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Innovation Union Competitiveness report 2011

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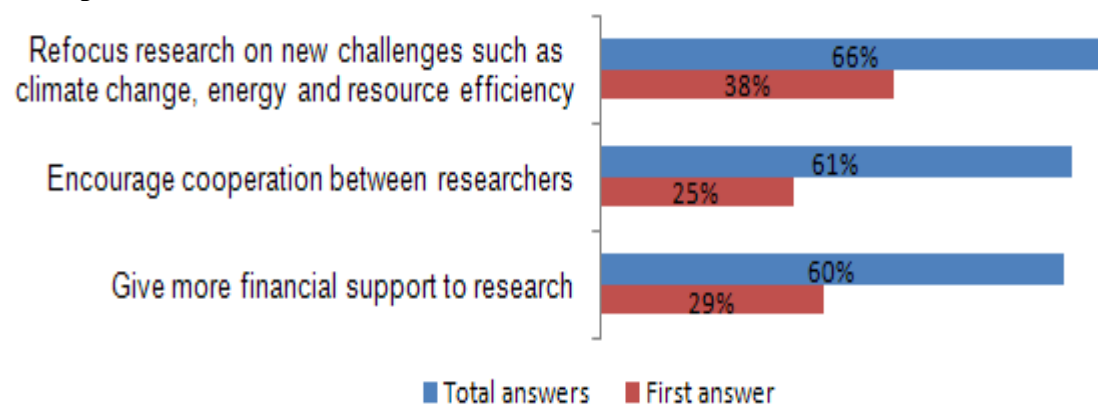
Executive summary

Introduction

Against a backdrop of rising societal concerns and lagging economic performance, the European Union launched in 2010 the *Europe 2020 strategy*¹ to guide Europe's economic recovery and present a comprehensive agenda towards becoming a more competitive, sustainable and inclusive economy. At the core of this strategy, the Innovation Union Flagship Initiative² sets out how Europe will tackle the 'innovation emergency' it is facing, through a strategic approach integrating research and innovation instruments and actors. It commits the EU and Member States to put in place framework conditions to make the business environment more innovation friendly, facilitate access to private finance, complete the European Research Area, and address major societal challenges.

The result should be an Innovation Union where fast-growing innovative firms strive and create new, high added value jobs and where innovation offers products and solutions responding to society's needs and expectations. The aim is to address both a competitiveness challenge (closing Europe's gap in innovation) and a cultural challenge (integrating research and innovation to focus on societal challenges) which should lead to structural change towards more knowledge intensive economic activities. These priorities correspond largely to the main preoccupations expressed by the European citizens as regards Innovation:

Figure 1: Opinion of European citizens on the three main priorities for Innovation in Europe, 2010



Source: DG Research and Innovation

Data: DG Communication, Eurobarometer 2010

The Innovation Union flagship initiative calls for setting in place a strong monitoring mechanism for measuring innovation performance and progress towards Europe's shared objectives. This echoes Treaty provisions³ regarding periodic monitoring and evaluation in that domain.

¹ COM (2010) 2020

² *Europe 2020 Flagship Initiative Innovation Union* COM (2010) 546 final. The Europe 2020 strategy also includes other Flagship initiatives enhancing competitiveness: “an Industrial Policy for the Globalisation Era”, “the Agenda for New Skills and Jobs”, “the Digital Agenda”

³ Article 181, §2: "In close cooperation with the Member States, the Commission may take any useful initiative to promote the coordination referred to in paragraph 1, in particular initiatives aiming at the establishment of

To this end, a three-tier monitoring framework has been developed constituted of:

1. **Headline objectives:** *where do we want to go?* One of the five headline objectives in the Europe 2020 strategy is to improve the conditions for research and development, in particular with the aim of raising combined public and private investment levels in this sector to 3% of GDP. In complement, the European Council of 4 February 2011 called for the development of a new, single integrated indicator to allow a better monitoring of progress in innovation. The European Commission, in cooperation with the National Statistical offices and with the OECD is currently developing such an indicator, focusing on the share in the employment of the fast-growing innovative enterprises.
2. **A performance scoreboard:** *where do we stand?* The Innovation Union Scoreboard (IUS) was published in early 2011 and will be updated annually to provide comparative benchmarking of EU and Member State performance against 25 core R&I indicators and, for 12 of them, against major international partners.
3. **An analytical strategic report:** *what are the causes and remedies for an insufficient performance?* Every two years, the Innovation Union Competitiveness report (IUC) will provide an in-depth statistical and economic analysis covering the main features of an efficient and socially effective research and innovation system. It will constitute a key tool for an evidence-base policy making in the context of the Innovation Union.

