# Human capital in EU10 countries: Changes in education and research and development

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In the 21st century, human capital, the quality of the human resources have become a significant element of development. In narrow sense the development of human capital means the training of high-performing and high skilled labor-potential, and also the creation and development in chain of the following territories: education – science-policy – research; development – invention – innovation. In wider sense it includes the shaping of the value-creating potential of the whole workforce, an important part of which is the development of skilled staff through training and education. The development of human capital with rational, perspective planning and adequate funding might play a decisive role in catching up with the global economy. At least two main areas must be rapidly developed to make use of human potential: education and research and development (R&D), because these are the basis of the development. The creation of human capital is first of all not a quantitative, but a qualitative process. Hungary for example was way ahead in the field of human resources for a long time (in the beginning of the 21st century, between the two world wars and beyond), skilled workers and inventions compared to its general economic development. In the second decade of the 21st century, EU10 countries - including Hungary - do not reach the requirements of our times, but they are far from exploiting their intellectual potential, due to the quality of their education and the lagging behind of scientific results in their economies.

This study is primarily an investigative, analytical comparison. The reason for that is that R&D and educational expenditures are based on the economic and solvency situation of a country. Nevertheless the change of these shares is the result of economic policy decisions, that is how much one country spends on these areas. All countries are keen on spending more to develop these always important and recognized fields, but due to budget deficit, financial barriers set narrow limits. Also in the case of crises, the human capital-intensive areas like the healthcare system, education and R&D suffer. There are only a few historical exceptions like Hungary and Finland between the two world wars. They spent the most in world comparison – 15% of its GDP - on education and scientific research. (This is not directly comparable to today's GDP figures, but it would be more than 10% of GDP in current prices).

The human capital potential and scientific research are determined by long-term conditions and trends. We can only assess the present situation based on historical capabilities, and the impact of contemporary development in a long time horizon, at least 5-10-15 years later. (The now graduated student will get degree within 5-6 years, about 8-9 years for a PhD, and to become a scientific researcher plus 10-15 years.)

Concerning R&D, the EU had to face major changes in this field from the millennium. It became increasingly apparent that the intensification of globalization (which was accompanied by continued market liberalization) sovereignty of the economic policy and the technology policy has declined and there is a gradual loss of national control. The EU member countries tried to balance it, instead of macroeconomy (the main element of which was also placed on the supranational level, due to EMU) they promote microeconomy and companies in the competition. The large number of TNCs in the EU encourage governments and the EU at the same time, to

support the innovation capacity of SMEs, who serve TNCs. This could be the new aspect of technology policy. With the enlargement of the EU the community's R&D potential has significantly increased. The reason of this phenomenon is not the rise in governmental expenses, but the scientific capacities and the number of R&D area working staff within the EU10 countries.

### Table 1: Total public expenditure on education as % of GDP, for all levels of education

| | 2000 | 2004 | 2005 | 2010 | 2011 |
|---|---|---|---|---|---|
| European Union (28 countries) | : | 4.95(e) | 4.92(e) | 5.41(e) | 5.25(e) |
| European Union (27 countries) | 4.91(s) | 4.95(e) | 4.92(e) | 5.41(e) | 5.25(e) |
| Bulgaria | 3.88 | 4.40 | 4.25 | 4.10 | 3.82 |
| Czech Republic | 3.83 | 4.20 | 4.08 | 4.25 | 4.51 |
| Estonia | 5.57(i) | 4.92 | 4.88 | 5.66 | 5.16 |
| Croatia | : | 3.87 | 3.98(d) | 4.31(d) | 4.21(d) |
| Latvia | 5.64 | 5.12 | 5.14 | 4.96 | 4.96 |
| Lithuania | 5.63 | 5.17 | 4.88 | 5.36 | 5.17 |
| Hungary | 4.50 | 5.44 | 5.46 | 4.90 | 4.71 |
| Poland | 4.87(i) | 5.41(d) | 5.47(d) | 5.17(d) | 4.94 |
| Romania | 2.88 | 3.28 | 3.48 | 3.53 | 3.07 |
| Slovenia | : | 5.74 | 5.73 | 5.68 | 5.68 |
| Slovakia | 3.92(i) | 4.19(d) | 3.85(d) | 4.22(d) | 4.06(d) |
| :=not available; e= estimated; s= Eurostat estimate; i= see metadata; d=definition differs; see metadata | | | | | |
| Source: Eurostat | | | | | |

### Table 2: Total public expenditure on education
Million Euro PPS

| | 2000 | 2004 | 2005 | 2007 | 2010 | 2011 |
|---|---|---|---|---|---|---|
| European Union (28 countries) | :(u) | 534,765.1(e) | 555,912.9(e) | 610,557.3(e) | 662,028.3(e) | 663,029.3(e) |
| European Union (27 countries) | :(u) | 532,677.2(e) | 553,644.7(e) | 607,854.9(e) | 659,311.3(e) | 660,293.4(e) |
| Bulgaria | 1,715.8 | 2,551.4 | 2,695.1 | 2,976.4 | 3,328.1 | 3,278.5 |
| Czech Republic | 5,313.1 | 7,245.4 | 7,427.7 | 8,646.8 | 8,709.1 | 9,530.3 |
| Estonia | 710.9(i) | 825.2 | 908.6 | 1,107.2 | 1,183.9 | 1,200.3 |
| Croatia | : | 2,087.9(d) | 2,268.1(d) | 2,702.4(d) | 2,717 | 2,735.9 |
| Latvia | 904 | 1,164.9 | 1,279.6 | 1,597.3 | 1,401.9 | 1,534 |
| Lithuania | 1,547.3 | 1,948.2 | 1,990.1 | 2,322.1 | 2,486 | 2,609.5 |
| Hungary | 4,896 | 7,486.4 | 7,812.4 | 8,159.7 | 7,890.6 | 7,922.1 |
| Poland | 17,517(i) | 22,572.9 | 24,030.9 | 25,431.3 | 30,686.2 | 31,154.9 |
| Romania | 3,242 | 5,246.6 | 5,907.4 | 9,484.1 | 8,846.2 | 7,970.6 |
| Slovenia | : | 2,146.5 | 2,249.2 | 2,297.2 | 2,397.1 | 2,469.7 |
| Slovakia | 2,121(d) | 2,780.9(d) | 2,803.1(d) | 3,306(d) | 4,156.9 | 4,140 |
| :=not available; u=low reliability; e=estimated; i=see metadata; d=definition differs, see metadata | | | | | | |
| Source: Eurostat[154] | | | | | | |

