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A RATIONALE FOR ACTION

Accompanying document to the

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

Europe 2020 Flagship Initiative
Innovation Union

COM(2010) 546

Contents

1. INTRODUCTION

This document accompanies the Commission Communication 'Innovation Union: Transforming Europe through Research and Innovation', which launches the flagship initiative on research and innovation announced in the Europe 2020 strategy for jobs and growth.[1]

The preparation of the Communication required an extensive period of evidence gathering involving the commissioning of numerous studies, trend analyses and impact assessments; the setting up of a Business Panel on future EU innovation policy and a number of other Expert Groups to assess future policy options; conferences designed to elicit the views of major stakeholders; and more widespread public consultation exercises. A list of the most relevant studies, reports and events is presented in Appendix 1 of this document.

After consideration of the available evidence and policy options, the Communication set out a series of major policy actions aimed at overcoming obstacles preventing innovative ideas from reaching the market; launching European Innovation Partnerships focused on breakthrough solutions to major societal challenges; helping Member States to optimise their research and innovation policies and governance systems; establishing priorities for international cooperation; and outlining a clear division of responsibilities for improved governance and effective implementation.

This report examines the rationale for these policy priorities and reviews the supporting evidence for the specific actions proposed for the Innovation Union.

Section 2 discusses the rationale for the overall Innovation Union – a new, more strategic and distinctive European approach to innovation.

Section 3 concentrates on the measures needed to strengthen the European knowledge base and reduce the current fragmentation of support initiatives.

Section 4 presents the rationales underpinning the main policy measures proposed in the Innovation Union to remove obstacles preventing innovative firms getting good ideas to market.

Section 5 highlights the steps needed to increase the social benefits of innovation and ensure their widespread distribution across all parts of the EU.

Section 6 focuses on the evidence and arguments underpinning the proposed European Innovation Partnerships.

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[1] European Commission (2010a)

Section 7 examines the rationale for activities designed to expand international cooperation and exploit a new world of opportunities.

Section 8 considers the steps needed to make the Innovation Union a reality, reviews the rationale for the EU to support Member States in their efforts to improve their innovation systems and suggests ways of doing this.

2. OVERALL RATIONALE FOR ACTION

This Section reviews the evidence for the main premises underpinning the Innovation Union Communication. These can be summarised as follows:

- Research and innovation have a critical role to play in the creation of economic prosperity and the resolution of major societal challenges, and win-win policies designed to stimulate the economy and tackle major societal challenges are both viable and desirable.

- The current performance of European research and innovation systems – at EU and Member State levels – warrants policy interventions designed to improve their performance.

- Under-performance is a consequence of weaknesses in the constituent parts of research and innovation systems and the way these parts link together and are governed at EU, Member State and regional levels.

- New challenges affecting the way research and innovation systems function are likely to exacerbate the situation.

- Policy responses are needed at EU level to support Member States in their attempts to improve the performance of their own research and innovation systems; to improve the performance of the EU system as a whole; and to ensure that the EU plays a leading role in the global economy.

2.1. Are research and innovation important for economic development and the resolution of major societal challenges?

2.1.1. Research, innovation and economic development

Research and innovation are inter-related but independent concepts. Research involves the investment of resources in attempts to expand our scientific and technological knowledge base, often in order to solve particular problems that confront different sectors of society, but also to satisfy the demands of intellectual curiosity. Innovation, on the other hand, involves the creation of value via the introduction of new products, processes, services and ways of doing things. Innovation requires knowledge inputs drawn not only from the arena of scientific and technological research, but also from many other sources. This broad concept of innovation can thus include the introduction of new products,

processes and services ('product, process and service innovation'); innovations that involve changes in the way business or manufacturing processes are organised ('organisational innovation'); innovation that draws heavily upon knowledge inputs from customers and markets ('user-driven innovation'); changes in the way that firms and other organisations access and exploit knowledge to produce innovations ('open innovation'); and innovations in the way that society organises itself, especially the different ways that the public sector serves the needs of society at large ('social innovation').

All types of innovation, however, can be expected to have a range of downstream socio-economic impacts, and there is now a solid body of evidence describing the relationship between research, innovation and economic development. This was comprehensively summarised in the documentation accompanying the publication of the recent OECD Innovation Strategy.[2] Following the pioneering work of Schumpeter, many authors have demonstrated that **there are strong links between R&D, technical change, the knowledge capabilities of firms, various types of innovation and downstream impacts on the growth, productivity and competitiveness of economies**.[3]

Some of the more salient points to emerge from recent research on the topic are as follows:

- Macro-economic model simulations suggest that increasing R&D investment in the EU to 3% of GDP could have significant and positive impacts on GDP growth in all Member States over a 25-year period.[4]

- In particular, a recently completed simulation of the impact of increasing average R&D investment across the EU27 to 3% of GDP by 2020 suggested that GDP could increase by 3% and employment by 1.5% by 2020. The corresponding figures for 2025 are 5.4% for GDP and 2.5% for employment, leading to overall potential gains of €795 billion in GDP and 3.7 million jobs.[5]

- Investment in 'intangible assets' that give rise to innovation (R&D, software, human capital and new organisational structures) now accounts for up to 12% of GDP in some countries and contributes as much to labour productivity growth as investment in tangible assets (e.g. machinery and equipment).[6]

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2 OECD (2010a)

3 See Solow (1957); Pakes and Griliches (1980); Romer (1990); Aghion and Howitt (1992); Hall and Mairesse (1995); Jones and Williams (1998); Crepon *et al* (1998); Griliches (1998); Mitchell (1999); Guellec and van Pottelsberghe de la Potterie (2001); Griffith *et* al (2004); Bilbao-Osorio and Rodriguez-Pose (2004); Klette and Kortum (2004); Janz *et al* (2004); Rogers (2006); Pessoa (2007); Soete (2007); Kafouros (2008); Hall *et al* (2009); Kumbhakar *et al* (2010); Cincera *et al* (2010) etc.

4 Gardiner and Bayar (2010)

5 Fougeyrollas *et al* (2010)

6 Corrado *et al* (2009)

- Investment in intangible assets and other assets related to innovation (e.g. investment in information and communication technologies (ICTs) and other tangible assets that improve the joint productivity of capital and labour) accounted for between two thirds and three quarters of GDP growth in several OECD countries between 1995-2006.[7]

- Income gaps between countries are closely related to differences in total factor productivity, which is a close proxy for differences in technology and innovation performance levels.[8]

- Although it is possible for innovation to displace employment due to gains in labour productivity, recent firm level evidence suggests that the overall, long-term impact on employment levels is positive in many countries due to factors such as lower costs and increased demand.[9]

- Barriers to innovation preventing the realisation of economic benefits are diverse. For UK firms responding to the Community Innovation Survey in 2005, the most important barriers to innovation, for innovators and non-innovators alike, were cost-related barriers (high economic risks; high direct costs; high cost of finance). These were followed by market-related barriers (market dominated by established enterprises; uncertain demand); regulation-related barriers (need to meet government regulations; need to meet EU regulations); and finally by knowledge-related barriers (lack of qualified personnel; lack of IT; lack of information on markets).[10]

Public opinion also acknowledges that research and innovation are critical for sustainable growth. According to the latest Eurobarometer survey of EU citizens, conducted in autumn 2009, the most widely supported priority concerning ways to boost growth in a sustainable way is through the stimulation of research and innovation in European industry (31%).[11]

2.1.2. Research, innovation and societal challenges

The contribution of policies and policy instruments in spheres such as environment, energy, transport, health etc. to the resolution of major societal challenges in these areas has long been recognised. Porter and Linde also suggested in 1995 that environmental policies, especially regulatory policies, could have beneficial impacts on innovation. Prior to the late 1990s, however, relatively little attention was paid to the notion that research and innovation policies could make an important contribution to the resolution of 'Grand Challenges'. As noted by one Expert Group concerned at the time with the

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7 OECD (2010a)

8 OECD (2010a)

9 See Blechinger *et al* (1998); Klette and Forre (1998); Evangelista and Savona (2002); Harrison *et al* (2008); OECD (2010a); Bogliacino and Pianta (2010).

10 Importance was assessed in terms of the proportion of firms assessing barriers to be highly important. See D'Este *et al* (2006). Subsequent surveys in other Member States have produced similar findings.

11 European Commission (2009a)

issue of climate change: "Where this issue has been addressed, the focus has been mainly on research aimed at clarifying the nature and dimensions of the threat and reducing uncertainty concerning its causes and consequences. There has been much less emphasis on RTD and innovation designed to alleviate or cope with climate change. Little attention has been given, either, to the strategies, processes and policy procedures needed to develop and exploit relevant knowledge".[12]

The report of the Expert Group concluded that support for research relevant to major societal challenges such as climate change should be integrated into broader innovation policy support packages, and that these should be carefully incorporated into sectoral policy mixes dealing with environment, transport, energy, etc. – themes that were being explored in parallel in many other quarters.[13] Subsequently, in 2008, another Expert Group[14] argued that the European Research Area (ERA) should have "a clear purpose which is meaningful to Europe's citizens and political leaders and relevant to its key actors", and that the central means of achieving this was "to engage the research system in Europe's response to a series of Grand Challenges which depend upon research but which also involve actions to ensure innovation and the development of markets and/or public service environments". This theme was then promoted by the French Presidency of the EU in 2008 as a way of focusing EU level actions and leveraging national and private sector contributions and taken even further by subsequent Presidencies, notably the Swedish Presidency in 2009.

Across the Atlantic, support for the notion that there are strong synergies between the research and innovation policies needed to improve competitiveness and economic performance and the policies needed to resolve societal challenges has also been emerging. In 2009, for example, 49 US Nobel Prize laureates penned an open letter to President Obama stressing the importance of the link not only between the public funding of scientific research and downstream economic impacts, but also with the ability of the US to tackle and resolve major societal problems.[15]

The list of major societal challenges that urgently need to be confronted is daunting.[16] The problem of scarce energy resources has to be resolved, our environment has to be safeguarded and growth has to be sustainable. New security threats have to be countered and adequate supplies of food guaranteed. The changing needs of an ageing society also have to be met as our demographic profile continues to evolve, and society has to be continually on its guard against both new and old threats to the health of its citizens.

Most, if not all, of these challenges pose threats that have dire economic implications if they are not tackled. On the other hand, many of them also offer new market

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12 Svedin and Guy *et al* (1998)

13 See especially Kemp (2000), OECD (2000), Anderson *et al* (2001) and the papers by Boekholt and Larosse (2002), Guy (2002), Heaton (2002) and Kemp (2002) in Boekholt (Ed.) (2002)

14 Georghiou and Cassingena Harper *et al* (2008)

15 Open letter to President Obama, 2009. Quoted in Soete, Guy and Præst Knudsen *et al* (2009)

16 See Boden *et al* (2010)

opportunities that can be met by waves of innovative effort. Take climate change, for example. Conservative estimates predict that it will reduce global GDP by up to 3% by 2030, assuming that Earth's temperature will not rise by more than 2-3°C, with poorer countries being affected disproportionately. At national levels, climate change will cut revenues and increase spending needs, causing deterioration of public finances. The cost of extreme weather alone could reach 0.5-1% of world GDP per annum by the middle of the century. At the same time, markets for low-carbon energy products are likely to be worth at least €500bn per year by 2050, and perhaps much more.[17]

The Innobarometer survey for 2009 also provided an interesting perspective on societal challenges as sources of future growth. Companies felt that energy efficiency would be the main driver of innovation in the immediate future, with 32% of managers stating that increased demand for energy-efficient products and services provided the greatest opportunity for innovation over the next two years. A further 16% saw meeting the needs of older people as an opportunity to introduce new products and services, while another 12% pointed out the opportunities presented by increased demand for social, education and health services.[18]

The key therefore, is to mobilise resources at EU and global levels to tackle major societal challenges through investment in research and innovation, seeking win-win situations by focusing on areas where both market potential and the need to resolve major societal challenges are greatest.

2.2. Does the performance of the research and innovation system need to improve?

There is growing evidence that the EU research and innovation system is under-performing compared to its major rivals and that there are major differences in capabilities and performance levels between Member States. All the material presented below in Sections 2.2.1 and 2.2.2 suggest that urgent action backed by high-level commitment to the importance of innovation is needed, while the explanations for underperformance set out in Section 2.2.3 suggest the need for a new strategic approach that attempts to improve performance across the whole breadth of the EU research and innovation system.

2.2.1. Performance variations between the EU and other countries

Some of the major differences between the EU and its main trading rivals are summarised below:

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17 Stern (2006)

18 European Commission (2009b). All Innobarometer results are available at: http://www.proinno-europe.eu/page/innobarometer

2.2.1.1. Academic institutions

- Expenditure on higher education as a percentage of GDP is much higher in the US (3.3%) than in the EU27 (1.3%),[19] largely as a consequence of the relatively massive private sector funding of education in the US (1.8% of GDP compared to 0.2 % in the EU, with most of this funding stemming from student fees plus philanthropic contributions to some of the larger, well-known institutions).[20]

- Only 27 of Europe's universities featured in the top 100 of the 'Shanghai Ranking' of the world's universities in 2009, whereas the corresponding figure for US universities was 55.[21]

- Compared to the US, the EU's academic research system is less specialised in high-tech related activities; in emerging scientific disciplines; and in some of the most dynamic scientific fields.[22] Similarly, EU inventive activity is less specialised in high technology fields such as pharmaceuticals, computers, office machinery, telecommunications and electronics than in medium technology fields such as general machinery, machine tools, metal products and transport.[23]

2.2.1.2. R&D levels

- Business investment in R&D (which plays an important role in determining productivity levels) reached 1.21% of GDP in the EU in 2008 compared to 2.0% in the US, with only Finland and Sweden above the US average.[24]

- In 2008, the US Government Budget Appropriations or Outlays for Research and Development (GBAORD) accounted for 0.99% of GDP compared to 0.71% of GDP for the EU.

- R&D intensity (R&D expenditure as a share of GDP) in 2008 stood at 1.9% – much less than the target of 3% set at Barcelona and considerably lower than R&D intensity levels in Japan (3.44% – 2007 figure) and the US (2.76% – provisional figure for 2008). R&D intensity levels in China are lower (1.44% – 2007 figure), but rising faster.

- In 2009, both the US and China pledged investment R&D investment targets on a par with the EU's target of 3% of GDP. The US is already far ahead of the EU in terms of achieving this target and China is overtaking the EU at a fast pace. India has also just

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19 Soete, Guy and Præst Knudsen *et al* (2009)
20 Soete, Guy and Præst Knudsen *et al* (2009)
21 Shanghai Jiao Tong University (2009)
22 Soete, Guy and Præst Knudsen *et al* (2009)
23 European Commission (2008a)
24 Unless otherwise stated, the figures in this section are based on the latest provisional data supplied by Eurostat.

launched a 'decade of innovation' involving massive investment in research, education and entrepreneurship.

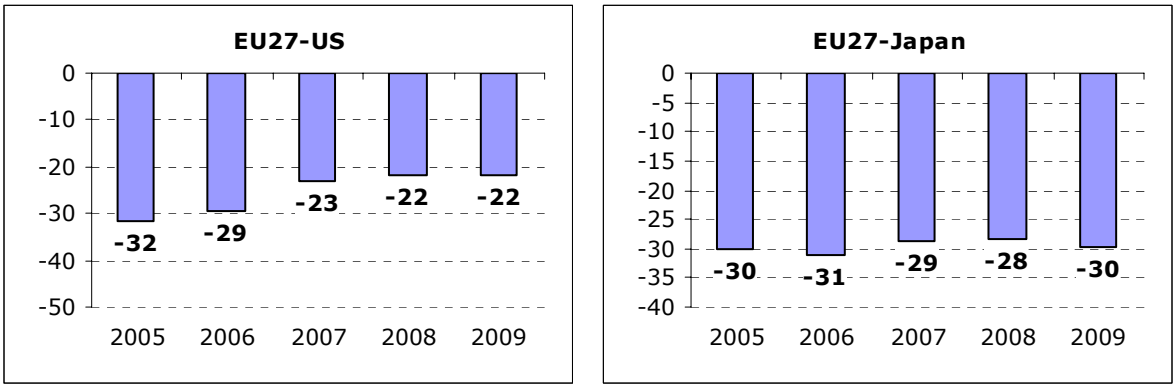
- R&D personnel (expressed in head counts) as a percentage of total employment was 1.57% in the EU in 2007 (43% in the business sector; 57% in the public sector), compared to 1.81% in Japan (61% in the business sector; 38% in the public sector), where growth was also faster.

2.2.1.3. Innovation activity

- In terms of patenting behaviour, 35% of triadic patent families[25] originated in the US in 2007, with 31% originating in Japan and 25% originating in the EU27.[26]

- The share of companies in the EU that demonstrate innovative behaviour (via the introduction of new or improved products, processes, services, marketing methods or organisational changes) stood at 53% in 2007,[27] but only 25% of such companies typically introduce new goods or services in national markets other than their own,[28] thus failing to take advantage of the single market.

Exhibit 1: Overall Innovation Gaps between the EU27 and the US and Japan



Performance for each reference year is measured using, on average, data with a two-year lag (e.g. performance for 2009 is measured using data for 2007).

Source: European Commission (2009c)

25 A patent is a member of a so-called triadic patent family if and only if it has been applied for and filed at the European patent Office (EPO) and the Japan patent Office (JPO), and if it has been granted in the United States Patent and Trademark Office (USPTO).

26 European Commission (2009c)

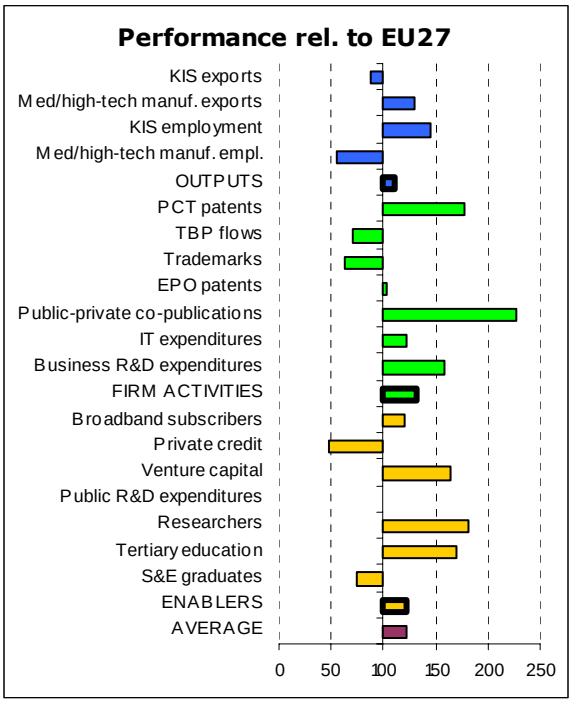
27 European Commission (2009c)

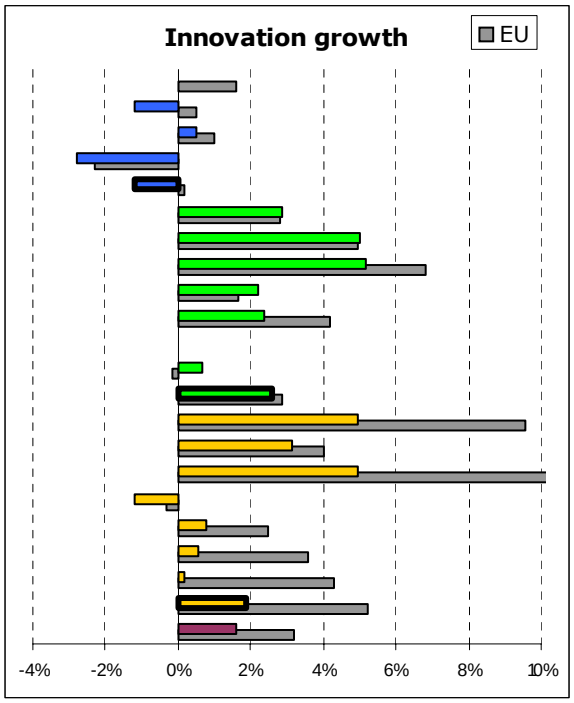
28 European Commission (2004)

- Using a composite indicator to summarise overall innovation performance, the European Innovation Scoreboard 2009 estimates that the innovation gap between the EU27 and the US is still considerable, even though it shrank from a deficit of 32 percentage points in 2005 to a deficit of 22 percentage points in 2009. The corresponding deficit with Japan is 30 percentage points.[29] Trends over time are depicted in Exhibit 1.

- Breaking down the composite indicator into its constituent parts, Exhibit 2 shows that the US performs better than the EU27 along 11 dimensions out of the 17 for which comparative data are available, although the innovation lead shrank along many of these dimensions as EU27 growth rates over the period 2005-2009 exceeded those in the US. A similar situation also exists with regard to Japan.

Exhibit 2: EU27-US Innovation Performance Indicators





Average annual growth rates are calculated over a five-year period.

The indicators reflecting Enablers are highlighted in yellow, those reflecting Firm activities in green and those reflecting Outputs in blue.

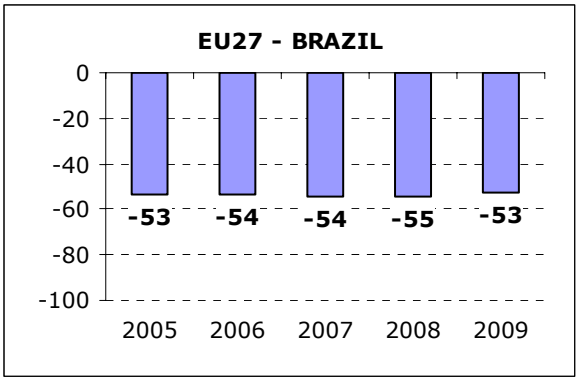
Source: European Commission (2009c)

[29] European Commission (2009c)

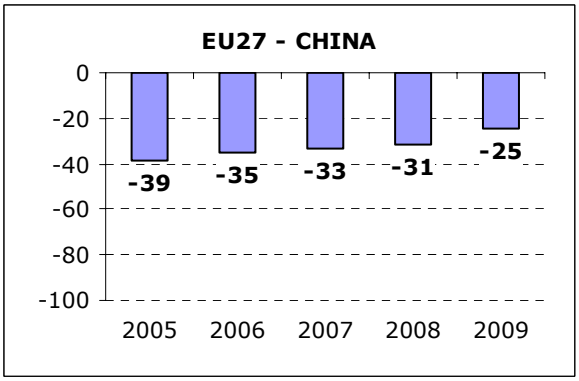
- Compared to the so-called BRIC countries (Brazil, Russia, India and China), the EU27 still has a strong lead (see Exhibit 3), but China narrowed the gap from 39 percentage points in 2005 to 25 percentage points in 2009 and is rapidly catching up.[30]

Exhibit 3: The Innovation Gaps between the EU27 and the BRIC Countries

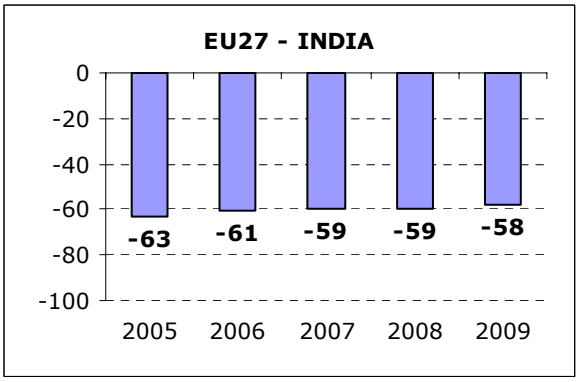
Strong and stable lead to Brazil



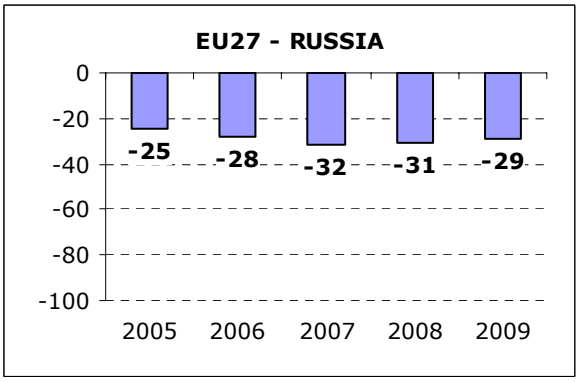
Declining lead to China



Strong but slowly declining lead to India



Stable lead to Russia



Source: European Commission (2009c)

- Further breakdowns, based on the new Performance Scoreboard for Research and Innovation, are presented in Annex II of the Innovation Union Communication.[31]

2.2.1.4. Productivity performance

- The EU27 productivity gap with the US in 2008 was about 50% in GDP per capita or 28% in GDP per hour worked.[32]

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30 European Commission (2009c)

31 These numbers are not comparable to the tables in the Innovation Union Communication which are from the new Performance Scoreboard for Research and Innovation.

