

Innovation Union Competitiveness report 2011

Overall picture: Europe's competitive position
in research and innovation



Table of contents

CHAPTER 1 Europe's competitive position in research and innovation	15
1.1. Is the EU improving its performance in research and innovation?	16
1.2. How big a player is the EU in the multi-polar world of science and technology?	19
CHAPTER 2 Investments in knowledge and human resources	20
2.1. Is the EU investing sufficiently in research, education and innovation?	20
2.2. Can the EU count on a growing number of human resources and researchers?	23
2.3. Are EU firms increasing their R&D investments in order to generate and absorb new knowledge and boost innovation?	26
CHAPTER 3 Towards the construction of a European Research Area (ERA) open to the world	28
3.1. What is the overall progress towards the European Research Area?	28
3.2. Is Europe advancing towards a single market for knowledge?	30
3.3. Has Europe achieved world excellence in science and technology?	32
CHAPTER 4 Innovation for a knowledge economy and societal challenges	34
4.1. Are European firms/companies achieving technology-based innovation?	34
4.2. Can the EU count on the right framework conditions to boost innovation?	35
4.3. Is the EU shifting towards a more knowledge-intensive economy?	37
4.4. Is European R&D addressing societal challenges?	41

OVERALL PICTURE

Europe's competitive position in research and innovation - Acting in the new geography of knowledge



This first section of the Innovation Union Competitiveness Report presents the overall picture of European Research and Innovation (R&I). It benchmarks Europe's efforts to maintain its scientific, technological and innovation competitiveness in the new multi-polar world, and reveals some strengths and weaknesses of the European system. In addition, the analysis helps to monitor the progress towards an Innovation Union that contributes to smart, sustainable and inclusive growth in Europe. New threads and opportunities are identified in a rapidly changing world and the need for a long-term and global vision for Europe is put forward.

In order to depict this general picture, the analysis identifies some key indicators on (1) the investments done and the performance achieved by the European R&I system, (2) the progress to build an efficient system that maximises the results accruing from these investments, with a special emphasis on the construction of the European Research Area and the free movement of knowledge across Europe and beyond, and finally, (3) the framework conditions to boost business R&D and innovation in view of enhancing economic competitiveness and addressing societal challenges.

CHAPTER 1

Europe's competitive position in research and innovation

HIGHLIGHTS

The EU's Research and Innovation (R&I) remains relatively competitive, even in a changing multi-polar world. The EU has one of the highest numbers of researchers in the world and in terms of research funding, scientific production and patenting of technologies, the EU remains the second major R&I centre after the United States of America. However, in many areas, the EU is still behind its main world competitors and its overall competitive position is declining.

The EU has made progress in some areas to increase its R&I capacity and performance and has managed to build some distinctive **strengths**. More precisely, the EU benefits from a number of researchers and a sizable and increasing share of the population graduating from academic tertiary education every year. Moreover, the EU is also advancing in its scientific and technological integration, thanks to closer collaborations between European researchers - albeit not at a desirable speed. Progress is also being made towards higher scientific excellence. Finally, the EU is well positioned in some upcoming technologies aimed at addressing societal global challenges, such as climate change technologies, that can yield significant economic results and become new growth areas. However, despite these encouraging signals, the overall R&I competitive position of the EU has been progressively declining in the last decade. This decline is mainly due to the sharp rise of Asia, a trend likely to continue given the ambitious R&D targets of South Korea, Japan or China; and the inability of the EU to address some important **weaknesses** of its R&I system, which are:

1. A severe underinvestment in Research and Education vis-à-vis the United States and major Asian economies. The underinvestment in R&D is particularly worrying in the private sector, as firms face unfavourable framework conditions that deter them from investing or accessing the necessary resources to invest.
2. Weak knowledge exchanges between Science and Industry hamper the diffusion and use of existing knowledge and its commercialisation.
3. Poorer scientific and technological excellence in comparison to the United States — as evidenced by a lower percentage of scientific publications among the most cited publications worldwide and much lower licence and patent revenues — affects the EU's capacity to lead groundbreaking innovations.
4. Unfavourable framework conditions for innovation in terms of access to financing (including venture capital), the much higher cost of patenting in Europe and business conditions that would enhance entrepreneurship activity.

The persistence of these weaknesses **threatens** the capacity of the EU to enhance its future R&I competitive position and its capacity to accelerate its currently sluggish progress towards a knowledge-intensive economy. Without this structural change to the EU economy, its future economic competitiveness in high-value-added products and services may be at risk. The EU needs to react opportunely, addressing the weaknesses and continuing to build on its strengths in order to grasp the new **opportunities** that a changing R&I multi-polar environment offers. In particular, closer cooperation with Asian economies can multiply and accelerate the generation and use of new, valuable knowledge, while the rise of new areas of economic growth closely associated with the increasing demand for R&I to address societal challenges can offer important opportunities for future economic growth and social progress.

1.1. Is the EU improving its performance in research and innovation?

Each Research and Innovation (R&I) System has its own characteristics which depend on the socio-economic realm in which it is embedded. However, it is generally accepted that well-functioning systems share a number of common features¹⁰, (European Commission 2010¹¹). The European Commission, after a broad consultation with stakeholders, has identified 10 of these features, which range from governance and design of R&I policies, to adequate and sufficient support for R&I, availability of the right mix of skills, support for effective knowledge flows, and the improvement of framework conditions that will promote private investment¹².

This section provides an overview of how the EU performs on a series of indicators that capture some of these features. An analysis of 25 indicators¹³ of the Innovation Union Scoreboard¹⁴ (IUS) is used. The 25 indicators of the scoreboard are grouped into 8 dimensions and were selected for their capacity to describe the competitive position of a system, both in terms of research and innovation performance, and of the factors affecting its capacity to achieve this performance.

The IUS, therefore, provides an appropriate framework to overview the R&I competitiveness of the EU *vis-à-vis* its main trading competitors, namely the United States and Japan, and the new rising scientific and technological economies in Asia, e.g. South Korea and China. International comparison of the EU with non-EU countries is already possible for 14 out of the 25 indicators proposed by IUS, although with different geographical coverage. For the remaining 11 indicators (mainly indicators on innovation), the absence of the necessary data in many non-EU countries prevents any international comparison. Nevertheless, the available indicators cover most of the relevant dimensions fairly well, and the IUS remains a suitable framework for our analysis. The two figures below present (1) an overview of the gap between the EU, the United States and Japan in the key dimensions

of the IUS where data are available (Figure 1), and (2) a comparative analysis of the current state of play and the recent evolution of the EU, the United States, Japan and also China and South Korea, two countries rapidly gaining in scientific, technological and economic fields (Figure 2). From this overview, two overall conclusions can be drawn:

- 1. R&I performance in the EU keeps lagging behind that of the United States and Japan. The much weaker R&I activity of EU private firms, coupled with a less favourable environment in terms of accessing funding (including venture capital) and the much higher cost of patenting, are major competitive challenges for the EU.**
- 2. New competitors are swiftly growing. In particular, South Korea and China have emerged as important science, technology and innovation centres, in some areas outperforming Europe and the United States.**

The United States remains the world R&I leader, although in some areas such as business R&D investments or technological production measured by PCT¹⁵ patents, some Asian countries, e.g. Japan and South Korea, have taken the lead. As figure 2 shows, the EU tends to lag behind the United States, Japan and South Korea particularly in terms of business R&I-related activities. The strengths of the EU lie in its production of new doctoral graduates and in the role of the export of knowledge-intensive services. Similar findings can be found in the recently published European Innovation Scoreboard.

In dynamic terms, the Asian economies, especially China, South Korea and Japan, have increased their R&D investments and scientific and technological performance more sharply than the EU or the United States. This trend is likely to continue given the ambitious R&D targets that they have set for the next decade. South Korea will aim to achieve an R&D intensity of 5%, Japan of 4%, Singapore of 3.5% and China of 2.5%, compared to the EU's 3% target for 2020.¹⁶ Moreover, the United States plans to launch a very ambitious R&I investment policy which could aid them in *'maintaining their leadership in research and technology as a crucial policy to support America's success'*¹⁷.

10 OECD (2009): 'The OECD Innovation Strategy: Getting a head start on tomorrow' (http://www.oecd.org/document/15/0,3343,en_2649_34273_45154895_1_1_1_1,00.html).

11 European Commission (2010): 'Europe 2020 Flagship Initiative: Innovation Union' (http://ec.europa.eu/research/innovation-union/pdf/innovation-union-communication_en.pdf).

12 A detailed description of these 10 features can be found in Annex 1 of the Innovation Union initiative.

13 While 25 indicators comprise the Innovation Union Scoreboard, only 24 indicators are currently computed, as the indicator on "high-growth innovative enterprises as a percentage of all enterprises" is not sufficiently available yet.

14 The 25 indicators can be found in "Performance Scoreboard for research and innovation", Annex II of the Innovation Union initiative.

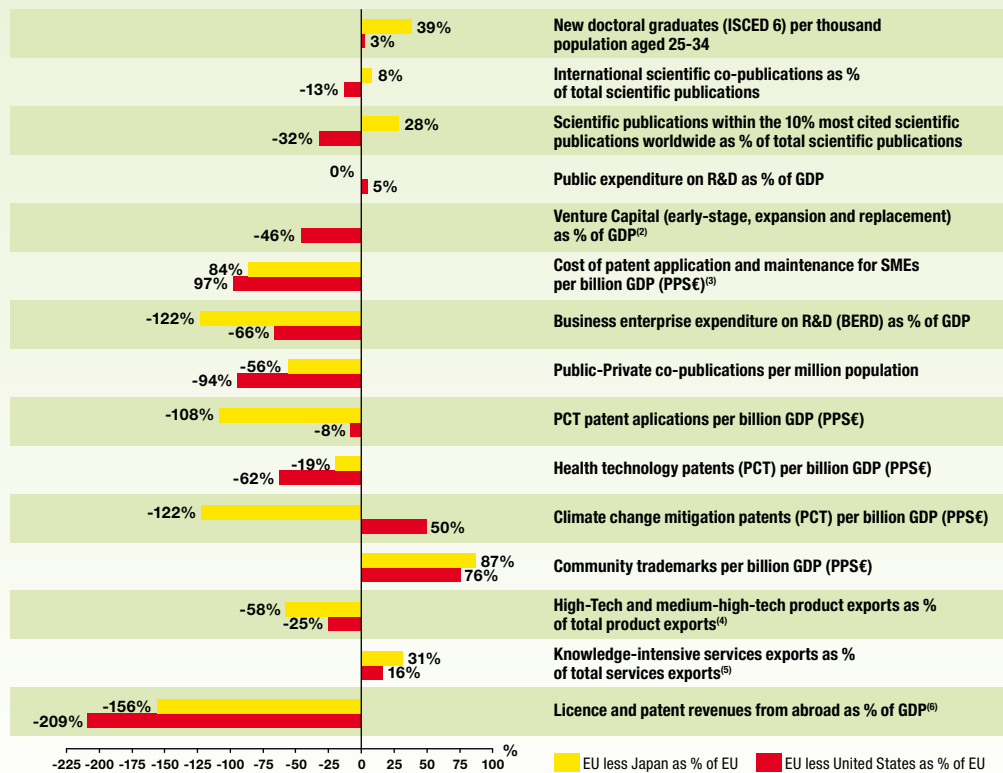
15 Patent Cooperation Treaty.

16 A detailed analysis of the EU's 3% R&D intensity target is presented in Part I, chapter 1.

17 President Barack Obama's speech on the State of the Union, 25 January 2011.

FIGURE 1

Performance Scoreboard for Research and Innovation indicators - The gap between the EU and the United States and Japan, 2009⁽¹⁾



Source: DG Research and Innovation

Data: Eurostat, OECD, Science Metrix / Scopus (Elsevier), Innovation Union Scoreboard 2010

Innovation Union Competitiveness Report 2011

Notes: (1) The values refer to 2009 or to the latest available year.

(2) EU does not include EE, CY, LV, LT, MT, SI, SK.

(3) The values are on the left side of the graph because they express higher costs.

(4) EU includes intra-EU exports and was calculated from the unweighted average of the values for the Member States.

