregate picture, after stagnated in 2001-2002, EU R&D intensity started to decrease slightly after that. Thus, in 2006 only 1.84 % of GDP was spent on R&D in EU-27. If the current negative trend continues, by 2010 Europe's R&D intensity will have declined to its mid-1990s level of less than 1.80 % of GDP.

As a result, R&D intensity in EU-27 remains at a lower level than in most of the other major world economies such as the US, Japan and South Korea. Moreover, new emerging economies such as China are rapidly catching up. If current trends persist, it is expected that China will have caught up with the EU by 2009 in terms of R&D intensity. The Russian Federation has also increased its allocation of resources to R&D at a much faster pace than the EU since the mid-1990s.

Human Resources in Science and Technology Activities

R&D and other S&T activities are not possible without human resources. If the R&D expenditure target of 3 % of GDP is to be achieved, making sure that there are sufficient human resources for research represents a preliminary step in the right direction. To this end, the European Commission advocates increasing the proportion of researchers in the labour force from five to eight per thousand (2).

S&T Labour Force

The role of human resources educated and employed in science and technology occupations (‘highly-qualified S&T workers’) is fundamental in knowledge-driven economies, because these people contribute directly to the expansion of R&D activities and to the development of technological innovations.

Within EU-27, over 66% of the S&T human resources with a tertiary education were also employed in S&T. The highest shares were found in Luxembourg (86.5 %), Sweden (78.8 %), Czech Republic (78.3%), Italy and Romania (77.7 %) (Table 1).

In 2006, highly-qualified S&T workers represented 16 % of the EU-27 total employment. At the national level, they accounted for more than one fifth of the total employment in Belgium, Finland, Sweden, Luxembourg and Denmark (Table 1). As one might expect, highly R&D-intensive countries have the largest shares of core S&T workers in the total employment.

Table 1. Highly qualified scientific and technical workers (HRSTC)[1] as % of labour force and as % of total S&T human resources with tertiary education (HRSTE), and age distribution, 2006

Geopolitical entity	as % of total employment	as % of HRSTE	Age distribution (%)		
			25-34	35-44	45-64
EU27	16.0	66.7	32.4	30.6	37.0
BE	21.6	61.1	35.5	31.2	33.3
BG	15.7	64.0	26.0	30.3	43.6
CZ	11.1	78.3	33.7	27.2	39.1
DK	24.1	75.4	29.6	30.2	40.1
DE	17.2	70.2	21.9	34.1	44.1
EE	16.6	51.5	31.1	28.3	41.5
IE	15.9	55.3	40.7	28.4	30.6
GR	16.9	70.7	31.0	34.7	34.2
ES	17.8	56.3	39.7	30.7	29.6
FR	18.1	66.5	37.7	30.4	31.8
IT	11.5	77.7	29.0	34.3	36.6
CY	18.2	60.2	43.1	27.7	29.2
LV	13.1	63.4	31.7	29.6	38.7
LT	16.3	57.4	38.4	29.4	32.2
LU	23.0	86.5	37.8	33.3	31.1
HU	14.5	70.7	35.7	25.0	39.2
MT	11.2	77.3	47.1	23.5	23.5
NL	19.9	72.1	30.4	30.2	39.5
AT	11.3	64.5	29.1	33.4	37.5
PL	15.0	71.6	44.3	25.8	29.9
PT	10.2	77.1	40.3	30.2	29.4
RO	10.1	77.7	38.9	25.0	35.9
SI	16.9	75.0	35.8	30.2	34.6
SK	11.9	73.9	36.1	24.1	39.8
FI	22.5	64.8	27.6	30.0	42.5
SE	22.7	78.8	29.8	26.7	43.5
UK	16.3	58.2	31.1	29.4	39.4

Source: own calculation based on Eurostat online data: http://epp.eurostat.ec.europa.eu; Date of extraction: September 2008; Last update: Fri Jan 25 2008.

Notes: (1) Highly qualified scientific and technical workers (HRSTC) refer to the group of people both educated *and* employed in scientific and technical occupations (see

Box 1).