2.2.2. Performance variations between Member States of the EU

Some of the major differences between different Member States within the EU are summarised below:

2.2.2.1. Academic institutions

- Expenditure on higher education as a percentage of GDP varies considerably across the EU27. In 2007, it was more than 2% of GDP in only one country (Denmark), but under than 1% in eight countries (Bulgaria, Croatia, Italy, Latvia, Poland, Slovakia, Spain, United Kingdom).[33]

- The 27 EU27 universities featured in the top 100 of the 'Shanghai Ranking' of the world's universities in 2009 came from only seven Member States. Of these, 11 came from the UK and five from Germany. Nine EU27 countries had no universities in the top 500 of the Shanghai Ranking.[34]

2.2.2.2. R&D levels

- Eight Member States have GBAORD levels greater than 0.8% of GDP, with six having levels of less than 0.3% of GDP.[35]

- Within Europe, seven Member States had R&D intensity levels greater than the EU average in 2008. Intensity levels had increased in six of them and decreased in one. Conversely, levels were lower than average in the remaining 20 Member States, although growing in 15 of them.

- In terms of Business R&D intensity, two countries had levels of over 2% in 2008 (Sweden and Finland), while seven countries had levels below 0.2% (Cyprus, Bulgaria, Greece, Latvia, Lithuania, Poland and Romania).

- Across the Member States, ten Member States had above EU27 average levels for R&D personnel (expressed in head counts) as a percentage of total employment in 2007, whereas 17 had below average levels.

2.2.2.3. Innovation activity

- In terms of the European Innovation Scoreboard, Exhibit 4 shows that there is still a wide divergence across the EU in terms of both innovation performance levels and annual average growth in innovation performance. There is, nevertheless, an overall process of convergence within the EU27, with most countries with below average

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32 European Commission (2008b)

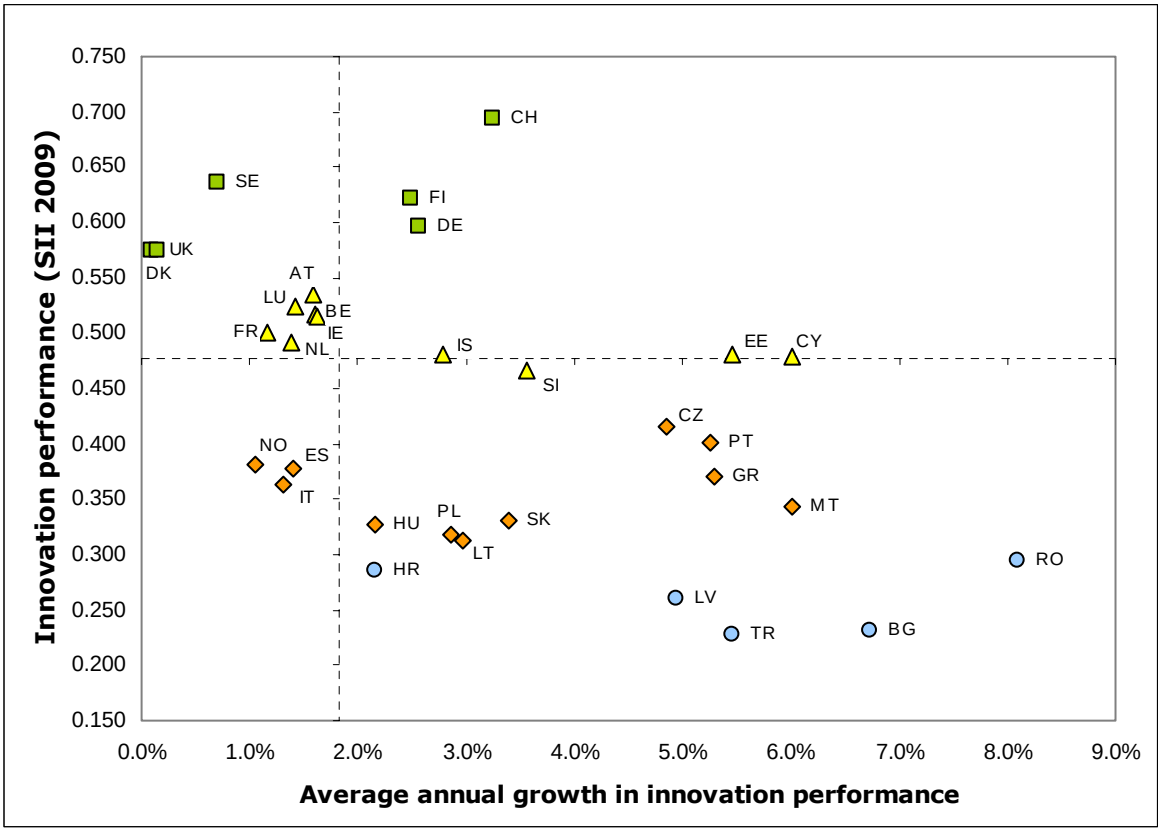
33 Eurostat: Total public expenditure on tertiary education (ISCED 5-6) as % of GDP (2007)

34 Shanghai Jiao Tong University (2009)

35 Unless otherwise stated, the figures in this section are based on the latest provisional data supplied by Eurostat.

performance displaying faster growth rates than those whose performance is above the average. Growth rates were below average, however, for three of the leading five innovation performers and the overall growth rate for the EU27 has flattened out.

Exhibit 4: Innovation Performance Convergence in the EU27



Colour coding is used to distinguish between four groups of countries: green are the Innovation leaders, yellow are the Innovation followers, orange are the Moderate innovators, blue are the Catching-up countries. Average annual growth rates as calculated over a five-year period. The dotted lines show EU27 performance and growth.

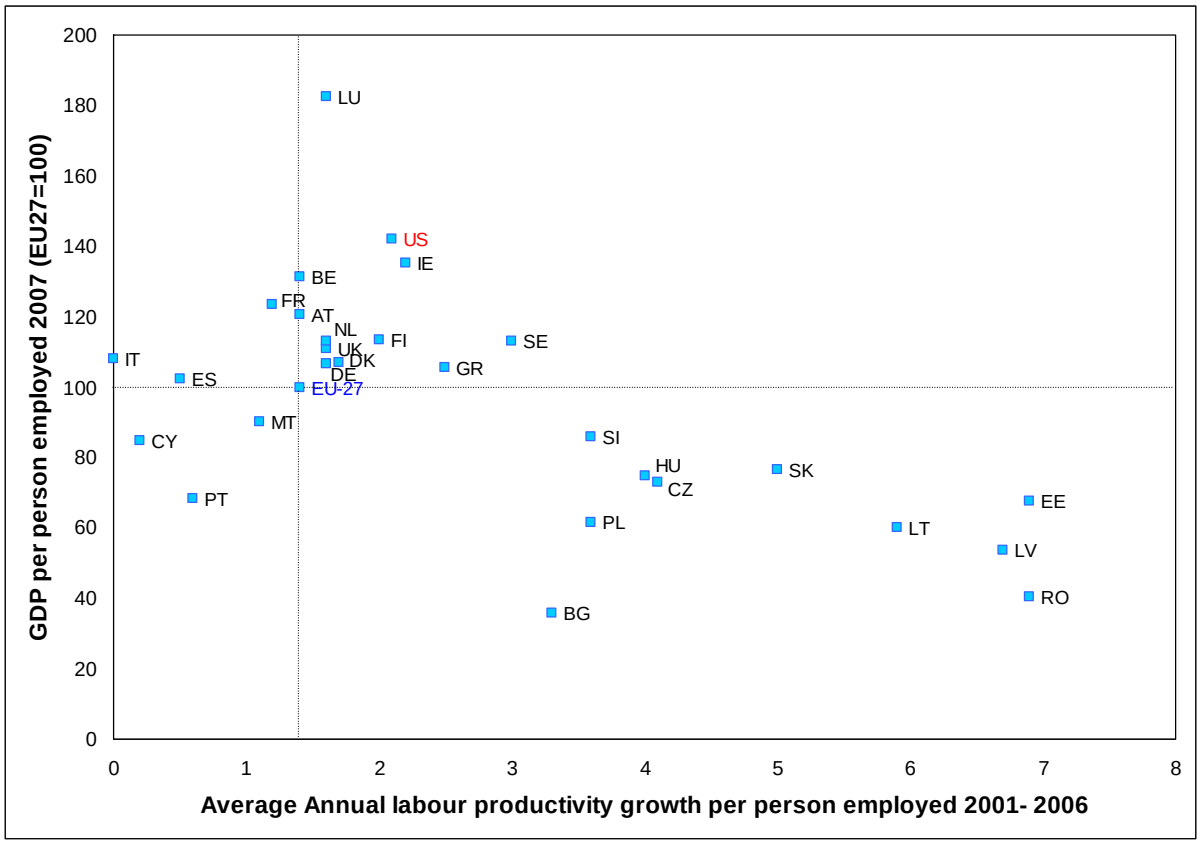
Source: European Commission (2009c)

- The divergence in innovation performance within the EU is even wider if regional innovation performance is considered. The 2009 edition of the 'Regional Innovation Scoreboard' (RIS) reveals that all countries have regions at different levels of performance. This emphasises the need for policies to reflect regional contexts and for better data to assess regional innovation performances. The most heterogeneous countries are Spain, Italy and Czech Republic where innovation performance varies from low to medium-high**.**

2.2.2.4. Productivity performance

- There are wide differences between both productivity levels and productivity growth rates across the Member States. Taking GDP per person employed in 2007 for the EU27 to be 100, values for individual Member States ranged from a high of 182.3 (Luxembourg) to a low of 35.6 (Bulgaria). Similarly, growth rates in terms of annual labour productivity growth per person employed for the period 2001-2006 ranged from a high of 6.9 (Romania and Estonia) to a low of zero growth (Italy). Eleven countries demonstrated above average productivity and above average rates of productivity growth (Luxembourg, Ireland, Belgium, Austria, Finland, Netherlands, Sweden, UK, Denmark, Germany, Greece), while 10 countries demonstrated below average productivity but productivity growth rates that were still above average (Slovenia, Slovakia, Hungary, Czech Republic, Estonia, Poland, Lithuania, Latvia, Romania, Bulgaria). However, three countries with higher than average productivity levels had growth rates lower than average (France, Italy and Spain), while the remaining three had lower than average productivity levels and growth rates (Malta, Cyprus and Portugal). (See Exhibit 5)

Exhibit 5: Productivity levels and Growth Rates across the EU27



Source: JRC-IPTS: derived from European Commission (2008b)

2.3. What are the key weaknesses that need to be addressed?

Many explanations have been put forward to explain different aspects of the relative under-performance of the EU research and innovation system as a whole and the variations that exist between Member States. One way to categorise these is via a simple conceptual model comprising five main 'system components' ('Human Resources'; the 'Science Base'; 'Industrial R&D'; 'Industrial Innovation'; 'Users and Markets'), all of which are fed by an additional 'Finance' component. Examples of the types of policy issues typically associated with these domains and the links between them are shown in Exhibit 6.[36]

The most cogent explanations for the under-performance of research and innovation systems in Europe include: the under-financing of various activities across research and innovations systems; weaknesses in the operation of specific components of these systems at EU, national and regional levels; the failure of many of these system components to function or link effectively together; and weak research and innovation governance systems and resulting policy portfolios.

2.3.1. Under-investment in research and innovation

Under-investment (equivalent to low flows from the finance component) affects the efficient and effective functioning of all other system components, thus undermining overall system performance and, ultimately, downstream impacts on economic performance and social well-being.

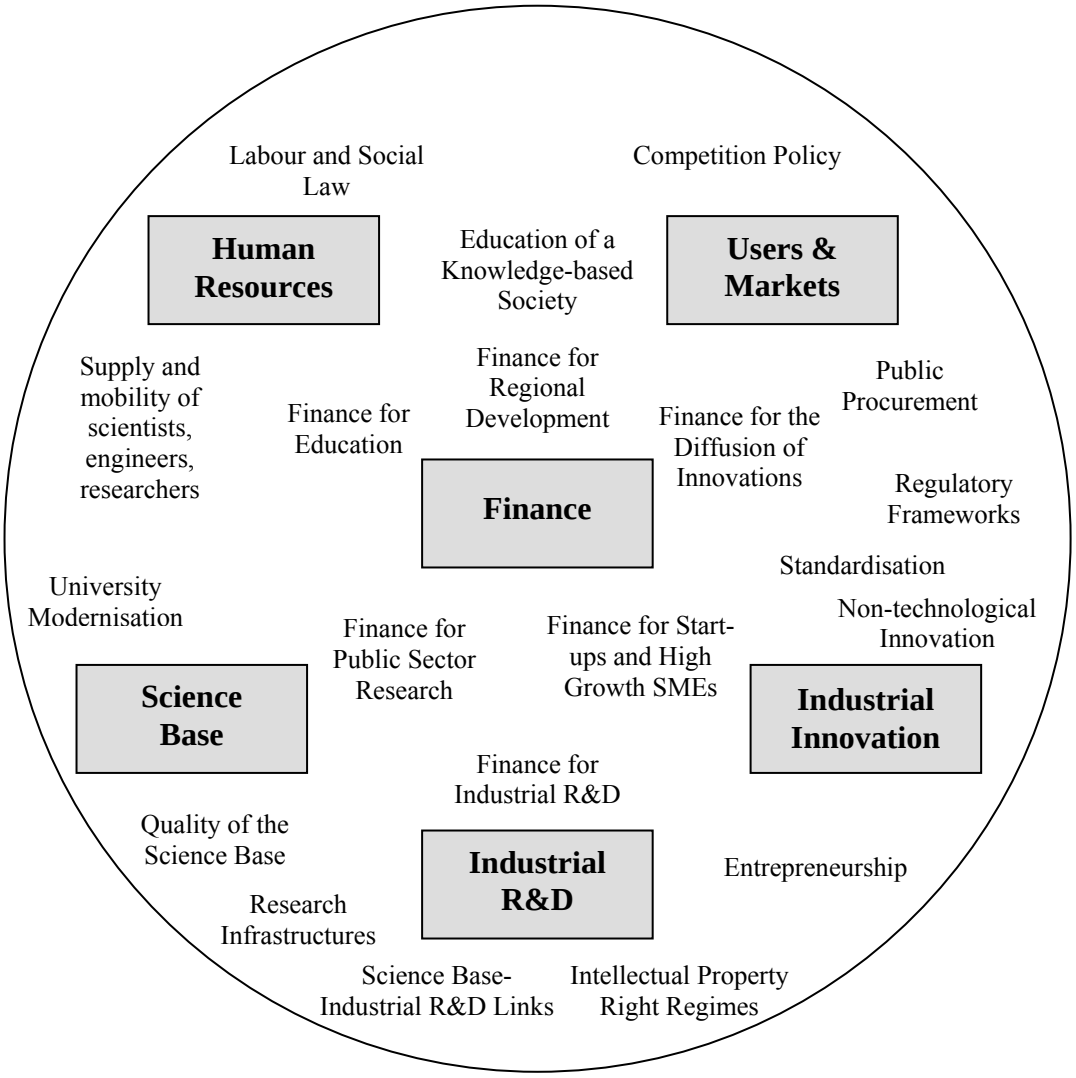
2.3.1.1. Human resources

- Comparatively low levels of investment in education and training in the EU (compared to the US) have downstream impacts on innovative activity and economic performance. Insufficient investment in the higher education system has been identified as one major cause of modest innovation performance.[37]

[36] Many such models have been elaborated over the last decade or so, most of which are complex and difficult to portray in two dimensions. This simple model draws on many of them but does justice to few of them. It is nevertheless useful as a means of structuring a narrative describing the weaknesses of European research and innovation systems.

[37] Aghion *et al* (2007)

Exhibit 6: Research and Innovation System Components and Policy Concerns



Source: JRC-IPTS

2.3.1.2. Science base

- In some areas, Europe lacks world-class research infrastructures capable of attracting the talent needed to conduct high quality research. This is particularly so in newly emerging key technology areas – a situation that has to be rectified if Europe is to keep abreast of the world. The costs associated with the construction and maintenance of these infrastructures, however, are often such that they cannot be met by individual Member States alone, and current levels of investment are still insufficient despite the

efforts being made by the European Strategy Forum on Research Infrastructures (ESFRI).[38]

2.3.1.3. Industrial R&D

- One of the reasons for the productivity gap with the US is the relatively low level of investment in R&D in the EU, particularly by the private sector.

- Low levels of investment in R&D are largely due to differences in industrial structure and company demographics[39] and not to the propensity of individual EU-headquartered firms to invest less than similar companies headquartered elsewhere.[40] High R&D intensity sectors in the EU are generally smaller than in the US and Japan and contain proportionately more SMEs, which invest less per firm than larger companies. These sectors are thus less R&D intensive than their equivalents in other countries (20% less R&D intensive than in the US)[41] and make lower contributions to overall R&D intensity than they do in either the US or Japan.[42]

- The productivity gap is further aggravated by the fact that, compared to the US, private sector R&D investment in the EU is more concentrated in the medium-high tech sector than in the high-tech sector, since the impacts of R&D investment on productivity are greater in high-tech sectors than they are in medium- and low-tech sectors.[43] Bridging the gap between the EU and the US would require a substantial increase in the share of high-tech, high R&D intensity sectors in the EU economy, but this is hindered by the fact that few R&D intensive SMEs grow into large corporations capable of gradually shifting the structure of the economy towards large, high R&D performing and wealth creating sectors.[44] Few large European high-tech companies have been created over the last couple of decades and the average age of big R&D spenders in the EU is consequently much higher than in the US.[45] The drivers of change are young leading innovators (or 'Yollies'), which are far more numerous in the US than in the EU, especially in leading-edge sectors such as semiconductors and biotechnology.[46]

2.3.1.4. Industrial innovation

- One factor affecting both the start-up and the continued growth of innovative companies is access to the finance needed to fuel activities at various growth stages. Numerous studies have noted that such access is limited in Europe for a number of

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38 See Section 3.2.3 for further details
39 See Moncada-Paterno-Castello *et al* (2009), DGPTE (2006) and European Commission (2008c)
40 Soete, Guy and Præst Knudsen *et al* (2009)
41 European Commission (2008c)
42 DIUS/BERR (2008)
43 Kumbhakar *et al* (2010)
44 Hughes (2007)
45 Soete, Guy and Præst Knudsen *et al* (2010); Veugelers (2009)
46 Veugelers and Cincera (2010)

reasons. These include the risk-averseness of banks, the lack of competent staff within them to understand and assess the new opportunities offered by emerging technologies, the fragmentation of venture capital markets and low perceived returns on investment (especially in the short term).[47]

- Areas of particular concern include finance to bridge the so-called 'valley of death' that young companies face when attempting to raise the capital needed to transform potentially good ideas and research results into marketable goods and services. Another critical area, especially given the dearth of small companies that succeed in growing to become major players, is capital to fuel this growth.

2.3.2. System component weaknesses

The way individual components of research and innovation systems operate can ultimately affect the overall performance of whole systems, with each system ultimately limited by the strength of its weakest link.

2.3.2.1. Human resources

- A recent independent expert report confirmed Europe's skills deficiencies and stressed the importance of providing the right incentives for people to upgrade their skills, to better link education, training and work, to develop the right mix of skills, and to better anticipate skill needs in the future.[48]

- Lack of the right kind of education and training is also an important issue, with a persistent lack of focus in the EU on the development of innovation skills and entrepreneurial behaviour.[49] Entrepreneurial attitudes and skills are thus relatively under-developed in the EU, with many new businesses reluctant or failing to grow after entry.

- A key human resource problem for Europe is the constrained mobility of researchers within the EU and the relative attractiveness of the EU to inward flows of researchers from other parts of the world. Increased mobility is strongly associated with the creation of dynamic networks, improved scientific performance, improved knowledge and technology transfer, improved productivity and ultimately enhanced economic and social welfare, but many barriers (low salary levels, legal and regulatory constraints, language barriers, lack of open recruitment practices in public research institutions etc.) continue to act as a deterrent to 'brain circulation'.[50]

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47 See, for example, European Commission (2009d) and (2009e)

48 European Commission (2010b)

49 Green *et al* (2007). See also Ferrari *et al* (2009)

50 Fernandez-Zubieta and Guy (2010)

2.3.2.2. Science base

- The strength of the EU science base has an important influence on downstream innovative performance and economic development. There is mounting evidence, however, that the modernisation of the EU's universities – which is needed to attract the highest quality staff, establish critical masses of research effort and interact effectively with industry – continues to be hampered by a complex web of different legal and regulatory hurdles in each Member State.[51]

- Collectively, policy initiatives at EU level that span attempts to strengthen the research base, modernise universities, improve research infrastructures and improve the supply and mobility of researchers have been brought together under the umbrella of the ERA initiative – an ambitious attempt to develop a new integrated research system at a European level capable of exploiting the full potential of Europe's talent pool and promoting the free movement of knowledge and researchers. This has been on-going since 2000, but there are still many obstacles to its full realisation. The consequences are that the sub-criticality of many research activities and the lack of mechanisms to focus adequate amounts of research funding on key areas of research continue to undermine the overall efficiency of the whole research and innovation system.

2.3.2.3. Industrial R&D and innovation

- The ability of industry to exploit the fruits of research in some sectors depends critically on the existence of adequate intellectual property regimes (IPR) capable both of protecting the undesired exploitation of intellectual capital and of stimulating its desired exploitation (via licence agreements etc.) In Europe, the absence of an accepted EU patent and the costs involved in applying for and obtaining patent protection in multiple Member States has long been perceived as a barrier to the effective function of the EU research and innovation system.[52]

- Another weakness has been the absence of an effective marketplace linking potential users with unexploited sources of intellectual capital. Some patents exist solely to prevent the exploitation of intellectual capital by unauthorised users, but an estimated one third to one half of all patents are dormant patents that are potentially available to interested parties.[53]

2.3.2.4. Industrial innovation, users and markets

- Markets for innovative goods and services are often constrained by regulations that act as a disincentive to change. Conversely, there is increasing evidence that timely regulations can be a spur to innovation, as firms attempt to find ways of complying with new regulations. It is possible, therefore, to contemplate the construction of

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51 See, for example, European Commission (2007a)

52 See, for example, van Pottelsberghe de la Potterie and Danguy (2010)

53 Harhoff *et al* (2007)

innovation-friendly regulations. But as Greenspan[54] has noted, markets evolve and regulations always seem to be in flux, with shifting regulatory schemes unavoidably leaving obsolescent regulations in their wake. Simply introducing new, innovation-friendly regulations is not enough. Occasional but regular reviews of all existing regulations are needed in order to revise or rescind those that are out of date.