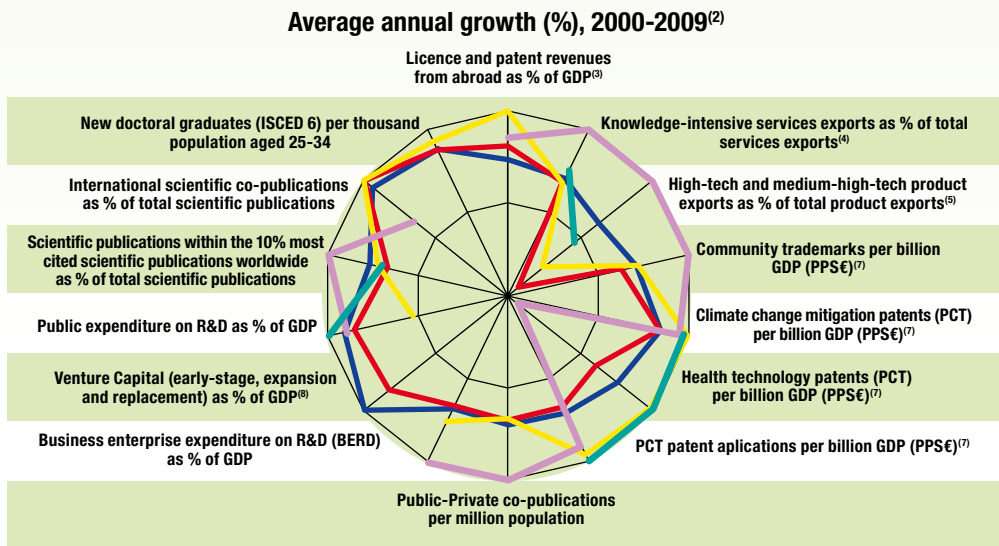
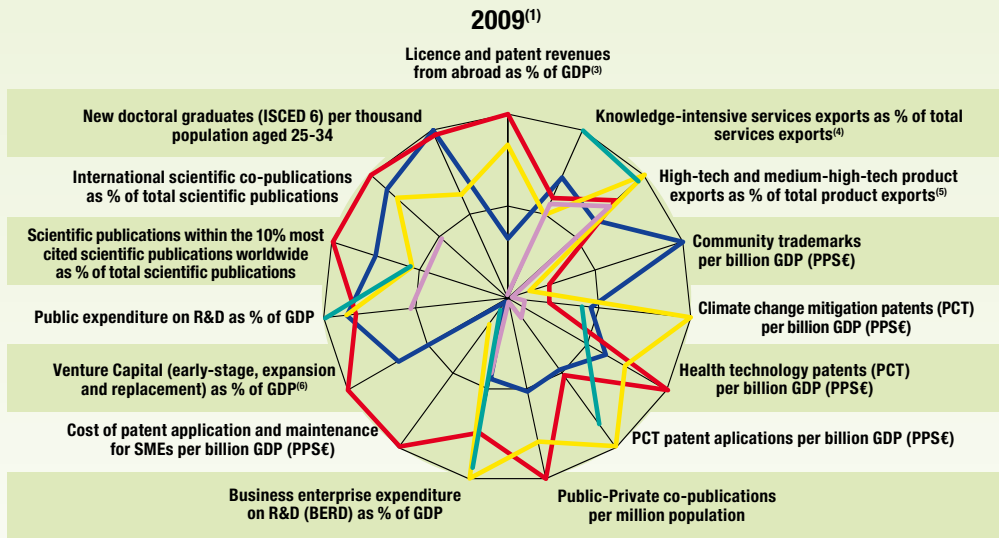
(5) EU includes intra-EU exports.

(6) EU refers to extra-EU.

(7) Elements of estimation were involved in the compilation of the data.

FIGURE 2

Performance Scoreboard for Research and Innovation indicators



— EU — United States — Japan — China — South Korea

Source: DG Research and Innovation

Data: Eurostat, OECD, Science Metrix / Scopus (Elsevier), Innovation Union Scoreboard 2010

Innovation Union Competitiveness Report 2011

Notes: (1) The values refer to 2009 or to the latest available year.

(2) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2009.

(3) EU refers to extra-EU.

(4) EU includes intra-EU exports.

(5) EU includes intra-EU exports and was calculated from the unweighted average of the values for the Member States.

(6) EU does not include EE, CY, LV, LT, MT, SI, SK.

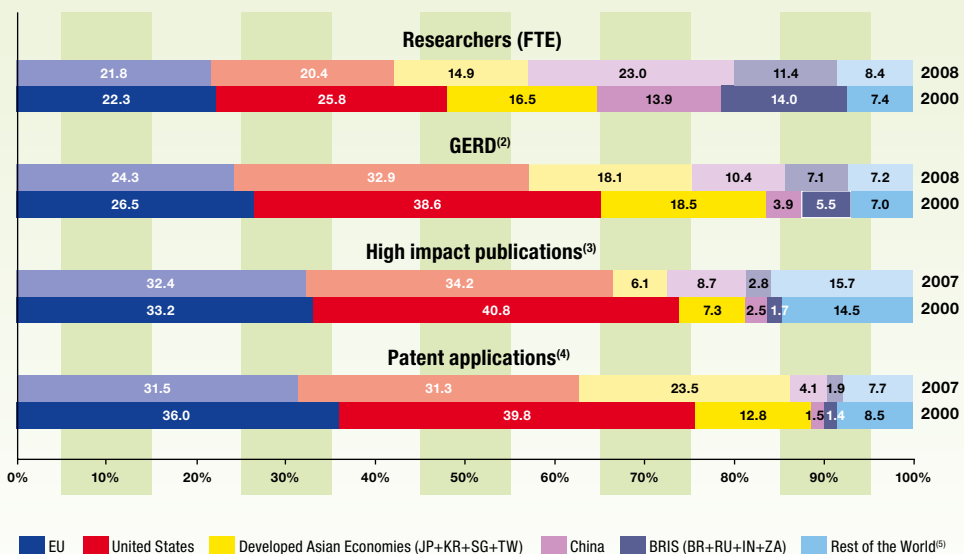
(7) Average annual growth refers to real growth.

(8) EU does not include BG, EE, CY, LV, LT, LU, MT, SI, SK.

(9) Elements of estimation were involved in the compilation of the data.

FIGURE 3

Participation in global R&D – % shares



Source: DG Research and Innovation

Data: Eurostat, OECD, UNESCO, Science Metrix / Scopus (Elsevier)

Notes: (1) Elements of estimation were involved in the compilation of the data.

(2) GERD : Shares were calculated from values in current PPSE.

(3) (i) The 10% most cited scientific publications - fractional counting method;

(ii) Developed Asian Economies does not include SG and TW.

(4) Patent applications under the PCT (Patent Cooperation Treaty), at international phase, designating the EPO by country of residence of the inventor(s).

(5) The coverage of the Rest of the World is not uniform for all indicators.

Innovation Union Competitiveness Report 2011

1.2. How big a player is the EU in the multi-polar world of science and technology?

Overall, the EU's R&I competitiveness remains strong, but the world's centre of gravity for research and technological activity is shifting. If recent trends continue, Asia will become the new main pole of science and technology by 2020

Figure 3 shows that the EU's R&I competitiveness remains strong. The EU accounts for 24.3% of the total research investment in the world, almost 22% of the researchers, 32.4% of all the high impact publications and 31.5% of all PCT patents. However, the EU's relative position has declined because of the rise of five Asian economies: Japan, South Korea, Singapore, Taiwan and especially China. Since 2000, the share of China in global R&D investment has increased from 3.9% to above 10%. Perhaps, more surprising is the translation of these increasing research investments into new knowledge and technology. In 2007, China

authored 8.7% of all high impact publications and filed 4.1% of all PCT patents, compared to 2.5% and 1.5% respectively in 2000. This rapid growth of China has raised the scientific and technological profile of Asia. If these recent trends continued¹⁸, in 2020 Asia would become the world research leader¹⁹, accounting for more than half of the world patents and researchers, 28.6% of all the high-impact publications and 43% of the research investment. To a certain extent, given the sharp population increases in Asia and the stagnation in Europe, this trend is normal and should not necessarily be interpreted as a sign of weakness of European R&I, but rather as a shift in the centre of gravity of scientific and economic activity for which Europe needs to be prepared.

¹⁸ It is important to note that the rapid growth rates experienced by the 5 Asian economies, notably China, in the last seven or eight years are likely to slow down as the catching-up effect is likely to continue at a more moderate pace. Also, high growth rates are expected to be more difficult to maintain as the absolute levels of these quantities grow.

¹⁹ The recent "UNESCO Science Report 2010" highlights that "given the size of Asia's population, one would expect it to become the dominant scientific continent in the coming years" (p.9) - http://www.unesco.org/science/psd/publications/sc_rp_10.shtml

CHAPTER 2

Investments in knowledge and human resources

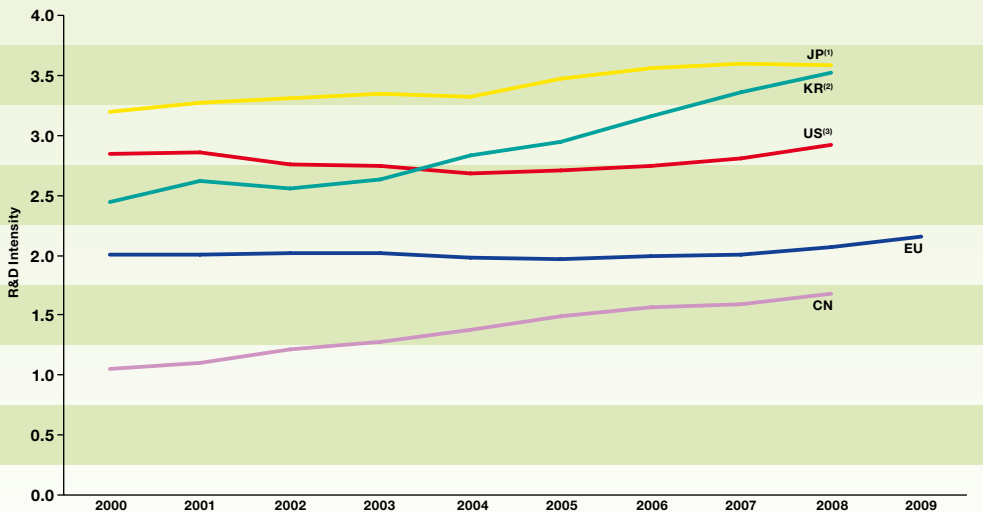
Investment in knowledge generation, diffusion and use is crucial for R&I. High investments in research, innovation and human resources are one of the key features of all well-functioning R&I systems. Research investment, both public and private, is crucial for the development of new scientific and technological knowledge and for building the capacity to absorb and use this knowledge. Moreover, non-scientific knowledge is important for innovation, and non-R&D investments, e.g. ICT investments, are also important for innovation activities. Finally, knowledge is produced, diffused and used by people, who need to have the right skills. This section analyses the EU's investment in knowledge generation in comparison to its main trading competitors.

2.1. Is the EU investing sufficiently in research, education and innovation?

Research intensity in the EU has increased only marginally, in contrast with the remarkable growth in the major research-intensive Asian countries²⁰

Despite a more than 20 % real-terms increase in research expenditure over the period 2000–2009, R&D intensity in EU-27 has stagnated at around 1.85 % of GDP since 2000, with a slight increase to 2.01 % of GDP in 2009 (Figure 4), mainly as a result of the fall in GDP due to the economic downturn that year. In 2008, the year with the highest GERD investment of the decade, R&D

FIGURE 4 Evolution of R&D Intensity, 2000–2009



Source: DG Research and Innovation

Data: Eurostat, OECD

Notes: (1) JP: There is a break in series between 2008 and the previous years.

(2) KR: (i) GERD for 2000–2006 (inclusive) does not include R&D in the social sciences and humanities.

(ii) There is a break in series between 2007 and the previous years.

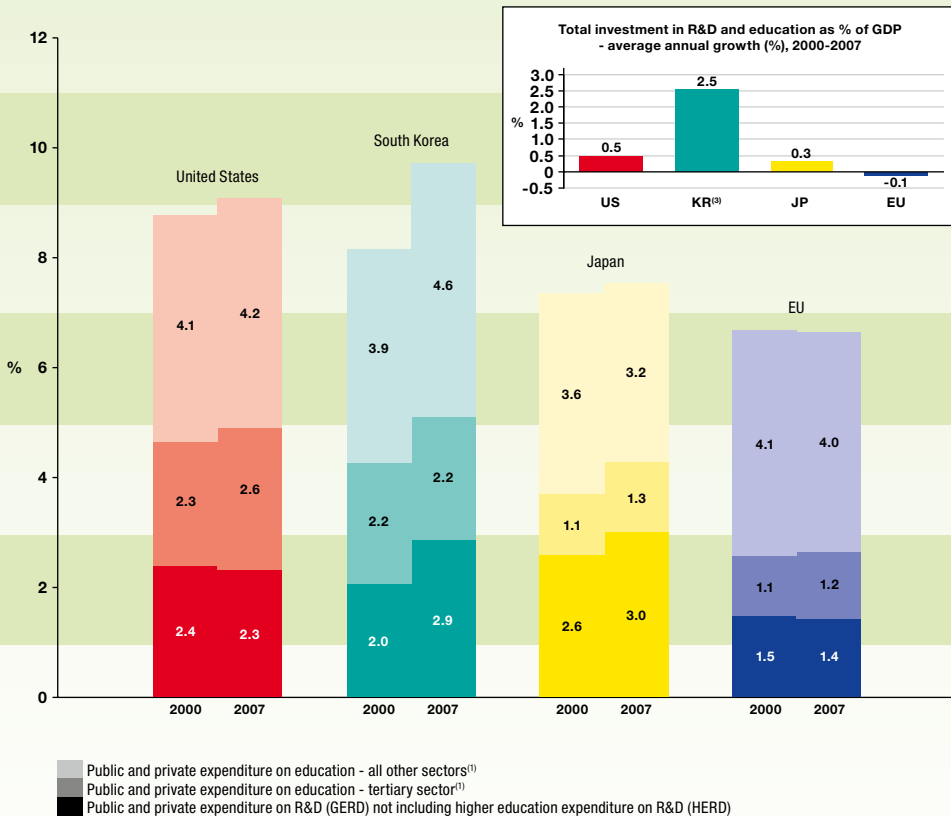
(3) US: GERD does not include most or all capital expenditure.