Box 1. Researchers and human resources in science and technology

According to the OECD Frascati Manual, researchers are professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems and also in the management of the projects concerned. Researchers are classified in ISCO-88 Major Group 2 (sub-major groups 21, 22, 23, 24), 'Professionals', and in 'Research and Development Department Managers' (ISCO-88, 1237). Human resources in science and technology (HRST) comprise people who have successfully completed education at the third level in an S&T field of study (natural sciences, engineering and technology, medical sciences, agricultural sciences, social sciences and humanities – Canberra Manual, §71) and also people who, although not formally qualified in this way, are employed in an S&T occupation where such qualification is normally required (corresponding to professionals and technicians – ISCO-88 International Standard Classification of Occupations levels 2 and 3 and also certain managers, ISCO 121, 122 and 131). Human resources in science and technology – Core (HRSTC) comprise people who have successfully completed education at the third level in an S&T field of study and are employed in an S&T occupation. HRSTE refer to human resources educated in science and technology, but not necessarily employed in an S&T occupation.

Source: (5)

At EU-27 level, 37% of highly-qualified S&T workers were aged 45-64 years (Table 1). Sweden, Finland, Germany, Austria and Denmark –Member States with some of the highest R&D intensities had the oldest population of highly qualified S&T workers with the 45-64 years age group exceeding 40 % of the total. By contrast Portugal, Ireland, Cyprus, Poland and Malta had shares of more than 40 % of highly-qualified S&T workers in the youngest age group of 25-34 years.

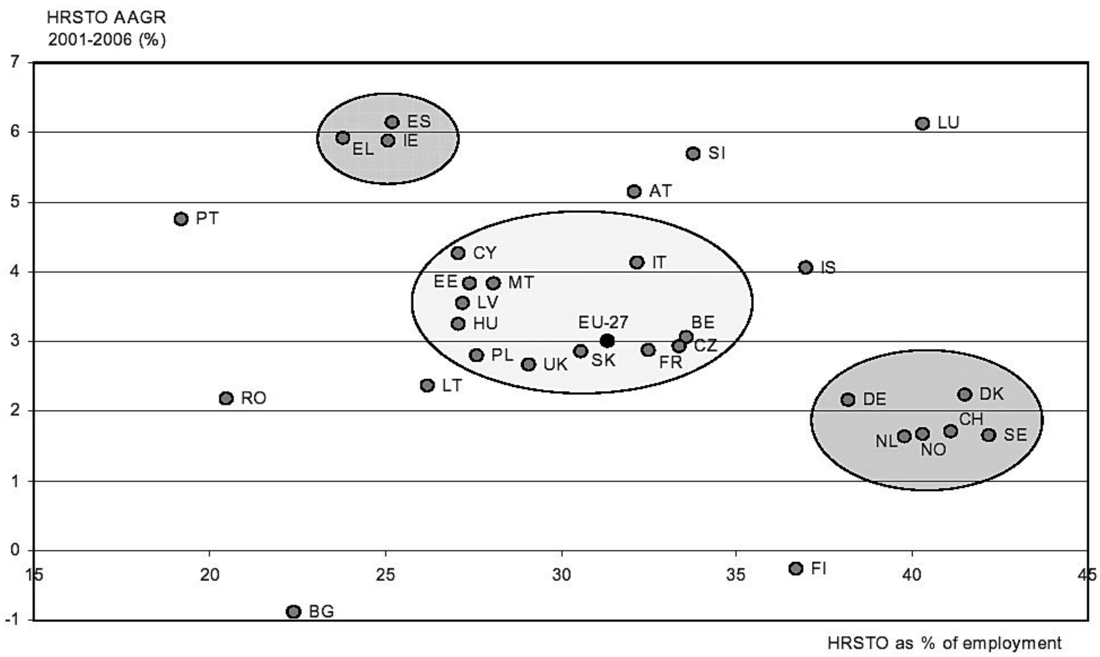

Fig. 2. Annual average growth rates of human resources employed in an S&T occupation as professionals and technicians (HRSTO), 2001 to 2006, and their proportion in the total employed population, in the EU and selected countries, 2006