- The development of common standards is also critical for the development of markets for new innovative products and services, especially those that need to interact with other technologies and technological infrastructures. The process of developing standards, however, is time-consuming, and ways need to be found of speeding up standard-setting procedures to cope with shortening innovation cycles.[55]

- Public procurement, which accounts for almost 17% of EU GDP,[56] can be used not only to satisfy the immediate needs of the public sector, but also as a way of stimulating and catalysing far broader market development as firms seek additional customers for the goods and services they produce, initially, to satisfy public sector demand. The bulk of such public purchases, however, do not put a premium on innovation, although committing just 0.5% of current procurement budgets to the procurement of innovative solutions and pre-commercial procurements would generate an annual market for innovative products and services worth some €10 billion.[57]

- Policy initiatives dealing with standards, regulations and public procurement can all affect the process of market development when applied at Member State level, but for obvious reasons the potential scale of their impact is significantly increased when they are implemented at EU level.

2.3.3. System linkage weaknesses

The way in which different components of research and innovation systems interact with each other also helps determine overall performance levels.

- The importance of adequate links between the science base and industrial research and innovation activities as a means of improving the overall performance of innovation systems has long been recognised and many policy initiatives have been launched to nurture links of this nature at EU, national and regional levels. Evidence of disillusionment with the bureaucracy surrounding many of these initiatives, however, threatens to make them unattractive, unless procedures can be simplified.[58]

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54 Greenspan (2002)

55 European Commission (2008d)

56 Figures reported by Member States to the European Commission for 2009.

57 The EU budget in 2009 was approximately €11,800 million; EU procurement expenditure was approximately €2 billion; and 0.5% of this is roughly €10 billion.

58 See, for example, European Commission (2010c)

- Weak linkages are also evident between other innovation system components. For example, innovative companies, especially SMEs, often encounter difficulties establishing links with sources of finance, advanced users, marketing specialists and other sources of specialist knowledge.

- Broad concern with weak connections between knowledge creation, knowledge utilisation and economic and societal benefits has led to a new policy focus on linkage mechanisms, the majority of which try to link the world of ideas with the marketplace by removing obstacles to the speedy transformation of ideas into products, processes and services and their subsequent diffusion in the marketplace.

- Linking individual elements of innovation systems together, however, will not be enough. Adequate links across the whole system need to be in place if the system as a whole is to function effectively, and this calls for concerted efforts to evolve broad policy mixes that help pave the whole way 'from idea to market'.

2.3.4. System governance weaknesses

The policies and policy-making structures and processes associated with R&D and innovation systems have, until recently, been characterised by policy mixes dominated by supply-side instruments, with limited synergy between instruments and few processes and structures in place to ensure the construction of appropriate and coherent policy mixes. The spread of 'innovation system thinking', however, has begun to shift the focus of good governance away from the functioning and management of individual system components and towards consideration of the balance between policies addressing these components, the way in which they interact and the evolution of context-dependent policy mixes.

2.3.4.1 The balance between supply- and demand-side instruments

- Nearly half the enterprises responding to the Innobarometer 2009 survey indicated that demand-side policies had positively impacted their innovation activities.[59] Despite the potential impact of such policies, however, reviews of the policy mixes in place in national contexts indicate that much more reliance is placed on supply-side instruments such as the provision of funds or tax incentives for organisations to carry out research or develop innovations. This is changing in some of the more mature and sophisticated national research and innovation systems, with demand-side instruments starting to occupy a more prominent position in national policy portfolios, and there have been interesting developments in the stimulation of lead markets at a European level, although the full power of demand-side instruments has yet to be unleashed.[60]

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[59] European Commission (2009b)

[60] For policy developments at a country level, see the annual analytical country reports produced by ERAWATCH (http://cordis.europa.eu/erawatch/index.cfm?fuseaction=reports.content&topicID=600&parentID=592) and the annual country reports produced by Inno-Policy TrendChart (http://www.proinno-europe.eu/trendchart/annual-country-reports)

2.3.4.2. Interactions between supply- and demand-side instruments

- There is also little to suggest that demand-side instruments, when used, are adequately linked either conceptually or practically to the implementation of more conventional supply-side instruments. Some countries, however, are moving in this direction, especially countries that have chosen to focus support and build up critical masses in scientific and technological areas and industry sectors that they consider to be of strategic importance.

2.3.4.3. Appropriate policy mixes

- The wide differences in performance of the research and innovation systems of Member States have undoubtedly contributed to the EU-US productivity gap that has widened since the mid-1990s.[61] Although innovation-related expenditures – especially R&D expenditures – have risen in Member States, innovation and productivity performance improvements have not been enough to close the productivity gap with the US. In terms of the policies needed to continue to reduce the performance differences between Member States and close the productivity gap with the US, there are no simple, generic policy prescriptions that can be universally applied. This is a straightforward consequence of the complexity of research and innovation systems and the huge differences between them in terms of comparative strength, maturity and governance structures and processes. That said, recent studies have suggested that generic approaches to the design of policy mixes can be identified and that these can be distilled into a series of 'hints and tips' for policymakers interested in improving the design of policy mixes and enhancing innovation system performance.[62]

- Key steps include investment in adequate 'strategic intelligence' capabilities; the establishment of clear goals that are effectively communicated to all stakeholders; the implementation of parallel policy initiatives to build on specific strengths and rectify key weaknesses in the functioning of overall research and innovation systems (identified via the 'strategic intelligence' capabilities); tackling specific problems through the use of tightly linked and coordinated 'policy packages' or 'mini-policy mixes' spanning supply- and demand-side instruments; and the establishment of sound governance structures ensuring strong linkages between supply- and demand-side instruments, between different arms of government, and between different levels of governance (e.g. regional, national and international). These ideas are further developed in Section 8 in the context of the Innovation Union proposal to define a set of good policy practices to which Member States can aspire.

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61 See Sections 2.2.1 and 2.2.2

62 See, for example, Guy *et al* (2009)

2.4. What new challenges are likely to affect research and innovation performance?

In addition to all the factors noted above that affect the functioning of research and innovation systems, **overall performance is likely to be affected in future by a number of new challenges. These include the impact of the recent financial crisis; the sheer scale of the societal challenges that confront us; increased competition from countries such as China and India; and changes in the way that innovation is conducted and where it occurs**.

2.4.1. Financial crisis

- The levels of debt incurred by the public sector as a consequence of the financial crisis are likely to increase the pressure for cuts in public support for research and innovation. There is historical evidence, however, that a strong, continued focus on these areas throughout downturns can create a springboard for future recovery and growth.[63] The extent to which the public sector is now inextricably involved with the private financial sector also provides an opportunity for a new era of public-private partnerships capable of nurturing a new phase of innovation-fuelled growth.[64]

2.4.2. Major societal challenges

- The sheer number, scale and urgency of the major societal challenges we face are daunting. A policy imperative, therefore, will be to mobilise the resources needed to tackle the problems associated with climate change and energy shortages; to promote sustainable development and provide affordable high-quality healthcare; and to address a host of other societal problems, many of which would benefit from research and innovations that are capable of resolving or mitigating them.

- This involves placing a far greater emphasis than hitherto on attempts to influence the direction rather than the rate of technical change and innovation. It also implies that concerted efforts will be needed to ensure that public resources across Europe are pooled in an effort to tackle these problems along a united front, rather than dissipated in sub-critical, duplicative initiatives.[65]

2.4.3. Globalisation and agglomeration

- One aspect of the increasing globalisation of trade, production, innovative activity and research has been the emergence and multiplication of a range of new competitors (notably the BRIC countries) to challenge innovative firms and scientific institutions in Europe and elsewhere. It is no longer true, for example, that emerging economies are lagging behind in technological development. Many have significant pockets of

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63 See, for example, OECD (2009)

64 Soete, Guy and Præst Knudsen *et al* (2009)

65 Soete, Guy and Præst Knudsen *et al* (2009)

academic excellence; strong educational programmes; major programmes to create research infrastructures and attract leading academic researchers; strong entrepreneurial industries; and sophisticated, well-educated users and consumers. In turn, these developments increase the pressure on the EU to continue to be globally competitive in terms of the quality of its research, its innovative goods and services and its ability to attract researchers and innovators of the highest calibre.

- Despite increasing globalisation, however, an uneven spatial distribution of research and innovation-related activities still persists across the globe, with investment in these activities often concentrated in a relatively small number of locations, even though the number of such agglomerations or 'innovation hot spots' is increasing as a consequence of globalisation. This is the case even in relatively new fields. Policies to foster 'innovation hot spots' or 'clusters' have long been a focus of regional, national and EU policy. Accumulations of knowledge assets such as these generate added value and knowledge spillovers, which in turn attract other mobile assets (human and capital) and act as a disincentive to the dissipation of existing assets. These 'hot spots' then act as growth poles for regional development, which is why 'cluster' policies which support the development of business environments and public private partnerships that provide fertile ground for innovation and the emergence of new industries have been warmly embraced by regions as a way of deploying Structural Funds.

- In Europe, 85% of firms affected by cluster policies claim that their competitiveness increased as a result,[66] and firms such as these are generally more innovative than non-clustered firms.[67] According to one comparison made by the European Cluster Observatory, however, Europe still lags behind the US in terms of average 'cluster strength'.[68]

- The increased competition that globalisation brings, therefore, will probably require intensified efforts to strengthen existing 'hot spots', to support the development of emerging industry clusters driven by new technologies and service innovations, and to ensure that regions in the EU make wise or 'smart' decisions about the types of agglomerations they nurture. This is the essence of 'smart specialisation' – the attempt to build on regional strengths in key strategic areas, but doing so informed by an over-arching picture of each region's competitive advantages and disadvantages in a context of fierce global competition for resources.[69]

- Whereas agglomeration can be characterised as the accumulation of knowledge stocks, and past policies can be characterised by their strong focus on strengthening such stocks, globalisation brings something new to the game. Globalisation certainly involves the entry of new players in new countries in knowledge production (leading

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66 Sölvel *et al* (2003)
67 European Commission (2006a)
68 Cited in European Commission (2008e)
69 See Foray and van Ark (2007)

to an overall increase in knowledge stocks), but it is also characterised by increases in the circulation of knowledge and the international flow of skilled people between existing and new players (increasing knowledge flows), and by the increased exploitation of knowledge generated elsewhere by research and innovation actors around the globe (so called 'open innovation').

- While the traditional policy approach was to ensure that existing agglomerations in Europe were strengthened and new agglomerations were created in research and innovation-intensive sectors (an emphasis on knowledge stocks), the new approach demands a much greater focus on efforts to create and nurture global research and innovation networks capable of ensuring access to the vast range of heterogeneous knowledge inputs demanded by knowledge accumulation and open innovation (an emphasis on knowledge flows), together with greater efforts to ensure that the EU captures a significant share of the economic activity generated by open innovation. In turn, this requires much stronger co-operation and linkages between research and innovation actors and activities in the EU and those located elsewhere, based on an advanced international co-operation strategy that ensures that knowledge sharing support's Europe's needs and is mutually beneficial to all partners.

2.4.4. New forms of innovation

- The rise of 'open innovation' – which involves companies relying much more on 'traded' knowledge inputs and outputs instead of primarily or even solely on self-generated inputs and outputs – is only one of the many shifts affecting the pattern of innovative activities across the globe. A recent OECD report describes the 'new nature of innovation'[70] and its characteristic drivers. One driver transforming the way companies innovate increasingly sees users involved in the co-creation of value, resulting in so-called 'user-driven innovation', while another sees public sector challenges – e.g. the challenge of delivering better health and welfare systems to ever more demanding and discerning citizens – driving a wave of so-called 'social innovation', which is likely to call for new interactions and partnerships between the public and private sectors for innovation activities that have a social benefit. Underpinning all these developments, there is increasing evidence that ICTs, especially recent social media applications, are important enablers of open, user-driven and social innovation.[71]

- Related to all of these new forms of innovation is the increasing importance of 'non-technological' innovation, especially within the burgeoning service sector. Forms of non-technological innovation have always been important in the manufacturing sector – witness the historical importance of 'organisational innovation' involving changes in

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70 OECD (2010b)

71 See, for example, Punie *et al* (2009). Available at: http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=2819; and Punie, Misuraca and Osimo (2009). Available at: http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=2820

the way work flows and production have been organised[72] – but 'soft' innovations involving the introduction of new business models, marketing strategies, service delivery modes etc. are critically important in the service sector, which typically accounts for the majority of employment in many Member States. The trend towards the bundling of services with products in many manufacturing sectors also means that such forms of innovation are important in an expanding range of sectors.

- Although research is a vital input for many innovation activities within firms and for overall competitiveness, evidence from the Community Innovation Survey (CIS) shows that almost half of European innovators (and higher percentages in the new Member States and low technology sectors in particular) do not conduct intramural or in-house research (see Exhibit 7).[73] Their innovation activities are based instead on advanced machinery and computer systems purchased to implement new or improved processes and deliver new products and services; on the purchase of rights to use patents, licences, trademarks and software; on innovation-related training; and on the design and marketing innovations needed to realise returns on new products and services. In such instances, therefore, the focus of innovation support policies shifts significantly towards diffusion schemes and schemes supporting organisational innovations, especially in countries with high shares of non-R&D innovators and low research intensities, while traditional research support schemes are still needed to increase aggregate research intensities in these countries.

- Social innovation is of particular importance for policy development because of the important role that governments are expected to play in the resolution of societal problems. Social innovations can be defined in terms of both ends (new solutions to societal problems) and means (the new forms of social organisation needed to ensure their delivery). They necessarily involve new forms of organisation and interaction that respond to social demands for new and better ways of resolving societal problems and satisfying social needs. It is difficult to estimate the extent to which social innovation occurs because of a distinct lack of adequate metrics, but there is no doubt that the demand for social innovation, in terms of ends and means, is increasing given the scale and diversity of societal problems that have to be resolved.

- The broad implication of all these trends and new forms of innovation is that the scope of innovation policy has to become broader. Traditional innovation policies are typically characterised by a preoccupation with the manufacturing sector, an emphasis on technological rather than non-technological change, and strong dependencies between research and innovation (hence the many policy instruments designed to strengthen this link). Increasingly, however, policymakers have begun to acknowledge that innovation is also taking place somewhere else. The growing roles of services, creative industries, software and software-related innovative activities, for example,

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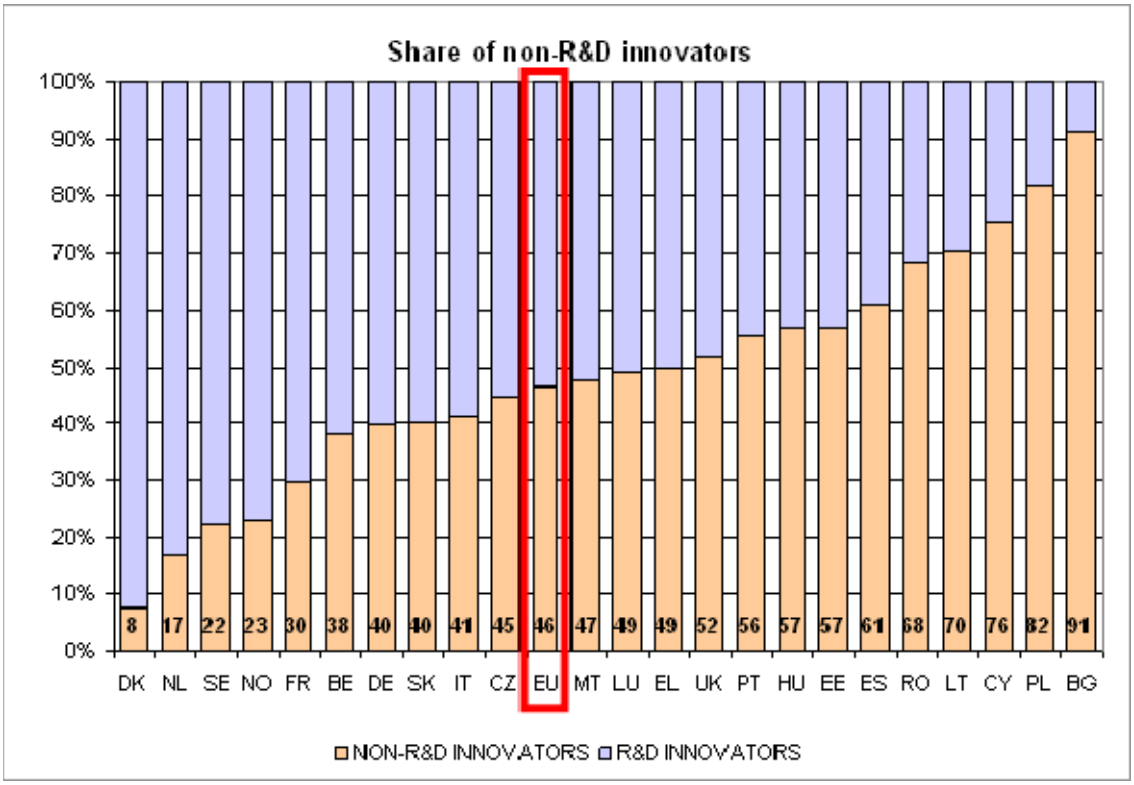
[72] As noted by Lam (2004), Schumpeter saw organisational change as a key factor in 'creative destruction' as early as 1950.

[73] European Commission (2007b)

have been amply illustrated in numerous reports,[74] and more and more Member States, particularly those regarded as 'Innovation Leaders', have introduced measures to support innovation in the service and creative industry sectors. Policy agendas thus need to be modified to take account of such developments.

Exhibit 7: R&D and Non-R&D Innovators in the EU



Source: European Commission (2007b)

2.5. What policy responses are needed at EU level?

- Many recent policy initiatives at EU, Member State and regional levels have sought to improve the performance of research and innovation systems in the EU27, but the gaps in research, innovation and economic performance that still exist between the EU and its trading partners, the wide disparity in performance levels across Member States and EU regions, and the wide range of weaknesses that need to be rectified across the EU, all testify that a great deal still needs to be done if the EU is to continue to be a strong, innovation-led economy. Moreover, the scale of the new challenges presented by the financial crisis, major societal problems, globalisation, the increased expectations of society etc. further **testify to the urgency of the situation and the need to change gear in the development of a strong research and innovation system capable of powering sustainable economic growth and enabling the EU to**

[74] See, for example, Turlea *et al* (2010)

compete on favourable terms with our major economic competitors in the global marketplace.

- The rationales for the specific policy responses that are required are set out in Sections 3 to 8. In the following sub-sections, however, we comment firstly on the role the EU could play in terms of contributing to the activities of Member States and secondly on problems that are best dealt with at the level of the EU itself.

2.5.1. Improving performance at Member State level

- No individual Member State is identical to another and the problems they face and the policies they need to tackle them are highly context-dependent and best formulated and implemented by national and regional authorities. That said, many countries and regions face similar sets of problems and would benefit from an overview of how other countries confront them, especially when they do so successfully.

- Two areas are of particular relevance to attempts to improve research and innovation systems. The first concerns improved understanding of the ways in which other countries have gone about constituting and implementing successful policy mixes. Experiences with different national policy mix review processes, conducted under the auspices of CREST[75] and the OECD[76] respectively, suggest that countries can benefit considerably from an appreciation of 'best practice' even if such practice invariably has to be customised to their own particular circumstances. Codified versions of 'best practice' developed via overviews of experiences across the EU (and more widely) could thus be used by countries and regions to benchmark their own efforts to improve research and innovation system performance (this idea is developed further in Section 8).

- The second area concerns the topic of 'smart specialisation' at a regional level. Member States typically exploit Cohesion policy and the Structural Funds to further regional development, but the implementation of 'smart specialisation' strategies depends not only on an appreciation of a region's own strengths and weaknesses, but also on an appreciation of external threats and opportunities, which in turn calls for a comprehensive overview of global developments in potential areas of interest. There is scope here, therefore, for the EU to play a role in the provision of 'helicopter' perspectives.

- The EU can also contribute actively to policy efforts at Member State level when the dilemmas they confront or the weaknesses inherent in their research and innovation systems are common to all or most Member States. Lack of risk capital, low levels of entrepreneurship and weak links between the science and business worlds are problems shared by most Member States and are thus areas where policy actions at EU level would complement those that are implemented by Member States themselves.

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75 See http://www.consilium.europa.eu/showPage.aspx?id=1430&lang=en

76 See www.oecd.org/sti/innovation/reviews

2.5.2. Improving performance at EU level

- Some problems cannot be tackled by Member States alone and need to be tackled at the level of the EU. No single country, for example, can offer the advantages of scale that the single EU market offers. Similarly, the existence of innovation-friendly, EU-wide standards and regulatory frameworks offer far greater benefits than similar constructions at Member State level.

- The scale-related logic that underpins the single market also supports the drive to establish the free circulation of knowledge and unfettered researcher mobility both within the EU and between the EU and other regions of the world. It also underpins the construction of the European Research Area, which involves attempts to create critical masses and networks of research effort in strategic areas and to overcome fragmentation and duplication on the funding side via the selective pooling of resources in key areas. Notably, this can be achieved via multilateral actions organised on a variable geometry basis between Member States, where the EU frequently has a critical role to play as a catalyst, as a facilitator, and as a provider of direct financial support.

- The scale and urgency of major societal challenges now also demand collective efforts at EU level, since these challenges cannot be tackled effectively by individual Member States alone. In part, since all Member States face similar sets of 'grand challenges', EU actions designed to complement national efforts to improve individual aspects of their own research and innovation systems are all likely to contribute to the resolution of major societal problems. However, there is now also a need to improve not only the policy mixes of individual Member States, but also the coherence and effectiveness of the collective policy mix of the EU itself through the implementation of focused actions deploying coherent sets of policy instruments on both the supply- and demand-sides to tackle specific societal challenges. This point is further developed in a number of later Sections, especially Section 6.

- There is also an increasing role for the EU in an area which historically has largely been within the purview of individual Member States, namely international co-operation and the mechanics, for example, of drawing up and implementing scientific and technical co-operation agreements between countries. The demands of globalisation and open innovation call for open and level playing fields and the removal of obstacles to the free flow of researchers, knowledge and intellectual capital. It makes little sense, however, for individual Member States to be involved in a multitude of complex and time-consuming negotiations to remove such barriers to co-operate with countries outside of the EU when a viable alternative is for the EU to negotiate umbrella arrangements. Moreover, the EU would be in a stronger position to argue the case for reciprocity in terms of the opening-up, for example, of research programmes to prospective partners around the globe, and to ensure that the benefits of co-operation are shared mutually by all partners.

3. STRENGTHENING THE KNOWLEDGE BASE AND REDUCING FRAGMENTATION

The evidence and analyses presented in Section 2 suggest that multiple policy initiatives are needed to improve innovation system performance in the EU. In particular, Section 2.3 highlighted the need both to strengthen individual components of the European research and innovation system such as the science base and to ensure that all link effectively together. Section 2.5 further emphasised the need for actions at an EU level to ensure that the multiple policies in place to effect these changes are complementary rather than fragmented and duplicative. The rationales for actions proposed in the Innovation Union Communication under the heading of 'Strengthening the Research Base and Reducing Fragmentation' are thus discussed below.

3.1. Promoting excellence in education and skills development

In a global knowledge-based economy where the ability to succeed is based on a propensity to create, exchange, appropriate and exploit knowledge, it is essential to establish a sound knowledge base via policies that aim to educate, train, attract and retain a sufficient cadre of highly skilled knowledge workers. This means excellent universities, leading-edge research infrastructures, relevant and attractive curricula and the establishment of a reputation for excellence that can attract knowledge workers from all over the world and persuade businesses to establish research and innovation-related facilities within the EU. This is critical because there is a global competition for talent which Europe cannot afford to lose if it is to continue to be a world leader.