Innovation Union Competitiveness Report 2011

20 For a more comprehensive analysis of the EU's progress towards its 3 % target on R&D investments, see Part I, chapter 1.

FIGURE 5

Investment in R&D and education as % of GDP, 2000 and 2007



Source: DG Research and Innovation

Data: Eurostat, OECD

Innovation Union Competitiveness Report 2011

Notes: (1) Public and private expenditure on education: Funds from international agencies and other sources are not included.

(2) US: GERD not including HERD does not include most or all capital expenditure.

(3) KR: (i) HERD does not include R&D in the social sciences and humanities;

(ii) There is a break in series between 2007 and 2000;

(iii) Average annual growth refers to 2000-2006.

intensity remained at 1.9%. In the United States, after a continuous decline during the first half of the decade, R&D intensity started to pick up again in 2005, rising to up to 2.76% of GDP in 2008, slightly above its 2000 value (2.69% of GDP). This quasi-stagnation of R&D intensity in the EU and the United States contrasts with the strong increases observed in Japan, South Korea and China during this period, of up to 3.44%, 3.21% and 1.54% of GDP respectively.

In absolute terms, GERD investment in the EU rose up to EUR 225 billion²¹ in 2009, slightly below the almost EUR 230 billion invested in 2008. In 2008, in the United States the total R&D investment rose to

EUR 310 billion²², i.e. almost 40% more than in the EU; while Japan, China and South Korea invested EUR 116 billion, almost EUR 100 billion and EUR 34 billion more than the EU respectively.

The gap between the EU's knowledge investment and that of other advanced economies is even broader and has grown in the last decade²³

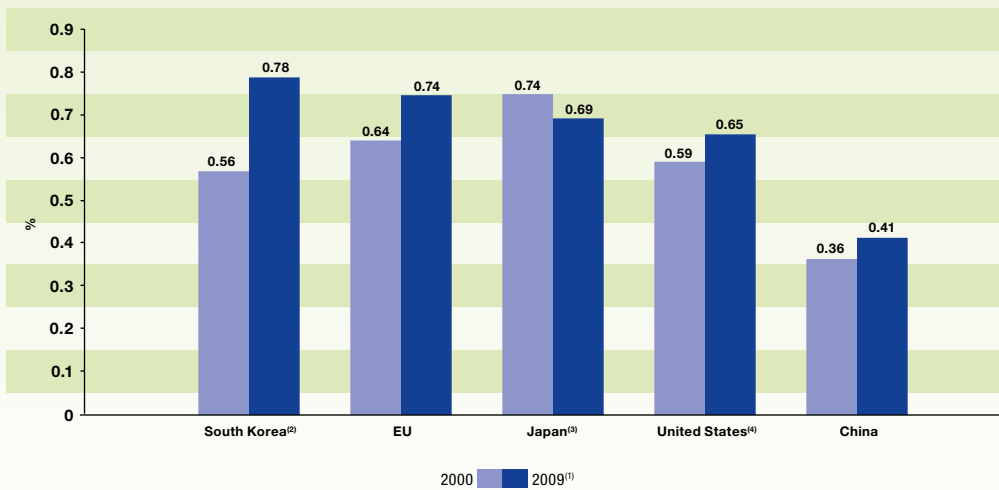
Investment in research and education are crucial for the generation, use and diffusion of new knowledge in an economy. The EU has traditionally invested less than other advanced economies both in research and

²² This figure does not include most of the capital investment.

²³ For a more comprehensive presentation of public investment in research and education, see Part I, chapter 3.

²¹ Values in current prices in PPS.

FIGURE 6

Public R&D expenditure as % of GDP, 2000 and 2009⁽¹⁾

Source: DG Research and Innovation
Data: Eurostat, OECD

Notes: (1) US, JP, CN, KR: 2008.

(2) KR: (i) There is a break in series between 2008 and the previous years;

(ii) R&D in the social sciences and humanities is not included in 2000.

(3) JP: There is a break in series between 2008 and the previous years.

(4) US: (i) Most or all capital expenditure is not included

(ii) Government expenditure on R&D refers to federal or central government only.

Innovation Union Competitiveness Report 2011

education. In recent years, this gap has broadened, which may jeopardise the EU's current and future economic competitiveness. More precisely, the EU's investment intensity in research, higher education and other educational sectors amounted to 6.6% of GDP in 2007, while the United States invested 9.2%, Korea 9.7% and Japan almost 7.5% of their wealth (Figure 5). In evolutionary terms, South Korea increased its investment intensities by an average annual growth rate of 2.5% between 2000 and 2007, while the United States and Japan experienced very low annual growth rates over this period (0.4% and 0.1% respectively). In contrast, the EU suffered a decrease in the same period.

Public R&D intensity has increased in the EU, although it remains far from the 1% target set for 2010 by the Lisbon Agenda²⁴

The EU's R&D expenditure in the public sector amounted to 0.67% of GDP in 2008 — a slight increase since 2000 (0.64%) — and rose to 0.74% of GDP in 2009 due to the fall in GDP and the resilience of public R&D investments (Figure 6). R&D intensity in the EU public sector is slightly above that of the United States (0.65%) and Japan (0.69%) and well above China (0.4%), but below South Korea, where public R&D expenditure amounted to 0.78% in 2008. These values show that some progress to foster the role of research in the public sector has been made in the EU. However, this progress has not been enough to meet the 1% target²⁵ set by the Lisbon Agenda.

24 It should be noted that the Lisbon Agenda established a 1% target for publicly funded R&D. In this point, we are referring to publicly performed R&D. While there tends to exist a strong correlation between the two variables, some differences in specific countries may also exist. A specific analysis of publicly funded R&D is covered in the next session of this report.

25 The Lisbon Agenda set the objective of raising public R&D funding to 1% of GDP by 2010. While the public expenditure indicator refers to publicly performed R&D, in general there is a high correlation between the two variables and the differences between public R&D funding and publicly performed R&D tend to be small in most countries, perhaps with the notable exception of Japan, where public funding of R&D is 0.55%.

2.2. Can the EU count on a growing number of human resources and researchers?

The EU lags behind other advanced economies in numbers of tertiary education graduates, hampering progress towards a knowledge-based economy²⁶

Highly skilled people are crucial for the generation, diffusion and use of knowledge which is at the core of innovation in an economy. In the EU, more than 30% of the population aged 25–34 counted on a university degree in 2009. Although this percentage has increased in recent years, it is still much lower than in other advanced economies, especially South Korea or Japan, where more than half of the population in this age cohort have attained a university education (Figure 7). The Europe 2020²⁷ strategy has set a target of increasing the percentage of the population aged 30–34 with a university degree to 40%, which will help bridge the current gap. Data for this age group was 32.3% in 2009.

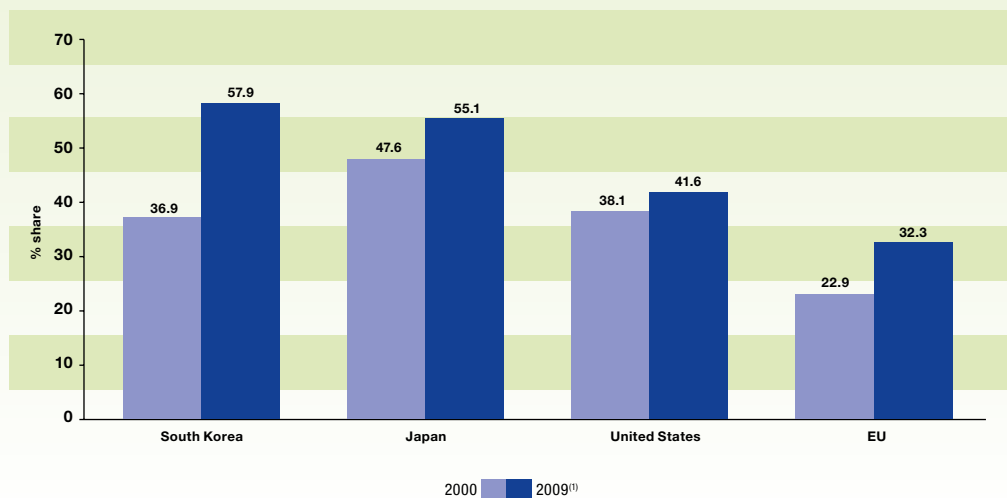
The EU has increased the number of new PhD graduates in the last few decades. These new cohorts of doctoral students increase the pool of researchers needed in Europe

In the last decade, the number of new doctoral graduates per thousand population aged 25–34 has steadily increased by an average annual growth rate of 3.5–5% in the EU, the United States and Japan. In total, in 2008 the number of new doctoral graduates in the EU aged 25–34 was 110 073, in the United States 63 712, and 16 296 and 9 369 in Japan and South Korea respectively²⁸.

It is important to note that in 2008 the positive trend in the EU changed sign and the number of doctoral graduates per thousand population aged 25–34 fell to 2004 levels, probably due to the economic crisis and the lower employment expectations of the new doctoral graduates. As a result, fourteen people in every ten thousand aged 25–34 in the EU have a doctoral degree²⁹.

FIGURE 7

Share of population aged 25-34 having completed tertiary education, 2000 and 2009⁽¹⁾



Source: DG Research and Innovation
Data: Eurostat, OECD
Note: (1) US, JP, KR: 2008.

Innovation Union Competitiveness Report 2011

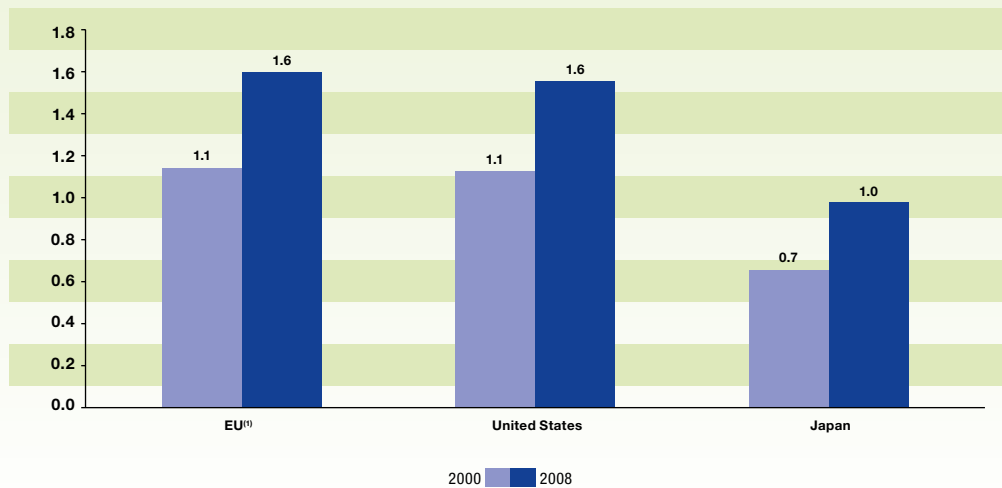
²⁶ For a more comprehensive analysis of human resources and researchers, see Part I, chapter 4.
²⁷ http://ec.europa.eu/europe2020/index_en.htm.

²⁸ Source: Eurostat. The EU aggregate was calculated by DG Research and Innovation.

²⁹ All new doctoral graduates of the year are counted, including those aged below 25 (rare) or above 34 (more frequent). The population aged 25–34 is only a normalisation figure and does not constitute the sole population considered to count as new doctoral graduates.

FIGURE 8

New doctoral graduates (ISCED 6) per thousand population aged 25-34, 2000 and 2008



Source: DG Research and Innovation

Data: Eurostat, OECD

Note: (1) EU aggregate does not include LU.

Innovation Union Competitiveness Report 2011

This ratio is slightly below that of the United States (sixteen people in every ten thousand in the same age band) and significantly higher than that of Japan (nine people in every ten thousand).

This increasing number of doctoral graduates signals the increasing interest of students in continuing further research education and the capacity of the system to train them. An interpretation of these data must also consider the size of the total population of doctoral graduates along with the demographic prospects for each country.³⁰

The EU has also managed to mobilise more women to undertake doctoral studies, so that 45% of all doctoral graduates in 2008 were women – almost bridging the gender gap

In 2008, 45% of all PhD graduates on average across the EU were women who were joining the research community, which increased the still very low share of female researchers³¹ in Europe (Figure 9). Since 2002, the proportion of new female doctoral holders has increased by an annual average rate of 6.8%, outperforming the growth rate of male doctoral graduates, at 3.2%. If this trend continues, gender parity in doctoral graduates will shortly be achieved, as in the United States at present.