The present *Innovation Union Competitiveness report* monitors progress towards the EU and national R&D headline targets and provides economic evidence and analysis to underpin EU and national policy making in support of Innovation Union. It aims to complement the overall review of Europe 2020 targets in the European Commission Annual Growth Survey by offering a deeper perspective on R&D intensity targets at EU and national level and presenting evidence on the dynamics of knowledge-intensive firm and other aspects of innovation. The report also extends and complements the Innovation Union scoreboard indicators to address the whole cycle innovation, including the impact of research and innovation on raising competitiveness and tackling societal challenges.

This executive summary presents a selection of the key findings from the 2011 Innovation Union Competitiveness report.

Key findings

Investing for the future

1. The EU is slowly advancing towards its 3% R&D target - but there is a widening gap between the EU and its world competitors notably due to weaker business R&D investment

Investment in research and innovation is a key driver of growth and innovative ideas for the future of Europe. This is why increasing investment in R&D is one of the five priorities of the Europe 2020 strategy.

During the period 2000-2007, the EU **R&D intensity** stagnated as a result of parallel increase in GDP and Gross Expenditure on R&D (GERD). More recently, EU R&D intensity has grown from 1.85% of GDP in 2007 to 2.01% in 2009 as the result of a decrease in GDP and widespread budgetary prioritisation of public R&D funding combined with the resilience of private investment in R&D. This can be attributed to the positive impact of the Lisbon agenda and national reforms initiated starting in 2005.

Between 2000 and 2009, R&D intensity has progressed in 24 Member States with acceleration in the period 2006-2009 in a majority of Member States. Despite this progress, most Member States in 2009 were still far short of the national 2010 R&D targets they set for themselves in 2005. In 2010, nearly all the EU Member States set new R&D targets for 2020, which are generally ambitious but achievable.

Between 1995 and 2008, total **research investment in real terms** rose by 50% in the EU. However, the performance was higher in the rest of the world, as the world economy became more knowledge-intensive. During the same period, the United States increased its total research investment in real terms by 60%, the four most knowledge intensive countries in Asia (Japan, South Korea, Singapore and Taiwan) by 75%, the BRIS countries (Brazil, Russia, India, South-Africa) by 145%, China by 855% and the rest of the world by almost 100%. The result is that a rapidly growing share of R&D activities in the world is being carried out outside Europe. **In 2008, less than a quarter (24%) of the total world R&D expenditure was performed in the EU** compared to 29% in 1995. On current trend, China is set to overtake the EU by 2014 in terms of intensity of R&D expenditure.

EU under-investment in R&D is most visible in the business sector where Europe is falling further behind the United States and the leading Asian economies. **Relative to GDP, business invest twice more in Japan or in South Korea than in Europe**⁴.

The business R&D intensity gap in the EU is due to two main reasons: (i) the EU has a smaller and decreasing share of high-tech manufacturing sectors in its economy than the United States and (ii) these sectors are less research-intensive in the EU than in the United States. This is largely attributable to the framework conditions in place in Europe which are less favourable to investing and attracting investors than for instance in the United States. The slow speed of structural change in Europe makes also investment in R&D in Europe less likely to develop in fast growing sectors. As a result, the average annual growth rates of

⁴ In the last decade, EU business expenditure on R&D has indeed stagnated at around 1.20% of GDP (1.25% in 2009), a much lower level than in the United States (2.01% in 2008), South Korea (2.45% in 2007) and Japan (2.68% in 2007)

business R&D intensity in Japan and South Korea were much higher than those of the EU. Chinese firms are also becoming increasingly R&D intensive, with the result that **since 2000 business R&D intensity in China has been growing 30 times quicker than in Europe** to reach a level of 1.12% in 2008.⁵

Major obstacles to be tackled include access to finance, e.g. venture capital, the much higher cost of patenting in Europe particularly for SMEs, and the framework conditions required in order to enhance knowledge-intensive entrepreneurial activities.