Source: (6)

Fig. 2 illustrates the dynamism of human resources employed in S&T as professionals and technicians (HRSTO). For this, it compares the annual average growth rate of HRSTO with their share of total employment. Over the period 2001 to 2006 the number of human resources employed in S&T increased at an annual average growth rate of 3% at EU level. In parallel, more than 31% of the employed population formed part of the HRSTO in 2006. But national disparities are clearly shown in this figure. Two countries, Finland and Bulgaria, saw a decrease in their number of HRSTO between 2001 and 2006 (-0.3% and -0.9% respectively). Bulgaria also combined this decrease with one of the lowest proportions of HRSTO among total employment (22%). Romania and Portugal also had low shares of HRSTO.

In the same period, Luxembourg and Spain had the highest annual average growth in HRSTO, with 6.1%. In addition, the share of Luxembourg HRSTO among total employment was one of the highest in 2006, at 40%. This result illustrates the specificity of this small Member State, with the EU institutions and the financial institutions contributing to employment in S&T occupations. Conversely in Spain, the share of HRSTO among the employed population was much smaller (25%). Ireland and Greece were in the same position, but, as all these three Member States have high growth rates, they might soon have shares of HRSTO equal to the EU average. In Sweden and Denmark, and in four other countries, HRSTO accounted for a high share of total employment (around 40%), combined with a moderate growth rate (more or less 2%).

R&D Personnel and Researchers

If S&T is a key element of knowledge, the numbers of R&D personnel and in particular, researchers are key indicators of its dissemination and development as they demonstrate the human resources going directly into R&D activities.

In 2006, the EU employed more than 2.1 million R&D personnel measured in Full Time Equivalent (FTE) (see Table 2).This unit is a measure of the real volume of R&D performed.

Germany and France were the most important R&D employers in the EU, with almost 40 % of the EU's R&D personnel employed in these two countries. Among the new Member States, the main countries employing R&D personnel were Poland, Romania and the Czech Republic.

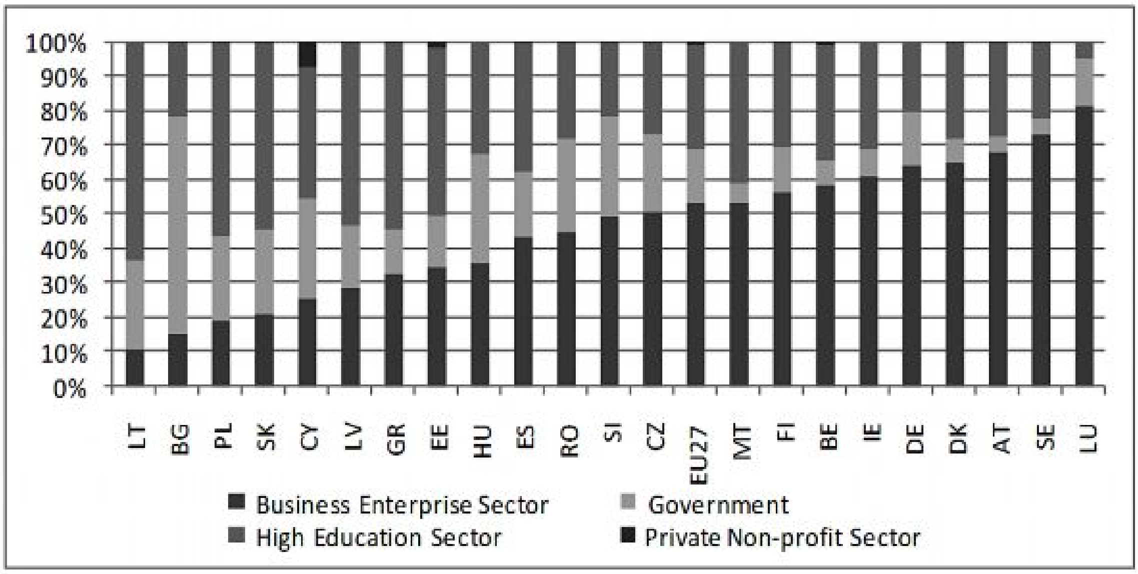

Fig. 3. Structure of R&D personnel by sectors of performance, 2006, %

Source: own calculation based on Eurostat online data: http://epp.eurostat.ec.europa.eu; Date of extraction: September 2008; Last update: Fri Jan 25 2008.