The EU now has one of the highest numbers of researchers in the world, but in comparison to other developed economies and China, the EU engages fewer researchers in the private sector

In terms of researchers, the EU has overtaken the United States and now has more researchers in absolute terms than almost any other system in the world, with the exception of China (Figure 10). There were almost 1.5 million researchers in the EU in 2008. This front-runner position has been due to a good growth rate in the number of researchers in the last decade, at almost 4% on an annual average. Only China and South Korea, with very strong research investment increases, grew at a faster pace.

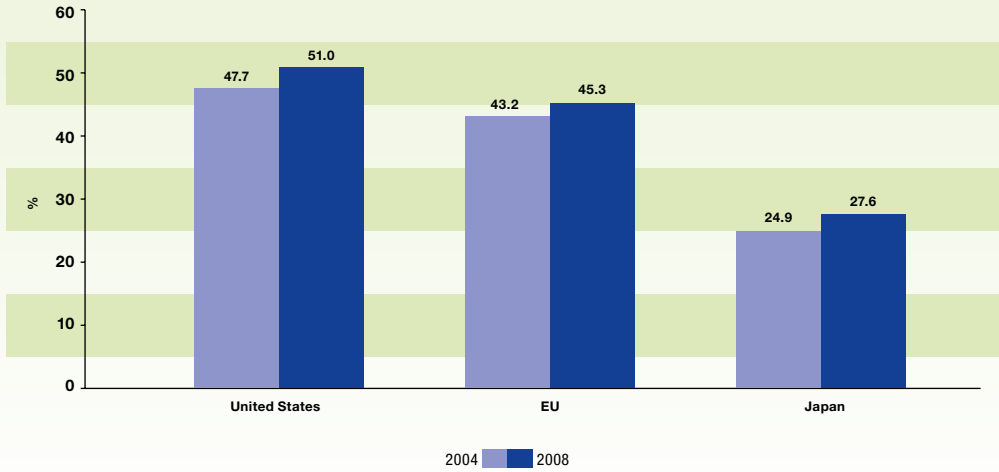
It is important to note that European researchers are mainly employed by the public sector. More than half of the researchers in EU are employed in public laboratories, while in the United States, almost 80% and in Japan and South Korea 60% of the researchers work in private firms. This structural difference in the sector of employment raises some questions about the role of the researchers in the EU and the involvement of the private sector in research activities.

³⁰ See Part I, chapter 4.

³¹ In 2006, women represented only 30% of the total number of researchers in the EU (Source: DG Research, 'She figures 2009').

FIGURE 9

Female PhD / doctoral graduates as % of total PhD / doctoral graduates, 2004 and 2008

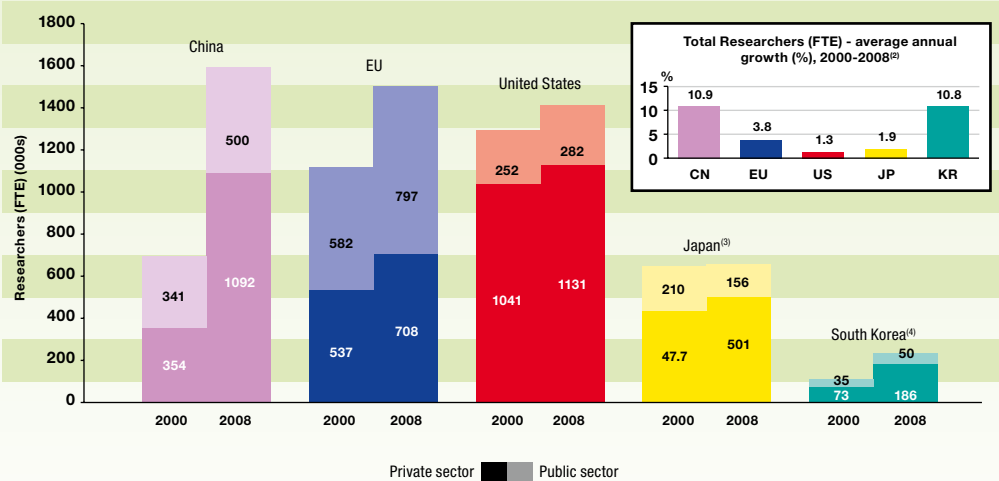


Source: DG Research and Innovation
Data: Eurostat

Innovation Union Competitiveness Report 2011

FIGURE 10

Researchers (FTE) broken down by public and private sector, 2000 and 2008⁽¹⁾



Source: DG Research and Innovation
Data: Eurostat, OECD

Innovation Union Competitiveness Report 2011

Notes: (1) US: 2007.

(2) KR: 2000-2006; US: 2000-2007; JP: 2002-2007.

(3) JP: There is a break in series between 2002 and the previous years and between 2008 and the previous years.

(4) KR: (i) There is a break in series between 2008 and the previous years; (ii) R&D in the social sciences and humanities is not included in 2000.

2.3. Are EU firms increasing their R&D investments in order to generate and absorb new knowledge and boost innovation?

EU firms have not increased their research efforts in the last decade. In contrast, Japanese, South Korean, and above all, Chinese firms have made good progress

EU firms have maintained their research efforts at a value of around 1.2 % of the European GDP (Figure 11). This stagnation in the private research effort contrasts with the rapid growth in other developed economies, especially Japan and South Korea, who in 2008 already doubled this intensity effort, or the United States, where the research carried out by firms accounted for 2 % of the national GDP. Moreover, Chinese firms are increasingly becoming technology-familiar, and since the year 2000, they increased their R&D efforts at an average annual growth rate of 10 %. As a result, China's private R&D intensity has surpassed the 1 % barrier and is quickly approaching the EU values.

Several factors could explain the remarkable difference in private research intensity between the EU and other developed economies. The EU's economic structure³², or more precisely, the absence of change in an economic structure geared towards a more research-oriented, high-added-value economy, ranks high in this list.³³

Small and Medium- size firms in the EU are less research oriented than those in other major countries³⁴

Research and technological development requires an entrepreneurial spur to trigger innovation and economic competitiveness. Small and Medium-size Enterprises (SMEs) are crucial players in the EU, contributing to a large part of the economy and employment. Moreover, successful economies worldwide are characterised by the emergence of new and fast-growing firms,

mainly SMEs, that allow the economy to become more dynamic and in many cases contribute to the technological and structural change of the economies. As such, the research investment performed by SMEs reflects entrepreneurial innovative dynamism. As figure 12 shows below, despite the larger role of SMEs in the EU's economy, they are investing less than SMEs in the EU's main trading competitors, with the exception of Japan, whose economy is dominated by large conglomerates and has a lower presence of SMEs³⁵. These data confirm some preliminary findings, showing that on average European research-intensive SMEs spent less on R&D as a proportion of their turnover than SMEs in the United States³⁶. Moreover, while in recent years SMEs in the EU have increased their R&D investments, these increases have been lower than those of their international competitors.

³² It is important to note that changes in the economic structure are also the consequence of the research investments that affect the global competitiveness of specific sectors, and therefore it should not be regarded as a static constant that influences R&D investment.

³³ For a more comprehensive analysis on private R&D investments, see Part I, chapter 5 of this report.

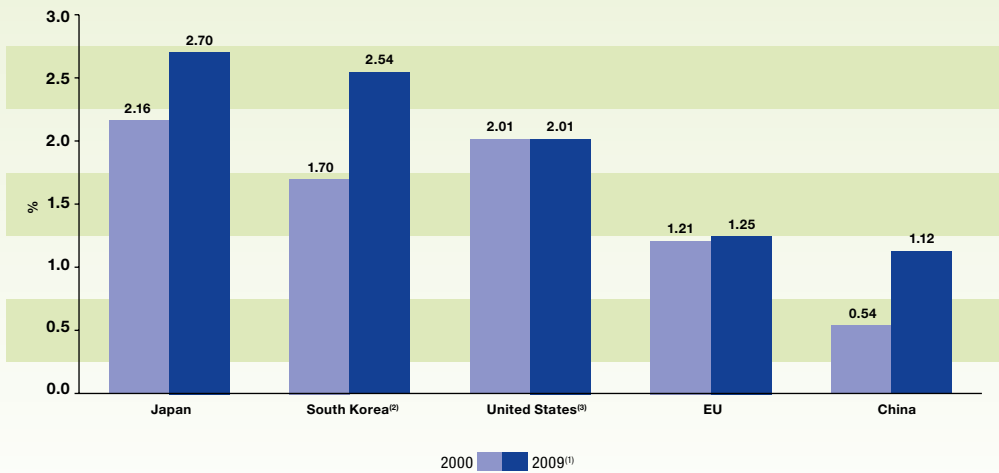
³⁴ For a more comprehensive analysis of knowledge-intensive SMEs, see Part III chapter 1.

³⁵ 99 % of all firms in Europe can be considered SMEs. European Commission (2010): 'Interim evaluation of the seventh Framework Programme. Report of the expert group'.

³⁶ Ortega-Argilés R and Brandsma A (2009): 'EU-US differences in the size of R&D intensive firms', IPTS working papers on corporate R&D and Innovation, DG JRC.

FIGURE 11

BERD Intensity (Business enterprise expenditure on R&D (BERD) as % of GDP), 2000 and 2009⁽¹⁾



Source: DG Research and Innovation

Data: Eurostat, OECD

Notes: (1) US, JP, CN, KR: 2008.

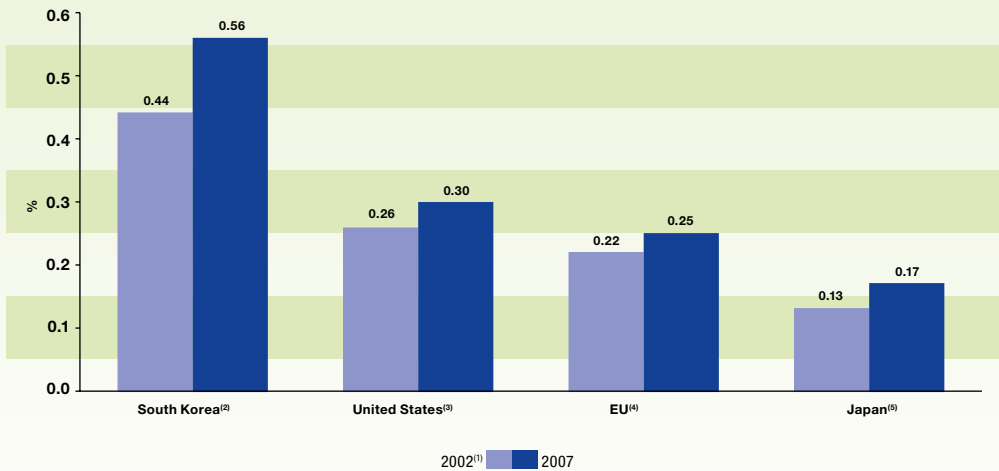
(2) KR: (i) There is a break in series between 2008 and the previous years; (ii) BERD for 2000 does not include R&D in the social sciences and humanities.

(3) US: BERD does not include most or all capital expenditure.

Innovation Union Competitiveness Report 2011

FIGURE 12

BERD performed by SMEs as % of GDP, 2002⁽¹⁾ and 2007



Source: DG Research and Innovation

Data: Eurostat, OECD

Notes: (1) EU: 2003.

(2) KR: (i) There is a break in series between 2007 and the previous years; (ii) BERD for 2002 does not include R&D in the social sciences and humanities.

(3) US: BERD does not include most or all capital expenditure.

(4) EU does not include BE, IE, EL, IT, LU.

(5) JP: BERD by size class is underestimated.

Innovation Union Competitiveness Report 2011

CHAPTER 3

Towards the construction of a European Research Area (ERA) open to the world

Europe needs to build an efficient research system that resolves the fragmentation of European research and helps to build sufficient critical mass to compete globally. Moreover, a well-functioning single market for knowledge needs to be sufficiently developed to maximise research synergies and speed the development and use of new knowledge within Europe.³⁷

In order to measure progress in the construction of a European Research Area, the European Commission has, in dialogue with Member States and Associated Countries, proposed a draft list of core indicators for the monitoring of the ERA (provisionally named 'ERAM indicators'). Several of these indicators are presented in this overview part of the RIC report, e.g. indicators measuring investments, human resources, innovation and technologies for societal challenges. This chapter presents some of the other ERAM indicators, with a specific focus on the integration of the European research system.

3.1. What is the overall progress towards the European Research Area?

Since the launch of the ERA in 2000, Europe has made some progress towards the coordination of research investments and there has been an increase in internal scientific collaboration. However, further work is needed

Data on some key indicators on the European Research Area covered in Figure 13 below, show that some progress towards the construction of the ERA has been achieved in the last decade, but also that further work is still needed to construct a true, well-functioning ERA.

According to experimental data, in 2008 around 4.5 % of EU Member States' R&D budget is directed to 'trans-nationally coordinated research' on average — only slightly up from 4.3 % in 2007. There is scope to augment

the amount of national funds used to support R&D programmes coordinated between countries.