Policy imperatives, therefore, are as follows: to build up the stock of knowledge workers, especially researchers, since a great deal of innovation stems from research performed in higher education establishments and research institutes; to reduce or remove barriers to the free flow of knowledge, knowledge workers and knowledge-related capital assets; to encourage and support universities to grow into world-class knowledge centres; to encourage the spread of curricula relevant to the education of future generations of researchers, innovators, knowledge workers and entrepreneurs; to create and maintain leading-edge research infrastructures; to ensure that researchers work in conditions that are conducive to excellence; and to support all knowledge-related activities that feed into innovation in its broadest sense..

3.1.1. The stock of human resources

In Europe, our knowledge foundations are primarily laid by researchers and the institutions in which they perform research. The knowledge base they create is necessary for economic growth and increases in productivity to take place. While excellence in the knowledge base will never guarantee innovation, innovation will not flourish without it. Knowledge-intensive economies that rely for their success on the creation and implementation of novel ideas are largely dependent on the excellence of the individuals who perform research and the institutions that host them.

Europe's talent pool, however, will need to increase if the EU's knowledge economy is to flourish and remain competitive. An adequately stocked, mobile, human resource base is

a necessity. Europe therefore needs to focus on generating a talent pool to maintain its position as a global leader. Currently the stock of researchers in Europe is insufficient. Although the number of researchers in the EU (1.5 million FTE in 2008) has been increasing since 2000 at a faster rate than in the US and Japan, the EU still lags behind in the share of researchers in the total labour force. In 2008, this stood at 6.3 per 1000, compared to 9.4 in the US (in 2006) and 10.7 in Japan (also in 2006). The difference is due to a much lower share of researchers in the business sector. Recent estimates by the Commission services (DG Research) suggest that 1 million net additional researchers may be needed in Europe by 2020 to meet an R&D intensity target of 3% of GDP (see Appendix 2).

Europe also lacks a strong human resource base with the right mixture of skills to innovate. Skill sets need to be adapted to foster creativity, entrepreneurship and other transversal skills ('T-skills') such as team-work, risk-taking and project management, all of which are essential for the generation, development, commercialisation and diffusion of innovation. The availability of these specific skills is essential in order to increase the innovation performance of individuals, to improve the competence of private and public organisations, to facilitate knowledge and technology transfer, and thus to improve the overall competitiveness and the attractiveness of Europe as a region.

Moreover, a recent study on mobility[77] provides evidence that the EU research market is considered less attractive than that of the US due to limited funding opportunities, less satisfactory infrastructures, lower remuneration levels and fewer opportunities in general. The limited number of opportunities is primarily due to the lack of open recruitment practices in many European public research institutions, where 'academic in-breeding' (a preference for internal candidates) is still a widespread phenomenon.[78] So, as things currently stand, Europe will not become more attractive unless it implements policies targeted at promoting excellence in human capital and attracting the best talent.

Policies geared towards improved doctoral training will be vital, as will policies designed to make research careers both attractive and easy to follow. Member States can be expected to take the lead in implementing such policies, but their task would be facilitated by a set of basic principles for doctoral training in Europe that reflect shared and accepted quality standards. Ideally, these principles should be based on international best practice[79] covering research excellence; interdisciplinary research approaches; exposure to industry; international networking; and the development of transferable skills related to teamwork, communication, project management etc. They should also highlight

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77 See http://www.researchersmobility.eu/, the website of the MORE study on Mobility patterns and career paths of EU researchers. Results of the study are due to be published in 2010.

78 'Academic inbreeding' is a form of nepotism in recruitment which consists of showing favouritism to the closest candidates even when the applications of some more distant candidates would be considered superior according to the usual evaluation criteria used by the academic community. In other words, it refers to selection processes based on personal relationships rather than the standardised evaluation of applications or the thorough analysis of individual skills.

79 See the 'Salzburg Principles' articulated as the conclusions of a Bologna Process seminar in 2005. Available at: http://www.eua.be/eua/jsp/en/upload/Salzburg_Conclusions.1108990538850.pdf

the need for attractive research environments, excellent working conditions and clear career development paths, all designed to empower doctoral candidates. Principles such as these should provide guidance to doctoral candidates, universities and funders across Europe, and the EU could promote their widespread diffusion and uptake via the provision of direct competitive support to a number of innovative doctoral programmes following these principles.

In terms of making research careers more attractive and easy to follow, the existence of a European Career Framework for Researchers that clearly articulates distinct levels of attainment and the accumulation of various competences at different steps along career paths has much to commend it, especially if attainment levels are 'sector- and institution-neutral', i.e. independent of the sector or type of institution in which researchers work. If clearly recognised across Europe (and more globally), such a framework would benefit both researchers and employers and greatly facilitate job search and recruitment. It would also facilitate mobility across the continent and beyond, expand employment opportunities for European researchers and help raise standards overall via the efforts of Member States to compare, contrast and adopt best practices.

3.1.2. University performance

Universities are key actors in the transition to a knowledge-based economy and society. They also play a pivotal role in the so-called 'knowledge triangle' (research, innovation, education).

The relative importance of research activity in universities has increased steadily in most EU Member States. Over the last decade, universities have increased their weight in national research systems. Higher education in the EU-27 accounted for 22% of total R&D expenditures in 2008, with more than one third of researchers working in the sector. In 2000, the respective figures were 20.6% and less than one third of researchers.[80]

The research performance of European universities, however, does not compare well with that of universities in some other parts of the world (particularly the US). In Europe, research talent is spread across a larger proportion of the total university population than in the US, where talent tends to concentrated in a smaller number of centres. European universities are thus more widely represented in the top 500 of global rankings such as the 'Shanghai Ranking' or the 'Times Higher Education Ranking', both of which place considerable emphasis on research performance. Compared to the US, however, European universities are clearly under-represented in the higher echelons of these rankings. For example, out of the top 50 universities featured in the 'Shanghai Ranking' in 2009, 10 were European and 36 were American.

[80] These figures are taken from DG-RTD's Regional Key Figures (RKF) database, 2008

One of the reasons for this is insufficient investment. In 2001, the EU-25 invested 1.3% of GDP in higher education (accounting for both private and public investments), while in the US the percentage was 3.3%.[81]

However, some characteristics of the European university system, such as poor governance, inadequate funding mechanisms, insufficient links with the private sector (especially businesses) and insufficient autonomy (mainly to allocate funds and to the negotiate salaries of teachers and researchers), are also to blame.[82]

To remedy these shortcomings and move towards a modern, dynamic network of universities engaging in excellent research, there have been significant examples of modernisation in Europe.[83]

Many universities across Europe, for example, have been granted greater institutional autonomy in order to make them more competitive, and university governance structures and management practices are changing. Traditional collegial models are slowly moving towards other managerial approaches, leading to more hierarchical decision-making modes that often involve a growing number of external and non-academic stakeholders (via the use of boards, for example) and the increasing use of managerial tools. As a result, university management has tended to become detached from other interests and functions within universities, leading to a greater degree of professionalism.

University funding is also changing. Broad trends include a decline in block grants and line item budgets and a rise in competitive funding and money from external contracts.[84] At the same time, various new ways of costing research are being implemented throughout the EU, such as the full economic costing of research.

But however important these trends might be, progress across EU Member States has been uneven. To a certain degree this is to be expected, given the different starting points of the Member States. So while there appears to be progress, greater efforts are still required in some quarters to modernise the European university research system.

University ranking systems can often act as a spur to progress, but only if they are well constructed and capable of embracing many of the different elements that need to change if universities are to improve their overall performance. Current ranking mechanisms focus largely on research performance and paint a poor picture of European universities, but they do not capture performance along many of the different dimensions that characterise university activities, such as teaching and interacting with the business community. There is scope, therefore, for the development of a multidimensional ranking

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81 Aghion *et al* (2007)

82 The challenges facing universities – notably concerning governance, funding, new multidisciplinary curricula and stronger links with the private sector – were covered in great detail in European Commission (2006b).

83 ERAWATCH (2008)

84 Lepori *et al* (2007)

system that European universities can use as a benchmark to understand and improve their own performance.

3.1.3. Filling the innovation skills gap

In the context of a coherent and fully integrated 'Knowledge Triangle' linking the worlds of education, science and innovation, entrepreneurship and entrepreneurship education are vital areas in which European universities need to make urgent progress in order to remain competitive. One important reason for Europe's limited innovation capacity is the relatively low level of entrepreneurship fostered in the EU compared to the US and, increasingly, the BRIC countries. On the whole, professors, researchers and students have poorly developed entrepreneurial mindsets in Europe, where individuals frequently prefer to be employees rather than employers – a situation which hinders the development of innovative new start-ups and SMEs. The challenge for higher education is to provide learning environments and curricula that stimulate independence, creativity and an entrepreneurial approach to harnessing knowledge.

Many efforts have been devoted at EU level to strengthening the relationships between research and innovation and between research and education. The EU has also demonstrated a political determination to enhance relations between innovation and education, i.e. between business and academia. This is a core element, for example, of the European Higher Education Area and the modernisation agenda for universities. Furthermore, the University-Business Forum has opened a dialogue between the two worlds about how they can work more closely together, with a view to ensuring that education delivers high-level and highly valued skills. But progress to date in terms of the concrete implementation of effective partnerships between business and academia has not been systemic, leaving the link between education and innovation as the 'poor relation' in the knowledge triangle.

Ideally, such partnerships should be structured, results-driven co-operative ventures, uniting businesses with education and training institutions to develop new, innovative ways of delivering education, new multidisciplinary curricula and new degree courses. The aim at all times should be to ensure that graduates and post-graduates emerge not only with in-depth knowledge of specific fields and research issues, but also with well-developed transversal skills, 'hands-on' experience and creative, innovative and entrepreneurial attitudes – all likely to enhance their adaptability, improve employment prospects and stimulate innovative and entrepreneurial behaviour.

3.1.4. e-Skills for innovation and competitiveness

The Internet and ICTs provide essential enabling infrastructures and tools for boosting the innovation and competitiveness capacity of enterprises of all sizes in all sectors. ICTs also contribute to more than 40% of overall productivity growth.[85] The importance of ICTs is reflected in R&D budgets worldwide, where ICT-related R&D typically accounts

[85] European Commission (2009f)

for more than 30% of the total. The challenge is to turn R&D results into products, services, profits and job creation, not merely into publications and patents.

A return on investment does not come from technology alone. It comes from the users of technology. This requires successful technology transfer mechanisms and relevant ICT-related skills or 'e-skills'.[86] Entrepreneurs, managers, practitioners and advanced users with e-skills are crucial for fostering innovation and enhancing the competitiveness of European enterprises. Emerging economies are building huge armies of e-skilled professionals. Advances in ICTs and global sourcing are enabling dynamic new companies to develop and bring to market innovations that were too expensive to develop beforehand. Combined with e-skills, these advances help reduce design and coordination costs, manufacturing and marketing costs, and the amounts of capital needed to bring an innovation to market. SMEs can compete with larger firms in ways that were previously not possible.

To take full advantage of the opportunities offered by ICTs, it is clear that more and better qualified ICT practitioners, researchers, entrepreneurs, managers and advanced users are needed. Over the last ten years, business leaders have stressed that the EU is not producing, attracting or keeping enough ICT practitioners to meet the requirements of its enterprises.[87] To remedy this situation, the European Commission adopted a Communication in September 2007 entitled 'e-Skills for the 21st Century'.[88] This included a long-term EU e-skills agenda that was welcomed by the Competitiveness Council.[89]

Within the framework of this agenda, the e-Skills Industry Leadership Board[90] was established to foster 21st century e-skills and improve the digital literacy of Europe's workforce and citizens. According to this Board, an e-skills strategy aimed at developing higher level e-skills is not only a logical next step but a necessity if European innovation

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86 The term 'e-skills' covers three main categories:
ICT practitioner skills: the capabilities required for researching, developing, designing, strategic planning, managing, producing, consulting, marketing, selling, integrating, installing, administering, maintaining, supporting and servicing ICT systems;
ICT user skills: the capabilities required for the effective application of ICT systems and devices by the individual. ICT users apply systems as tools in support of their own work. User skills cover the use of common software tools and of specialised tools supporting business functions within industry;
E-business skills: the capabilities needed to exploit opportunities provided by ICT, notably the Internet; to ensure more efficient and effective performance of different types of organisations; to explore possibilities for new ways of conducting business/administrative and organisational processes; and/or to establish new businesses.

87 The number of ICT practitioners in Europe was 4.7 million in 2007 and is forecast to be between 4.95 and 5.26 million in 2015. Advanced ICT users represent 30% of the European workforce (68 million in 2007) and they are the key players of the digital transformation of our economy. (See: Empirica/IDC (2010))

88 European Commission (2007c)

89 Council of the European Union (2007)

90 The European e-Skills Industry Leadership Board includes leading ICT vendors and ICT using companies from all sectors and relevant associations.

and competitiveness is to be enhanced. The Board considers that this strategy should be based on foresight scenarios (to assess future supply and demand); guidelines for new and better curricula; quality labels for industry-based training; and awareness raising activities. The separate disciplinary areas of design, engineering, computer science, business and marketing have also developed to the point where an integrated framework for the development of innovation skills ('i-skills') is needed. Support for an approach of this nature was endorsed by the European e-Skills 2009 Conference[91] and reflected in 'The e-Skills Manifesto'[92] developed by leading figures in government, education, policy, research and industry and launched at the European Business Summit on 30 June 2010. There is thus clear support for the implementation of an integrated framework for the development and promotion of higher level e-skills for innovation and competitiveness based on partnerships with stakeholders.

3.2. Delivering the European Research Area

Section 2.3.2.3 noted that many obstacles still block the realisation of a truly integrated ERA that can fully exploit the potential of Europe's talent pool. Critically, the movement of knowledge and researchers is still constrained, limiting the establishment of critical masses of research effort in research and innovation 'hotspots' across the EU, and mechanisms designed to pool research funding, thus reducing fragmentation and duplication, are still inadequate. Strengthening the EU knowledge base will also call for considerable levels of investment in the modern, world-class research and innovation infrastructures that are needed to ensure the success of the Innovation Union.

3.2.1. A framework for improved mobility

Mobility is a feature of the career path of many EU university-based researchers. A recent study on mobility indicated that more than half (56%) of the study population had been 'internationally mobile' for a period equal to or greater than three months at least once during their research career.[93] Up to 80% believed that their experience of mobility had had a positive impact upon their career. The benefits of mobility across institutions, disciplines, countries and sectors are becoming increasingly recognised.

The study also revealed a range of obstacles to mobility, such as the difficulty of obtaining funding and finding suitable positions (often due to the 'academic in-breeding' noted above), as well as a whole host of other issues concerned with social security and pension rights. In turn, recognition of these obstacles has led to policies promoting the 'Fifth Freedom', i.e. the free movement of knowledge in addition to the classical free

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91 See the conclusions of the European eSkills 2009 Conference at: http://www.ecdl.org/files/cepis/20091126111011_e-Skills%202009%20Conference%20Concl.pdf. This event, organised by the European Commission and the European Economic and Social Committee, emphasised the crucial importance of e-skills for innovation and business value creation.

92 McCormack, A. (2010),

93 IDEA Consult (2009)

movement of goods, services, capital and labour.[94] However, the limits of what can be achieved via voluntary 'partnership' approaches to the implementation of such policies are becoming increasingly apparent, and more decisive actions may be needed, e.g. the evolution of legally binding measures at EU level developed in the context of a new 'European Research Area (ERA) Framework' designed to remove obstacles to mobility and cross-border co-operation.

One study by JRC/IPTS[95] looked at national policies on mobility. It found that there was broad support for the notion that increased researcher mobility is intrinsic to the development of a dynamic, knowledge-based Europe. However, there is a broad divide between countries that have embraced the concept of 'brain circulation' and those that have not. The fears associated with 'brain drain' continue to dominate policy discussions in a large number of countries, particularly in those with weaker research capacities.

The paradox, however, is that the gap in performance between countries with weaker research systems and those with stronger research systems is likely to widen if fears about brain drain continue to hamper 'brain circulation'. Countries with stronger research capabilities have increasingly recognised the benefits of policies that encourage a balanced and expanded 'brain circulation', as opposed to policies that simply attempt either to stem outward flows or encourage inward mobility.

However, there is more to ensuring that improved knowledge flows and greater 'brain circulation' contribute to the development of a European knowledge society than just implementing policies to reduce barriers to mobility. It also requires (a) focusing on excellence in research on various fronts in order to increase (or maintain) the attractiveness of the European research system, especially to researchers from outside the EU, and (b) implementing effective policy mixes that allow the operation of a 'free market', while at the same time 'channelling' knowledge flows towards the attainment of socially-determined goals.[96]

3.2.2. A common framework for competitive funding

A lack of consistency between funders in terms of the rules and procedures associated with competitive funding creates severe problems for researchers and hampers the efficient functioning of the ERA. An overview of funder practices would demonstrate little shared understanding of accounting terminology; the use of a wide range of heterogeneous cost models (in terms of eligible costs and co-financing requirements); disparities in the accountability requirements placed upon research institutions; the volatility of rules over time; and a variety of approaches to the rules and procedures governing the sharing of IPR. This generates unnecessary transaction costs for

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94 The need for a 'Fifth Freedom' relating to research was first raised by Commissioner Potočnik in a speech in April 2007. See: http://europa.eu/rapid/pressReleasesAction.do?reference=SPEECH/07/257&format=HTML&aged=1&language=EN&guiLanguage=en

95 Fernandez-Zubieta and Guy (2010)

96 These issues are likely to be addressed in the EU2020 flagship initiative entitled 'Youth on the Move'.

universities and other public research institutions at a time when research performers are increasingly dependent on external research funding and general constraints on the availability of public finances call for cost savings to be made at all levels.

Building a coherent legal and administrative framework for research in Europe that would facilitate the mutual opening of programmes, cross-border funding and/or co-funding from public funding agencies from different Member States through a new 'ERA funding framework' is key to the enhancement of trans-national research collaboration and to the successful implementation of activities such as Joint Programming. Identifying common principles for ERA funding is thus an important task that would actively support the promotion of coherent and stimulating funding conditions for research institutions across Europe.

Having more compatible funding frameworks would allow European research actors, both public and private, to compete in more programmes without having to contend with a wide range of diverse requirements and practices. Research performing organisations could tender more easily for non-national research schemes and either compete or collaborate as they see fit with organisations in other countries in response to both national and trans-national calls. Individual researchers could participate in multiple and diverse programmes, many of which are now competing to attract foreign researchers. It would also be easier for funders to work together jointly to design collaborative funding instruments.

3.2.3. Research infrastructures

The term 'research infrastructures' refers to the range of facilities and services upon which excellent research depends, e.g. radiation sources for new materials, clean rooms for nanotechnologies, data banks for genomics and observatories for earth sciences.[97] Such infrastructures catalyse the knowledge creation process, facilitate the networking of researchers and stimulate knowledge flows generally. They also enhance the prospects for downstream impacts and have important accelerator effects on local economies.

State-of-the-art research infrastructures are needed to address major societal challenges and underpin the innovations needed to resolve them. These challenges include climate change, viral pandemics, food security, ageing populations, maintaining biodiversity and establishing secure energy supplies, and it is vital to identify and direct funding to the new generation of leading edge research infrastructures needed to tackle them.[98] In 2002, the Member States and the European Commission set up the European Strategy Forum on Research Infrastructures (ESFRI) to support a coherent and strategy-led approach to policy-making on research infrastructures in Europe. Major achievements of this process were the publication of the first Roadmap for pan-European research infrastructures in 2006 and its update in 2008. The latter lists forty-four key new research infrastructures (or major upgrades of existing ones) that are due to be developed over the next 10

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97 European Commission (2007d)

98 Leon and Elias *et al* (2010)

years,[99] and another 5 or 6 projects are due to be added to this list in the forthcoming 2010 update of the ESFRI Roadmap. Their total construction costs amount to some €20 billion and their operational costs to more than €2 billion per year.

The construction and operation of these infrastructures frequently requires the pooling of resources from several Member States, and this has necessitated the development of appropriate new legal and governance structures. The Commission, for example, has developed a new EU legal framework for a European Research Infrastructure Consortium (ERIC), adopted by the EU Council in 2009. It is expected that the ERIC regulation will facilitate the joint establishment and operation of European facilities between several Member States and associated countries, and several projects are currently preparing to apply to the European Commission for the status of an ERIC.

Raising sufficient funds for the construction of the projects listed in the ESFRI Roadmap is currently a key concern. Through FP7, the EU provides catalytic support to an initial *Preparatory Phase* (~€220 million) that addresses the legal, governance, financial and technical issues associated with the launch of projects. EU FP7 funds supporting the actual *Construction Phase* are much more limited (€90 million). Additional financial resources (€200 million) are available as loans via the Risk-Sharing Finance Facility operated by European Investment Bank (EIB), but the overall contribution of FP7 (~€500 million) is rather limited compared to the total estimated construction costs of €20 billion.

On several occasions the Council has recognised the need to make more funds available for the realisation of ESFRI projects. It has also recognised the need to combine all available public and private resources (e.g. from Member States, regional authorities, various industries, the EIB, Structural Funds, FP7 etc.) in an efficient way. Structural Funds, for example, can provide substantial support to research infrastructures. Of the €49.8 billion designated for RTDI (Research, Technology, Development and Innovation) from 2007 to 2013, €9.8 billion is earmarked for RTD infrastructures and centres of competence. This support is particularly important for the 12 new Member States, where the €4.8 billion earmarked for RTD infrastructures will have a decisive impact on the ability of these countries to fund new research infrastructures.[100]

Good progress has been made since the publication of the ESFRI Roadmap and ten projects have effectively started, although much remains to be done to finalise all the details. The majority of the ESFRI projects are at various stages of preparation, and the Member States and Associated Countries, as well as the European Commission, need to continue working with the relevant scientific communities to clarify and resolve governance and funding issues prior to their implementation.[101] Since the publication of the first Roadmap in 2006, a first wave of 10 projects out of the total set of 44 has been launched, with the construction phases of these projects expected to stretch over several years. Providing the funds necessary for this first wave, while simultaneously launching

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99 ESFRI (2008)

100 European Commission (2008c)

101 ESFRI (2009)

additional projects, will be a considerable challenge. Maintaining the momentum established in the first four years (2006-2010) over the next five years should lead to the realisation of about 60 percent of the ESFRI projects by 2015. For this to occur, however, a common effort by Member States and the European Commission will be needed to allocate the additional funds needed for the construction and operation of these new research infrastructures.

Launching the ESFRI projects, open to all researchers, will ensure that Europe continues to act as a magnet for the world's brightest talent. These projects will also enable researchers and research infrastructure users to make decisive contributions to the solution of major societal challenges. Every effort thus needs to be made to foster public and private investment in these projects. While the possibility of increased support stemming from the Structural Funds deserves continuing attention, the possibilities offered by other European initiatives should also be explored. These include the Joint Programming Initiatives (including the SET Plan), the development of European Innovation Partnerships (see Section 6) and the possibility of a dedicated European fund for the construction of research infrastructures.

3.3. Focusing EU funding instruments on Innovation Union priorities

EU research and innovation instruments have helped strengthen the EU research and innovation system through their historical emphasis on collaboration and excellence. From the evidence presented in Section 2, however, there is now a clear need to focus efforts on societal challenges and to ensure the coherence of the policy mixes put in place to tackle them. A stronger focus on innovative, high growth SMEs is also warranted (see Section 2.3.1.3). Such SMEs are vital sources of innovative ideas, and capitalising upon their potential is crucial to the success of policies designed to ensure that good ideas reach the market.

There is also the ever present need to reduce the administrative burden on the beneficiaries of individual programmes via the streamlining and simplification of administrative processes. Strengthening the EU knowledge base will also call for key stakeholders, including both existing and relatively new EU institutions, to play crucial roles in efforts to focus EU policy instruments on the strategic priorities of the Innovation Union.