[154] http://epp.eurostat.ec.europa.eu/tgm/web/_download/Eurostat_Table_tps00158HTMLDesc_09a1da4a-f8f6-453e-90c5-f53171b898ef.htm#

The spending on education and training as the ratio of GDP is the major indicator if we want to know how much attention the state pays to public education. From post-transition EU member states, Slovenia spends most on education relative to the GDP, even more than the EU average. Lithuania and Estonia spend permanently more than 5% of the GDP on education, their educational potential is developing. Poland and Hungary are in the middle level. Interestingly, the Czech Republic spends relatively little on public education. The catching up of Romania and Bulgaria is hindered by the low rate of public expenditure on this field. The extremely low ratio of these two countries has declined in comparison with the mid-2000s period. Only Estonia and the Czech Republic have increased the ratio of their public education expenditures if we compare 2000 to 2011, but in the other analyzed countries we observe decrease in the same timeframe (see Table 1).

The total spending on public education differs from what we would expect based on the economic potential of countries and the number of students. Educational expenditure in absolute terms indicates the input size of performance. Based on the whole population, the number of students and the budget, Poland, Czech Republic, Romania and Hungary rank first in absolute value of expenses. The other EU10 countries have lower levels of expenditure, because of low student numbers. Between 2000 and 2011, the public education expenses rose in the region, in case of Hungary and the Czech Republic this happened during 2000-2004, but in the other analyzed countries generally after 2004. In Hungary and in Romania, the governmental subventions declined due to the economic crisis in the period 2007-2011, but in all the other countries, subventions increased (see Table 2).

**Table 3: Annual expenditure on public and private educational institutions compared to GDP per capita**

By level of education - based on full-time equivalents (% - based on full-time equivalents)

| | 2000 | 2004 | 2005 | 2006 | 2010 | 2011 |
|---|---|---|---|---|---|---|
| European Union (28 countries) | : | 24.6(e) | 25.2(e) | 25.1(e) | 28(e) | 26.9(e) |
| European Union (27 countries) | : | 24.6(e) | 25.2(e) | 25.1(e) | 28(e) | 26.9(e) |
| Bulgaria | 23.4 | 24.2 | 23.7 | 23.6 | 24.6 | 23.2 |
| Czech Republic | 19 | 21.7 | 21.3 | 23.3 | 23.6 | 25 |
| Estonia | : | : | 20.4 | 20.4 | 27.2 | 25.5 |
| Croatia | : | :(u) | :(u) | :(u) | 25.7 | 25.7 |
| Latvia | 25.6 | 24 | 24.3 | 24.7 | 26.8 | 26.5 |
| Lithuania | :(i) | 21.1 | 19.9 | 20.2 | 25 | 24.3 |
| Hungary | :(u) | 26.7 | 26.7 | 26.8 | :(z) | :(z) |
| Poland | 21.8(i) | 24.8(d) | 26.6(d) | 24.8(d) | 29.1(d) | 28.4(d) |
| Romania | : | : | 18.3 | :(u) | 18.7 | 17.5 |
| Slovenia | : | 29.5 | 30.5 | 30.4 | 32.4 | 32.3 |
| Slovakia | 17.7 | 21(d) | 19.9(d) | 19.6(d) | 23.3(d) | 22.5(d) |

:=not available; e=estimated; i=see metadata; d=definition differs, see metadata; u=low reliability; z=not applicable; b=break in time series

Source: Eurostat[155]

[155] http://epp.eurostat.ec.europa.eu/tgm/web/_download/Eurostat_Table_tps00069HTMLDesc_fcdc8729-6816-4e8c-a682-ef1259006ca8.htm#

Table 3 provides an overview of spending on public education from public and private resources in relative proportion of GDP per capita. It is based on the annual expenditure of educational institutions. Indeed it means how much of the GDP per capita will be invested in education. In 2004, the EU-28 spent 24,6% of its GDP on these aims, and by 2010, this increased to 28%, but in 2011, it decreased to 26,9%. The rank of countries in 2004 was the following: Slovenia, Hungary and Poland, in 2011 Slovenia was also the first, but Poland and the Baltic states caught up. Hungarian data for 2010-2011 are not available. In Romania and Bulgaria, educational expenditure declined compared to the 2005 GDP per capita ratio.