2. The economic crisis has hit business R&D investments hard. However, as part of a counter-cyclic effort, many European countries are maintaining or increasing their levels of public R&D funding

Despite the economic crisis, there was a positive continuity in public R&D funding trends in 2009 and 2010, with sustained investment rates in many Member States. Seventeen Member States were able to maintain or increase their R&D budgets in nominal terms in 2009 compared to 2008, and only seven Member States decreased their R&D budgets over the same period⁶. **In 2010, sixteen Member States planned to increase their R&D budgets.** However, the preliminary data available show that, relative to GDP, R&D budgets decreased in more countries in 2010 than in 2009 and this trend seems to be maintained in 2011. These are worrying signs, since evidence from previous crises shows that maintaining public R&D funding during an economic downturn is key to ensuring a more rapid return to sustained economic growth.

While the crisis has had a stronger impact on private R&D investment than on public funding, **R&D spending by firms headquartered in the EU fell in 2009 half less than that by US firms** (-2.6% and -5.1% respectively). This impact was greater in the automotive and IT hardware sectors than in the electronic & electrical equipment and the health sector (which actually posted an increase in R&D investment in 2009). However, as a whole it is noticeable that due to intense competition based on investment in knowledge creation and innovation, private R&D investment proved to be relatively resilient in 2009, and even increased in Asia. This demonstrates the determination of the business sector to preserve R&D investments in times of crisis to maintain their competitiveness in the present globalisation context.

The challenge to invest more in knowledge remains a key priority even under the current tight budgetary constraints in Europe. Member States should therefore both consolidate public finances and safeguard the resources for future growth and competitiveness by investing in growth-enhancing policies such as research, innovation and education.

⁵ With an average annual rate of 9.2% against 0.3%

⁶ This does not add up to 27: data is not available for Greece; break in series in Spain and Poland in 2009 prevents a direct comparison of the 2009 R&D budget (Government Appropriations or Outlays on R&D) with 2008 for these two countries

3. Europe is host of a large and diversified pool of skilled human resources in particular in Science and Technology, which the business sector is not fully nor optimally making use of; in terms of new tertiary educated graduates, China now weights as much as the EU, the United States and Japan combined

Its large **number of researchers** and skilled human resources is one of Europe's major assets. In 2008, there were 1.5 million full time equivalent researchers in the EU, compared to 1.4 million in the United States and 0.71 million in Japan. However, in absolute terms, China has taken the world lead with 1.6 million researchers in 2008. The EU will need to create at least 1 million new research jobs if it is to reach an R&D intensity of 3%. This net **increase by two thirds of the number of European researchers by 2020** should primarily benefit the business sector where there is a large gap with the United States. In addition a large number of the existing research work-force will retire by 2020. This, combined with the need to strongly adapt the profiles of researchers to new priorities and market demands, will constitute one of the main challenges facing national research and innovation systems in the years to come.

More than half (54%) of the researchers in the EU work in the public sector, and only 46% work in the business sector. This is a European exception. **The share of researchers employed by the private sector is much higher within our main economic competitors, e.g. 69% in China, 73% in Japan and 80% in the United States.**

In dynamic terms, a sizeable and increasing share of the EU population graduates from academic tertiary education every year and represents a unique chance to meet this quantitative and qualitative challenge. The EU produces more than 940,000 students with a tertiary degree in Science and Engineering every year, and the number of tertiary degrees in the EU has increased at an average annual rate of 4.9% per year in the period 2000-2008. The same applies at the doctoral level. With 111,000 new doctorates awarded every year, **the EU produces nearly twice as many doctorates than the United States.** This proportion is even higher for Science and Engineering where the EU produces more than twice the number of doctorates than the United States. However, relative to GDP, the United States invests about 2.5 times more in higher education than the EU, mainly due to much lower private spending in the EU. As a result, education expenditure per graduate or PhD student in Europe is a fraction of what it is in the US, sacrificing quality for quantity at the risk of not meeting the expectations of the business sector.

Regarding the enrolment of students, the real breakthrough of the last decade however occurred in China: in 2009, China enrolled as many undergraduate students as the EU, the United States and Japan combined, i.e. more than 6 millions. Less than seven years ago, China enrolled a similar number of undergraduate students as the EU (around 3 millions) or the United States (2.5 million).

