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European Competitiveness Report 2011

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Industrial Policy: reinforcing competitiveness

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SI	**Slovenia**
SK	**Slovakia**
UK	**United Kingdom**

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FOREWORD

This is the 14th edition of the Commission's European Competitiveness Report (ECR). The first ECR was published in 1997, on the basis of the 1994 Industry Council resolution, which called on the Commission to report annually on the competitiveness of European industry.

As in previous editions, the ECR 2011 analyses a number of topics that are important for the competitiveness of the EU industry and economy. The analysis is based on economic theory and empirical research. The aim of the report is to contribute to policymaking by drawing attention to recent economic trends and developments and by discussing policy implications.

The first chapter presents an overview of the recovery from the recent recession, changes in GDP in the EU and the Member States, labour productivity and employment. The analysis shows that the experience of the recession varies according to how the countries were involved in the build-up of imbalances in the period 2000-07. It also argues that the competitive sectors that grew in a balanced way before the crisis will continue to be the leaders during the recovery. The specific role of R&D and innovation in the process of economic recovery is analysed, arguing that a strong and sustained recovery growth will depend on the capacity to create the environment in which firms can thrive, and where innovations are created and taken to the market.

Chapter 2 analyses knowledge intensive business services (KIBS) and their role as sources of innovation, technologies and as inputs for manufacturing and the whole economy. KIBS are defined as computer and related activities, R&D and other business services. Their importance for the rest of the economy has become visible as firms increasingly tend to develop new services as part of a product package that includes physical, tangible goods. This is a prominent feature of what has been called the "convergence process". The convergence of manufacturing and services is an opportunity for the European manufacturing sector to increase its competitiveness and market base. The shares of direct and indirect KIBS in total exports have increased over time for both the EU-12 and EU-15. Measured directly, KIBS activities account for 4% of EU-12 and 11% of EU-15 exports and, if measured indirectly, KIBS account for 9% of EU-12 and 18% of EU-15 exports.

Chapter 3 shows that the EU space sector is a world technology leader in certain segments and enjoys a strong competitive position internationally, especially in heavy launchers and associated launching services as well as in satellite communication services. Together with the United States, it is a major net exporter of space products, and less hampered than its US competitor by export control rules. The EU space sector is heavily influenced by public policies, funding and procurement, but the share of commercial customers is growing. In order to remain competitive the sector needs to secure its supply of skills and sustain innovation efforts and R&D funding. It should also be vigilant in the face of competition from emerging space nations eager to build up their own space industries and become less dependent on the EU and US space sectors.

Chapter 4 analyses the EU's import dependence on non-energy raw materials and how this affects the competitiveness of certain EU manufacturing industries. In terms of raw materials, two main competitiveness areas can be distinguished for the sectors analysed. The first one refers to the cost competitiveness effects on essential raw material inputs, stemming from different sources such as increasing global demand, trade restrictions, transport costs etc. The second competitiveness issue concerns company strategies, including recycling and use of substitute materials etc., applied to tackle scarcity of raw materials. Access to raw materials can be facilitated by different policy tools, such as ensuring a better operational and regulatory environment for industries affected by the scarcity of raw materials, fostering a global level playing field in trade and investment, ensuring intelligent exploration and exploitation of the resources available in Europe, and encouraging R&D and innovation into substitutes, better recycling techniques and sustainable production.

Chapter 5 reviews the progress made in moving EU industry towards a more sustainable growth path over the last 10-20 years. The analysis reveals that EU industry overall has improved its resource efficiency, carbon and energy intensity during the period and that these trends are continuing in most sectors and Member States. The overview of public policy instruments currently in use showed that, at the EU level, attention has recently been strongly focused on energy and controlling carbon emissions. However, the number of policy initiatives is increasing, with the emphasis of policy attention shifting towards sustainable consumption and production, green public procurement and, more recently, resource-efficiency. Choosing and designing a coherent and effective mix of policies is crucial to improving eco-performance and facilitating industry's simultaneous transformation towards more sustainable ways of production and improved competitiveness. Aspects such as the whole life cycle of products and different stages of the supply chains, complementarities between the existing national and regional regulatory frameworks, enforcement and monitoring costs, effects on competitiveness and compliance burdens on EU industry need to be taken into account in the selection and design of these policies.