**Table 4: Annual expenditure on public and private educational institutions per pupil/student**
PPS based on full-time equivalents

| | 2000 | 2004 | 2005 | 2010 | 2011 |
|---|---|---|---|---|---|
| European Union (28 countries) | : | 5,455.2(e) | 5,643.1(e) | 6,908.9(e) | 6,846.4(e) |
| European Union (27 countries) | : | 5,476.8(e) | 5,662(e) | 6,933.9(e) | 6,869.2(e) |
| Bulgaria | 1,266.9 | 1,806.4 | 1,948.5 | 2,655 | 2,713.4 |
| Czech Republic | 2,571.9 | 3,663.6 | 3,790.5 | 4,600.4 | 5,032.2 |
| Estonia | : | : | 2,818.8 | 4,242.6 | 4,426.1 |
| Croatia | : | :(u) | :(u) | 3,766.2 | 3,901.9 |
| Latvia | 1,817.6 | 2,415 | 2,702.2 | 3,608.4 | 3,987.9 |
| Lithuania | :(i) | 2,354.7 | 2,446.1 | 3,738.3 | 4,044 |
| Hungary | :(u) | 3,635.1 | 3,793.4 | :(z) | :(z) |
| Poland | 1,970.5(i) | 2,717.7(d) | 3,061.5(d) | 4,483.6(d) | 4,640.6(d) |
| Romania | : | : | 1,437.2 | 2,132.5 | 2,074.6 |
| Slovenia | : | 5,526.5 | 5,995.5 | 6,676.7 | 6,781.7 |
| Slovakia | 1,686 | 2,588.9(d) | 2,689.1(d) | 4,235(d) | 4,262.2(d) |

:=not available; e=estimated; i=see metadata; d=definition differs, see metadata; u=low reliability; z=not applicable; b=break in time series

Source: Eurostat[156]

The data of Table 4 partially correlate with economic development, partly indicating educational expenditures of states. It is interesting to observe that in the EU10 countries, educational spending per student is deeply under the EU-average. (In Slovenia the situation is favorable.) The Baltic states, Poland and the Czech Republic made significant effort to improve their own educational area and the expenditure per student ratio since 2000 and from the EU accession. Regarding educational expenditure, the catching up will be hard, because of the deep gap between the EU-average and these countries. Data are available only until 2011, but the prominence of Slovenia and the Czech Republic is clear. The database of Slovakia and Poland are not comparable to the other countries data, because of definition differences. Bulgaria and Romania are at the end of the list in the EU, regarding this comparison.

[156] http://epp.eurostat.ec.europa.eu/tgm/web/_download/Eurostat_Table_tps00067HTMLDesc_fe0f02d7-62fc-42d9-974b-cd237bf7f82e.htm#

**Table 5: Tertiary education participation**
Trends in the number of students (ISCED 5-6) (1 000)

| | 2000 | 2004 | 2005 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|
| European Union (28 countries) | : | 18,359.2 | 18,664.8 | 19,991.1 | 20,283.3 | 20,245.9 |
| European Union (27 countries) | 15,920.8 | 18,232.9 | 18,530.2 | 19,841.2 | 20,129.3 | 20,088.6 |
| Bulgaria | 261.3 | 228.5 | 237.9 | 287.1 | 285.3 | 285.0 |
| Czech Republic | 253.7 | 318.9 | 336.3 | 437.4 | 446.2 | 440.2 |
| Estonia | 53.6 | 65.7 | 67.8 | 69.0 | 69.1 | 67.6 |
| Croatia | : | 126.3 | 134.7 | 149.9 | 154.0 | 157.3 |
| Latvia | 91.2 | 127.7 | 130.7 | 112.6 | 103.9 | 97.0 |
| Lithuania | 121.9 | 182.7 | 195.4 | 201.4 | 187.1 | 175.1 |
| Hungary | 307.1 | 422.2 | 436.0 | 389.0 | 381.9 | 380.8 |
| Poland | 1,579.6 | 2,044.3 | 2,118.1 | 2,148.7 | 2,080.3 | 2,007.2 |
| Romania | 452.6(d) | 685.7 | 738.8 | 999.5 | 871.8 | 705.3 |
| Slovenia | 83.8(d) | 104.4(d) | 112.2 | 114.9 | 107.1 | 104.0 |
| Slovakia | 135.9 | 164.7 | 181.4 | 234.5 | 226.3 | 221.2 |

:=not available; d=definition differs; see metadata

Source: Eurostat

**Table 6: Population with tertiary education attainment**
Percentage, ISCED97: First and second stage of tertiary education (levels 5 and 6)

| | 2000 | 2004 | 2005 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|
| European Union (28 countries) | : | 19.1 | 19.6 | 22.7 | 23.6 | 24.5 | 25.3 |
| European Union (27 countries) | 17.1 | 19.1 | 19.7 | 22.8 | 23.7 | 24.6 | 25.4 |
| Bulgaria | 15.1 | 17.9 | 17.8 | 19.4 | 20.1 | 20.7 | 22.2 |
| Czech Republic | 9.5 | 10.4 | 11.0 | 14.5 | 15.8 | 17.0 | 18.1 |
| Estonia | 24.1(b) | 25.6 | 27.7 | 30.0 | 31.3 | 32.1 | 33.2 |
| Croatia | : | 13.2 | 13.4 | 15.5 | 15.3 | 15.7 | 16.5 |
| Latvia | 15.1 | 16.7 | 17.1 | 22.6 | 23.6(b) | 25.2 | 27.0 |
| Lithuania | 35.3(d) | 21.6 | 22.4 | 26.9 | 27.9 | 28.6 | 29.8 |
| Hungary | 11.7 | 14.2 | 14.5 | 17.2 | 18.1 | 19.0 | 19.5 |
| Poland | 9.2(b) | 12.8 | 13.9 | 19.4 | 20.3 | 21.5 | 22.6 |
| Romania | 7.5 | 8.7 | 9.1 | 11.9 | 13.0 | 13.6 | 13.9 |
| Slovenia | 12.9(b) | 15.7 | 16.7 | 20.2 | 21.6 | 23.0 | 24.4 |
| Slovakia | 8.2 | 10.4 | 11.4 | 15.1 | 16.4 | 17.0 | 17.7 |

:=not available; b=break in time series; d=definition differs, see metadata

Source: Eurostat

The number of participants in higher education is the index of future human capital potential (Table 5). This indicator significantly correlates with the evolution of the given population, while forecasts the future high-skilled labor potential. Most of the young people study in higher education in Poland and Romania (in 2012, more than 2 million, and 700 thousand students). Number of students in higher education increased dynamically during 2000-2005 in each country. However, after the crisis, the number of students in higher education started declining except for Croatia and the Czech Republic, but in 2012 there was a decline in the Czech Republic too. The largest decline was reported in Romania, with nearly 300 thousand losses. In Hungary, the number of students in

higher education was lower by approximately 60 thousand from 2005 to 2012. The decrease is explained partly by demographical changes, but the main reason was the reduction of state funded higher education and the increase of tuition fees paid by the students. Due to the crisis, the financial capacities of poorer families were significantly reduced, which could only be partly compensated with grants.