It is not possible yet to measure the share of national public funding directed to the *construction* and *operation* of national public research infrastructures³⁸, nor to calculate the share of national public funding for multi-national public research infrastructures. The annual total capital R&D expenditure³⁹ in the public sector is currently measured by country, and is much broader than investment in the construction of national research infrastructures. On average in the EU-27, capital expenditure has been stable at around 12.5 % of total R&D expenditure in the public sector. The share of capital expenditure in R&D expenditure is lower, and tends to decrease, in countries with higher labour cost. In many catching-up countries, the share of capital expenditure has considerably increased since 2000, which may reflect intensive investments in upgrading and constructing infrastructures for research in the public sector.

Scientific collaboration between Member States has been intensifying since 2000: the number of scientific publications involving at least two Member States in total EU scientific publications has increased by 36 % between 2000 and 2009. In most Member States, between 30 % and 50 % of their scientific publications are co-authored with one or more other Member States. To a large extent, this may be due to an increased mobility of researchers across Europe. The number of doctoral holders who studied or carried out research in another European country for at least 3 months was around 17 % of the total in 2006. Although there is no comparative data for previous years, this figure is likely to have increased thanks to the different programmes incentivising the mobility of researchers.

³⁸ Research infrastructures are defined as medium or large-scale, single-sited, distributed or virtual facilities or joint resources that provide unique access and services to research communities in both academic and technological domains.

³⁹ Expenditure on land, buildings, instruments and equipment for the performance of R&D activities.

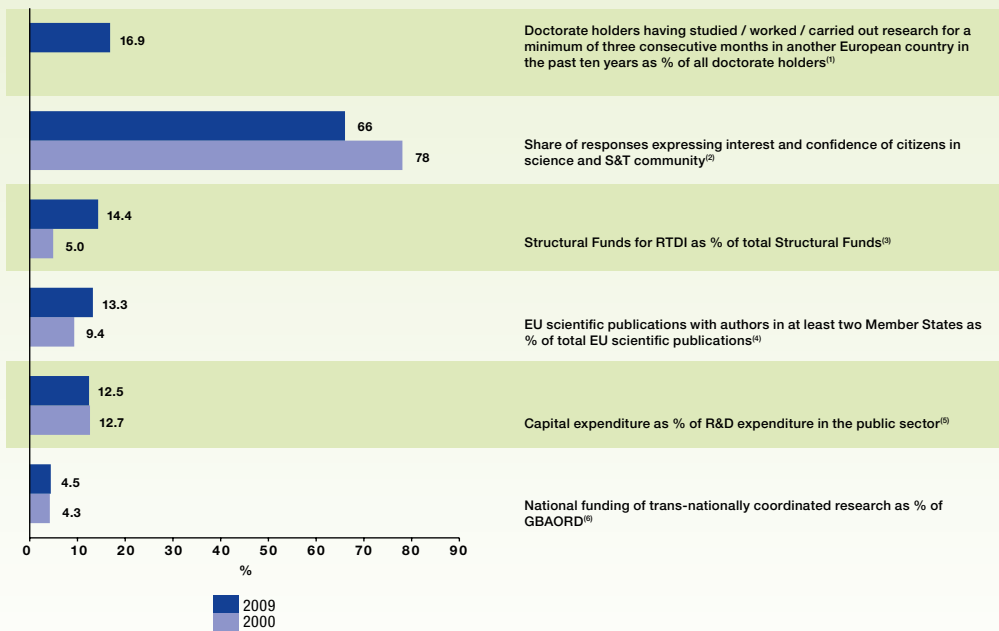
³⁷ Europe 2020 Flagship Initiative Innovation Union, SEC (2010) 1161.

Moreover, in order to benefit from an efficient internal market for knowledge, all regions and Member States should be able to contribute and benefit from the circulation of new knowledge. This requires that those regions of Europe whose scientific and technological capacity currently lags behind make an effort to enhance their research and innovation capacity supported by national research and innovation policies. In this respect, the EU's Structural Funds are playing a crucial role as 14.4% of all the Structural Funds are and will be devoted to research and innovation activities for the 2007–2013 programme. In the previous 2000–2006 programme, these activities accounted for only 5% of all Structural Funds⁴⁰.

Finally, European research and innovation can only advance and gain credibility if there is a strong social acceptance and confidence. In the last five years, i.e. from 2005 to 2010, this confidence in the capacity of science and technology to improve our quality of life has decreased from 78% to 66% of the population⁴¹. This indicates both the need for a reorientation towards societal benefits and for a better communication of the potential and achieved benefits accruing from scientific and technological research.

FIGURE 13

EU - selected ERAM indicators, 2000 and 2009



Source: DG Research and Innovation

Data: Eurostat, DG REGIO, OECD, Science Metrix / Scopus (Elsevier)

Notes: (1) (i) 2006; (ii) EU includes BG, DK, ES, LT, AT, PL.

(2) 2005 and 2010.

(3) 2000-2006 and 2007-2013.

(4) 2000 (citation window 2000-2003) and 2007 (citation window 2007-2009).

(5) 2008 and 2009.

(6) 2007 and 2008.

Innovation Union Competitiveness Report 2011

40 These figures include actions related to research, development, technology and innovation (RDTI). On top of this, the Structural Funds also support entrepreneurship, human capital and ICT. This would increase the total amount from EUR 50 billion to EUR 86 billion (24.5% of cohesion funding).

41 More detailed information can be found in section 3 'New Perspectives', Chapter 3.

3.2. Is Europe advancing towards a single market for knowledge?

In addition to the scientific knowledge flows analysed in the previous section, a single market for knowledge also needs to foster stronger knowledge flows between the public and the private sectors in order to bring the ideas to the market.

The linkages between public and private research actors in the EU are increasing, but remain much weaker than those in the United States and Japan⁴²

R&I seldom works in isolation. The linkages between research actors are crucial to expand the knowledge base. The linkages created between public and private research agents represent, to a certain degree, the cohesion of a system and its capacity to maximise the use of the local knowledge.

As Figure 14 shows, these interactions in the EU are relatively weak when compared to the United States or Japan. More precisely, Japan has almost twice as many

public-private co-publications per million population (56) as the EU (36). The United States is well ahead with 70 public-private co-publications per million population.

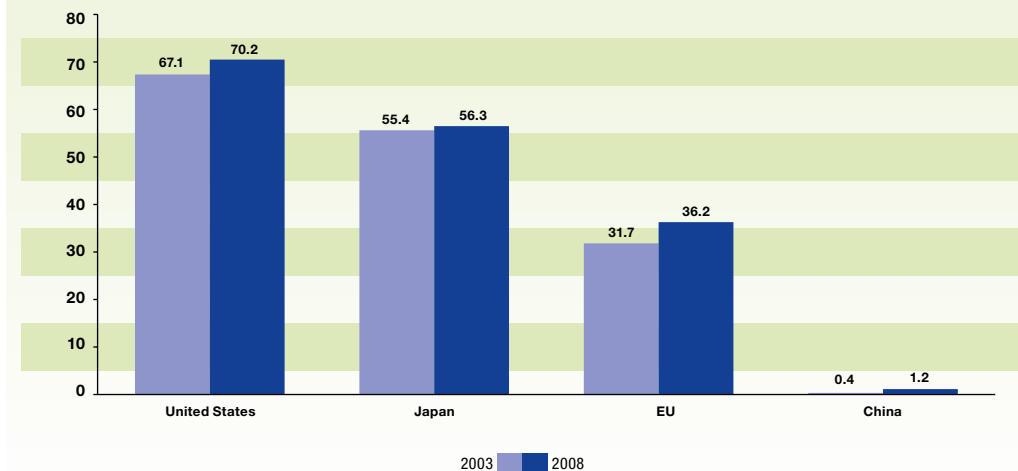
Since 2000, the EU has slightly improved this ratio with an average annual growth rate of almost 3 % that has helped to slightly bridge the gap between the EU and the United States and Japan. However, the sharp increase of almost 12 % in China's average annual growth is more remarkable, although it starts from a very low position.

The EU is increasingly becoming an open system, tapping into global sources of knowledge⁴³

The rise of a multi-polar scientific and technological world opens the door to an increased collaboration with foreign research agents in order to tap into knowledge developed abroad.

In terms of technological collaboration with co-inventors located abroad, China is the most open country, ahead of the United States and the EU (Figure 15). Over the period 2006–2008, almost 12 % of all PCT patent applications

FIGURE 14 Public-private co-publications per million population, 2003 and 2008



Source: DG Research and Innovation
Data: European Innovation Scoreboard, 2010

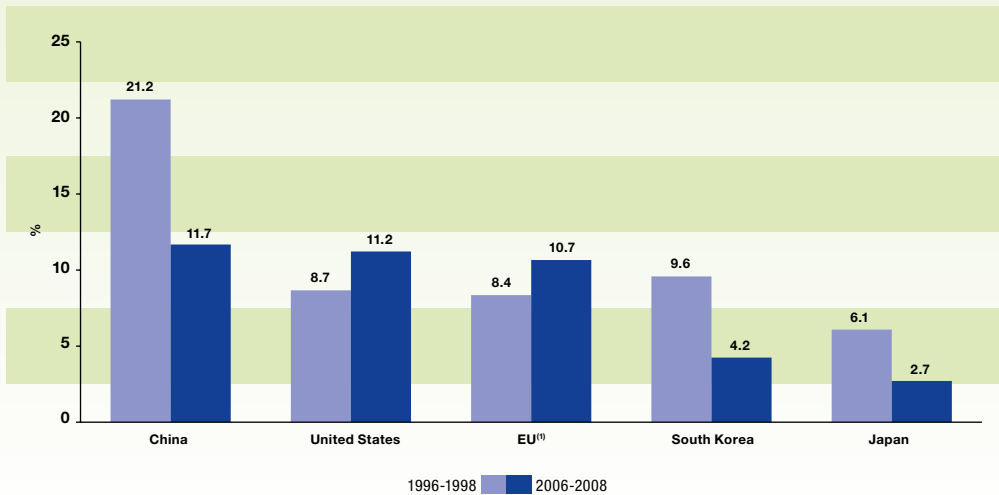
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42 For a more comprehensive analysis of public-private cooperation, see Part II, chapter 2.

43 For a more comprehensive analysis of transnational knowledge spill-overs and technology cooperation, see Part II, chapter 6.

FIGURE 15

PCT patent applications with at least one foreign co-inventor as % of total PCT patent applications, 1996-1998 and 2006-2008



Source: DG Research and Innovation

Data: OECD

Note: (1) The EU is treated as one country; intra-EU co-operation is excluded.

Innovation Union Competitiveness Report 2011

made by an inventor based in China involved at least one foreign-based co-inventor. This was the case in 10.7% of the PCT patent applications with an inventor based in the EU and 11.2% for the United States. Only 4.2% and 2.7% of the PCT patents with inventors based in South Korea and Japan respectively had co-inventors based in other countries.

Over time, both the United States and the EU have increased the share of co-patents, suggesting that both systems are increasingly open to foreign technological collaborations, while the Asian economies on the other hand show a decrease of this ratio, largely due to the sharper increase in the total number of patents, and also the rise of their technological capacity, which allows them to develop new technological inventions with local partners.

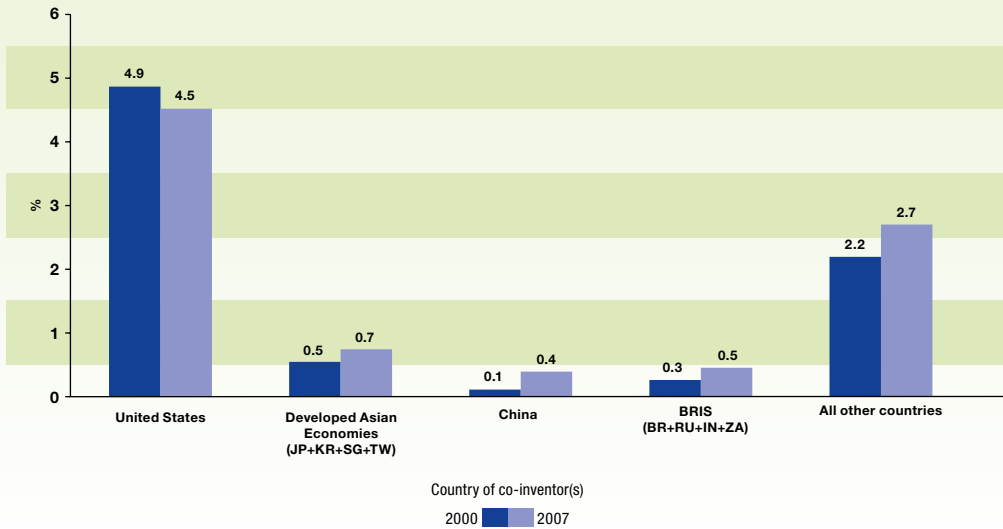
The United States remains the main technological partner for the EU, although closer links are being established with countries in Asia and in other parts of the world

In terms of nationality of collaborators in technology development, the EU's traditional cultural, scientific and technological ties to the United States make this country the main technological partner for European inventors. Almost half of all co-patents are filed with an American counterpart.