A central issue for the success of Innovation Union is for Member States to adapt their (tertiary) education systems in view of substantially increasing the number of available researchers and engineers while ensuring a better match of their skills with the needs of the business sector and improving the attractiveness of research careers for top talents from around the world.

4. While remaining a top player in terms of knowledge production and scientific excellence, Europe is losing ground as regards the exploitation of research results

The EU is the first producer of peer-reviewed scientific publications in the world, with 29% of the world production in 2009, ahead of the United States (22%), China (17%) and Japan (5%).

In terms of **scientific excellence**, during the period 2001-2009, the EU as a whole increased its share of total scientific publications in the top 10% most cited in the world from 10.4% to 11.6%, the world average being by definition at 10%. This means that Europe's capacity to produce high-impact scientific publications, which is a proxy for scientific quality, is 16% above the world average and has been increasing since 2000. The Netherlands, Denmark, Switzerland and Iceland score highest and rank amongst world leaders on that criterion. This achievement is correlated with the gradual development of a European Research Area and the improvement of EU and national R&D funding instruments as part of the Lisbon strategy.

In spite of such recent progress **the United States is still performing one third better than Europe in terms of R&D excellence**, with 15.3% of US publications among the world's 10% most cited.

In terms of development of competitive technology, Europe is losing ground in a context of increased competition. Today, the world share of PCT patents is at a comparable level for the EU, the United States and the five leading Asian countries (all at 25-30%). However, **the rate of growth in the number of PCT patent applications over recent years in Japan and South Korea is almost double that of the EU**. On current trend, by 2020, the respective shares of PCT patent applications could be: EU: 18%; United States 15% and 55% for the five leading Asian countries.

European Patent Office (EPO) patent applications, while not a perfect indicator for international comparisons with third countries, is an indication of the propensity of different countries to take a leading role in innovation processes. The share of the EU Member States in EPO patent applications declined from 44.8% in 2000 to 44.2% in 2007. Moreover, **the number of EPO patents relative to GDP has also decreased in the EU since 2000** while this ratio increased in the rest of the world. Even more worrying, about **half of the Member States do not produce high-tech EPO patents at all**. It is therefore not surprising that **licence and patent revenues from abroad are three times higher in the United States than in Europe**⁷, evidencing the difficulty for Europe to acquire a leading role on world technology markets.

The relative **high cost of filing and maintaining a patent in Europe** may partly explain this situation: An SME must disburse EUR 168,000 of legal fees to obtain and maintain a patent protection in all 27 EU Member States. It would cost only around EUR 4,000 for a protection of the same duration in the United States.

The development of the European Research Area, past and ongoing structural reforms of the national R&I systems and the deepening of the single market for knowledge are instrumental in improving the excellence of European science. However further steps are needed – in particular towards more cost-efficient intellectual property protection and management - to strengthen technological and regain innovation leadership in view of ensuring Europe's future competitiveness, growth and jobs.

⁷ Accounting for only 0.21% of its GDP, compared to 0.53% for Japan and 0.64% for the United States

A European Research Area for a more efficient R&I system

5. Member States are introducing reforms to improve the functioning of the public research base and increase public-private cooperation - however knowledge transfer in Europe remains weak

During the period 2000-2009, the EU Member States have started reforming their higher education institutions and organisations performing public research. In many Member States universities have been given more autonomy and have developed institutional strategies to prioritise research activities and attract top foreign researchers. In addition, the allocation of public funds is increasingly based on the monitoring and evaluation of performance and on a competitive basis. The development of the so called "third mission" of universities is progressing in most Member States, in particular through the development and promotion of public-private cooperation. Out of 200 European Universities recently surveyed, 86% had a Technology Transfer Office and more than a third had created 10 or more spin off companies.

However these reforms are often still underway, with large differences between countries. As a result, scientific and technological cooperation between the public and private sectors remains generally weak in Europe. **The number of joint publications between private and public actors per population in the EU is roughly half that of the United States** and one third lower than in Japan. It is however much higher in a number of Member States (Sweden, Denmark, Finland, the Netherlands). An encouraging sign is the 20% increase between 2000 and 2008 in the share of public R&D funded by business enterprises in the EU (which is superior to the situation in the United States and Japan). On this aspect as well, there are large variations amongst EU Member States and Associated Countries with Germany, Finland and Iceland performing much better than the EU average.