In the transition countries, the ratio of tertiary educated people within the active population is very different (Table 6). In the Baltic countries, especially in Estonia, the number of tertiary graduated citizens is higher than the EU-28 average. Estonia had outstanding successful efforts in this area, it increased its higher educated population from one-fourth to one-third between 2004-2013. Slovenia is just a little under the EU- average, with Bulgaria and Poland, they are between 20-25%. The number of graduated citizens is less than 20% of the population in the Czech Republic, Slovakia and Hungary. The situation is the worst in Romania, with its 13,9%.

**Table 7: Tertiary graduates in science and technology per 1 000 inhabitants aged 20-29 years**

| | 2000 | 2001 | 2004 | 2005 | 2010 | 2011 |
|---|---|---|---|---|---|---|
| European Union (28 countries) | : | 12.4 | 13.2 | 15.4 | : | 17.1(d) |
| European Union (27 countries) | 10.6(e) | 12.5(e) | 13.2 | 15.4 | 17 | 17.1(d) |
| Bulgaria | 7.5 | 8.5 | 8.6 | 12.1 | 12.4 | 13.3 |
| Czech Republic | 5.6 | 7.4 | 8.3 | 16.9 | 16.6 | 16.7 |
| Estonia | 8(d) | 8.9 | 12.2 | 12 | 12.7 | 13.2 |
| Croatia | : | 5.8 | 6.1 | 12.3 | : | 17.4 |
| Latvia | 7.6 | 9.7 | 10.2 | 12.1 | 12.8 | 13.5 |
| Lithuania | 14.8 | 18.1 | 19.8 | 21.8 | 22.6 | 23 |
| Hungary | 3.7 | 5.1(d) | 5.1 | 8.3 | 8.5 | 9.5 |
| Poland | 7.6 | 9.4 | 11.1 | 15.8 | 17.5 | 17.9 |
| Romania | 4.9(d) | 10.4 | 11.1 | 18.8 | 19.3 | 18.7 |
| Slovenia | 8.2 | 9.3 | 9.8 | 14.8 | 17.4 | 19.3 |
| Slovakia | 7.5 | 9.3 | 10.2 | 18.7 | 18 | 17.9 |

:=not available; d=definition differs, see metadata; e=estimated; u=low reliability

Source: Eurostat[157]

Table 7 shows how many from 1000 young people - aged 20-29 - get scientific, technical or mathematical education. Lithuania has the highest level, Romania, Poland, Slovakia follow it. Bulgaria and Hungary are at the end of the list regarding scientific and technical university degrees. Between 2001-2011, the EU-average of the number of science and engineering graduates increased by 70%, but in Slovenia, Slovakia and Poland the increase was even more pronounced than the EU-average. The same ratio doubled in Hungary from 3.7% to 9.5%.

[157] http://epp.eurostat.ec.europa.eu/tgm/web/_download/Eurostat_Table_tps00188HTMLDesc_985d9823-aab9-4ecf-bac1-cbf2e09643dc.htm#

**Table 8: Doctorate students in science and technology fields**
Percent of the population aged 20-29 years

| | 2000 | 2004 | 2005 | 2010 | 2011 |
|---|---|---|---|---|---|
| European Union (28 countries) | : | : | : | : | : |
| European Union (27 countries) | : | : | : | :(u) | 0.49(e) |
| Bulgaria | 0.11 | 0.19 | 0.2 | 0.16 | 0.15 |
| Czech Republic | 0.45 | 0.73 | 0.79 | 0.84 | 0.87 |
| Estonia | 0.23 | 0.36 | 0.39 | 0.56 | 0.62 |
| Croatia | : | 0.04 | 0.06 | 0.26 | 0.28 |
| Latvia | 0.13 | 0.13 | 0.13 | 0.19 | 0.28 |
| Lithuania | 0.16 | 0.23 | 0.24 | 0.23 | 0.31 |
| Hungary | 0.1 | 0.17 | 0.17 | 0.17 | 0.18 |
| Poland | 0.14 | 0.19 | 0.19 | 0.19 | 0.21 |
| Romania | : | 0.14 | 0.23 | 0.31 | 0.31 |
| Slovenia | : | : | 0.17 | 0.43 | 0.58 |
| Slovakia | 0.32 | 0.4 | 0.43 | 0.5 | 0.55 |

:=not available; u=low reliability; e=estimated

Source: Eurostat[158]

The proportion of scientific and engineering Ph.D students compared to the EU average in the 20-29 age group in 2011 was 0.49%. Among the transition countries, this ratio is highest in the Czech Republic, between 2000-2011 it almost doubled to 0.87%. Estonia has also increased the number of its Ph.D. students from 0.23% to 0.62%. In Slovenia and Slovakia, the proportion of Ph.D students are above the EU-average, thanks to their special attention to doctoral programs. Compared to 2005, there is a significant increase of Ph.D student numbers except Hungary, Poland and Bulgaria, where during this period there was further decline in the ratio. So in these countries are number of Ph.D students is the lowest (see Table 8).