3.3.1 The focus of future EU programmes

Section 2.1.2 outlined the case for determined efforts to mobilise resources at EU (and global) levels to tackle major societal challenges through investment in research and innovation, focusing in particular on areas where the markets for innovative solutions are appreciable. This is the logic that underpins the EU2020 strategy and the whole Innovation Union concept. It is also the logic that demands that all future EU research and innovation programmes are aligned to both these initiatives, especially to the specific objectives of the Innovation Union.

3.3.2 Tapping the potential of innovative, high growth SMEs

The EU has a long tradition of implementing measures that nurture the European knowledge base and most evaluations and impact assessments of these instruments conclude that there are net benefits for participants, including significant benefits for SMEs.[102] Participation in EU R&D projects, for example, allows SMEs to expand their knowledge capabilities, access complementary knowledge, extend their networks, acquire new customers and become more visible and active at international level as part of their business strategy. It also helps them produce new products and services, since they are generally more committed than other types of participant to the ultimate commercialisation of Framework Programme R&D project outputs.[103]

SMEs in research projects serve as a conduit for knowledge spillovers.[104] Due to their flexibility and knowledge of the markets, they provide in many cases the interface between research and the transformation of new ideas into successful, products, services and ultimately businesses. Entrepreneurs and small firms are often able to spot where new technologies meet customer needs and can develop products that meet this demand.[105] This reinforces the case for targeted support to SMEs in public research and innovation programmes. Even though the 7th Framework Programme for Research, Technological Development and Demonstration (FP7) is not primarily targeted at SMEs, their participation has been strongly promoted. Within the Co-operation programme, over 14% (€1.263 million) of the budget had been granted to SMEs by April 2010[106] and considerable efforts are being made to increase their share further via SME-dedicated calls and information and awareness-raising schemes.

However, increased efforts are also needed to reduce the administrative burden on SMEs participating in EU Programmes. Currently, SME access to EU grant funding is hampered by the fragmentation of support instruments with varying objectives, administrative procedures not adapted to SMEs and a lack of information and coaching. SMEs need a coherent European support scheme that is designed to meet their R&D and innovation needs along the path from idea to the market and helps promote their internationalisation. Such a scheme, for example, could build on the experience of the Eurostars initiative by extending partnerships with Member State agencies.

3.3.3. Streamlining and simplification

There is an overarching need to streamline procedures and reduce the administrative burden on all participants involved in EU support initiatives. A recent Expert Group[107] noted that "regardless of why they exist and who is responsible for them, the overly 'bureaucratic' ways of the Commission must be genuinely reformed and simplified". For

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102 See, for example, Rietschel and Arnold *et al* (2009)
103 Fisher *et al* (2009)
104 Audretsch *et al* (2009)
105 Lerner (2010)
106 European Commission (2010d)
107 Soete, Guy and Præst Knudsen *et al* (2009)

the Expert Group, it was clear that the financial rules imposed on the Commission acted as a major constraint on the way in which the Commission could operate. These, it argued, had introduced a management culture that was largely based on mistrust and failed to take into account the intrinsic risks associated with research and innovation projects. Consequently, it concluded that the only way to create a break-through towards a more risk-tolerant and trust-based approach was to revise the Financial Regulation, with the full backing of the European Parliament and the Council.

The steps needed to simplify the implementation of the Research Framework Programmes were spelt out in a recent Communication.[108] This has the overall aim of making participation transparent and attractive to the best researchers and innovative companies in Europe and beyond.

The first part of the Commission's strategy sets out to make improvements within the context of the current legal and regulatory framework. Some of these are already underway. They involve, for example, better IT systems, the more consistent application of rules, especially the rules governing auditing, and improvements to the structure and content of 'calls for proposals'.

The second part involves changing the existing financial rules to allow more radical simplification whilst maintaining effective control. One example is the more widespread use of 'average cost methodologies' that avoid the need for projects to account separately and painstakingly for each small item of expenditure. The Commission also aims to allow projects to use the same accounting methods for EU funding as they are required to use for national research funding.

The third type of change envisaged will be considered for implementation under future Research Framework Programmes. Among the options presented in the Communication is a move towards 'payment by results'. Rather than asking beneficiaries to report individual cost items, they would only be required to demonstrate that they had undertaken specific scientific tasks efficiently and effectively.

3.3.4. The European Institute of Innovation and Technology (EIT)

The European Institute of Innovation and Technology is an important new way of integrating the Knowledge Triangle at EU level. It is being implemented through the establishment of Knowledge and Innovation Communities (KICs), which bring together the fields of education, research and business in new ways. Each KIC consists of 4-6 'co-location centres'. These are geographical locations where existing world-class partners interact and work together face-to-face.

Through the KICs, the EIT is testing out new models of governance in the delivery of innovation, placing entrepreneurship at the core and a putting strong emphasis on leadership, effective decision-making and simplicity in order to maximise impact. The

[108] European Commission (2010c)

EIT is already implementing a societal challenge approach, with the current KICs covering climate change mitigation and adoption, sustainable energy and future ICTs. The dissemination of the experiences, results and best practice of KICs will shed light on how to address societal challenges via the integration of the knowledge triangle at EU level. The EIT is due to introduce EIT-branded degrees and diplomas and to launch an EIT foundation to pilot new, flexible models of financing high-risk entrepreneurial activities and to leverage private and philanthropic funds in support of innovation.

In 2011, the EIT is due to present its Strategic Innovation Agenda in accordance with its legal base. If it continues to build on its current experience and further develops its activities, it could act as an important showcase for the Innovation Union.

3.3.5. Underpinning policy formulation

Focusing EU funding instruments on the strategic priorities of the Innovation Union will demand increased investment in the 'strategic intelligence' capabilities needed to underpin policy formulation (see Section 2.3.4.3). These include the capacity to amass and assess the evidence base for future action and the forward looking capacity needed to envisage and weigh up different policy options via inclusive approaches that involve all relevant stakeholders.

Strategic intelligence capabilities are well developed in many organisations and institutions across Europe, both within European Commission services like the Joint Research Centre and external to the Commission. All could play an important role in the collective effort that will be needed to focus EU instruments on the Innovation Union priorities, perhaps facilitated by the creation of a 'European Forum on Forward Looking Activities'.

4. GETTING GOOD IDEAS TO MARKET

Section 2.3.3 stressed the need for policies aimed at easing the difficult and complex route from the initial conception of ideas, stemming from the research laboratory or elsewhere, to the eventual realisation of their potential in the marketplace. The rationales for actions proposed in the Innovation Union Communication under the heading of 'Getting Good Ideas to Market' – at both EU and other levels – are thus discussed below.

4.1. Enhancing access to finance for innovative companies

Access to appropriate sources of finance is one of the most significant constraints on business-led innovation in Europe. This leads to insufficient private sector R&D spending (the main reason for Europe's R&D investment gap)[109] and, more crucially, to a lack of financial support at the commercialisation phase for young innovative European

[109] According to Eurostat figures, investment in business R&D in Europe needs to increase by €105 billion annually to reach the 3% of GDP target.

companies and for entrepreneurship in general. The financial market crisis and the ensuing economic recession have aggravated the situation, hitting innovative SMEs the hardest. This situation has also adversely affected large European companies more than their US counterparts, given the greater sensitivity of their R&D investments to variations in their internal financial resources.[110] This requires public support to overcome market deficiencies and leverage the private sector finance needed to close this investment gap.

R&D and innovation activities are more expensive to finance when external sources of capital are needed. The difficulties associated with reaping the benefits of research and innovation and the imperfect, asymmetric nature of the information flows between lenders, equity investors and borrowers affect the capital investment decisions of firms and lead to credit rationing by lenders and equity investors. All this leads to levels of investment in these activities that are below the socially optimal level – hence the need for specific support instruments which compensate for these market failures. This has led Member States and the EU to establish a series of support instruments. These include the High Growth and Innovative SME Facility (GIF) under the current Competitiveness and Innovation Programme (CIP), covering equity investment at the seed, start-up and expansion stages; and the Risk Sharing Finance Facility (RSFF) supported by the Seventh Research Framework Programme and co-developed with the European Investment Bank (EIB), providing loans and guarantees for research, technological development and innovation activities carried out by private companies or public institutions with a higher financial-risk profile. In some countries, support from these instruments is complemented by the JEREMIE scheme, which uses Structural Funds to finance SMEs by means of equity capital, loans or guarantees. In all cases, there is close co-operation with the EIB and EIF, who manage EU funds for these instruments.

In terms of financing the growth of young innovative SMEs, however, Europe continues to underperform, which is one of the reasons why relatively few new companies in Europe have grown into large global companies over the past 30 years,[111] and access to the capital needed to ensure that innovative ideas reach the market is still limited. These deficiencies have to be rectified if Europe is to reap the full potential of its innovative enterprises.

Regular consultations with stakeholders and market professionals, international expert workshops, experience with the current Competitiveness and Innovation Programme (CIP) and the Risk Sharing Finance Facility (RSFF),[112] and a recent review of innovation financing for SMEs[113] all confirm that innovative firms need better access to appropriate

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110 This evidence comes from a recent analysis based on the financial data of large R&D investors in the EU and the US over a period of eight years (2000-2007). See Cincera and Ravet (2010).

111 See Cincera and Veugelers (2010). According to this study, the EU has fewer young firms among its leading innovators than the US. This matters for the overall R&D-to-GDP ratio as these companies are more R&D intensive. But this effect only accounts for about one third of the US-EU differential. The largest part of the differential (55%) is due to the fact that Young Leading Innovators are less R&D intensive in the EU than in the US.

112 See, for example, the evaluation report by Mann and Soete *et al* (2010)

113 European Commission (2009e)

forms of financing, with new and existing instruments adapted to the specificities of sectors, types of innovation and, in particular, different stages in the growth of businesses.

The review of SME innovation financing mentioned above notes that venture capital can be an appropriate form of financing innovation for young innovative companies. In sectors such as biotechnology and information technology, these companies play a crucial role in bringing new technologies to the market. Investors in innovative activities of this kind require an adequate level of reward, and normally venture capital is the most suitable instrument to ensure such rewards through an increase in the value of the firm and the realisation of this value. Venture capital in the form of share capital (equity) is generally more suitable than loans for new and fast growing innovative businesses. This is because such businesses, in their early stages, are very risky, have little or no collateral and have non-existent or weak cash flows that make interest payments infeasible.

European venture capital markets, however, are functioning well below their full potential. One of the most important problems is the equity gap in early-stage financing (seed and start-up capital) that is depicted in Exhibit 8. This is not surprising given the low returns on early-stage investments compared to the returns from other forms of private equity investments, such as growth capital and buy-outs.[114] In addition, there is a considerable difference between venture capital performance in the EU and in the US. On the input side, in 2008 the EU invested €15 billion a year less in venture capital compared to the US.[115] On the output side, at the end of 2008, the 10-year return on overall venture capital investment was 0.2% in Europe compared with 15.5% in the US.[116] The small size of European funds and the existence of fragmented markets are possible reasons for the low European return figure, but the end result is clear: for investors interested in venture capital as an asset class, it is sensible to invest in the US. It is clear that, under current circumstances, European funds cannot generate the levels of private investment that Europe needs in the context of intense competition for investment funds worldwide.

This venture capital performance gap between the EU and the US may be attributable in part to the different contractual relationships that exist between venture capitalists and start-up entrepreneurs in the US and the EU, and also in part to a better capacity in the US to screen projects and ensure their early stage success.[117]

Exhibit 8: Venture Investments as a Percentage of GDP in 2008

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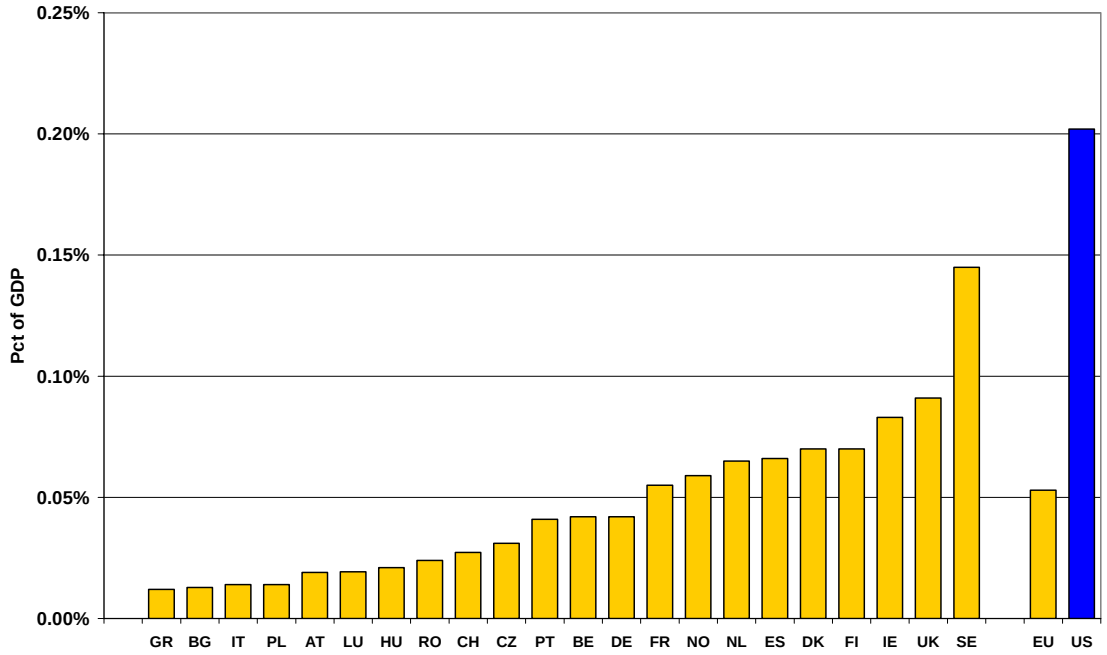
114 Based on the latest figures from the European Private Equity and Venture Capital Association (EVCA).

115 Based on 2008 figures from the European Private Equity and Venture Capital Association and National Venture Capital Association (NVCA) figures for the US. VC includes Early stage (seed and start-up) and Expansion and replacement capital.

116 Based on EVCA figures for Europe and National Venture Capital Association (NVCA) figures for the US.

117 Hege *et al* (2003)



Source: EVCA/PEREP Analytics; market statistics

The fragmentation of the EU's venture capital markets along national lines also imposes serious limits on the overall supply of early-stage capital for innovative SMEs. There are currently 27 different venture capital markets at different stages of development and maturity operating under different conditions and subject to divergent national approaches, all of which make the fiscal conditions for investors uncertain and adversely affect both cross-border fundraising and investment in innovative SMEs. Furthermore, the fragmentation of venture capital markets in Europe has resulted in a large number of small funds that cannot produce returns in line with those from larger funds, nor can they invest amounts that are large enough to foster rapid growth.[118] The existence of different legal frameworks also complicates the structuring of funds across multiple borders and makes it difficult and expensive to constitute large, integrated and professionally managed funds operating at EU level that could take full advantage of the single market. Facilitating cross-border operations could help venture capital funds to overcome these hurdles, allowing them to specialise, diversify portfolios, increase the overall supply of early-stage capital and stimulate investment in high-growth companies all over Europe.

The Commission has been promoting a more integrated European venture capital market since 2005. In its December 2007 Communication,[119] the Commission proposed a short-term approach encouraging the mutual recognition of venture capital funds. While the Council and Parliament agreed with the proposed approach in 2008, in practice most Member States have not yet taken significant steps to remove regulatory and tax

118 European Commission (2009g) and (2010e)

119 European Commission (2007e)

obstacles that would make fundraising and investing across borders easier for venture capital funds.[120]

To improve the situation, the recent report of a Venture Capital Tax Expert Group[121] on cross-border tax obstacles, coordinated by the Commission, contained two main recommendations for action: firstly, that VC funds managed in one country should not be treated for tax purposes as though they were a permanent establishment in that country; and secondly that, in order to prevent double taxation, all Member States should recognise the tax classification of a venture capital fund applied by the Member State in which the fund is established.

A new legal framework aimed at building an integrated venture capital market in Europe would help overcome many of the shortcomings described above. Such a regime would allow venture capital funds established in any Member State to operate and invest across the EU free from unfavourable fiscal or legal treatment. One role for the Commission, based on recent preparatory work, would be to work with Member States on the development of a best practice model for the fiscal treatment of cross-border venture capital operations. The Commission could also monitor the venture capital market to review other obstacles that might hinder or make it costly for venture capital to be raised across borders. It could then envisage further legislation or other appropriate action to overcome these shortcomings, thus promoting a more integrated European venture capital market, attracting more private and professional investors and increasing support for innovative firms.

The revision of the current Risk Capital Guidelines by the end of 2010 would also allow State aid rules for venture capital investments to be updated to reflect changing market realities. Moreover, the use of a broader definition of innovation in the current State aid Framework for Research and Development and Innovation (i.e. a definition that takes into account new 'innovation categories' such as non-technological innovation, user-driven innovation and social innovation, for example) could be introduced in the upcoming mid-term review (at the end of 2010) or incorporated in the new State aid Framework for Research and Development and Innovation (to be implemented in 2013). This would then expand the range of innovative activities eligible for financial support from the public sector.

The recent Demarigny report on the establishment of a proportionate regulatory and financial environment for 'Small and Medium-sized Issuers Listed in Europe' (SMILEs) highlighted the problems faced by SMEs trying to raise private capital. It argued that there are real economic benefits to be gained by creating a European passport for common EU-domiciled private equity funds. "This would allow more fluid cross-border investments in private equity and a better allocation of capital within the Single Market

120 European Commission (2009g)
121 European Commission (2010e)

for innovative and young companies that are likely to be admitted, sooner or later, to trading on an exchange-regulated or regulated market".[122]

There is scope for expanding existing instruments, such as the Risk Sharing Finance Facility (RSFF), and for launching new instruments aimed at stimulating the participation of private investors and promoting cross-border investment and fund-raising. The European economy could increase its growth by better harnessing the growth potential of innovative enterprises. In venture capital markets, there are not enough large funds capable of financing the growth of firms across Europe. Existing European initiatives have demonstrated the potential for EU level action[123] but have lacked the necessary critical mass to have a transformative impact on the market. New instruments are needed to catalyse the development of a single market for research and innovation financing, in particular for venture capital, by demonstrating good practices, by promoting cross-border investment and fundraising from institutional investors, by creating more developed markets for financing research and innovation, and by supporting the emergence of European markets in knowledge transfer and intellectual property.

A number of instruments addressing problems at different stages of both innovation cycles and company development paths are proposed:

- One type of instrument is an 'Innovation Start-up Facility'. This would focus on seed and start-up financing (especially 'business angel' financing); on venture capital development; on the financing of knowledge transfer; and on the exploitation of intellectual property. The aim would be for the deals done under this facility to have a demonstration effect; for them to have a cross-border element benefiting the development of the single market; and for deals to complement national actions. For venture capital investments, the aim would be to choose venture capital management teams capable of managing European funds with the potential to become competitive on a world stage. Concerning the exploitation of intellectual property, the goal would be to create a European market in intellectual property. Such an instrument could be implemented by the European Investment Fund, which would be able to invest alongside private partners in venture capital funds focusing on seed and start-up capital investments.

- A second type of instrument is a 'European Growth and Innovation Facility', a 'fund-of-funds' mechanism aimed at establishing a large venture capital fund with the capacity to invest in the growth phases of an enterprise. The aim here would be to attract private institutional investors that only consider investing large amounts but

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122 Demarigny (2010)

123 The current RSFF under FP7 and the financial instruments of the CIP have leveraged investments worth at least 15 times the contribution from the EU budget. To date, contributions of €430 billion from the EU budget and €800 billion from the EIB to the RSFF have leveraged investments of more than €18 billion (a leverage factor of 15), while a contribution from the EU budget of €400 million to the CIP instruments up to the end of 2009 leveraged investments of €9 billion (a leverage factor of 18) and benefited 68,000 SMEs. (See EIF report to the European Commission on the CIP. Available at: http://ec.europa.eu/cip/eip/access-finance/index_en.htm)

usually want to limit their risks, and to leverage these private capital sources. The aim would be for the fund-of-funds to invest in venture capital funds with a strong focus on cross-border investments. It would benefit from the single market, provide economies of scale, and build expertise in selected fields. An additional aim would be to gear investment towards areas linked to societal challenges. Only at European level would it be possible to achieve the necessary scale and the strong participation of private investors that are the hallmarks of a self-sustaining venture capital market. The goal of EU involvement would be to promote the development of such a self-sustaining venture capital industry, including the participation of private investors. The facility would allow the cross-fertilisation of experience gathered at national and local levels and would thus contribute to the development of venture capital market practices across Europe. Venture capital can only function effectively in the single market. This European-wide action would complement regional and national efforts to develop risk capital investments with a pan-European approach.

- A third type of instrument is risk-financing to support – by means of loans, guarantees and other appropriate forms of risk finance – investments in R&D and innovation projects by entities of any size and ownership in both the private and public sector. One possibility would be to expand the scope and scale of the existing 'Risk-Sharing Finance Facility' (RSFF) to encompass both research and innovation projects, as recommended by a recent Expert Group.[124] This 'Renewed RSFF' could also provide risk finance for research and innovation projects addressing the Europe 2020 grand challenges; for research infrastructures (including Digital Broadband infrastructures); and for particularly important target groups, such as research-intensive, innovative companies and fast-growing SMEs and Mid-caps competing at European or global levels.

- In addition, building on the experience with the current Competitiveness and Innovation Programme (CIP), a complementary 'Innovation Loan Facility' (ILF) could help fast-growing SMEs to secure access to bank loans for innovation-related projects and activities.

Coherently implemented, these instruments would allow technology-driven, innovative SMEs to access funding all along the route from 'blue-sky' research to the commercialisation of R&D results. An integrated approach of this nature, starting with grant funding and facilitating access to various sources of follow-on finance, would help bridge the 'Valley of Death' that SMEs face when attempting to commercialise the results of R&D projects.

It goes without saying that all these instruments should have clear and effective governance structures and streamlined processes that guarantee simple and fast access to the support offered and reduce the administrative burden on applicants, particularly SMEs.

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[124] Mann and Soete *et al* (2010)

Access to venture capital is a problem for young innovative companies in particular, but access to other forms of financial support for R&D and innovation is limited for SMEs and large research-intensive companies alike. Financial support for R&D and innovation at a Member State level is dependent on success in the competition for budget resources and is often limited, very fragmented and cyclical. In particular, lack of financial support can have very negative effects on research-related innovations that require public support to launch large-scale pilot and demonstration projects. This is particularly so in key areas related to the solution of 'grand challenges', such as new technologies for low carbon energy sources and the application of biotechnologies in the health sector.

In the light of all these problems, there is scope for further mobilising public financial instruments at EU and Member State levels to improve access to finance for R&D and innovation activities.

One option is for Member States to make more extensive use of the Structural Funds. Over successive programming periods, the Structural Funds have provided increased funding for research and innovation. In the current period, a budget of €86 billion is potentially available for research and innovation-related measures.[125] This is a significant increase over previous periods, and the Structural Funds have now become an important source of support for research and innovation in many European regions. Measures contained in the Operational Programmes span the whole innovation chain, including support for research and technological development, for entrepreneurship and start-ups, for advanced support services and for the development of human capital, to name just a few of the relevant categories. There is still scope within the current programming period, however, for Member States to increase their use of cohesion funds to enhance support for research and innovation activities. In particular, this could take the form of technical assistance to interested regions to move towards 'smart specialisation' and cross-border co-operation, with the Commission launching specific support actions and providing guidance on how this could be done.

4.2. Creating a single innovation market

The fragmentation of markets for innovative products in the EU hampers the demand-pull that an integrated and properly functioning European single market could offer. The recent Monti report on the re-launch of the single market illustrates the importance of an adequate and stable regulatory framework and the potential role that proactive use of standardisation could play in promoting the uptake of low carbon products and technologies.[126] The same report also highlights the key role that public procurement could play in relation to innovation, green growth and social inclusion if specific

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125 A figure of €49.8 billion is reserved for 'Research, Technological Development and Innovation' (RTDI) activities. A further €36 billion is reserved for activities that relate to a broad definition of innovation and which fall under the headings of 'Entrepreneurship', 'Innovative ICT' and 'Human Capital'. See European Commission (2007f) and http://ec.europa.eu/regional_policy/themes/statistics/2007_rd.pdf for more recent statistics.