The modernisation of the tertiary education system and public science base in Europe is a key structural reform for the deepening of the single market for knowledge. While it is well underway in most EU Member States as part of the efforts to complete the European Research Area, further efforts are still needed to foster public-private cooperation and knowledge transfer through e.g. the opening up of research institutions and the development of a demand-led approach to innovation.

6. The development of the ERA underpins the evolution and efficiency of scientific activities in Europe

The European Research Area is still far from being a reality and progress has sometimes been slow since the launch of the first initiative in 2000. It is estimated that in 2008 only 4.5% of the national R&D budgets of the EU Member States was allocated to trans-nationally coordinated research (4.3% in 2007). An important part of this funding was constituted by the financing of large-scale trans-national research infrastructures (e.g. CERN) or corresponded to national R&D programmes coordinated by Framework Programme's instruments (ERA-NET, ERANET+, Joint technology Initiatives, article 185 initiatives) and other Europe-wide R&D coordination schemes (e.g. Eureka, COST). There is currently no quantitative estimation of the share in Europe of "**open national R&D programmes**"⁸. However, first investigations show that they are very few of them.

⁸ i.e. fully open to research teams that do not reside in the country where the programme is launched

Intra-European mobility remains at a modest level. In 2008, only 7% of European doctoral candidates studied in another Member State. When it comes to established researchers however, 56% of researchers based in Europe have worked at least three months in another country during their career.

Indicators on co-publications show that researchers based in the EU are increasingly integrated in transnational networks, as evidenced by the higher growth of transnational co-publications (both within the EU and with non-EU countries) compared to the growth of publications within individual Member States over the same period 2003–2008. The growth of extra-EU scientific cooperation is lower but relatively close to the intra-EU growth (average annual growth rates of 8% and 9.8% respectively). **The figures show therefore both a greater EU integration in recent years and an increasing openness of EU research towards the rest of the world.**

Network analyses show that **knowledge flows inside Europe** (i.e. flows of students, electronic academic links, co-publications and co-patenting cooperation) **are however very unbalanced**, with a strong concentration amongst a few Western European countries, marginal involvement of EU-12 Member States and of most Southern European countries.

A major and visible progress towards a more efficient and integrated research funding landscape in Europe lies in the marked increase in EU-wide competitive research funding, mostly through the 7th Framework Programme, as well as in the **increasing orientation of Structural Funds towards research and innovation**. In 2008, almost 11% of the total EU budget was devoted to research and innovation, compared to less than 3% in 1985. This has a considerable impact on the European research community. In most EU-12 Member States, Structural Funds directed to Research, Technological Development and Innovation represent more than 60% of the national R&D budget, and even more than 100% in a few cases. This is a unique opportunity for these Member States to increase their research and innovation capacity. As to the **EU Research Framework Programme, according to preliminary Europe-wide estimates, it represents some 20% to 25% of all project-based funding in Europe.**

The development of an ERA framework will contribute to increasing the efficiency and performance of the European research system and help to overcome bottlenecks in the free circulation of knowledge in Europe. The increasing channelling of research and innovation funding through different EU instruments offers the prospect of improving the overall EU scientific excellence while strengthening cohesion.

7. Europe is increasing its international cooperation in science and technology, while striving to catch up with the United States

In a globalised economy, the competitive advantage of Europe mainly lies in its ability to compete on high value added products. However, the share of Europe in the world's research capacity (in terms of investments and researchers) and output (in terms of S&T publications and patents) is decreasing as the rest of the world, and in particular leading Asian economies, is emerging. In parallel with this long term trend, major societal challenges, such as climate change and the ageing of population, are creating new needs but also market opportunities which are global in nature. These challenges call for increasing the international scientific and technological cooperation in a focussed and strategic way, building on the excellent collaborative record and high scientific rating of European science but also addressing the issue of a comparatively much weaker technological cooperation.