**Table 9: Academic staff of tertiary education**

| | 2000 | 2004 | 2005 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|
| Bulgaria | 24,620 | 20,944 | 21,102 | 20,855 | 20,648 | 22,955 |
| Czech Republic | 20,010 | : | 24,298 | 16,656 | 18,002 | 17,476 |
| Estonia | 5,707 | 6,630 | : | : | : | : |
| Croatia | : | 7,917 | 8,764 | 15,721 | 16,319 | : |
| Latvia | 5,213 | 5,716 | 6,268 | 6,924 | 6,340 | 6,435 |
| Lithuania | 12,726 | 13,415 | 13,157 | 14,116 | 13,926 | 13,923 |
| Hungary | 21,249 | 24,708 | 25,413 | 24,596 | 22,697 | 24,279 |
| Poland | 85,971 | : | 95,144 | 102,595 | 102,621 | 101,407 |
| Romania | 26,977 | 30,137 | 30,857 | 31,103 | 29,746 | 28,365 |
| Slovenia | 2,491 | 4,143 | 4,475 | 6,947 | 7,214 | 7,348 |
| Slovakia | 12,211 | 12,635 | 12,709 | 13,333 | 13,080 | 12,887 |

:=not available

Source: Eurostat

[158] http://epp.eurostat.ec.europa.eu/tgm/web/_download/Eurostat_Table_tsc00028HTMLDesc_6a7112c7-f5cc-4f37-a320-01759525547b.htm#

The effectiveness of higher education largely depends on the number and quality of academics (Table 9). The number of academic staff is the largest in Poland, Romania, Hungary and the Czech Republic. Poland has more than 100 thousand academics, Romanian number is almost 30% and Hungarian figure is 24% of the Polish result. This indicator shows only the absolute potential, but the effectiveness depends on the quality of teachers, their teaching skills, the quality of the whole higher education, the level of organization in the higher education and the capacity of students. The changes of academic staff were largest in proportion in Slovenia, between 2000-2012, from 2491 person to 7348 person. In the same period, there was a decline in teachers' number in the Czech Republic, Hungary and Romania. However, in Slovakia there was stagnation. There is no data available on Estonian academics since 2004. In Croatia the number of academics almost doubled from 7917 (2004) to 16319 (2011).

**Table 10: Employed persons with attainment of tertiary education**

Employed persons, percentage, Age: From 15 to 64 years ISCED97: First and second stage of tertiary education (levels 5 and 6)

| | 2004 | 2005 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|
| European Union (28 countries) | 24.7 | : | 29.0 | 30.0 | 31.0 | 32.0 |
| European Union (27 countries) | 24.7 | 25.3 | 29.1 | 30.0 | 31.1 | 32.1 |
| Bulgaria | 25.5 | 25.7 | 27.1 | 27.9 | 28.5 | 30.1 |
| Czech Republic | 13.8 | 14.4 | 18.1 | 19.5 | 20.7 | 22.1 |
| Estonia | 33.0 | 35.8 | 38.4 | 37.9 | 38.9 | 39.9 |
| Croatia | 19.4 | 19.4 | 22.4 | 22.2 | 23.4 | 24.8 |
| Latvia | 21.8 | 22.9 | 31.0 | 32.4 | 34.1 | 34.9 |
| Lithuania | 28.4 | 30.7 | 39.9 | 40.4 | 40.1 | 40.9 |
| Hungary | 20.5 | 21.1 | 24.2 | 25.5 | 26.1 | 26.3 |
| Poland | 19.6 | 21.4 | 27.2 | 28.1 | 29.5 | 31.0 |
| Romania | 12.4 | 13.2 | 16.7 | 18.3 | 18.6 | 19.0 |
| Slovenia | 20.4 | 21.9 | 26.5 | 28.6 | 30.1 | 31.8 |
| Slovakia | 15.0 | 16.4 | 20.0 | 21.2 | 21.3 | 22.1 |

:=not available

Source: Eurostat

The number of people with tertiary education compared to the employed ones, indicates the quality of the workforce, and its value creation abilities (Table 10). This ratio rose in the EU between 2004-2013 from one-fourth to almost one-third. Unfortunately the proportion of high-educated people does not show the quality, the creativity and value creation ability of the graduated. Despite this, it is worth analyzing the database, however the comparison is limited, because of trainings, which are qualified as higher education courses. In the Baltic countries the ratio of graduated people is extremely high, in Estonia and Lithuania 40%, in Latvia 35%, and these are higher than the EU-28 average. In these countries the proportion of graduates and post-secondary vocational trainings was relatively high before the transition. Regarding the latter information, the situation is similar in Bulgaria. The graduated employment level is high in Slovenia and also in Poland. Hungary, Slovakia, the Czech Republic and Croatia are standing in the middle rank, with their 20-25%. In Romania, the ratio is less than one-fifth, but this result could be achieved after a significant increase between 2005 and 2013.

**Table 11: Research and development expenditure**
percent of GDP

| | 2001 | 2004 | 2005 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|
| European Union (28 countries) | 1.86(e) | 1.82 | 1.82 | 2(e) | 2.04 | 2.07 |
| European Union (27 countries) | 1.87(e) | 1.83 | 1.82 | 2.01(e) | 2.05 | 2.08 |
| Bulgaria | 0.46 | 0.49 | 0.46 | 0.6 | 0.57 | 0.64(p) |
| Czech Republic | 1.16 | 1.2 | 1.22 | 1.4 | 1.64 | 1.88(p) |
| Estonia | 0.7 | 0.85 | 0.93 | 1.62 | 2.37 | 2.18(p) |
| Croatia | : | 1.05 | 0.87 | 0.75 | 0.76 | 0.75 |
| Latvia | 0.41 | 0.42 | 0.56 | 0.6 | 0.7 | 0.66(p) |
| Lithuania | 0.67 | 0.75 | 0.75 | 0.79 | 0.91 | 0.9(p) |
| Hungary | 0.93(d) | 0.88(b) | 0.94 | 1.17 | 1.22 | 1.3 |
| Poland | 0.62 | 0.56 | 0.57 | 0.74 | 0.76 | 0.9 |
| Romania | 0.39 | 0.39 | 0.41 | 0.46 | 0.5(b) | 0.49 |
| Slovenia | 1.49 | 1.39 | 1.44 | 2.1 | 2.47(b) | 2.8(p) |
| Slovakia | 0.63 | 0.51 | 0.51 | 0.63 | 0.68 | 0.82 |