126 Monti (2010)

mandatory requirements related to concrete policy objectives were to be embedded in public procurement directives.

4.2.1. Knowledge management and protection

Knowledge management in the EU is fragmented and weakens the ability of EU stakeholders to compete at a global level. Few countries have developed strategic policies for the dissemination and exploitation of knowledge, and patents are presently maintained by national legal systems that make protection in the EU expensive, complicated and legally uncertain. The absence of a single, centralised patent-litigation procedure imposes a significant burden on businesses. In terms of costs per capita, a ten-year patent in 13 EU countries costs approximately six times that of a patent in the US, and nearly three times the cost of a patent in Japan. Translation and renewal fees account for a large proportion of the additional cost.[127] This situation is particularly detrimental to young innovators and high-tech SMEs that often face financing constraints. Recent analyses show that a shift from the current system to an EU patent would result in net savings of €250 million for the business sector.

4.2.2. Reinforcing demand side measures

The need to bring supply-side and demand-side measures together has been part of the policy agenda in recent years, as reflected in the broad-based innovation strategy presented by the Commission in 2006.[128] Concerning the demand for innovative products and services, the EU already benefits from a series of favourable conditions. In particular, EU consumers have relatively high incomes and a preference for high-quality goods. Nevertheless, "the fragmentation of markets across the national boundaries of Member States provides a major disincentive for innovation",[129] and it is generally agreed that public authorities have a role to play in both 'pushing' scientific and technological developments and 'pulling-through' the speedy deployment of new technologies, processes, designs and business models via the stimulation of market demand. The case for demand-side instruments, in particular, was well presented in the analysis underpinning the launch of the EU's Lead Market Initiative (LMI).[130] This identified public procurement, regulation, standardisation, labelling, certification and the framing of intellectual property rights as relevant demand-side measures. Standard-setting powers, for instance, can be used "to demand high-technical performance levels and reach agreement on new standards quickly and efficiently".

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127 van Pottelsberghe de la Potterie (2010)

128 European Commission (2006c)

129 Aho *et al* (2006)

130 European Commission (2007g), in particular pages 25-27. This analysis benefited from a series of broad stakeholder consultations with, amongst others, the Europe INNOVA community, the European Technology Platforms, industry representatives, representatives of relevant national ministries and user groups.

The Innobarometer analytical report of 2009[131] reveals that, between 2006 and 2009, innovation activities were more likely to be positively influenced by demand-pull factors, such as pressure from competitors or demand from clients, than by technology-push factors such as the emergence of new technologies or opportunities to cooperate with knowledge centres. The same survey also revealed that nearly half of the enterprises surveyed indicated that demand-side policies (such as changes in environmental or other regulations) had positively impacted their innovation activities, whereas just a third of all surveyed companies confirmed that newly introduced public policies in the field of taxation or direct subsidies for innovation had provided them with increased opportunities to innovate. Overall, however, only 16% of those surveyed felt that public sector attempts to influence the demand for innovation had a greater impact than factors such as increased competition from rivals or increased demand from commercial clients. There is obviously scope, therefore, for the greater use of more effective demand side instruments.[132]

4.2.3. Regulations

In general, compliance with regulations generates costs. These can be offset, however, by the positive impacts of the innovative activities stimulated by regulations.[133] Taking the case of environmental regulations, Porter and Linde[134] argued in the 1990s that these can create incentives for the development of new eco-friendly processes and products. In the short-term, they hypothesised, companies see only the costs of compliance, but in the longer term the innovative approaches needed to comply with new regulations can lead to improvements in international competitiveness and new markets for innovative products. Moreover, this hypothesis was recently corroborated in a comparative analysis by Blind of the innovation-related impacts of environmental regulations in 21 OECD countries using time series analyses for the period between 1998 until 2004.[135]

Different regulations and regulatory frameworks, however, affect innovation in different ways. As noted by Blind in the same study, which looked at a range of different types of regulation, "Regulatory framework conditions have been identified as important factors influencing the innovation activities of companies, industries and whole economies. However, in the empirical literature, the impacts of regulation have been assessed as rather ambivalent for innovation. Different types of regulations generate various impacts and even a single type of regulation can influence innovation in various ways depending on how the regulation is implemented". Similar conclusions have also been drawn by

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131 European Commission (2009b)

132 The empirical analysis by Aschhoff and Sofka (2009) also highlights the potential role to be played by public procurement in fostering innovation, especially by SMEs. Bisgaard *et al* (2009), pages 80-87, provide anecdotal evidence on demand-side policies and public procurement.

133 The Innobarometer survey of 2009 (see European Commission (2009b)) noted that environmental regulations in the sectors covered by the survey encouraged or required 35% of EU enterprises to innovate.

134 Porter and van der Linde (1995)

135 Blind (2010)

others. Walz,[136] for example, concluded that different ways of implementing regulations relating to wind energy in the US and Germany had a marked effect on comparative innovation performance.

One implication, therefore, is that the formulation and implementation of new regulations in different technical areas and social contexts need to be based on careful and detailed reviews and analyses not only on ways of reducing compliance costs and ways of incentivising firms to innovate, but also on the potential costs and benefits of applying the regulations in different ways and in different contexts. Moreover, as noted in Section 2.3.2.4, the contexts in which regulations and regulatory frameworks are applied are constantly changing, necessitating a vigilant approach to the continued efficacy of existing regulations.

One immediate way forward for the Commission, therefore, is to review existing regulatory frameworks in key areas (e.g. candidate areas for the European Innovation Partnerships discussed in Section 6), with a view to identifying their appropriateness, efficiency and effectiveness as catalysts of innovative behaviour. In areas such as eco-innovation, for example, the aim would be to ensure that suggested revisions to regulatory frameworks are incorporated into future action plans.

4.2.4. Standards

In recent years, the need for standardisation to play a stronger role in support of innovation has been identified as a policy priority.[137] If effective standardisation is in place, innovation is enabled because:

- It gives innovators a level playing field, facilitating interoperability and competition between new and existing products.
- It provides customers with trust in the safety and performance of new products and allows product differentiation.
- It facilitates the emergence of new markets and the introduction of complex systems (such as the expansion of the internet).
- It contributes to the dissemination of knowledge, facilitates the application of technology and can subsequently trigger non-technological innovation in the service sector.

Moreover, it is important that Europe plays a strong role in international standardisation in order to capitalise on European leadership in new markets and gain first-mover advantages in global markets. In this sense, world competition in the standards arena is very strong, with each side wanting to impose its own standards. For example, in the

136 Walz (2007)

137 See European Commission (2008d) and Council of the European Union (2008)

electro-technical field, 70% of standards approved by the relevant European Committee (CENELEC) simply mirror international standards (mostly originating in the US).

In order to improve the prospects for innovation, the current standardisation models in Europe and at international level need to be adapted to respond to accelerated market cycles, converging technologies and the trend towards global markets. The rapid development of technologies is sometimes not compatible with the time necessary to build a consensus via the use of formal standardisation routes. This situation creates incentives for industry to use informal standardisation channels for the rapid development of technical specifications with an international reach. Lack of synchronisation between research and standardisation activities also slows down the rate at which new inventions can reach markets. In addition, recent studies and consultations show that the EU needs to establish a clear strategy to identify those standards likely to have the greatest potential impact on innovation, and to take steps to increase the awareness and accessibility of all players involved.

The rapid setting of technical specifications (via formal or informal channels) is important at the initial stage of the innovation cycle as they aim to further develop novel technology and applications and to set basic conditions for interoperability and economies of scale. This stage could benefit from initiatives that bring major players together, such as the European Innovation Partnerships (see Section 6). European standards are more important during the growing phase. Their aim is to develop regulations, establish proven interoperability, and create a level playing field. It is important to understand the balance between time and consensus. Building up acceptance by all the interested parties may be necessary in areas linked to consumers and environment protection, but for other kinds of standards, such as technical specifications defining interoperability, speed is of the essence.

4.2.5. Public procurement

Innovation-friendly public procurement can stimulate innovation in markets where the government is a large consumer and can send important pointers to the private sector about future demand. Public procurement of this nature, for example, could be used in markets such as health services to stimulate innovation, satisfy demand and catalyse market growth. In reality, however, few public procurers in Europe have established innovation-friendly procurement regimes, and few innovative companies have shown an interest in public procurement. A Eurobarometer Flash survey in 2009 of 5000 innovative EU companies found that 62% were either not interested in public procurement or considered that it was not applicable to them. Twenty-seven percent had won at least one public tender since 2006, but the majority of these (64%) said that none of their tenders had involved innovation.[138]

The public procurement Directives already allow procurement officials to use selection criteria favouring the purchase of innovative goods and services, and in recent years the

[138] European Commission (2009b)

Commission has provided various types of guidance related to this issue (including advice relevant to the pre-commercial stage).[139] However, there are still severe obstacles to the use of such criteria and the spread of innovation-friendly public procurement practices. These include:

- Limited incentives to encourage innovation, since procurers favour low cost, low risk, 'off the shelf' solutions even though testing and procuring new technologies and solutions would provide public service providers with longer term benefits. Moreover, there is a 'first mover' problem, with no individual procurer willing to bear the additional cost and risk (financial, operational and political) of being the first to purchase a new technology or innovation, even though all procurers would benefit from somebody taking the first step.

- Limited knowledge in procurement circles concerning innovation in general and the availability of new technologies on the market in particular – especially those originating from outside their own regions or countries. This is compounded by the lack of an adequate dialogue between procurers and suppliers and the consequent lack of any clear signals of future demand which supply companies could use to plan their investment in research and innovation.

- Few links between public procurement objectives and higher-level public objectives in fields such as health, environment and transport, which means that public procurement (especially innovation-friendly public procurement) is rarely thought of as a tool to attain these higher level objectives.

- The fragmentation of demand, with individual procurements too small to encourage companies to make innovative investments, and no mechanisms to allow the pooling of risk and resources, either across government departments in an individual country or amongst similar departments in other countries.

Some of these problems have been addressed in the context of the EU's Lead Market Initiative through the creation of networks of public procurers in each of the areas in which initiatives have been launched to date. These networks aim to bring together organisations that are actively purchasing innovative goods and services. They include city authorities, procurement agencies, hospitals, fire brigades etc. In reality, however, their numbers are small. A public consultation in 2008[140] seeking views on how best to establish such networks revealed that, in many countries, few – if any – organisations had any knowledge of innovation in procurement markets or actively engaged in trans-national dialogues with suppliers in order to develop joint procurement strategies.

In other regions of the world, public procurement plays a more active role in driving innovation. For example, the US Small Business Innovation Research (SBIR) programme

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139 See European Commission (2007h)

140 See http://ec.europa.eu/enterprise/policies/innovation/policy/lead-market-initiative/pp-consultation_en.htm

provides an example of good practice in the use of procurement. The scheme has been evaluated over several decades and positive impacts on innovative start-ups and businesses have been demonstrated.[141]

The US SBIR requires Federal agencies to set aside 2.5% of their R&D budgets and to make this available to SMEs through procurement and grants. Within the EU, such an approach to the use of procurement is not compatible with either EU Procurement Directives or with the principle of non-discrimination in the EU Treaty. However, learning from the US experience, the Commission introduced a pre-commercial procurement approach that entails offering contracts for innovative products and services that meet the needs of public sector organisations but which are not currently available on the market. Procurement of this nature is typically characterised by high risk and, to reduce this, the approach advocated in the Commission's Communication on pre-commercial procurement[142] uses a staged approach and offers contracts to a number of suppliers in order to develop and test different solutions.

Some Member States have subsequently put this approach into practice – witness the UK SBRI scheme and the Dutch and Flemish SBIR schemes – and experience to date has generally been positive, with the schemes proving attractive to SMEs in particular. Such schemes are still at an early stage, however, and reaching an effective critical mass is likely to be difficult for schemes operating solely at a national level.

An alternative would be for Member States to launch joint pre-commercial procurement initiatives. This would be a particularly appropriate way of tackling many of the major societal problems that are shared by Member States in areas such as healthcare, social welfare, environment and energy. If implemented across Member States, such schemes would also stimulate the demand for innovative goods and services and allow procurers to develop the skills and experience needed to implement innovation-friendly public procurement regimes.

The launch of the Innovation Union and the proposals within it to promote public procurement and launch European Innovation Partnerships (see Section 6 below) provides an opportunity to change the current situation and to mobilise those responsible for drawing up targeted public procurement strategies at both national and EU levels.

US expenditure on R&D procurements is a crucial source of stimulation for high technology and innovative companies. In 2004 it amounted to $49 billion[143], $2 billion of which was provided through the SBIR scheme. Comparable figures in the EU were some twenty times lower for R&D, and pre-commercial procurements are only recently starting in a few Member States. Given these facts, there is scope for the Innovation Union communication to propose an initial ambition level (perhaps €10 billion per year) for pre-commercial public procurements and the procurements necessitated by the

141 National Research Council (2008)

142 European Commission (2007h)

143 See US Federal Procurement Data System (2004).

Innovation Partnerships, with this figure rising over time to levels comparable with those in the US.

There is scope, too, for a specific support mechanism that would allow contracting authorities to pool procurement budgets, draw up common technical specifications and offset the risks inherent in the procurement of innovative products and services.

This would need to be complemented by an adequate legal framework for joint procurement between the authorities of Member States. At present, the existence of practical and legal barriers hampers the practice of joint procurement. In the first instance, therefore, there is a need for specific legal guidance on joint procurement in order to enhance the use of the possibilities currently offered by the EU Procurement Directives to aggregate public demand. In addition, the obstacles to joint procurement need to be examined carefully in the context of the current evaluation of the existing EU Procurement Directives.[144] An amendment of the current rules to facilitate trans-national joint procurements could follow as part of a general revision of the Directives following this exercise.

Last, but not least, the EU could play an important role in the establishment of clear criteria determining the innovative character of products and services, primarily in order to avoid legal insecurity and the misuse or misapplication of rules, but also to establish a base for the eventual measurement and monitoring of innovation-friendly procurement practices across the EU. The EU would then be in a position to provide Member States with comparable information on innovation-friendly procurement levels across Europe.

4.2.6. Eco-innovation

Growing environmental pressures, resource scarcity, bio-diversity loss and deteriorating eco-system services will threaten the recovery and further development of the European and global economy in the medium- to long-term if not managed properly. Eco-innovation is the natural junction of the pursuit towards sustainability, competitiveness and job creation. Through eco-innovation, new and greener goods, services and solutions, new business models and more sustainable consumption and production patterns will emerge. In turn, these will lead to improved environmental and economic performance and offer new employment opportunities.

To meet the EU's environmental and economic objectives, much greater levels of deployment and take-up of eco-innovation are required. Many of the supply and demand barriers to eco-innovation are generic to the European innovation system as a whole and can be tackled through 'horizontal' measures that have repercussions for all sectors, but some are specific to the environment sector and closer alliances are needed with the environmental policy sphere. Until now, environmental policy has been and remains a

[144] DG MARKT is currently evaluating the Directives of 2004 and intends asking a set of specific questions in a Green Paper entitled "How public procurement can underpin the Europe 2020 priorities", scheduled for adoption in autumn 2010.

main driver for eco-innovation, but there is scope for further development and improvement towards more innovation-friendly environmental policy and regulation. In particular, there is a need to develop a detailed Eco-innovation Action Plan within the context of the Innovation Union that embeds eco-innovation firmly within the overall innovation framework and specifically aims to reduce the barriers to eco-innovation, since these are frequently more severe than the barriers to innovation in more conventional markets.[145]

An Eco-innovation Action Plan would aim to:

- Promote innovation in environmental goods, services and solutions.
- Promote the concept of eco-innovation in the development of environmental policy, environmental management and eco-friendly business models.
- Focus on the sustainable management of natural capital and natural resources, on the reduction of air, water, soil and noise pollution, and on the reduction of risks related to the use of chemicals and hazardous substances.
- Promote new environmental governance structures to bridge the innovation gap between business and environment and mobilise public, private and financial authorities and institutions to support eco-innovation concepts and actions.
- Promote eco-innovation when integrating environmental concerns into other EU policies, in particular agriculture, rural development and cohesion policies.
- Facilitate networking between businesses and other stakeholders of eco-innovation in the EU with those in third countries.

4.3 Promoting openness and capitalising on Europe's creative potential

Policies attempting to realise the innovative potential of firms, especially SMEs, need to recognise the variety of ways in which firms innovate and the importance of key factors such as design. There also has to be an appreciation of the broad range of sectors in which innovation occurs and the importance of the so-called cultural and creative industries, where policy support has been lacking despite their high innovation potential. Policy initiatives aimed at removing obstacles to the flow of ideas to market are also needed, especially those that improve access to knowledge and the intellectual capital generated in publicly-supported programmes.

4.3.1. User-driven innovation and design

As shown earlier in Section 2.4.4, many companies are innovative even though they do not perform R&D. One important source of inspiration is the user. The findings of the

[145] FUNDETEC (2007)

European Innovation Scoreboard 2009 thematic report on 'user innovation'[146] (based on an analysis of the Innobarometer surveys of 2007 and 2009) show that, while a substantial minority of innovative firms in the EU27 are involved in process and product modification (around 30%), more than half such firms involve users in support of their innovative activities. User innovation is also more or less evenly spread across industrial sectors and across EU27 countries, categorised according to their innovative capabilities. Large firms are more likely to be involved in all forms of user innovation than small firms.

A clear message from the analysis is that firms engaged in user innovation can be classed as 'super-innovators'. Compared to other innovative firms, they are more likely to introduce new products, processes or services. They are also more likely to initiate new organisational methods. Moreover, the proportion of 'user innovators' that carries out both intra- and extra-mural R&D and applies for patents is also higher. The main internal sources of ideas for 'user innovators' are management and production engineers and technicians. Externally, the most important source of information, advice or support to help customise or modify products is the original developer or supplier of these products.

Design is increasingly recognised as a key innovation activity that brings user considerations into the innovation process and encourages interdisciplinarity. A public consultation organised by the Commission[147] showed strong support for joint EU action in the area of design, and for better integrating design into innovation policy. Ninety-one percent of responding organisations considered that design is very important for the future competitiveness of the EU economy. Ninety-six percent considered that initiatives in support of design should be an integral part of innovation policy in general, and ninety-one percent considered that initiatives in support of design should be taken at EU level as well as at Member State and regional levels.

The Commission Staff Working Document on 'Design as a driver of user-centred innovation'[148] analysed a range of sources on the contribution of design to innovation and competitiveness. These sources show that companies that invest in design tend to be more innovative, more profitable and faster-growing than those who do not. At a macro-economic level, research shows that there is a strong positive correlation between the use of design and national competitiveness.

Although often associated with aesthetics and the 'look' of products, the application of design is in reality much broader. It allows a range of considerations beyond aesthetics to be taken into account, including environmental, safety and accessibility considerations. User considerations are the starting point and focus of design activities. With its potential to make products and services user-friendly and appealing, design 'closes the innovation loop' from initial research to commercially viable innovations and, as such, has the

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146 Flowers *et al* (2009)

147 See: http://ec.europa.eu/enterprise/policies/innovation/policy/designcreativity/design_consultation_en.htm

148 European Commission (2009h)

potential to complement existing innovation and research policy and to broaden the target audience for European innovation policy to mature markets, sectors and regions characterised by non-technological activities and large SME populations, for which investment in technological research may not be feasible or suitable.

There are potential barriers, however, to making better use of design for innovation in Europe. Design as a tool for innovation has developed rapidly in recent years, resulting in particular in concepts such as strategic design, design management and design thinking. But innovation policy and support, as well as education systems, have not yet caught up with these developments. Compared to research, science and technology, the general understanding of the role and nature of design is much less developed. Companies that lack experience of design – particularly SMEs, low-tech companies and companies not located in big cities where design businesses tend to concentrate – often do not know where to turn for professional help in the area of design. Design businesses are also generally very small, which limits their reach. Although some European countries are among the world leaders in design, others lack a robust design infrastructure and design capability in companies and engineering schools. This is a gap in the European innovation system that has largely gone unnoticed and unaddressed.

4.3.2. Using creativity for innovation more broadly in the economy

The cultural and creative sector is a dynamic trigger of economic activity and job creation throughout the EU, encouraging economic growth and creating new jobs.[149] Creative industries occur at the crossroads between arts, business and technology. They range from information services, such as publishing or software to professional services such as architecture, advertising or design. The manifold economic impacts of creative industries provide dramatic evidence of their importance: they create new jobs, play key roles in global value chains, spur innovation and are among the fastest growing sectors in the EU.

The increasing importance of creativity in the EU job market becomes even more obvious when one looks at professions that are 'creative', irrespective of whether they belong to the so-called 'creative industries' or to more traditional activities. Creative occupations are growing within and outside the creative industries in both older and newer EU Member States (although fewer data are available for the latter).

The creative industries are thus not only innovators in themselves, but are important drivers of innovation in the entire economy, thereby creating strong spillover effects in the rest of the economy. Conversely, some creative industries are large users of new technologies and thus play a key role in the diffusion of technological innovations. Publishing and software firms, for example, are pioneers as far as internet and e-business practices are concerned.

Organisations in the creative industries are typically small and often remain so. This makes them natural candidates for small-business policies. They are often constrained by

[149] KEA European Affairs (2010)

limited access to funds, and many sub-markets of the creative industries call for public authorities to ensure level playing fields. The public good characteristics of certain creative sectors also justify the use of targeted approaches, since they stimulate innovation and contribute to our intellectual and cultural heritage. Under-investment must therefore be avoided. Adequate education and training are also essential for the expansion of this sector.

At an EU level, a recent Green Paper[150] on the cultural and creative industries noted that they sometimes facilitate structural adjustment in declining regions and the participation of the socially deprived. It also emphasised the need for policies to improve competitiveness and innovation in these sectors, arguing that the EU can play a role by strengthening the international protection of intellectual property and reinforcing the single market for the services offered by the creative industries.[151]

4.3.3. Open access to publications and data from publicly funded research

All research builds on former work and depends on the ability of scientists to access and share scientific information. In the recent past, the internet and electronic publishing have resulted in unprecedented possibilities for the dissemination and exchange of information. 'Open access', defined as free access over the internet, aims to improve and promote the dissemination of knowledge, thereby improving the efficiency of scientific discovery and maximising the return on investment in R&D by public research funding bodies.

To date, the great potential of the internet in terms of access and dissemination is only partially exploited. This is due in part to the diversity of national policies and legal requirements and practices regarding access to scientific publications and data. This lack of coherence adversely affects the dissemination of knowledge created with public funds. Open access thus needs to be a key component of the development of any over-arching ERA regulatory framework.

4.3.4. Improving knowledge flows

Modern innovations are increasingly complex in nature and the entity performing the research is not always the most suitable innovator. With open innovation and other forms of collaboration, the need for knowledge transfer between different players becomes more pronounced. In this context, properly functioning markets are essential to ensure that Europe can exploit its full innovative capacity and make effective use of its intellectual property rights.

In recent years, research institutions and universities have increased their efforts to manage their knowledge assets and exploit them in the market. The establishment of

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150 European Commission (2010e)

151 For further studies of the creative industries, see Abadie *et al* (2008) and http://is.jrc.ec.europa.eu/pages/ISG/COMPLETE.html and http://is.jrc.ec.europa.eu/pages/EAP/SC.html.