However, it is worth noting that over time there has been a shift in the selection of technological co-partners. As Asia and the rest of the world become more technology-intensive, the role of these world regions in technological cooperation grows. The share of EU patent applications with a co-inventor from the developed Asian economies has grown from 0.7% to 1.1% since the year 2000, and EU patent applications with a co-inventor from a country other than the United States or the developed Asian economies, have risen from 2.6% to 3.6% (Figure 16).

FIGURE 16

EU patent applications to the EPO with at least one foreign co-inventor as % of total EU patent applications to the EPO, 2000 and 2007



Source: DG Research
Data: OECD

Innovation Union Competitiveness Report 2011

3.3. Has Europe achieved world excellence in science and technology?

The EU's scientific excellence improved in the last decade although it still lags behind the United States⁴⁴

Scientific excellence is measured here with an indicator relating the total number of publications in a country (or in the EU) to the number of those publications which are among the 10% most cited publications worldwide. According to this indicator, the United States remains the world leader in producing high quality, high impact scientific publications (Figure 17). The United States ratio is close to 1.5, meaning that 15% of their publications are among the 10% most cited scientific publications worldwide.

In contrast, the EU's share is 11.6%, i.e. slightly above the world average, and above the share of the major Asian countries. Over the last decade, the EU has progressed in terms of improving the quality of its scientific production. However, this progress has not been as sharp as that of China, which has significantly increased the share of its national publications ranking in the top 10% most cited publications.

However, the economic returns on the EU's technologies are relatively stagnant and lag behind those of the United States and Japan

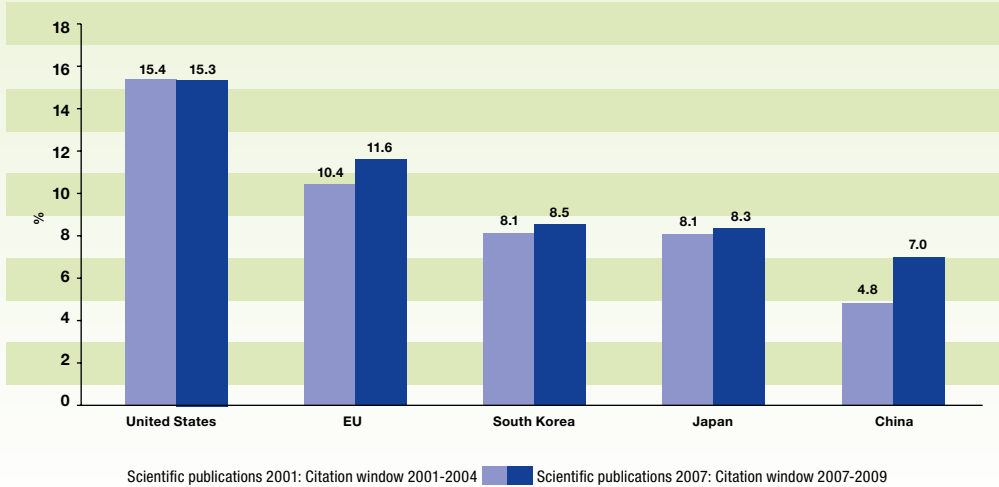
EU firms, universities and public research-performing organisations sell the results of their technological activity to other research agents in the world. The amount of revenue obtained can, to a certain extent, be interpreted as an indication of the quality and competitiveness of the technologies and innovations. In 2009, the economic revenues obtained by EU research agents amounted to 0.21% of the total GDP (0.20% in 2008). In comparison, the economic impact of the patents and licence rights sold by United States agents rose to more than 0.6% of the national GDP, a value slightly above Japan's 0.5% share in 2008.

Moreover, this performance gap between the EU and its main trading competitors is broadening over time, as both the United States and Japan have increased their license and patent revenues at a much faster pace than the EU (with annual growth rates of 5.8% and 13.4% respectively compared to 2% for the EU).

44 For a more comprehensive analysis of scientific and technological output, see Part I, chapter 6.

FIGURE 17

Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country⁽¹⁾, 2001 and 2007

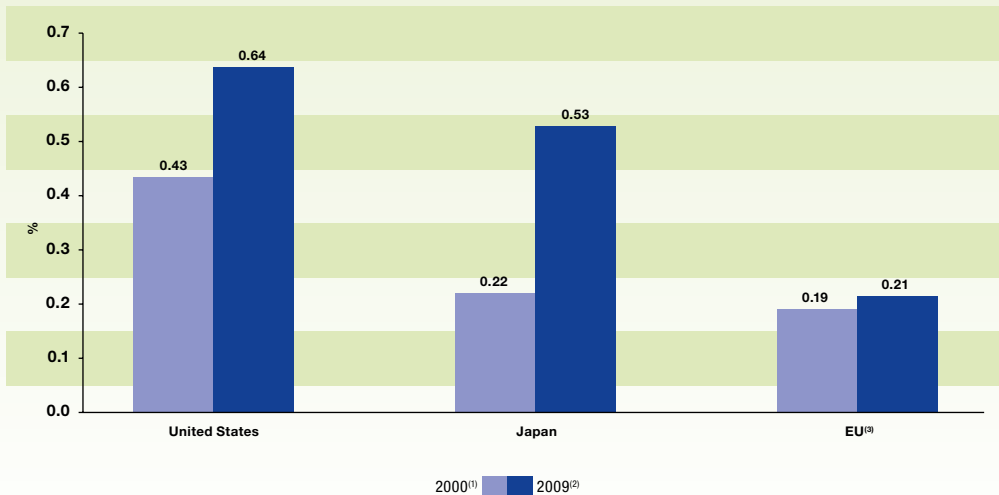


Source: DG Research and Innovation
Data: Science Metrix / Scopus (Elsevier)
Note: (1) Full counting method.

Innovation Union Competitiveness Report 2011

FIGURE 18

Licence and patent revenues from abroad as % of GDP, 2000⁽¹⁾ and 2009⁽²⁾



Source: DG Research and Innovation
Data: Eurostat
Notes: (1) EU: 2004.
(2) US, JP: 2008.
(3) Extra-EU.

Innovation Union Competitiveness Report 2011

CHAPTER 4

Innovation for a knowledge economy and societal challenges

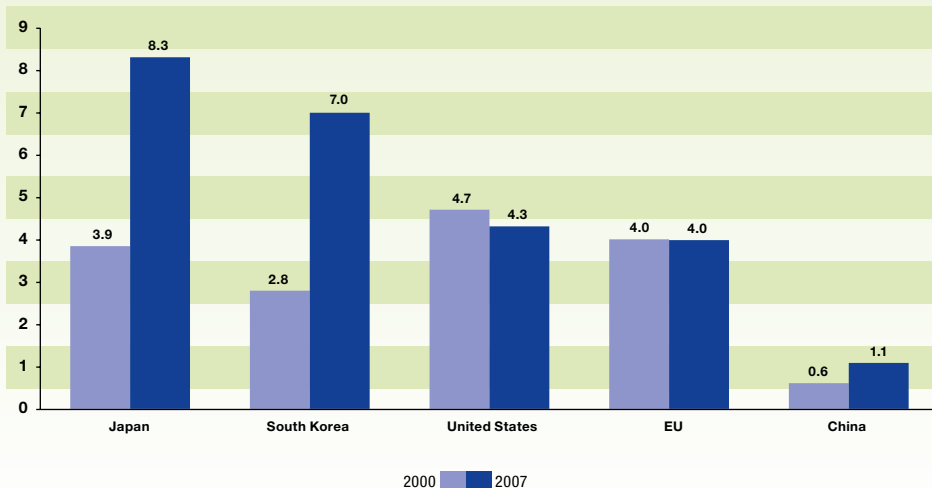
Smart, sustainable and inclusive growth that secures the economic competitiveness of the EU in high-value-added, high-wage activities will require a structural change of the EU economy towards higher knowledge intensity. In order to ensure this structural change, the EU needs to improve its framework conditions for business R&D by reducing the costs of Intellectual Property Rights (especially the cost of patenting), enhancing access to finance, and facilitating a more entrepreneurial environment for technology-based innovation. In parallel, research and innovation policies need to address global societal challenges by responding to both citizens' demands and expanding global markets.⁴⁵

4.1. Are European firms/companies achieving technology-based innovation?

The EU is catching up with the United States in terms of PCT patent applications per billion GDP ratio, but is falling further behind the leading countries in Asia⁴⁶

The EU's technological output reflects the intensity of research investment by private firms. The number of PCT patents per billion GDP (PPS €) gives an indication of the technological performance of a country and the technological intensity of an economy (Figure 19). In 2007, the EU had four PCT patent applications per

FIGURE 19 PCT patent applications⁽¹⁾ per billion GDP (PPS€), 2000 and 2007



Source: DG Research and Innovation

Data: OECD

Note: (1) Patent applications under the PCT (Patent Cooperation Treaty), at international phase, designating the EPO by country of residence of the inventor(s).

Innovation Union Competitiveness Report 2011

45 Europe 2020 Flagship Initiative Innovation Union, SEC (2010) 1161.

46 For a more comprehensive analysis of technology output, see Part I, chapter 6.

billion GDP, which is slightly below the United States and much lower than Japan and South Korea. In the latter two countries, the number of PCT patent applications per billion GDP was seven or above, almost double the EU average. China has one patent per billion GDP leaving a large technological gap between China and more advanced economies.

This indicator shows that the relative stagnation in private research efforts in both the United States and the EU since 2000 has resulted in a decrease in technological output: both the EU and the United States had slight negative average annual growth rates in PCT patent applications. In contrast, South Korea and Japan benefited from sharp increases, with average annual growth rates approaching 14% for South Korea, and 9% for Japan. China, with its sharp increase in private R&D investment in the last decade, has also benefited from a remarkable annual growth rate of 9% in its PCT patent application rate.

4.2. Can the EU count on the right framework conditions to boost innovation?

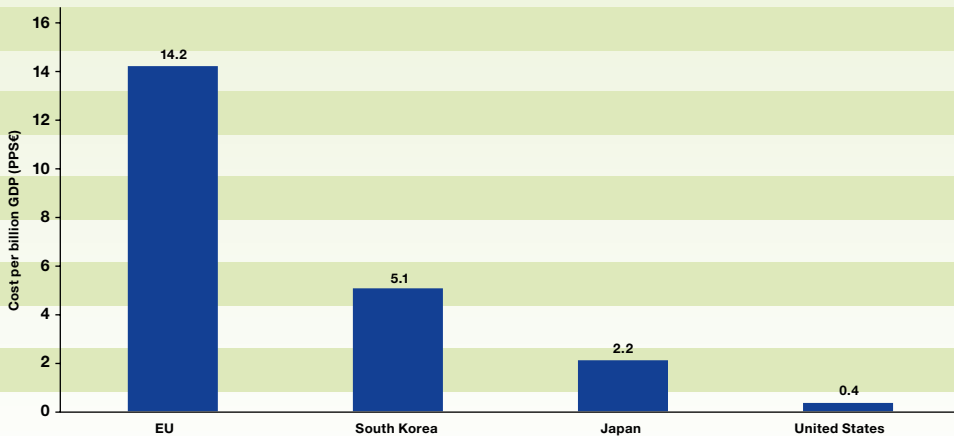
The cost of protecting intellectual property through patents is much higher for EU firms than for their competitors⁴⁷

Patents are one of the main means that firms use to protect the technological results of their research activity. They allow firms to exploit their technological production commercially and, as such, they provide an incentive for firms to invest further in R&D activities. However, the cost of applying for and maintaining a patent can discourage firms, especially SMEs, from engaging in the process and finally getting involved in R&D activities.

As figure 20 shows, the cost of applying for a patent and maintaining it is much higher in particular for SMEs in the EU than for their international competitors. The lack of a European Patent imposes high costs on EU companies that need to designate different patent offices in order to have their patent protected in the EU.