:=not available; e=estimated; p=provisional; b=break in time series; d=definition differs, see metadata

Source: Eurostat[159]

The R&D expenditures of the EU member countries should achieve 3% of their GDP according to the Lisbon Strategy, created in 2000. Nowadays most of the EU member states are still far away from this goal (Table 11). The goal has been shifted to 2020 in the Europe 2020 Strategy. In 2012, the mentioned ratio was in the average of the EU-28 countries a little above 2%. R&D is one of the main pillars of the knowledge based society. At the turn of the millennium, the R&D expenditures/ GDP ratio was very low in post-transition countries. Only Slovenia reached 1.5% and the Czech Republic a bit above 1%. The post-transition countries have made significant efforts compared to their own data between 2001 and 2012. The most significant development in the field of R&D was achieved in Slovenia and Estonia , because both have R&D fundings above the EU-average (2,47% and 2,37%). The Czech Republic and Hungary also made progress, but with their 1,88%/ GDP and 1,3%/ GDP ratio, they are far from the EU-average. Since their accession to the EU - in 2004 and in 2007 respectively - their R&D expenses/ GDP ratio increased. The EU membership and also its R&D framework program offers important impulse to these countries. (Since 1999, Hungary is full member of those programs.) The lowest R&D levels are observed in Romania, Bulgaria and Latvia, but Poland's and Slovakia's results do not achieve the 1%/GDP ratio either.

According to international experiences, those countries are the most successful in the field of R&D, in which the business world and the companies participate in the financing (especially Japan, South-Korea, Sweden and Finland). The EU also encourages the business sector to fund R&D activities. It is surprising that this ratio of the EU-28 average has not increased since the millennium, and even in 2011 the data is lower than it was in 2001. In 2011, the participation of the corporate sector in the R&D finance was 54.9%. In this year, from the EU10 countries only Slovenia and Estonia reached the EU-average. In Slovenia, the share of corporate sector in the financing was 61.2%, in Hungary the same figure was 47.5%. In other post-transition countries, the participation of the corporate sector is around 30%, but in Lithuania, it is less than 30%. Surprisingly, between 2004 and 2012,

[159] http://epp.eurostat.ec.europa.eu/tgm/web/_download/Eurostat_Table_tsc00001HTMLDesc_4d8342c4-194d-4c53-b37c-61ae66af8032.htm#

in all the countries except for Estonia, Slovenia and Hungary, the financial contribution of companies in the R&D activities declined. Neither domestic, nor foreign companies provide enough power to stimulate R&D (see Table 12).

**Table 12: Gross domestic expenditure on R&D (GERD) by source of funds**
Business enterprise sector; % of total GERD

| | 2001 | 2004 | 2005 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|
| European Union (28 countries) | 55.8(e) | 54.2(e) | 54.1 | 53.7(e) | 54.9 | : |
| European Union (27 countries) | 55.8(e) | 54.2(e) | 54.1 | 53.8(e) | 54.9 | : |
| Bulgaria | 27.1 | 28.2 | 27.8 | 16.7 | 16.9 | : |
| Czech Republic | 52.5 | 52.8 | 48.2 | 40.8 | 37.7 | 36.4(p) |
| Estonia | 32.9 | 36.5 | 38.5 | 43.6 | 55 | 51.2(p) |
| Croatia | : | 43 | 34.3 | 38.8 | 38.2 | 38.2 |
| Latvia | 18.3 | 46.3 | 34.3 | 38.8 | 24.8 | 23.8(p) |
| Lithuania | 37.1 | 19.9 | 20.8 | 32.4 | 28.2 | 26.1(p) |
| Hungary | 34.8(d) | 37.1(d) | 39.4(d) | 47.4 | 47.5 | 46.9 |
| Poland | 30.8 | 30.5 | 33.4 | 24.4 | 28.1 | 32.3 |
| Romania | 47.6 | 44 | 37.2 | 32.3 | 37.4(b) | 34.4 |
| Slovenia | 54.7 | 58.5 | 54.8 | 58.4 | 61.2(b) | 62.8(p) |
| Slovakia | 56.1 | 38.3 | 36.6 | 35.1 | 33.9 | 37.7 |

:=not available; e=estimated; p=provisional; b=break in time series; d=definition differs, see metadata

Source: Eurostat[160]