The older and better established scientific and technological collaborative networks in the world (as measured by co-publications and co-patenting) are between the United States and the EU. The future prospect for the transatlantic cooperation looks as good as ever, as evidenced in particular by the growing number of European students achieving their doctoral studies in the United States. **Over the last decade, the number of European citizens receiving their doctoral degree in the United States increased by more than 38%.**

Both regions are at the same time adapting to the new geography of knowledge production and market opportunities, by increasing their bilateral cooperation with emerging economies in Asia. In terms of students, both economies have a significant one-way inflow of Asian doctoral students. Over the period 2000–2009, the scientific cooperation (measured by number of co-publications) of the United States with the research-intensive Asian countries (Japan, South Korea and China) was higher than between the EU and the same countries. Nevertheless, over the same period, the EU increased its scientific cooperation with these Asian countries at a higher pace (average annual growth rate of 12.8%) than the United States (10.6%). The same applies to technological cooperation, with a higher absolute number of co-patents between the United States and the above mentioned Asian countries compared to the EU.

Finally, the share of participants in the Framework Programme from countries outside Europe is slowly growing - from 5.3% in 2002 to 6.0% in 2010 – as a result of its full international opening up. **Russia and China have the highest number of participants in FP projects, followed by the United States.** Among the European countries, it is mainly the five largest countries – Germany, the United Kingdom, France, Italy and Spain - which have collaborative links with Russia, China and the United States. In addition, the Netherlands and Sweden have also, relative to their size, a high proportion of collaborative links with these countries.

Further increasing the international cooperation in research and technology should be facilitated by a focussed strategy covering both the scientific and technological dimensions; by the use of a common framework for international collaboration; by further effort to attract students from outside the ERA countries.

8. The gender balance in the European research population is improving, but major research institutions continue to be predominantly led and managed by men

Reforms for a more efficient and creative research and innovation system also include measures for a better gender balance. In 2007, **women represented on average** in the EU 37% of total researchers in higher education institutions, 39% of researchers in public research organisations and **only 19% of researchers in the business sector**. Since 2002, the average annual growth rate in the number of female researchers has been higher than that of male researchers. Moreover, the gender gap has been closing more markedly among scientists than in the labour market in general. However, **only 13% of higher education institutions were headed by women in 2007**, and the proportion of female staff in research institutions having reached the position of full professor or equivalent remains very low: 7.2% in engineering and technology, 17% in medical sciences and 27% in humanities. Over the period 2004-2007, there has been a slight increase in the proportion of women having reached that level.

In principle, advancement in gender equality is the result of the combined effect of reforms in the R&I systems, the features of the labour market and the equity policies in place. To provide a diversified view on what constitutes a good life for Europeans and what enhances innovation, the capacities and creativeness of both men and women have to be used in a balanced way in the research and innovation context. Focused actions with clear objectives,

targets, deadlines and monitoring for gender equality should be included in sound national R&I strategies.

Research and Innovation for a sustainable economy and a better life

9. European SMEs are innovative but they do not grow sufficiently. The United States has shown a much better capacity to create and grow new companies in research-intensive sectors over the last 35 years

European SMEs are innovative. Out of those with innovation activities, **27% have introduced new or improved products to the market in 2008** according to surveys. This figure even reaches 41% in Sweden.

Relative to the size of the economy, **SMEs perform more R&D in the United States than in the EU**: in 2007, SMEs' R&D expenditure amounted to 0.25 % of GDP in the EU against 0.30% in the United States, with a high concentration in certain States such as California. However, in a number of European countries (Denmark, Finland, Belgium, Austria and Sweden), SMEs perform much more R&D (above 0.5 % GDP).

More worrying however is the fact that in terms of patenting activity, young (less than five years old) firms in the EU are less innovative than their counterparts in the United States, except in Norway and Denmark where more than 30 % of young firms have filed a PCT patent application between 2005 and 2007.

As a result, **innovative SMEs and enterprises of intermediate size do not grow sufficiently** to become large R&D-investing and innovative companies. The share of companies created after 1975 is three times higher among the top R&D-investing US companies (54.4%) than among the top R&D-investing EU companies (17.8%). This is symptomatic of a consistently lower capacity of the EU over the last 35 years to create and grow new companies in research-intensive sectors as compared to the United States. As a result the EU's industrial structure is not oriented enough towards fast-growing economic sectors.