Technology Transfer Offices has helped these institutions to structure relationships with businesses in the areas of research, development and innovation, and to develop their entrepreneurial skills, which include the professional management of intellectual property rights. This process has been supported by the Commission, which has promoted a dialogue between the business community and universities[152] and has adopted a Recommendation and Code of Practice on the management of intellectual property in knowledge transfer activities by universities and public research organisations.[153]

Despite these efforts, there are few incentives for those managing publicly-funded research to pursue intellectual property management policies, and there is little effective enforcement of the rules imposed by national and European funding programmes governing the dissemination of results and their subsequent exploitation. Moreover, there is very little training on offer to ensure that researchers understand the significance of effective IP management. The results of publicly-funded research are therefore not as well exploited as they might be, and it is difficult to monitor the effectiveness of any exploitation that does occur.

A study in 2006[154] revealed that up to one third of European patents are not used for any industrial or commercial purpose. About half of the unused patents are 'sleeping patents' that are left unexploited by the patent holder. This is in spite of a requirement to pay annual fees to keep patents in force. There is thus potential for greater exploitation of these unused patents, and consideration deserves to be given to initiatives that can match IP rights owners with potential investors or licensees. Stimulating the market for trade in intellectual property could also warrant further investigation as a means of encouraging investment in IPR. Based on existing experiences in the Member States, initiatives that merit consideration include:

- An online marketplace where intellectual property can be advertised. An initiative to create such a marketplace was launched by the Danish Patent Office to bring together the owners and users of IPR, but it could usefully be extended to cover the EU as a whole.

- A designated stock exchange linking inventors and users with investors, offering unit licence rights and possibly also financial coverage products to hedge risks or investments. The French financial organisation Caisse des Dépôts is currently planning such an initiative in cooperation with US bank Ocean Tomo,[155] and again there is scope for a similar initiative operating at EU scale.

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152 European Commission (2009i)

153 European Commission (2008f)

154 Gambardella *et al* (2006)

155 The aim is to launch an IP exchange in Paris for European patents, linked to a patent ratings system developed by Ocean Tomo.

5. MAXIMISING SOCIAL AND TERRITORIAL COHESION

The transition to an Innovation Union will have important repercussions for organisations in the public and private sectors of all Member States. Policy has to ensure that the benefits of an innovation-led economy are both maximised and fairly distributed across all countries, regions and citizens of the EU.

5.1. Spreading the benefits of innovation across the Union

Ensuring that the benefits of research and innovation-related activities are spread widely across all Member States has long been an important EU policy goal. Lately, however, the financial crisis has threatened this process despite a prior tendency for the innovation performances of individual countries to converge.[156]

The Structural Funds dedicated to research and innovation over the period 2007-2013 can help avoid the development of an 'innovation divide' between regions in terms of the benefits accruing to them. Section 4.1 noted that approximately €86 billion is reserved for innovation-related activities if a broad definition of innovation is used, and much of this remains to be committed and spent on specific activities. There is an overwhelming imperative, therefore, to spend this wisely along the lines suggested in earlier sections, e.g. on the development of 'innovative clusters' and 'smart specialisation' strategies (see Sections 2.4.3 and 2.5.1); on the development of modern research infrastructures (see Section 3.2.3); and on various ways of leveraging finance for innovative SMEs (see Section 4.1). There is also scope for Structural Funds to stimulate demand via public procurement strategies (see Section 4.2.5) and to encourage the greater pooling of resources and expertise via the possibility offered by Article 37 (6b) of Regulation EC No. 1083/2006 to launch trans-national projects.

5.2. Increasing social benefits

The public sector needs to deliver new and better services that respond to users' evolving needs and expectations. Social innovation, defined in Section 2.4.4 as new forms of social organisation and interaction that respond to social demands for new and better ways of resolving societal problems and satisfying social needs, offers a way for the public sector to respond to challenges that initially fail to provoke an adequate market response from the private sector.

Social innovations address a social demand or need (e.g. care for the elderly), contribute to addressing a societal challenge (ageing society) and, through their process dimension (e.g. the active engagement of the elderly; the provision of new services) they contribute to reshaping society in the direction of participation, empowerment and learning. This implies that social innovation requires significant changes in behaviour at many different levels.

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[156] See the conclusions of European Commission (2009c).

Social innovation is a complex phenomenon for which the theoretical framework is still being developed – hence the existence of an empirical but fragmented approach to its implementation – and its growth in Europe is hampered by insufficient knowledge of the sector; limited support for grass roots, social enterprise and social entrepreneurship activities; the limited reach and poor diffusion of existing examples of 'good practice'; and few opportunities for them to be scaled-up. Lack of adequate metrics and limited attempts to monitor and evaluate support measures and assess impacts also constrain their spread. The contexts in which social innovations are developed are also very different across European countries in terms of the welfare systems in operation and the relative roles of the state, the market and the family, which complicates the process of mutual learning and the spread of good practice.

Currently, many European public authorities at national, regional and local levels have instruments and policies in place to encourage public sector and social innovation. All have a role to play in raising Europe's capacity to develop and adopt effective and innovative methods. Many initiatives and instruments are also already embedded in existing EU actions, ranging from activities supported in the Framework Programme to investments in social innovation by the European Social Fund (ESF), which supports institutional capacity building at all levels. In the current programming period, the ESF invests more than €2 billion in institutional capacity building; another €2 billion supports mutual learning between the Member States and transnational cooperation; and a further €1 billion is spent on innovative activities related to new forms of work organisation, better use of employees' skills and resources, productivity improvement, new approaches to lifelong learning and new ways of combating unemployment through entrepreneurship.

Overall, however, activity levels are sub-critical and most authorities involved in social innovation activities recognise the need for experimentation and 'scaling-up'; for networking stakeholders and promoting new public-private partnerships; for developing common methodologies for measuring initiatives and impacts; for the creation of capital markets and appropriate regulations to attract investment; and for new infrastructures capable of supporting social innovation.

There is also a role for the EU to play in terms of coordination, as many social innovation activities and the societal challenges they address have a cross-border dimension. Social innovation requires multilevel governance and consistent regulatory frameworks, and the EU has a catalytic role to play in developing these. Good practice in some Member States can also inspire solutions in other European countries, and scope exists for the EU to support efforts aimed at developing a better understanding of the concept and practice of social innovation. There is scope, therefore, for a programme of research on all aspects of social innovation and the development of a European Public Sector Innovation Scoreboard to benchmark public sector innovation and facilitate processes of mutual learning.

5.3. The future of work

As the public sector becomes more innovative in its delivery of services and the private sector depends more on innovation as a source of growth and prosperity, the nature of work in all sectors and the numbers involved in all types of professions will evolve in line with the demands of more knowledge- and innovation-based societies. As yet, however, our understanding of how these changes will manifest themselves is partial and incomplete. In order to gear education and training activities towards meeting these new demands, however, this situation will have to change. The employment consequences of the shift towards a truly Innovative Union thus need to be explored more fully, especially in areas pinpointed as policy priorities, e.g. the areas tackled by the European Innovation Partnerships discussed below.

6. POOLING FORCES TO ACHIEVE BREAKTHROUGHS: EUROPEAN INNOVATION PARTNERSHIPS

The scale of major societal challenges and the adverse impacts associated with a failure to deal with them constitute reason enough to formulate research and innovation policies designed to confront and resolve them quickly. The complexity and pervasiveness of the challenges, however, dictate how they can be tackled. Typically, combating challenges calls for the formulation and implementation of policy responses spanning many policy spheres, levels of governance and policy instruments, and the involvement of a vast range of institutional actors, stakeholders, citizens and resources from the many countries and regions affected by the challenges.

In such situations, there are three broad options. The first calls for minimal policy intervention and a reliance on pure market forces to resolve major societal problems via the development of appropriate solutions and innovations. As noted above, however, for most countries the scale of the threats posed by 'grand challenges' and the political unacceptability of failing to deal adequately with them rule this option out.

The second option calls for 'uncoordinated' or 'loosely coordinated' policy responses – essentially a slightly more focused version of the status quo – with individual ministries in individual countries or regions deploying their own policy instruments to develop a range of innovative solutions, but with each tackling only those parts of the problem that are most visible to them. Increasingly, however, this option is sub-optimal, even though many Member States and other countries around the world are developing research and innovation policies to address societal challenges. As noted by the OECD:[157]

- No single country can successfully address the problems alone.
- Individual countries may not be willing to bear the costs of addressing global challenges because they cannot appropriate the benefits.

[157] See OECD (2010a)

- The uncoordinated efforts of many countries to address global challenges are likely to be more costly and less successful than coordinated, cooperative efforts.

In addition to these generic problems concerning the ability of countries to constitute effective policy solutions, there are also some more problems specific to the deployment of research and innovation policies within countries and regions. As noted in earlier sections, particularly Section 2.3, efforts to improve the performance of research and innovation systems increasingly demand greater linkages and higher levels of coordination between policy instruments addressing the supply and demand sides of the policy equation – necessary to ensure the effective translation of ideas into marketable and socially relevant goods, services and solutions – and between the key ministries, agencies and departments involved in the formulation and implementation of research and innovation support policies at all levels of governance. Moreover, when the intention is to orient research and innovation policies to the resolution of major societal challenges, there is an additional need to ensure that policy coordination takes place across a much broader range of policy spheres.

The third option, therefore, is for a much greater emphasis than hitherto on 'coordinated' policy responses underpinned by a high level of political commitment. Societal challenges cannot be addressed without the extensive adoption of innovative solutions, massive investment, and approaches that cross disciplinary and geo-political boundaries. Public entities need to re-orient their activities around the challenges and close cooperation is needed to guide national and regional investment efforts in order to avoid expensive duplication and share costs and benefits.[158]

Such coordination, however, is also not without its costs and the establishment of adequate coordination mechanisms is a complex process requiring time, patience, efficient information sharing and, preferably, a bedrock of collaboration experience upon which to draw.[159] Critically, the scale of major societal challenges, the number of people affected by them and the range of institutional actors involved in their resolution also pose their own problems for coordination. The larger a problem is and the more people involved in its solution, the more difficult coordination is likely to be.

The solution, therefore, is to ensure that policy efforts are pitched at an appropriate level and that governance structures determining the relationships between key policy actors and stakeholders are as simple as possible. Efforts to mobilise and coordinate all constituencies in all countries around the world to tackle all aspects of problems such as climate change in parallel have little chance of success (at least in the first instance). A more realistic approach is to break down 'grand challenges' into smaller (but still

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158 Cunningham and Karakasidou (2010a). For specific examples referring to climate change and ageing, see, respectively, Cunningham and Karakasidou (2010b) and Cunningham and Karakasidou (2010c).

159 The Strategic Energy Technology Plan provides a good example of reorganisation of existing initiatives around a societal challenge, while also providing an anchor for future policy instruments. See Hervás Soriano, Fernando and Mulatero, Fulvio (2010).

appreciable) sets of sub-challenges that are vital to the resolution of the whole but can be tackled more easily via the constitution of manageable 'partnerships' of key actors and stakeholders with relatively simple governance and coordination structures.

These considerations in part underpinned the Commission's intention, announced in the EU2020 strategy, to: "launch 'European Innovation Partnerships' between the EU and national levels to speed up the development and deployment of the technologies needed to meet the challenges identified".[160] A further critical consideration, however, is the need to create synergies between, on the one hand, research and innovation policies aimed at resolving the 'grand challenges' and, on the other hand, policies aimed at developing market frameworks, stimulating demand and providing businesses with the market signals and prospective returns that drive both the rate and direction of investment in research and innovation (see Section 2.1). The intention should be to realise win-win solutions that do both.

These are the main reasons why European Innovation Partnerships should form a central plank of the Innovation Union, with each partnership aiming to make a significant contribution to the resolution of major societal challenges through the development of innovative solutions with a large market potential. Given the complexity and ambition of the partnerships, pilot initiatives should be launched in the first instance to demonstrate intent and commitment, with further partnerships scheduled for launch after more widespread consultations with key actors and stakeholders across Europe and, in some instances, with interested parties in other parts of the world.

7. LEVERAGING OUR POLICIES EXTERNALLY

According to various rankings, while EU Member States like Sweden, Finland, Germany, Denmark and the UK are among the world leaders in innovation performance, the aggregate score for the EU27 Member States is mid-range. There is also a significant gap between the performance of the EU27 and that of the US and Japan, and even though the EU27 has a strong lead over the BRIC countries, China and India are catching up rapidly. China in particular has shown a rapid rate of relative improvement. The performance gap with the EU27 has decreased considerably and will disappear in the very near future if China's rate of improvement over the last five years is maintained.[161] China and India are also not isolated cases. Other Asian countries such as South Korea and Singapore have become new innovation hot spots.

The emergence of new innovation powers has accelerated the globalisation of research and innovation activities and increased the pressure on the EU to maintain and improve its innovation performance and competitive position. But globalisation also means that this can only be done via improved access to global knowledge sources and global markets for innovative products and services. Developing an appropriate and coherent

160 See European Commission (2010a)

161 Archibugi *et al* (2009)

relationship with international partners is therefore a key factor. As one EU Expert Group noted: "International opening (to the world) can help instigate virtuous circles whereby the EU becomes a stronger region in science and technology (S&T) and thereby becomes more attractive e.g. for internationally mobile scientists and engineers and for international investments in R&D".[162] Europe's future depends on global knowledge sourcing, which involves attracting and working with the best talents, researchers and entrepreneurs, and on coherent and coordinated relationships with third countries to ensure the efficient promotion of European interests abroad. Europe's researchers and entrepreneurs would also benefit from 'support platforms' located in strategic partner countries where they could obtain advice about potential sources of expertise and scientific and commercial contacts.[163]

Against this background, EU policy objectives concerning international cooperation are to:

- Strengthen Europe's competiveness and scientific excellence through international research and innovation co-operation, improve our capacity to respond to global challenges and attain leading positions in the biggest growth markets.

- Pool Europe's resources through enhanced partnerships between the EU and its Member States in the area of international cooperation to overcome fragmentation, increase focus and thereby strengthen Europe's global research and innovation performance.

- Ensure the engagement of EU, Member States and the business community so that Europe acts coherently in its co-operation with third countries.

Making Europe attractive to foreign researchers is one obvious way of encouraging global knowledge exchange, and efforts geared towards the reduction of obstacles to such flows would reap great benefits. However, there is also a case for schemes that encourage EU researchers to both share their expertise and enhance their own capabilities by working in other countries, thus making the concept of 'brain circulation' a reality.

Another way of improving knowledge flows and enhancing innovative potential is via schemes that aim to strengthen international links. While much EU research and innovation policy so far has been based mainly on actions addressing internal deficits in Europe's research and innovation system, the EU nevertheless has a strong track record in international S&T co-operation. The 6th Framework Programme, for example, established about 8,600 collaborative links with 130 countries around the world. Similarly, the 7th Framework Programme has deepened and extended these partnerships to 185 countries. In terms of thematic areas, most are centred on the global challenges, with 'sustainable development, global change and ecosystems' heading the list of areas of co-operation.

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162 Archibugi, Suma and Gammeltoft *et al* (2008)

163 TAFTIE (2010)

Most Member States also have their own independent strategies for international research co-operation. More than 20 EU Member States, for example, have established cooperative links with the BRIC countries.[164] These strategies generally reflect national priorities and interests, with little consideration of the potential advantages that could be derived at a European level from reduced fragmentation and the promotion of common European concerns and interests through a more rationalised, focused and coherent international ST&I co-operation strategy.

There is thus certainly scope for synergy. A more coherent European 'voice', particularly in multilateral fora addressing the global dimensions of societal challenges, will facilitate co-operation and ensure that European expertise is channelled towards the search for global solutions. It will also ensure that Europe plays a leading role in the determination of global priorities.

An important consideration when determining future policy actions will be that of reciprocity. Global knowledge sourcing is not a one-way street. Level playing fields are a precondition for international co-operation. This is reflected in the Council Conclusions of 2 December 2008, which called for international scientific and technological activities to "be based on principles and practices which uphold reciprocity, fair treatment and mutual benefits, as well as adequate protection of intellectual property".

In terms of presenting a common front to the rest of the world, there is scope for 'umbrella agreements' governing the S&T co-operation arrangements of Member States and the EU with priority Third Countries. More specifically, the OMC CREST Internationalisation of R&D Working Group, in its final report in 2009, proposed that the EU should "analyse options for providing a general legal framework including issues such as reciprocity, visa regimes, working permissions and social security for each other's scientists, exchange of scientific samples, cross-border access to research sites and transfer of scientific equipment through mixed agreements of the EU and its Member States such as partnership and co-operation agreements (PCA) or the EU S&T agreements".[165]

Global research infrastructures provide an ideal space for interaction and the exchange of knowledge, yet the high cost of cutting edge facilities are beyond the financial means of individual countries or regions (the European contribution to the ITER budget, for example, is currently around €7.2 billion). For the EU, therefore: "The joint planning, establishment, running and financing of S&T infrastructures provides the ground for efficient international research co-operation on a long-term basis through sharing knowledge, efforts and risks".[166]

International cooperation is also important for innovative businesses. Internationally active SMEs are far more likely to innovate than those without any international

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164 According to the latest figures provided by DG Research

165 Sonnenburg and Steinberger (2009)

166 Sonnenburg and Steinberger (2009)

activities. In a recent study, for example, 26% of internationally active SMEs introduced products or services that were new to their sector in their country, whereas for other SMEs the comparable figure was only 8%. Internationally active SMEs also reported greater employment growth (exporters reported employment growth of 7% compared to 3% for non-exporters).[167] However, only 13% EU27 SMEs are active in markets outside the EU. To promote the internationalisation of EU business and to support business cooperation in innovation, EU member states and the Commission have established a number of business support centres, innovation support centres, joint technology institutes and joint funding programmes. But the use of these public support measures needs to be improved, as only 16% of SMEs are aware of their existence and an even smaller number actually use them. One possibility would be to create 'one-stop shops' housing all EU business support services under a single roof in major conurbations. This could be particularly interesting for SMEs and start-up firms trying to enter new markets or to operate globally.

8. MAKING IT HAPPEN

For the Innovation Union to work, changes have to take place on many levels and systems are needed to track developments, monitor progress and learn from experience.

8.1. Reforming research and innovation systems

Innovation systems can be defined in many ways. National systems can be thought of as a collection of regional systems, and the EU innovation system can similarly be thought of as the sum – or hopefully more than the sum – of its national and regional innovation system components.

For the EU innovation system to function effectively, all of its component sub-systems at national and regional level have to function effectively in their own right and link together well, for overall system performance is adversely affected by the performance of the weakest links in the chain and by the way they interact with the other elements of the system.

Section 2.2.1 presented evidence on the performance of the EU as a whole; and Section 2.2.2 presented similar evidence on the performance of individual Member States. The wide variations across Member States suggest that improvements at regional and national levels are needed if the overall performance of the EU is to improve, and Section 2.3 further suggested that this will involve Member States in concerted efforts to strengthen both the individual elements of their systems (human resources, the science base, industrial innovation, market development, finance etc.) and the governance systems that ensure all these elements are linked together in a coherent fashion.

[167] EIM Business Policy & Research (2010)

There is now an extensive body of knowledge of potential use to national and regional policymakers interested in the evolution of efficient and effective innovation systems and the policy mixes needed to achieve them. The ERAWATCH[168] and Pro-Inno Europe[169] websites, for example, are a source of extensive empirical and analytical material on all relevant research and innovation policies in both Member States and a range of other countries. Since 2004, The European Research Area Committee (ERAC – formerly CREST) has also conducted a series of policy mix peer reviews of approximately half the Member States,[170] while the OECD performs similar reviews at the request of its members.[171] Both the OECD and the Commission have also supported a number of large scale studies into the governance of innovation systems (e.g. the 'MONIT' study)[172] and the constitution of effective policy mixes (the 'Policy Mix' study).[173]

The evidence emerging from these studies confirms that the efficiency of governance structures, the choice of appropriate policy mixes and the resultant performance of overall innovation systems are highly context specific, with much dependent on starting positions and socio-cultural environments. In other words, there is no simple 'one size fits all' policy prescription or governance structure that will guarantee success.

There are, however, numerous examples of 'good practice', i.e. modes of behaviour associated with well-performing systems. These cover aspects relating to governance structures; administrative processes; the composition, focus and balance of policy mixes; and overall levels of investment in research and innovation. Overall, they suggest a set of structures, practices, processes and objectives to which all Member States can aspire, especially when considered alongside the high-level aspirations of the EU 2020 strategy as a whole.

The most important indicative aspirations for all Member States can be summarised as follows:

- The adoption of an overall perspective that places innovation at the heart of government policy thinking and central to the attainment of economic development and improvements to the general quality of life, with a vital role to play in the resolution of major societal challenges.

- A complementary financial commitment to the provision of stable, long-term and appropriate levels of public funding for research and innovation, designed to create a solid platform for knowledge-based growth and to stimulate commensurate private sector investment.

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168 See http://cordis.europa.eu/erawatch/index.cfm
169 See http://www.proinno-europe.eu/
170 See http://www.consilium.europa.eu/showPage.aspx?id=1430&lang=en
171 See www.oecd.org/sti/innovation/reviews
172 See http://www.oecd.org/document/25/0,3343,en_2649_34273_35175257_1_1_1_1,00.html
173 See http://ec.europa.eu/research/policymix/

- The adoption of a broad-based definition for innovation, allowing for research-based innovation and other forms such as non-technological, user-driven and social innovation, and requiring the evolution of a rich mix of support instruments on both the supply and demand side.

- A parallel commitment to simplify the administrative arrangements governing the implementation of support measures – an increasingly important necessity given the number and diversity of instruments needed to deal adequately with a broad definition of innovation.

- The evolution of authoritative, high-level governance mechanisms, supported by adequate strategic intelligence and control capabilities, that can formulate and implement overarching strategies that are focused on key priorities and implemented coherently across all relevant areas.

- A strong focus on the development of the human resources needed to fuel a vibrant research and innovation motor, involving the strengthening of education and training capabilities and greater efforts to reap the benefits of international 'brain circulation'.

- A related emphasis on nurturing excellence via methods that both exploit competition for resources as a means of stimulating quality and encourage collaboration facilitating knowledge sharing and the pooling of international resources to attain critical masses of innovative effort.

- Framework conditions allowing innovative enterprises to flourish, with a particular emphasis on favourable tax environments, the ready availability of finance to fuel innovation and growth, and the removal of legal and regulatory barriers to all innovation-related activities.

- A strong focus on mechanisms that promote knowledge flows and interactions between all the different actors involved in the process of innovation, from support for regional clusters to consensus platforms, joint initiatives and new forms of public-private partnerships.

- A new but necessary role for the public sector in driving innovation, especially in areas relevant to the solution of major societal challenges, where governments can help stimulate demand and establish lead markets via innovation-friendly public procurement mechanisms.

Aspirations such as these are already evident in many countries, but they need to be widespread if the EU as a whole is to realise the EU 2020 vision. There is thus scope for the EU to consider how it can best support Member States in their efforts to improve their own national and regional innovation systems. This could include support for further studies and analyses that track and assess 'good practices'; expanded support for the type of policy mix peer reviews conducted to date by ERAC (formerly CREST), but with an expanded focus on the policy mixes needed to improve overall innovation system

performance rather than raise R&D investment levels (the original focus of the ERAC/CREST reviews); and the elaboration of more sophisticated indicators capable of describing and measuring different aspects of innovation system performance (see Section 8.2).

There is also scope for using the set of aspirations discussed above – or a similar set decided upon after further consultation with Member States – as a checklist that countries could use as a self-diagnostic tool when assessing the steps they need to take to implement their National Reform Programmes. Sharing these self-assessments would also allow Member States to learn from the experiences of other countries and to benchmark their own development. The EU could also benefit by using the diagnostic tool to assess its own governance structures and policy mixes.