FIGURE 20

The cost in 2009 of patent application and maintenance for SMEs, per billion GDP

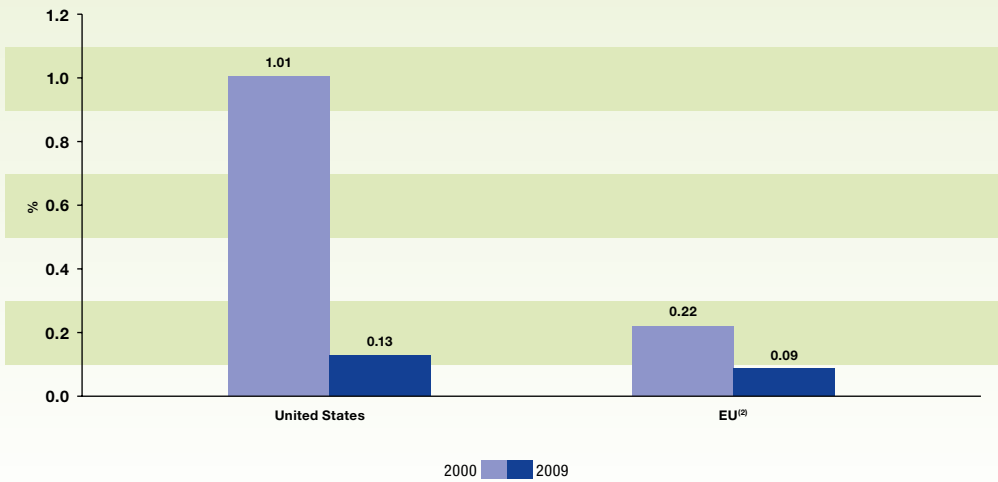


Source: DG Research and Innovation
Data: Eurostat, OECD, EPO, USPTO, JPO, KIPO

Innovation Union Competitiveness Report 2011

⁴⁷ For a more comprehensive analysis of the framework conditions for business research and innovation, including cost of patenting, venture capital and entrepreneurship, see Part III, chapter 2.

FIGURE 21 Venture Capital⁽¹⁾ as % of GDP, 2000 and 2009



Source: DG Research and Innovation

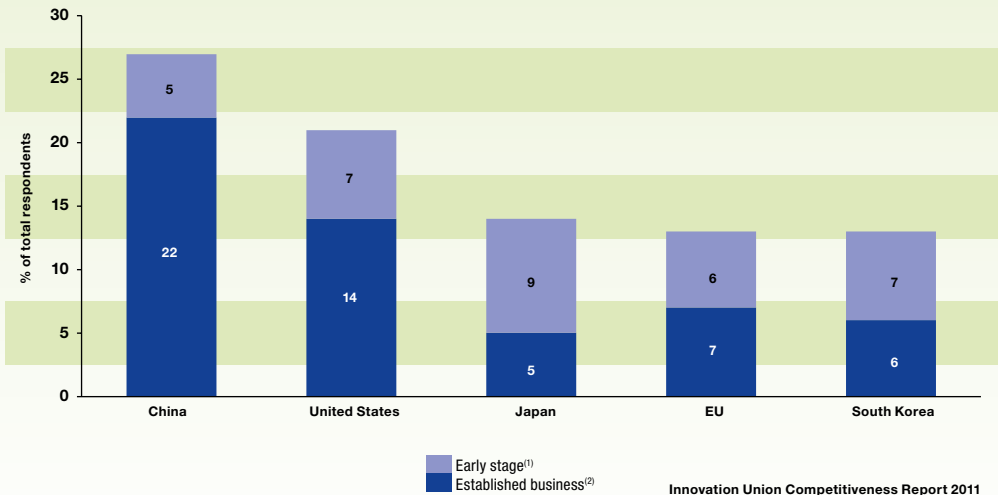
Data: Eurostat

Notes: (1) Early stage, expansion and replacement.

(2) EU does not include BG, EE, CY, LV, LT, LU, MT, SI, SK.

Innovation Union Competitiveness Report 2011

FIGURE 22 Entrepreneurial activity, 2009



Source: DG Research and Innovation

Data: Eurobarometer, Entrepreneurship in Europe and beyond, 2010. Q: Have you ever started a business or are you taking steps to start one?

Notes: (1) Early stage comprises embryonic entrepreneurship (respondents who were taking the necessary steps to start a business at the time of the survey) and new businesses (respondents who had started or had taken over a business in the last three years and which was still active at the time of the survey).

(2) Established business refers to still active businesses established by respondents three or more years before the time of the survey.

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The share of venture capital is lower in the EU than in the United States, but the gap has decreased over the last decade

The EU lags behind in the availability of venture capital funding, which is crucial for new technology-based firms and for promoting radical innovation. In 2009, the EU's venture capital investment amounted to less than 0.1 % of GDP, while in the United States, it is 0.13 % (Figure 21).

Venture capital is particularly important in the EU due to the large presence of SMEs in Europe, and these enterprises have difficulties in auto-financing their expansion and R&I plans.

Venture capital markets have proportionally decreased since 2000 both in the EU and the United States. The burst of the dot.com bubble in the early years of the 1990s and the financial crisis from the end of 2007 onwards brought about severe reductions of funding for venture capital, especially in the United States. Since then, venture capital has been growing, but it still remains below 2000 values.

The EU has lower entrepreneurial activity than the United States and China

The unfavourable framework conditions for R&I also affect entrepreneurial activity in the EU. While the entrepreneurial spirit is, to a large extent, the result of deeply embedded cultural factors, Europe seems to face higher barriers to starting new economic activities (Figure 22). As mentioned earlier, an entrepreneurial spur is the basis of innovation, and it is mainly the entrepreneurs who are bringing the ideas to the market.

4.3. Is the EU shifting towards a more knowledge-intensive economy?

European Young Innovators face difficulties in becoming leading innovators and contributing to economic growth and employment creation

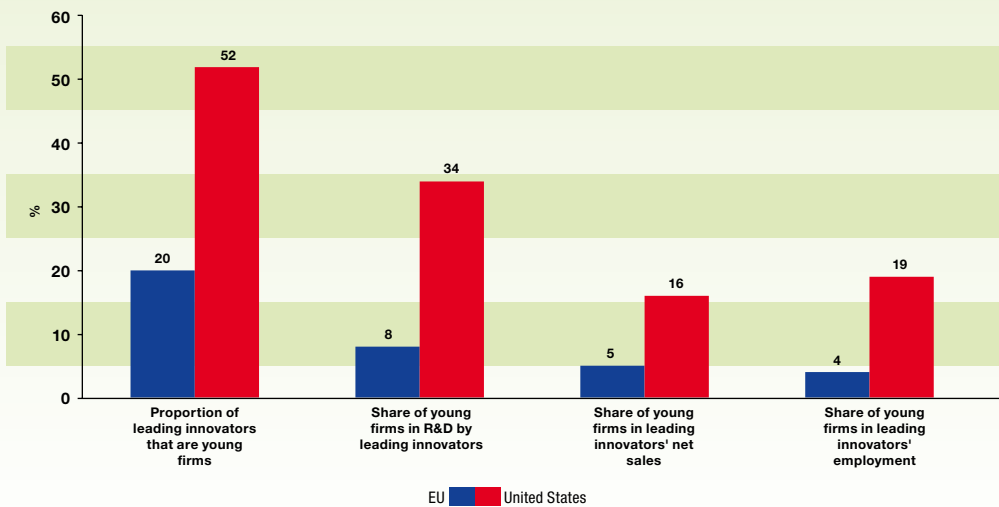
Yollies or 'young leading innovators' are R&D intensive firms that have, in a relatively short period, grown into world leaders on the basis of their substantial R&D efforts, while still remaining 'independent'⁴⁸. As such, they are crucial players in the development of new technologies and in bringing innovations in the market, and they contribute to transforming the economy towards more research- and knowledge-intensive activities.

As Figure 23 shows, EU-based yollies play a smaller role in the economy than in the United States. Only one out of five leading innovators based in the EU was born after 1975. On the other hand, this was the case for more than half of leading American innovators, and, moreover, the share of EU yollies in total leading firms' R&D expenditure is around 7 % in contrast to the 35 % in the United States. This shows the dynamism of the American economy and the sluggishness of the European, and once again hints at the existence of important barriers in terms of framework conditions, such as access to finance, fragmentation of the market or sophistication of users, but also to the 'eco-innovation system' that does not manage to effectively link the institutions and organisations that are active in innovation.

Moreover, Europe's technological profile seems to depict a relative negative specialisation in developing key enabling technologies such as ICT or biotechnology, whose use can spread across many technology fields and contribute to boost the overall innovation capacity and productivity of an economy

Enabling technologies, such as ICT, biotechnology or nanotechnology, have the potential to interact with a large set of established technologies and generate breakthrough innovations in products, services and processes and offer effective solutions which help address major societal challenges, such as healthy aging, climate change or energy dependency.

⁴⁸ Veugelers R and Cincera M (2010): 'Europe's mission yollies', *Bruegel Policy Brief*.

FIGURE 23 Share of 'yollies'⁽¹⁾ in number of firms, R&D, sales and employment, 2007


Source: DG Research and Innovation

Data: Bruegel 2010 (calculations based on data from IRMA)

Note: (1) 'Yollies' or Young Leading Innovators are post-1975 born R&D intensive enterprises, as covered in the EU Industrial R&D Investment Scoreboard.

Innovation Union Competitiveness Report 2011

It is expected that a significant number of the goods and services that will be available in the market by 2020 are yet unknown, but the driving force behind their development will be the deployment of key enabling technologies⁴⁹, and where first movers' benefits will be substantial. The nations mastering these technologies will count on an important competitive advantage to secure future economic growth. In the past, as previously presented, the United States benefited from larger productivity gains thanks to the mastering and extensive deployment of ICT across the national economy, especially in service sectors. In the future, further innovations could rely on ICT, but also on the use of biotechnology in, for example, industries such as agriculture and food processing, or nanotechnology in healthcare, energy, environment or manufacturing.

At present, Europe's relative specialisation⁵⁰ in these technologies is less pronounced than that of the United

States. More precisely, while the United States (Figure 24) presents a consistent positive specialisation in all three key enabling technologies, Europe presents a mixed picture. It lags behind in ICT and biotechnology, although it has managed to offset its relative lag in nanotechnology in the last decade. Given the large potential benefits associated with the first movers in these technologies, it would be important to boost Europe's capacity to develop and deploy these technologies.

Despite these difficulties, the EU's economy, like the Japanese and US economy, has slowly shifted towards higher knowledge intensity⁵¹

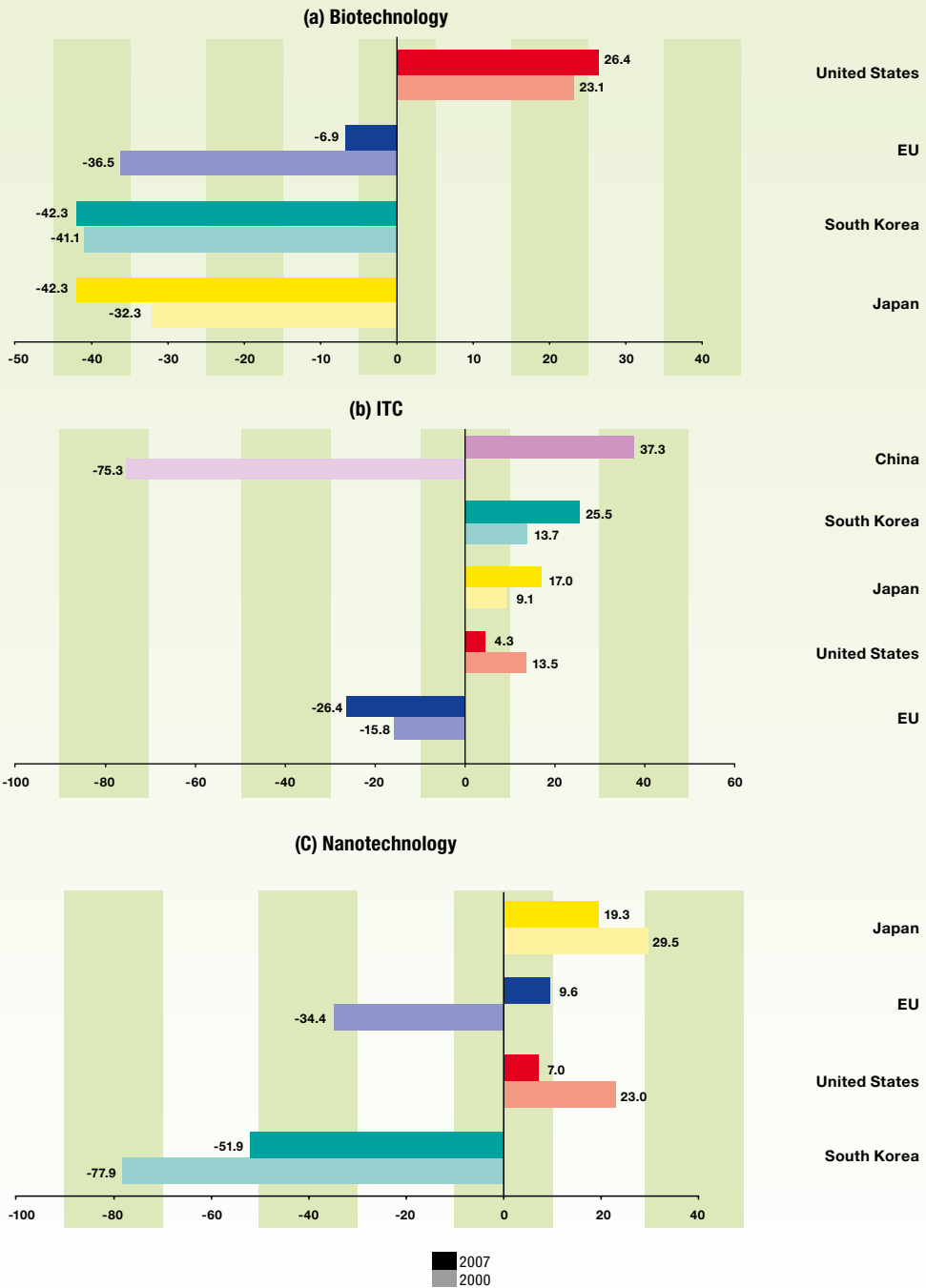
The availability of a well-educated working population is a key asset favouring innovation and an indication of the injection of knowledge into the economy in both high and low technology sectors. The size of knowledge-intensive activities in an economy in this sense is linked to its capacity to produce innovation outputs. Knowledge-intensive activities are defined as those activities where at least 25% of the workforce has a tertiary education. This new indicator provides

49 European Commission (2009): 'Preparing for our future: Developing a common strategy for key enabling technologies in the EU'.