All types of SMEs can innovate and should be encouraged to invest in R&I. Also important is the fact that fast-growing enterprises in the most innovative sectors of the economy are key actors for the development of emerging industries and for the acceleration of the structural changes that Europe requires in order to become a knowledge based economy with sustained economic growth and high quality jobs. This is why the European Commission's proposal for a new single innovation headline indicator focuses on the share in the economy of the fast-growing enterprises in the most innovative sectors. The growth resulting of such a development will benefit the whole economy, including SMEs in low and medium-high tech sectors and in services that depend heavily of the overall development of demand.

10. Weaker framework conditions for business R&D and a fragmented European market for innovation are hampering private R&D investments and affecting the attractiveness of Europe

The attractiveness of Europe for foreign firms depends in particular on the existence of a single market of 500 million consumers with transparent business environment, sound and enforceable competition rules and the availability of a large pool of skilled human resources. This economic openness is characterised by the intensity of intra-EU competition and the openness to foreign investments and products. Within the EU, economic competition is

perceived to be more intense in old Member States compared to new Member States and particularly strong in Germany, Austria and the Netherlands.

An important element in identifying the markets where companies prefer to innovate is the level of customer and consumer demand for new products and in particular the presence of lead users who may provide feedback and have a high propensity to take up innovations. The EU is the largest market in the world and should take full advantage of this by attracting investors to develop innovations that respond to the needs of consumers worldwide. This potential is however hampered by a lack of appropriate framework conditions at EU and national level for facilitating access to market of innovative goods and service, and promoting R&D and innovation investment by firms.

At national level, evidence shows that **framework conditions for business R&I vary considerably between EU Member States**. Northern European countries are systematically in the top positions for many indicators; while new Member States are generally in less attractive positions.

A typical example of the major obstacles to innovation concerns the protection and management of intellectual property. While there is a political will at European level to facilitate the transfer of knowledge from research to technology and towards the market, further efforts are needed to create a genuine market place for research results and for patents and licensing. **In particular, the total cost of patenting and of maintaining a patent is around twenty times higher in Europe than in the United States⁹** (40 times higher in the case of SMEs). Most of this difference is due to the cost of fees for maintaining a patent over the period which is needed for a firm to expand its activities and get resources to develop a new generation of innovative products.

When it comes to access to private finance by firms, Europe lags well behind the United States regarding venture capital. **Early stage venture capital funds in the EU are at less than half of the level in the United States** and are only prominent in Norway, the Netherlands, Denmark, Portugal, Finland, Belgium and France. There are only three EU Member States that stand out regarding venture capital investments at the expansion phase: the United Kingdom, Sweden and Switzerland. New Member States have low levels of venture capital and generally still insufficiently attractive framework conditions for private R&D in spite of recent progress. As a result, the interest and demand for domestic R&D and innovation is low with no sufficient prospect for high return on investment.

At EU level, current initiatives mostly provide incentives stimulating the supply of innovation in fast-growing sectors (including the SET Plan, Joint Technology Initiatives, European Technology Platforms, and Joint Programming) whereas there have been fewer and less intensive efforts to stimulate the demand side (e.g. the Lead Market Initiative).

The Innovation Union flagship aims therefore to create a genuine single market for knowledge and set in place framework conditions to attract entrepreneurs and business investment and to provide European citizens with better public services and working opportunities.

In complement to current incentive schemes, the Innovation Union flagship aims to set in place a business environment more favourable for business R&D and innovation by improving key framework conditions. EU initiatives are being launched to modernise European standardisation, promote innovative procurement, create an EU-wide market for IPR and facilitate access to private finance.

⁹ Costs are computed over 20 years in order to make the comparison valid: maintenance fees in the USA disappear after 7 years, whilst steeping up in Europe.

11. Sustainable economic competitiveness in high knowledge-intensive sectors requires faster structural change in Europe

In the last 15 years, the EU economy has become ever more service oriented with the weight of manufacturing sectors shrinking to 20% of the total Value Added.

This structural change has important consequences for the EU research and innovation system as the growing weight of the services sectors, which have a lower R&D intensity, offsets in most EU Member States recent increases in the research-intensity of manufacturing sectors. At the same time business R&D concentrates in high-tech and medium-high tech sectors which become ever more research intensive as more economies around the world move closer to the technological frontier. The net result of this complex evolution is that, while the EU economy has become slightly more knowledge-intensive since 2000, the gap with the United States has widened due to the higher share of high-tech sectors in the US economy and higher research intensities in individual sectors including services.