**Table 13: Human resources in science and technology (HRST)**
Percent of active population

| | 2002 | 2004 | 2005 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|
| European Union (28 countries) | : | : | : | 40.3 | 42.3(b) | 42.9 | 43.4 |
| European Union (27 countries) | 35 | 37 | 37.8 | 40.5 | 42.4(b) | 42.9 | : |
| Bulgaria | 31.2 | 31.2 | 31.6 | 31.6 | 33(b) | 32.6 | 33 |
| Czech Republic | 31.6 | 32.8 | 34.5 | 37.8(b) | 35.6(b) | 36.5 | 36.9 |
| Estonia | 40 | 41.5 | 44.8 | 45.2 | 47.3(b) | 49.2 | 49.5 |
| Croatia | 27.6 | 27.9 | 28.2 | 32.1(b) | 30.9(b) | 32.3 | 34.5 |
| Latvia | 33.5(b) | 31 | 32.7 | 38 | 38.2(b) | 40.1 | 41.2 |
| Lithuania | 32.3(b) | 34.6 | 37.4 | 42.7 | 43.6(b) | 43.9 | 45.6 |
| Hungary | 29 | 31.8 | 31.6 | 33 | 34.6(b) | 35.4 | 35.7 |
| Poland | 25.6 | 28.3 | 29.6 | 35.9(b) | 36.6(b) | 37.7 | 39 |
| Romania | 20.8(b) | 21.2 | 22 | 24.4 | 25.8(b) | 25.7 | 25.2 |
| Slovenia | 32.3 | 35.8 | 37.3 | 40.8 | 42.4(b) | 42.8 | 43.5 |
| Slovakia | 28.5 | 28.8 | 30.7 | 33.5 | 33.9(b) | 32.5 | 32.5 |

:=not available; b=break in time series

Source: Eurostat[161]

[160] http://epp.eurostat.ec.europa.eu/tgm/web/_download/Eurostat_Table_tsc00031HTMLDesc_89fb65fc-ed53-46f8-a242-ca77e1ddda09.htm#
[161] http://epp.eurostat.ec.europa.eu/tgm/web/_download/Eurostat_Table_tsc00025HTMLDesc_da99e3e2-c888-4c45-92ae-72cb8952a0a8.htm#

The proportion of workers in scientific-technical fields in relation to the active population gives overview about the ratio of workers in the R&D sector, which is necessary for the development. (This number included the entire staff, not just R&D activists). In 2013, in the EU generally 43.4% of the labor forces worked in scientific-technical areas. Among EU10, this ratio is higher than the EU average in the Baltic countries and in Slovenia. Among V4 countries, the ranking is Poland, Czech Republic, Hungary and Slovakia. The lowest level was measured in Romania. Thanks to economic development, this ratio has become higher, however, between 2002 and 2013 only Slovenia and the Baltic states could improve their position significantly (Table 13).

**Table 14: Total researchers (FTE)**
All sectors; FTE: full-time equivalent

| | 2000 | 2004 | 2005 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|
| European Union (28 countries) | : | 1,314,471(e) | 1,374,849 | 1,607,004(e) | 1,628,443 | 1,661,499(e) |
| European Union (27 countries) | 1,123,553(e) | 1,307,331(e) | 1,369,122 | 1,599,901(e) | 1,621,596 | 1,654,812(e) |
| Bulgaria | 9,217 | 9,827 | 10,053 | 10,979 | 11,902 | 11,295(p) |
| Czech Republic | 14,987 | 16,300 | 24,169(b) | 29,228 | 30,682 | 33,169(p) |
| Estonia | 2,681 | 3,369 | 3,331 | 4,077 | 4,511 | 4,570(p) |
| Croatia | : | 7,140 | 5,727 | 7,104 | 6,847 | 6,688 |
| Latvia | 3,497 | 3,324 | 3,282 | 3,896 | 3,947 | 3,904(p) |
| Lithuania | 8,075 | 7,356 | 7,637 | 8,599 | 8,390 | 8,023 |
| Hungary | 14,666(d) | 14,904(b) | 15,878 | 21,342 | 23,019 | 23,837 |
| Poland | 56,148 | 60,944 | 62,162 | 64,511 | 64,133 | 67,001 |
| Romania | 19,726 | 21,257 | 22,958 | 19,780 | 16,080(b) | 18,016 |
| Slovenia | 4,498 | 4,030 | 5,253 | 7,703 | 8,774(b) | 9,093(p) |
| Slovakia | 9,585 | 10,718 | 10,921 | 15,183 | 15,326 | 15,271 |

:=not available; e=estimated; p=provisional; b=break in time series; d=definition differs, see metadata

Source: Eurostat[162]

Regarding the number of researchers, the EU has a strong potential, which grew even stronger after the millennium period (see Table 14). In 2001 1.12 million people worked in the EU as a researcher (full time employment), but in 2012 the number reached 1.65 million employees. Overall among the EU10, Poland, the Czech Republic and Hungary have the biggest researcher potential. In 2012 Poland had 67,000, the Czech Republic 33,000, and Hungary 24,000 researchers. The number of researchers – except for Romania – increased between 2001 and 2012, which could serve as a basis for the improvement of R&D, if other factors and inputs are also getting better. The Baltic countries and Croatia have the lowest number of researchers. Due to financial and economic crises, the number of researchers in Croatia and Lithuania fell.

[162] http://epp.eurostat.ec.europa.eu/tgm/web/_download/Eurostat_Table_tsc00004HTMLDesc_687c4708-d3c2-4b7f-9c3c-d3bb69ed3072.htm#

**Table 15: European high-technology patents**
Per million inhabitants

| | 2000 | 2004 | 2005 | 2010 | 2011 |
|---|---|---|---|---|---|
| European Union (28 countries) | 24.543 | 22.067 | 21.299 | 18.773 | 9.951(p) |
| European Union (27 countries) | 24.771 | 22.259 | 21.483 | 18.93 | 10.036(p) |
| Bulgaria | 0.173 | 0.263 | 0.838 | 0.067 | 0.136(p) |
| Czech Republic | 0.482 | 1.317 | 1.492 | 1.496 | 1.753(p) |
| Estonia | 0.121 | 1.464 | 3.584 | 9.66 | 5.889(p) |
| Croatia | 0.073 | 0.325 | 0.425 | 0.504 | : |
| Latvia | 0.369 | : | 0.889 | 0.825 | : |
| Lithuania | 0.578 | 0.453 | 0.387 | 0.637 | 0.819(p) |
| Hungary | 3.378 | 2.906 | 2.248 | 4.728 | 2.361(p) |
| Poland | 0.117 | 0.545 | 0.603 | 1.621 | 0.829(p) |
| Romania | 0.089 | 0.118 | 0.274 | 0.39 | 0.338(p) |
| Slovenia | 2.148 | 1.503 | 1.952 | 4.621 | 1.868(p) |
| Slovakia | 0.256 | 0.573 | 0.443 | 0.798 | 1.159(p) |