50 The relative specialisation of a country is based on the specialisation index. This index is a Balassa index that measures the relative importance of a technology field in one country in comparison to the importance of that technology in the world. If the value is zero, the country is not specialised in that technology. If the value is positive, the country is then positively specialised in that technology, and conversely if the value is negative, the country is negatively specialised. The higher or lower the value, the more positively or negatively specialised it is. Europe's relative specialisation is analysed in the section 'New Perspectives', chapter 2.

51 For a more comprehensive analysis of structural change towards a more knowledge-intensive economy, see Part III, chapter 3, and for change in each country, see the section on the overall review of the EU Member States and Associated countries in the end of the report.

FIGURE 24 Specialisation indices⁽¹⁾



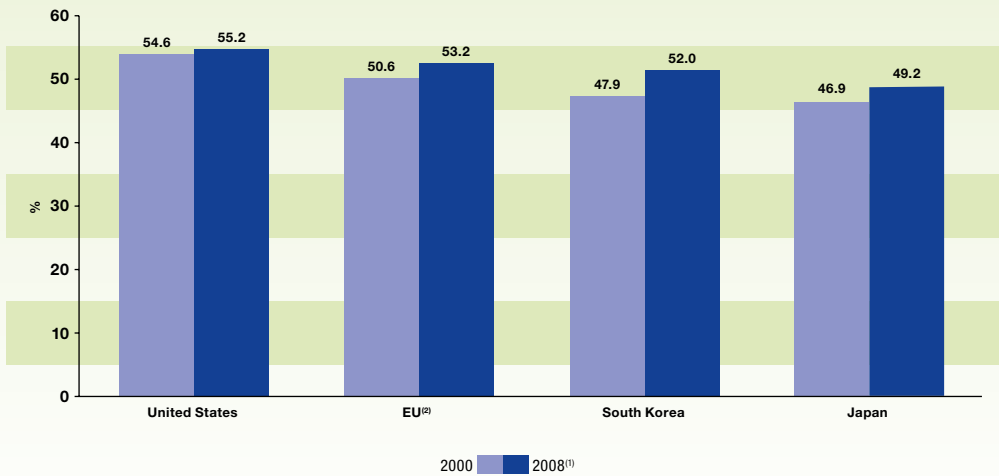
Source: DG Research and Innovation

Data: JRC-IPTS (calculations based on data from OECD)

Note: (1) Patent applications by inventor's country of residence.

FIGURE 25

Value added for knowledge-intensive services (KIS) and high-tech and medium-high-tech industries as % of total value added, 2000 and 2008⁽¹⁾



Source: DG Research and Innovation

Data: OECD

Notes: (1) US: 2007; JP: 2005.

(2) (i) EU does not include BG, CY, LV, LT, MT, AT, RO

(ii) Elements of estimation were involved in the calculation of the EU aggregate.

Innovation Union Competitiveness Report 2011

an indication of the knowledge intensity of the entire economy, also covering services and other sectors beyond manufacturing.⁵²

The EU's economy has slowly become more knowledge intensive. More precisely, in the EU, the percentage of the value added by knowledge-intensive services and high-tech and medium high-tech industries has increased in the last decade from 50.6% of the total to 53.2% (Figure 25). The United States, one of the most knowledge-intensive economies, has followed a similar path as the value added by these activities has moved up from 54.6% in 2000 to 55.2% in 2007. Finally, Japan and above all South Korea have also experienced a positive shift towards more knowledge-intensive activities, moving from 46.9% and 47.9% in 2000 to 49.2% and 52% respectively in 2008. Based on these findings, the EU still falls behind the United States but, surprisingly, scores higher than Japan and South Korea, two highly technology-based countries, although both of them are closing the gap with the EU.

The share of the total EU product export given over to medium- and high-technology manufacturing has remained stable over time, but is lower than that of its main competitors

The quality of research and technological production should contribute to the economic competitiveness of a country.⁵³ The share of the exports in knowledge-intensive sectors, both in manufacturing and services, provides an indication of the capacity of a country to compete internationally in high-value-added knowledge-based sectors. Changes in these shares would also reflect the impacts of a country's science, technology and innovation on their overall competitiveness.

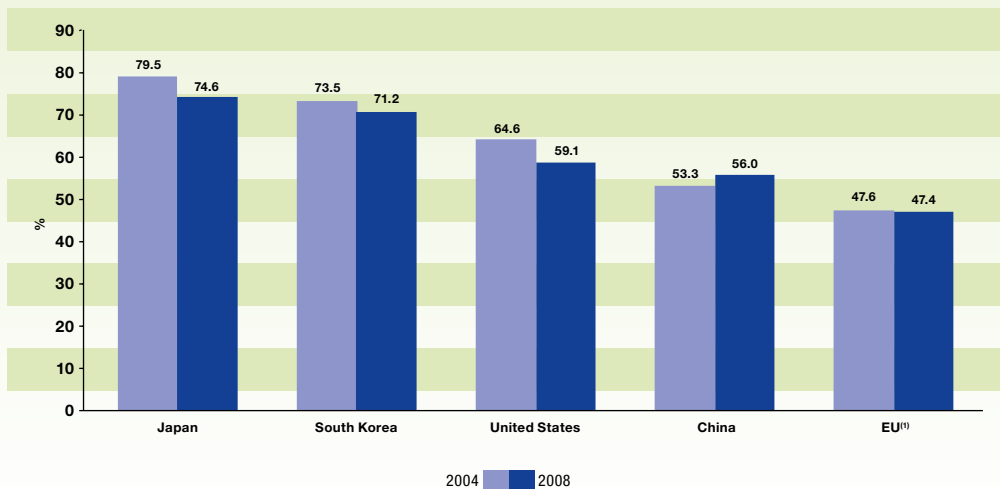
In this context, as Figure 26 shows, Europe's share of medium and high-technology manufacturing exports is below 50% of the total manufacturing exports. This value is well below that of China, the United States and especially Japan, where almost 75% of the exports fall under this category. To a certain extent this finding reflects the economic structure of the EU, which is less technologically advanced than the United States and Japan. However, in an increasingly knowledge-intensive world economy, this threatens the EU's long-term economic competitiveness.

⁵² Tertiary education in this context is defined as ISCED 5 and ISCED 6. This is a new key indicator developed by Eurostat after advice from the expert group on ERA indicators and monitoring, financed by the European Commission, 2009. This new indicator is presented in Part III, chapter 3. However, since data for the United States and Japan are not yet available, this comparative Overall Picture uses the current OECD classification in knowledge-intensive services, high-tech and medium-high-tech industries.

⁵³ For a more comprehensive analysis of competitiveness in Europe, see Part III, chapter 4.

FIGURE 26

High-tech and medium-high-tech product exports as % of total product exports, 2004 and 2008



Source: DG Research and Innovation
Data: European Innovation Scoreboard 2010

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Note: (1) EU includes intra-EU exports and was calculated from the unweighted average of the values of the Member States.

In evolutionary terms, it is worth noting that the EU's share has remained relatively stable over time. In contrast, both the United States and Japan suffered clear decreases, while China benefited from the sharpest average annual growth rates (approaching 1%), which reflects once again its scientific and technological rise.

However, the EU is competitive in knowledge-intensive services, although the United States, Japan and China are catching up

Almost half of the service exports from the EU fall under the category of knowledge-intensive service exports. This share is higher than that of other competitors, which once again may reflect the economic structure of the countries (Figure 27). It is also important to highlight that even if the EU has showed better progress than the United States and Japan, the most remarkable increase has occurred in China, indicating a strong injection of knowledge in its services too.

4.4. Is European R&D addressing societal challenges?

The EU's research contributes to address some of the most pressing societal challenges, although its technological production stills lags behind the United States and Japan⁵⁴

The EU invests in research oriented to the production of new technologies that help address some of the most pressing challenges our society faces. The EU produces more than one PCT patent in health-related technologies for every EUR 2 billion GDP and almost one PCT patent in climate-change mitigation for every EUR 10 billion GDP. However, the EU still lags far behind the United States in producing health-related patents, and it lags behind Japan in producing both health-related and climate-change mitigation patents (Figure 28).

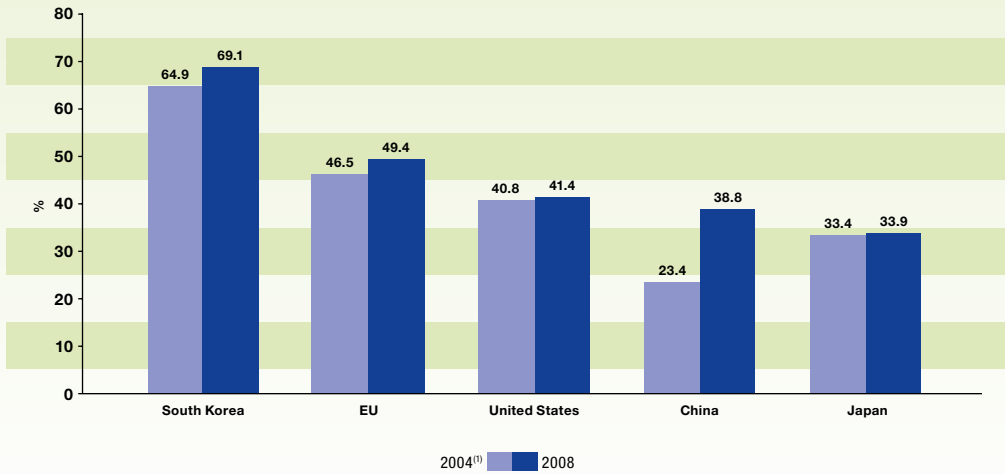
This relative European lag in the production of new technologies to improve the quality of life of citizens⁵⁵ can also have important economic implications, as these technologies can rapidly become new areas of future economic growth. This is especially true in a context of an ageing and a more environmentally aware population.

⁵⁴ For a more comprehensive analysis of the role of research and technology in addressing societal challenges, see Part III, chapter 5.

⁵⁵ This finding can be interrelated to the decline of European citizens' confidence in science and technology which will improve their quality of life (see section 'New Perspectives', chapter 3).

FIGURE 27

Knowledge-intensive services (KIS) exports as % of total services exports, 2004⁽¹⁾ and 2008

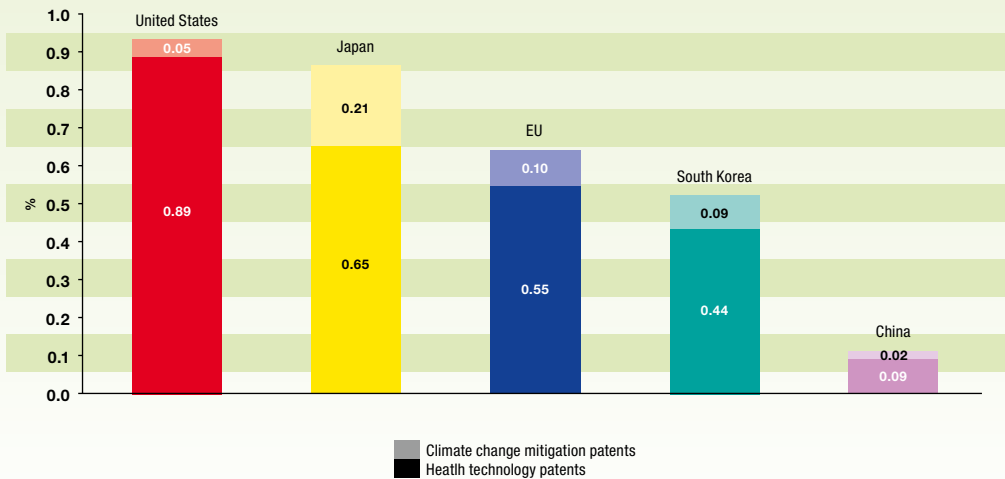


Source: DG Research and Innovation
 Data: European Innovation Scoreboard 2010
 Notes: (1) US, KR: 2006.
 (2) EU includes intra-EU exports.

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FIGURE 28

PCT patent applications in societal challenges per billion GDP (PPS€), 2007



Source: DG Research and Innovation
 Data: Eurostat, OECD

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