The increasing level of education and skills in the workforce is also an indicator of ongoing structural change. In 2009 **knowledge-intensive activities (KIAs)**, where more than one third of the employees have a tertiary education degree, **represented 35 % of total employment in the EU** with generally no large variation around this rate among EU Member States. Between 2008 and 2009 there was a slight increase in KIAs at EU level.

Compared with the United States, there is room for further increases in the research intensity of the high-tech and medium high-tech industries and of services. Structural change is facilitated by the development of lead markets and addressing obstacles to the growth of new technology-based firms. Structural change from the perspective of R&D intensity can also be analysed at the level of firms. The 2010 European Industrial R&D Investment Scoreboard, covering the 1000 EU top firms in terms of R&D investments in a range of sectors, shows that in 2009 the R&D intensity of the EU companies slightly increased to reach 2.4%.

Worldwide, the Industrial Scoreboard shows that, despite the impact of the crisis, the world's R&D landscape has maintained its sectoral specialisation, with the United States dominating in high R&D intensive sectors, which concentrate 69% of the total BERD, and the EU in medium-high ones, which account for 48% of the total BERD. R&D is a main competitiveness factor for key sectors such as Semiconductors, Software and Biotechnology: in these sectors, the United States' companies dominate in terms of number of companies and total investment. EU companies increased their share of R&D investment in Chemicals, Electronic & Electrical Equipment, Software & Computer Services, Automobiles & Parts and Pharmaceuticals & Biotechnology. The emergence of strong R&D investors from China and India is well visible through the Scoreboard: with one and zero company in the 2004 edition to 21 and 17 companies respectively, in the 2010.

Finally, the trend in the contribution of innovation-related trade in manufactured goods to the balance of trade goods is an indicator of competitiveness. In the period 2000-2008, almost all EU Member States increased the knowledge-intensity in their manufacturing export as share of the trade balance. Between 2002 and 2007, countries like Denmark, Greece, Ireland, Germany, Luxembourg and the Netherlands had as well a very positive contribution of knowledge intensive services to trade balance; over the same period, the other Member States displayed a knowledge-intensive service trade deficit.

Improving the EU innovative capacity and competitiveness calls for increases in the research intensity of the high-tech and medium high-tech industries, together with a more evenly

distribution of the competitive factors among different regions. A faster structural change in Europe requires ensuring that framework conditions in particular availability of personnel with appropriate skills and incentives on both the supply and demand side to facilitate and encourage investment in product-markets which are growing.

12. Europe has a strong potential in technological inventions for societal challenges and new global growth areas, which could be successfully brought to the market by implementing the comprehensive and integrated approach set out in Innovation Union

Major societal challenges require developing innovative solutions which in turn will provide major opportunities in future high-growth markets around the world. **The percentage of European citizens that trust science and technology to improve their quality of life decreased over the last five years from 78% to 66%.** There is therefore a genuine expectation for science to reorient its efforts to contribute to addressing the societal challenges of our time.

Amongst the global societal challenges currently addressed, patenting activity shows that the emphasis in the EU has been on **climate change mitigation: the number of PCT patent applications filed in the EU relative to GDP has more than doubled between 2000 and 2007** in this area. Europe thus has a strong research and innovation capacity for the development of technologies for climate change mitigation and the environment. As a result of the rapidly increasing European patenting activity in this area, the EU had in 2007 a positive technological specialisation in environmental technologies, whereas it suffered from a negative specialisation in health technologies and other fast-growing technology fields.

In 2007, the EU accounted for 40% of all patents related to climate change technologies in the world, with Germany, Denmark and Spain accounting for nearly half of world wind energy production in 2009. In contrast, the photovoltaic industry is dominated by Asian and US firms, with only two out of the ten largest companies in the world based in Europe.

In the field of health technologies, Europe is lagging behind **the United States**, which **accounts for almost half of all health-related patents in the world**, for both pharmaceutical products and medical technologies. EU patenting in health technologies has fallen slightly since 2000. However, individual Member States such as Denmark, the Netherlands, Sweden and Germany are at the forefront of technology in health-related technologies.

Targeted research and demonstration Investments in key areas, combined with measures to support market development at EU and national, can lead to new technologies and innovations capable of addressing major societal challenges. This new, integrated approach which will be supported notably through European Innovation partnerships constitutes a new source for future economic growth in Europe.