:=not available; p=provisional

Source: Eurostat[163]

The achieved results in the field of high-tech patents indicate the performance of the EU member states in R&D area. The evaluation of the number of patents could be followed in Table 15. In 2000, for 1 million European people 24,543 European high-tech patent were referred. Between 2000-2011, there was a negative tendency in the number of new patents. In 2000, the largest number of high-tech patents for 1 million people came from Hungary and Slovenia, while in 2010, Estonia, Hungary and Slovenia ranked first. Between 2000 and 2010, the Czech Republic and especially Poland had a significant patent activity in the high-tech field. Bulgaria, Romania and Lithuania have been the least active. It is important to emphasize that the Estonian, Hungarian, Slovenian and Czech researchers were able to connect effectively to international research programs, and to EU R&D framework programs. The other EU10 countries could reach less success in international dimension of high-tech research. The reason of this is that their small economic power, their R&D potential and financial capability do not allow them to implement capital-intensive, big projects. FDI could improve the results, but it has been spent only marginally on R&D in these countries.

The main instrument of the EU's R&D policy is the so-called Framework Programs, that finance specific, common collaboration based researches. The current 7th Framework Program has several successful projects and results, but severe problems and criticism also arise against them. The recognition of deficiencies of the European R&D activities is that in Europe, new technology creation capability is needed, and also the rapid application of new technologies. Therefore the future oriented technical innovation needs cooperation between developers and users of the new technologies.

The national research-development policy could cover only part of the innovation risks, therefore companies have to take part of the execution. In the EU, the main direction of technical-development policy is to secure more favorable frameworks, to improve the technical-economical development information supply, to promote the risk-management, and to give accurate information about the technical and market opportunities related changes.

[163] http://epp.eurostat.ec.europa.eu/tgm/web/_download/Eurostat_Table_tsc00010HTMLDesc_2993954a-d89d-43ed-a86b-59d167c51e3a.htm#

This is complemented by the encouragement of diffusion-oriented technical development. In this field the R&D framework programs of the EU play an important positive role.

The economic policy analyses forecast the improvement of the EU technical development positions, strengthening competitiveness in the world market through the improvement of the European innovation activity framework conditions, and the political environment. To enhance the technical development, they are looking forward to stimulate competition and fiscal policy, which are regulated in this area.

## Conclusion

Demographic problems, the economic impact of aging and problems of the large service systems threat the long term stability of the pension system. This is connected to the development of the human resources, and its role, which determines the growth and financial balance, or lack of them.

In the EU10, among them in Hungary, large part of the human resources is well qualified, developed, but its effective utilization is far from the EU-average and from the consistent building of knowledge based society. The situation got worse with healthcare and educational problems. Due to these, the creation of knowledge based society, the realization of the Lisbon Strategy and its implementation is far. It can be worrying that many transition countries are affected by transitional crises dramatically. The R&D expenditures, their share to the GDP and to the budget has fallen significantly. The Lisbon Strategy envisages a 3% per GDP ratio for R&D expenditures. This is fulfilled only by the Scandinavian countries, the EU average is 1.8-1.9%, and there is not much progress. The same ratio in the USA is 3%, in Japan much more than 3%.

The R&D expenditures in Europe are only one-fourth of the innovation expenditures. Innovation would be effective in the market, if three times more R&D expenditures were spent to innovation. This proves that R&D is significant part of our development, but not a sufficient factor. Within the innovation expenditures, the weight of R&D fell, but on the other hand, the technology-development and production were raised. In the EU10 countries, it is absolutely necessary to strengthen the R&D sector, expenditures and to improve the efficiency of its improvement and effectiveness at the same time. Our R&D results should become competitive, which requires the creation of developed innovation chains.

The gap of the EU10 countries in the area of education, trainings are less than in their GDP per capita, they have advantages compared to the “old” member states. The strengthening of human capital in its quantitative and qualitative potential plays a major factor in economic recovery, therefore this area should be prioritized in the economic policy and expenditures. In general, increasing the length of education increases the productivity. Education, training of the human capital should play a key role in the recovery of the EU10 region and it should be the basis of growth together with the improvement of the workforce potential. However, for example in Hungary we can experience opposite tendencies.

International analyses and experts of the European Commission found the European R&D policy non-effective, mature for reforms. The EU10 countries must also have their own reform strategy.

The European Union has lagging development compared to the USA. The disadvantages of productivity and faster diffusion of innovation could be reduced by increasing the impact of information and communication technologies. The same is true for EU10 countries. The growth rate of investments in the EU10 states is

permanently higher than in the EU15 countries, but their structure should be corrected to converge towards the value added activities.

It is important to note that in the developed EU countries, GDP growth comes from the extremely highly productive non-financial services, mainly from R&D related to innovation and its support activities. In the EU10 countries, the economic policy promotion and the corporate strategies should also focus more on that.

The improvement of R&D expenditures, and ensuring the human resources for R&D are necessary, but far from sufficient. The improvement of the utilization of R&D expenditures and rapid introduction of its results is essential also in the EU10 countries. The handicaps of EU10 states are based on the slow implication of innovations. The improvement of the investment environment, the consistent economic policy have significant role in the recovery of EU10 countries, and among them, Hungary. Finally, countries have to emphasise the social impact and acceptance of new technologies.