With the exception of the Malta and the Czech Republic, over 50% of the R&D personnel in the new Member States were employed in the public sector (government and higher education).

This is in contrast to most of the other Member States, where the private sector accounted for the highest share (see Fig. 3).

Of the 2.1 million R&D personnel in the EU-27, approximately 60 % are employed as researchers (see Table 2), namely professionals who are engaged in the conception or creation of new knowledge, products, processes, methods and systems (6).

Table 2. R&D personnel (Full Time Equivalents) and researchers as % of R&D personnel, all sectors, 2006

Geopolitical entity	R&D personnel FTE	Researchers as % of R&D personnel
EU27	2,167,381	60.0
EU15	1,923,512	58.9
BE	55,161	61.5
BG	16,321	63.3
CZ	47,729	55.0
DK	45,182	63.4
DE	489,145	57.7
EE	4,740	74.1
IE	17,647	68.9
GR	35,140	56.7
ES	188,978	61.3
FR	353,554	57.8
IT	175,248	47.1
CY	1,220	61.9
LV	6,520	61.7
LT	11,443	70.2
LU	4,586	51.2
HU	25,971	67.6
MT	752	63.2
NL	94,689	48.4
AT	50,322	60.5
PL	73,554	81.0
PT	25,728	82.1
RO	30,802	66.6
SI	9,765	59.7
SK	15,028	78.4
FI	58,257	69.4
SE	78,715	70.8
UK	323,358	55.8

Source: own calculation based on Eurostat online data: http://epp.eurostat.ec.europa.eu; Date of extraction: September 2008; Last update: Fri Jan 25 2008.

Notes: Italy, France, Portugal and United Kingdom: 2005.

Regarding the most important European employers of researchers, the highest proportions of researchers among R&D personnel are to be found in Portugal (82.1%), Poland (81%) and Slovakia (78,4%).

With over 66 researchers at 100 persons employed within R&D sector Romania places above the EU-27 average. On the contrary, in Italy and Netherlands the share of researchers as a percentage of R&D personnel hardly surpasses 47%.

Conclusions

Although R&D expenditure increased between 2000 and 2006 (from 0.37% to 0.45% of GDP), Romania has a long way ahead in order to improve the R&D intensity and to comply with the European established targets in this field.

Given the fact that highly qualified scientific and technical workers hold a share of 10% in total employment, the Romanian economy recorded the poorest performance compared with all the other EU Member States.

Although one of the globalization specific behaviours consists of delocalising /relocalising some economic capacities, developed economies tend to maintain the R&D/S&T activities at national level. Moreover, these economies are offering net advantages in terms of wages, conditions of living etc. for foreign labour force, in particular highly qualified specialists. In the context of free movement of the labour force within the UE, these advantages can be acquired much easier. This socio-economic phenomenon could trigger serious drawbacks for Central and East European countries to accomplish the broader objective of sustainable development.

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Resursele umane din sectorul Ştiinţă şi Tehnologie – perspectivă europeană

Rezumat

Ştiinţa şi tehnologia joacă un rol important în identificarea unor soluţii pentru problemele economice, sociale şi de mediu ce caracterizează modelul actual de dezvoltare ca fiind nesustenabil, însă acestea nu sunt suficiente pentru a asigura creşterea economică, competitivitatea şi crearea de locuri de muncă. Activităţile de cercetare-dezvoltare şi alte activităţi din domeniul ştiinţei şi tehnologiei nu pot fi realizate fără resurse umane adecvate din punct de vedere cantitativ şi calitativ, o condiţie fără de care atingerea obiectivului de 3% din PIB alocat sectorului cercetare-dezvoltare poate fi considerată nesustenabilă.