8.2. Measuring progress

For many years, Member States have been able to use a range of indicators to assess different aspects of their research and innovation performance, with commensurate data across most countries facilitating benchmarking and mutual learning. Perhaps the most well known of these is the indicator of research intensity, namely the ratio of national expenditure on R&D to Gross Domestic Product (GDP), which has been used not only to compare research intensities across countries but also as a public policy target for the EU as a whole (the so-called 3% target first set at the European Council meeting in March 2002).

A composite indicator based on a range of research and innovation-related indicators has also been available for many years – the Summary Innovation Index presented in the EU's Innovation Scoreboard. This is useful as a broad indicator of overall innovation performance and changes over time provide some guide to progress, but it is difficult to use a composite indicator based on so many component indicators to set meaningful policy targets. Even tracking progress is complicated by the fact that commensurate data is not available for all indicators across all Member States – and certainly not for all trading partners outside the EU.

The European Council therefore requested the European Commission to identify two headline indicators to assess and compare R&D and innovation performance at the level of the EU, one of which is to assess R&D performance (R&D intensity); the other to assess innovation performance.

A high-level panel of leading business innovators and economists was therefore set up to examine the availability and quality of possible indicators.[174] It concluded that, as yet, there is no single indicator for which internationally comparable data are available that

[174] The High Level Panel on the Measurement of Innovation started its work in June 2010. Based on the recommendations of the panel, the Commission will present a proposal for a new headline indicator for innovation to a European Council meeting dedicated to research and innovation in late 2010.

can be used to assess innovation performance, using a broad definition of innovation accommodating both research-based and other forms of innovation.

It did conclude, however, that the prospects for developing a single innovation indicator (based on the number of fast-growing, innovative companies in an economy) within a time-frame of two years are good, but that this would depend on the agreement not only of Member States to provide the requisite data, but also on the agreement of the EU's main trading partners.

The panel also suggested that, prior to the development of this new, single, headline indicator, the main aspects of innovation performance could be captured by a relatively small number of indicators (three) covering patents, the contribution of high-tech and medium-tech products to the trade balance, and employment in knowledge-intensive activities.

By building on the European Innovation Scoreboard, there is also scope to produce a new Innovation Union Scoreboard based on a revised and expanded set of indicators reflecting the multi-faceted nature of innovation in its broadest sense. More work will be needed, however, to ensure the adequacy and availability of data reflecting the full range of innovative activities that need to be taken into account.

9. APPENDIX 1: DIALOGUES WITH STAKEHOLDERS AND EXPERTS

The December 2008 European Council called for a 'European Plan for Innovation'. As a first step, an assessment of achievements made under the EU's broad-based innovation strategy was conducted, accompanied by reviews of the Lead Market Initiative, innovation in services, financing innovation in SMEs and the effectiveness of innovation support measures. In parallel with the implementation of the ERA Vision 2020 and ongoing ERA initiatives, these provided the basis for dialogues with stakeholders and experts.

9.1 Public consultations

A number of public consultations were launched:

- Business Panel consultation on future EU innovation policy

From 7 July to 31 August 2009, an appointed panel held an open, on-line consultation on its ideas and proposals via the medium of the Innovation Unlimited blog[175], where the results of the panel's deliberations were also published.

- Public consultation on Community innovation policy

The consultation explored stakeholder responses to the findings of the Communication 'Reviewing Community innovation policy in a changing world'[176] and two previous consultations, one on the effectiveness of innovation support in Europe and one on design as a driver of user-centred innovation. The consultation was launched on 16 September 2009 with a deadline for responses of 16 November 2009. In total, 215 responses were received.[177]

- On-line discussion on the Innovation Union

Commissioner Geoghegan-Quinn hosted an on-line discussion on the Innovation Union flagship initiative on 17 June 2010. This allowed 600 on-line participants to make numerous suggestions concerning the transformation of Europe into an Innovation Union.[178]

- Eurobarometer surveys

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175 See http://blogs.ec.europa.eu/innovationunlimited/

176 European Commission (2009j)

177 See http://ec.europa.eu/enterprise/policies/innovation/future-policy/consultation/results_en.htm

178 See http://ec.europa.eu/commission_2010-2014/geoghegan-quinn/headlines/news/2010/20100617_innovation_untion_en.htm

A special Eurobarometer survey on science and technology was published in June 2010,[179] and another Eurobarometer survey on the importance of 'Europe 2020' initiatives to European citizens was published in August 2010.[180]

9.2 Expert Groups

The Commission established the following Expert Groups and Panels to advise on future research and innovation policy:

- Business Panel on future EU innovation policy

A Business Panel on future European innovation policy was established to provide inputs from a business perspective on priorities and actions for future EU innovation policy. The results of its deliberations, together with the results of the public consultation it launched, were published in a report entitled: 'Reinvent Europe through innovation – from a knowledge society to an innovation society'.[181]

- Knowledge-based economy Expert Group

This Expert Group, set up at the end of 2008 and chaired by Prof. Luc Soete, was asked to review and interpret the evidence on the state of the knowledge-based economy in Europe; to assess the effectiveness of existing research policy instruments; and to come up with recommendations on how to frame and articulate Community research policy in the post-2010 period. The recommendations were published in October 2009 in a report entitled: 'The Role of Community Research Policy in the Knowledge-Based Economy'.[182]

- Expert Group on a knowledge intensive future for Europe

This expert group, chaired by Dr. Björn von Sydow, made recommendations on future targets and policies to foster a more knowledge-intensive economy, based on an assessment of the impact of the 3% R&D intensity target on European research. The broad thrust of the recommendations, targeted at Member State and EU levels, reflected a core emphasis on how Europe could be made more attractive to business and to its citizens. It also focused on the structural reforms and knowledge infrastructures needed to attain these objectives. The results of the Expert Group were published in a report entitled: 'A knowledge intensive future for Europe'.[183].

- Expert Group on ERA indicators and monitoring

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179 European Commission (2010g)
180 European Commission (2010h)
181 See: http://ec.europa.eu/enterprise/policies/innovation/files/panel_report_en.pdf
182 See: http://ec.europa.eu/research/era/pdf/community_research_policy_role.pdf
183 See: http://ec.europa.eu/research/era/docs/en/understanding-era-knowledge-intensive-future-for-europe-eur24165-2009.pdf

The overall objective of this Expert Group was to promote and contribute to the development of an evidence-based system to monitor progress towards the ERA and the realisation of a knowledge-based economy. Combining economic and statistical expertise, the Expert Group, which was chaired by Prof. Remi Barré, presented a comprehensive and flexible framework for an evidence-based monitoring scheme. The results of this Expert Group were published in a report entitled: 'ERA indicators and monitoring'.[184].

- European Research Area Board (ERAB)

This high-level Advisory Group was set up to advise on the realisation of the European Research Area (ERA). In October 2009, it published its first annual report: 'Preparing Europe for a New Renaissance: A Strategic View of the European Research Area'.[185]

- European Technology Platform Expert Group

The group met six times between January and September 2009 to discuss the future of European Technology Platforms. The recommendations of the group were presented in October 2009 in a leaflet entitled: 'Strengthening the Role of European Technology Platforms in Addressing Europe's Grand Challenges'.[186]

9.3 Conferences and seminars

- ERA 2009 Conference, 'Working together to strengthen research in Europe', Brussels, 21-23 October 2009

This conference was the first major research stakeholder event on the European Research Area since the 2007 Green Paper 'The European Research Area: New Perspectives'. It set out to contribute to the development of key ERA policy initiatives dealing with researchers, joint programming, knowledge transfer, infrastructures and international cooperation, as well as other areas of the ERA policy agenda under development or under consideration, e.g. open access, the funding of research institutions, progress indicators, specialisation and research policy in the post 2010 strategy.[187]

- Spanish Presidency conference, 'Corporate R&D: an engine for growth, a challenge for policy', Seville, 3-4 March 2010

This conference focused on the impact of corporate R&D on various aspects of business and economic performance and the implications for future support policies in the context of the EU2020 strategy.[188]

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184 See: ftp://ftp.cordis.europa.eu/pub/era/docs/era_indicators&monitoring.pdf
185 See: http://ec.europa.eu/research/erab/pdf/erab-first-annual-report-06102009_en.pdf
186 See: ftp://ftp.cordis.europa.eu/pub/technology-platforms/docs/i652-etp09-flyers_en.pdf
187 See http://ec.europa.eu/research/conferences/2009/era2009/index_en.htm
188 See http://iri.jrc.ec.europa.eu/concord-2010/

- Spanish Presidency conference, 'European challenges for innovation', Bilbao, 27-28 April 2010

The aim of the conference was to help define an innovation strategy for Europe. It brought together policy makers and innovation practitioners to discuss cases of good practice in Member States and exchange views on the way forward for Europe.

- European Research Area Board (ERAB) conference, Seville, 7-8 May 2010

At this conference, the new Commissioner for research and innovation, Máire Geoghegan-Quinn, asked science and technology community leaders and promising young scientists to suggest ways in which research, innovation and science could address society's grand challenges and pave the way for Europe's post-crisis transition to a smart, green economy and society. Based on feedback from the conference delegates and its own discussions, the ERAB came up with 10 key recommendations.[189]

- European Technology Platforms conference, 'Working together on societal challenges', Brussels, 11-12 May 2010

This conference brought together 350 representatives of industry, academia, civil society, EU Member States and Commission departments to discuss opportunities to collaborate on ways to address societal challenges and to exchange experiences and best practices relating to innovation. The conference also afforded Commissioner Geoghegan-Quinn another opportunity to meet with industry leaders.

- 'Innovation in healthcare: from research to market. SMEs in focus' conference, Brussels, 20-21 May 2010

The main objective of the conference was to address the challenges that European healthcare enterprises currently face. Commissioner Geoghegan-Quinn met with CEOs of health and biotech start-ups/SMEs. The report from the conference includes recommendations and proposals for the Innovation Union strategy.[190]

- 'Europe 2020 Strategy – Innovation insights from European research in socio-economic sciences' conference, Brussels, 1 June 2010

This event allowed European Commission officials to discuss topics relevant to the Innovation Union initiative with leading economists and social scientists.

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189 See: http://www.erab2010.com/Resources/documentos/noticias/10_recommended_actions_final_online.pdf

190 See: http://ec.europa.eu/research/health/pdf/healthcare-report-on-the-outcome-conference_en.pdf

10. APPENDIX 2: IMPACT OF THE 3% R&D TARGET ON THE NUMBER OF RESEARCHERS NEEDED IN THE EUROPEAN RESEARCH SYSTEM IN 2020

10.1. Background

In March 2010 the European Council confirmed the 3% R&D intensity target as one of the headline indicators needed to assess the progress of the EU towards smart, sustainable and inclusive growth. This target should catalyse broad changes not only in the research system but also in the economy – which will need to undergo structural change – and the educational and labour systems – which will have to supply an increasing number of skilled workers, including researchers. More precisely, an increase in research intensity will require both quantitative and qualitative changes in the population of researchers in Europe. Quantitatively, more researchers will need to be trained in the EU or attracted from outside the EU in order to take advantage of increased R&D resources. Qualitatively, many of these new researchers will need to be trained in new scientific fields and will have to acquire a broader set of skills than hitherto.

In order to avoid bottlenecks in the scientific, technological and economic transformation of the EU, it is therefore important to estimate the required net increase in researchers by 2020.

The total number of researchers to be trained and hired by 2020 is the sum of the net increase in the number of researchers needed to reach the 3% target and the number of those retiring by 2020. Due to the limited availability of data on the demographics of researchers in Europe, however, the estimate provided in this analysis does not take into account the number of researchers retiring. The total number of researchers to be trained and recruited is therefore higher than the figure estimated in this analysis.

10.2. Some initial background figures

In 2008, the EU had approximately 1.5 million researchers (FTE): about 690,000 in the Private Sector; 610,000 in the Higher Education System; and 190,000 in the Public Sector. In 2000, the number of researchers was about 1.1 million: 525,000 in the Private Sector; 410,000 in Higher Education; and 170,000 in the Public Sector.

These figures reveal important characteristics of the community of researchers in the EU that have to be taken into account when estimating the need for new researchers. Firstly, only half of the researchers in the EU work in the private sector, where research is more closely linked to innovation. This situation contrasts markedly with that in other countries. In the US, almost four out of five researchers – and in Japan, two out of three researchers – work in the private sector.[191]

[191] Based on OECD figures available at: http://www.oecd.org/document/26/0,3343,en_2649_34451_1901082_1_1_1_1,00.html

Secondly, the figures show that, over a period of 8 years, the number of researchers in the EU increased by almost 30% at an average annual growth rate of 3.8%. The size of the research population and R&D expenditure both increased at the same rate, while R&D intensity stagnated due to an equivalent increase in GDP.

Thirdly, the increase in the number of researchers was not homogeneous across sectors. It increased by an annual average of 5% in the Higher Education System; by 3.5% in the Private Sector; and by 1.2% in the Public Sector.

As a consequence, the combination of an increase in R&D intensity to 3% by 2020 and expected levels of economic growth during the period 2010-2020 will require a very sharp net increase in the number of researchers in the EU.

10.3. An approach to estimate the number of researchers needed

Estimating the net increase in the number of researchers needed in the EU is complex because many of the variables affecting this estimate co-evolve over time,[192] i.e. the value of one variable affects and interacts with the value of another and the accuracy of any estimate based on past data is therefore tentative and has to be treated with caution.

Despite these difficulties, estimates can be made. As noted in the previous section, the number of researchers is related to the absolute level of research investment in the economy, and research investment can be decomposed into two factors: (1) an increase in GDP; and (2) an increase in research intensity.

In order to calculate the impact of the increase of research investment on the number of researchers needed in the economy, a three step approach can be followed:

Step 1: Calculation of the research investment in the EU in 2020

Research investment will increase due to an expansion of the overall economy and an increase in research intensity. If GDP increases at an average annual rate of 2% over the next decade, the GDP of the EU in 2020 will increase to €14,660,430 million (PPS).

GDP EU-27 (2009) = €11,790,842 million (PPS)

GDP EU-27 (2020) = GDP EU (2009) x $(1+2\%)^{11}$ = €14,660,430 million (PPS)

As the EU target is to increase research intensity to 3%, total research investment will therefore rise in this scenario to approximately €440 billion (PPS).

GERD (2020) = GDP EU-27 (2020) x 3% = €439,813 million (PPS) (1)

[192] Economic structure, the rate of economic growth and the scientific and technological specialisation of an economy are variables that are closely interrelated with research investment levels and the number of researchers an economy needs. Changes in these variables also affect each other.

Step 2: Calculation of the ratio of research investment per researcher in Europe in 2008

Levels of funding for individual researchers vary greatly depending on the characteristics of the field of research and the type of research being conducted. However, an average amount of research investment per researcher can be calculated. For the EU, this value was €151,000 (PPS) per researcher in 2008.

Ratio of research investment per researcher = GERD (2008) / Number of researchers

Ratio of research investment per researcher = €227,191 million (PPS) / 1.5 million researchers = €151,000 (PPS) per researcher (2)

Step 3: Calculation of the number of researchers needed in the EU in 2020, not taking into account any major change in the economic and scientific structure of the EU

Once estimates of total research investment in 2020 and the ratio of research investment per researcher have been calculated, the number of researchers needed in 2020 can be calculated by dividing these estimates. This calculation yields a result of 2.95 million researchers, which represents a net increase of around 1.5 million researchers.

Number of researchers (2020) = GERD (2020) (1) / Ratio of research investment per researcher (2)

Number of researchers (2020) = €439,813 million (PPS) / €151,000 (PPS) per researcher = 2.95 million researchers (3)

10.4. Correction of the estimate based on expected changes in economic and scientific structure

The figure of 2.95 million researchers assumes that the ratio of research investment per researcher remains constant in the EU. The evidence suggests, however, that this ratio increases as an economy becomes more research intensive (see Chart 1).

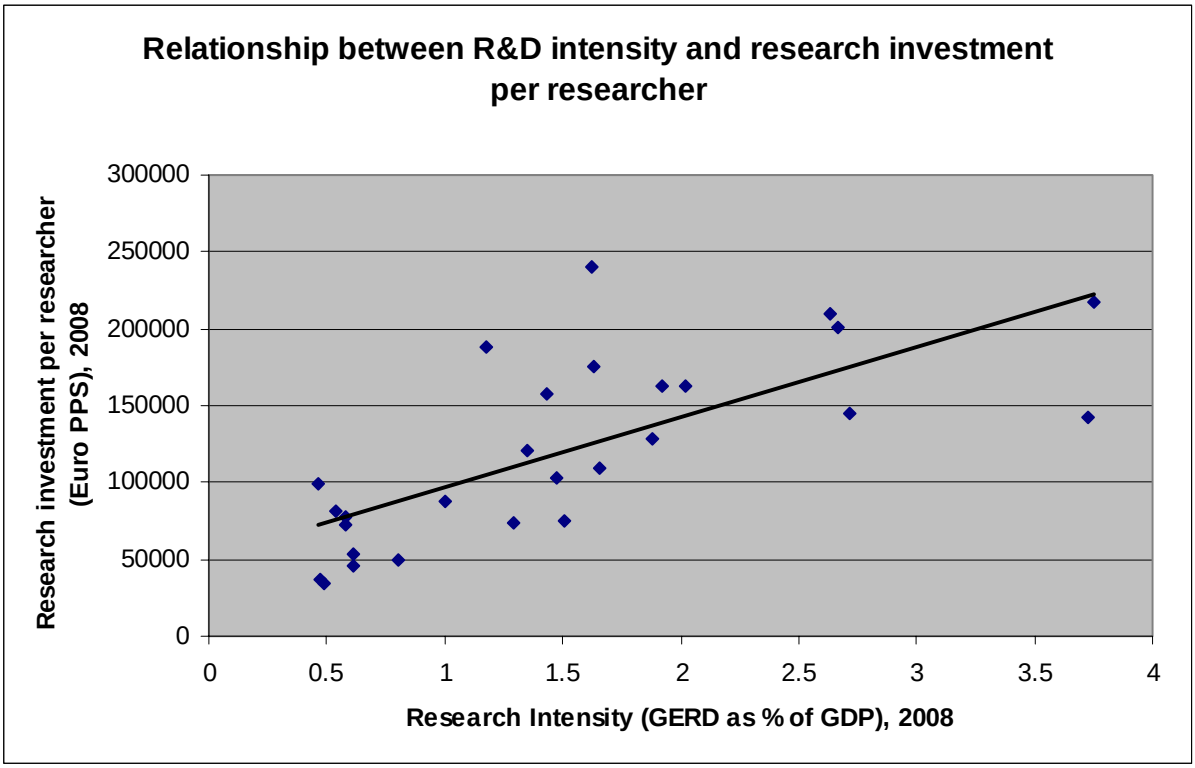
There are two main reasons for this:

1) Research intensive activities often involve higher paid researchers and better (and more costly) infrastructures, leading to higher levels of research investment per researcher.

2) Research intensive economies tend to have a high proportion of private sector research, which has a higher ratio of research investment per researcher.

As a result, the initial estimate needs to be corrected to control for these factors.

Chart 1 Relationship between R&D intensity and research investment per researcher (OECD countries, Argentina, China, Russia, Romania and Slovenia)



Source: DG Research
Data: Eurostat 2010. Data is for 2008 or last available year

In 1996, research investment per researcher in the EU was €127,364. By 2008, however, this ratio had risen to around €151,000.[193] These data appear to corroborate the assumption of higher research investment per researcher as R&D intensity increases. If this trend is extrapolated, research investment per researcher in the EU should approach €200,000 in 2020.

This value is similar to the level of research investment per researcher in countries such as the USA, Germany, Austria or Sweden (all of which have a ratio around or above €200,000 per researcher). On the other hand, the ratio is somewhat higher than it is in other research intensive economies such as Finland, Korea, Japan or Denmark (all of which have ratios between €140,000 and €160,000). However, the marked specialisation in ICT of Finland, Korea and, to a lesser extent Japan, suggests that the ratio of research investment per researcher in the EU is likely to evolve towards the ratio in the first group of countries.

[193] Research investment is measured in PPS.

When the correction for an increased level of research investment per researcher is applied, the resulting number of researchers needed in Europe in 2020 drops from the original estimate of 2.95 million researchers to 2.45 million researchers**, i.e. a net increase of around 1 million researchers over the situation in 2008**. It should also be remembered that this is an underestimate, since lack of data prevents any correction for the number of additional researchers that will be needed to replace those retiring before 2020.

10.5. Calculation of the number of researchers needed per country

Using national research targets for 2020,[194] the same methodology can be used to calculate the number of additional researchers that will be needed in 2020 by individual Member States.[195] The results are shown in Table 1.

These national values are consistent with the earlier estimate for the EU, since the sum of the researchers needed in all Member States is approximately 2.44 million. **As before, this corresponds to a net increase of around 1 million new researchers**, which should again be treated as an underestimate given that additional researchers will need to be trained to replace those retiring before 2020.

These results highlight the fact that the EU as a whole needs both to attract research talent and to invest in the education and training of a considerable number of new researchers in order to respond to the vast demands of a very research-intensive economy.

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194 Some Member States have not specified particular targets. For these countries, realistic targets have been estimated based on past performance and past R&D targets under the Lisbon Strategy.

195 The estimates of research investment per researcher for smaller countries have a larger margin of error than those for larger countries because of potential changes in economic structure and research specialisation patterns.

Table 1 Number of researchers needed per country in 2020

	(A)	(B)	(C)	(D)	(E)	(F)
	GDP 2020 (million Euro PPS)	GERD 2020 (3%) (Million Euro PPS)	Ratio research investment/researcher 2020	Number of researchers 2020	Number of researchers 2008	Net increase in the number of new researchers*
Belgium	365568.6	10235.9	225437.8	53059.6	36382.0	16677.6
Czech Republic	247475.8	6434.4	92122.6	53474.9	29785.0	23689.9
Denmark	190004.1	5700.1	171813.2	31888.1	30945.0	943.1
Germany	2775856.4	97155.0	319700.7	338659.9	299000.0	39659.9
Ireland	171721.1	5151.6	192046.8	25409.2	13709.0	11700.2
Greece	312865.8	3754.4	42185.7	42516.2	20817.0	21699.2
Spain	1401781.9	42053.5	106601.0	253192.1	130986.0	122206.1
France	2030392.2	60911.8	250809.5	355119.7	215755.0	139364.7
Italy	1796206.9	35924.1	254940.9	137889.4	96303.0	41586.4
Cyprus	22983.5	344.8	91460.5	3247.2	885.0	2362.2
Luxembourg	38979.3	1169.4	492263.7	4133.3	2282.0	1851.3
Hungary	185160.3	3703.2	43948.4	23975.6	18504.0	5471.6
Malta	9399.3	282.0	50917.1	2670.5	524.0	2146.5
Netherlands	631108.9	18933.3	292875.3	101976.4	51052.0	50924.4
Austria	299937.6	11337.6	339632.0	47928.5	34377.0	13551.5
Poland	679650.5	10194.8	17355.2	120167.6	61831.0	58336.6
Portugal	244182.9	7325.5	39739.1	68109.0	40563.0	27546.0
Romania	285103.5	5131.9	19809.6	21964.2	19394.0	2570.2
Slovenia	51576.8	1547.3	72843.7	8729.4	7032.0	1697.4
Slovakia	113670.1	1250.4	13717.0	34917.1	12587.0	22330.1
Finland	173255.3	7276.7	23809523.8	51226.0	40879.0	10347.0
Sweden	329590.1	13842.8	23809523.8	63837.6	48220.0	15617.6
United Kingdom	2104801.2	58934.4	168193.2	467735.6	261406.0	206329.6
EU-4 + Difference to 3%	199158.2	31218.2		144902.5	31357.0	113545.5
EU-27	14660430.3	439812.9	192321.8	2456729.5	1504575.0	952154.5

Source: DG Research

Data: Eurostat 2010. Data is for 2008 or last available year

* These values do not include the number of researchers retiring by 2020 that would need to be added in order to calculate the total number of researchers to be trained or attracted by 2020.

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