Chapter 6 examines the interplay between industrial policy, competition policy and trade policy in promoting the strengths of European companies and enhancing their competitiveness. In the light of the EU enlargement, the expansion of global value chains and the recent economic and financial crisis, it argues that there is great potential and underexploited synergies in the existing competitiveness-related policies. As underlined in the 2010 Industrial Policy Communication, the key challenge is to create a framework that accompanies firms through all phases of their life cycle and provides the right incentives for them to increase their competitiveness in a globalised environment. The remaining challenges involve refocusing on the needs of the real economy, and in particular on improving access to finance and creating a global level playing field (as also highlighted in Chapter 4).

EXECUTIVE SUMMARY

1. Introduction

The European Union and the world economy are recovering from a deep global economic crisis, but this process has been relatively slow. In view of the difficult economic situation, global competition has become much tougher while the need to remain competitive on the world market has become more important.

The 2011 European Competitiveness Report is prepared in the context of the 'Europe 2020 strategy for smart, sustainable and inclusive growth' and in consideration of its major flagships, in particular 'An integrated Industrial Policy for the Globalisation Era. Putting Competitiveness and Sustainability at Centre Stage' which was adopted by the Commission in October 2010.

The Report looks first at the overall economic performance and its impact on productivity - the key factor for competitiveness in the long run - as well as the role of R&D and innovation in this process. Developments in a number of sectors and topics that are key for the competitiveness of European industry and its economy in general are then analysed. These topics include convergence in knowledge intensive services, the competitiveness of the European space sector, access to non-energy raw materials and EU industry in a context of sustainable growth. Finally, the Report analyses the relationship between the EU industrial and competition policies as well as the changes in this respect that have taken place over the last decade.

2. Crisis, recovery and the role of innovation

The European Union is recovering from the effect of the major global crisis in 2008-2010. The recession originated from the accumulation of considerable imbalances in the pre-crisis period 2000-07, notably the inflation of house and stock prices in the US and some EU Member States, and the subsequent unbalanced capital flows.

The crisis has affected all EU Member States and, with the exception of Poland and Slovakia, no country experienced less than a full year of recession. Even if by mid-2009 most countries had started to recover, some Member States like Greece, Ireland or Romania were still in recession by the beginning of 2011: after almost three consecutive years of decreasing income. The experience is also mixed when it comes to the depth of the recession, ranging from a tiny one-quarter point drop in Poland to a 25 percent loss during the more than two years of recession in Latvia. The reason is that not all countries played the same role during the accumulation of these imbalances and, consequently, not all countries are affected in the same way. On the one hand, countries like Latvia, Ireland or Spain, which were severely affected by a housing bubble, are now going through a major readjustment. On the other hand, there are countries like Austria, Belgium or Germany that can be seen mostly as suffering the collateral effects from the readjustments in the US and in the first group of Member States; these countries have been affected chiefly through international trade, but also through the exposure of their financial systems to loans made to countries with large imbalances.

As expected, employment reacted later and is recovering more slowly. In countries not directly affected by internal imbalances, the contraction of employment (and the increase in unemployment) has been moderate. Belgium, Germany or the Netherlands experienced slight changes, while countries like Estonia or Spain have seen their unemployment rates soar by 15 percentage points. This distinctive reaction of employment can be explained by the different exposure to mispriced assets and, to a lesser extent, to other factors such as the degree of openness or the introduction of certain structural reforms before the crisis. In countries affected by these distortions, households had the incentive to borrow in order to purchase these assets. Once the bubble burst, the price of these assets drops mechanically and caused and exposed the vulnerability of highly indebted households. Hence, in these countries there are two reasons why their unemployment is rising by more than the average and also more persistently. First, they are undergoing a major structural readjustment, namely the downsizing of the construction sector which is having permanent effects. Second, households and firms are trying to deleverage, i.e. reduce the level of liabilities relative to assets by cutting down consumption and increasing savings, thus slowing down the recovery and worsening the business conditions for firms which, in turn, are then reluctant to hire new workers. In contrast, the countries not affected by the bubble faced better prospects of a swift recovery, with the result that employers were able to resort to labour sharing schemes which kept employment at a relatively stable level.

Despite the severity of the recession, it has not come close to wiping out a decade of relatively strong growth. All in all, most EU countries display reasonable records of real growth during the decade 2000-10. This is particularly true for EU-12 countries, immersed in a catch-up process following their accession to the EU. Two exceptions stand out among EU-15: namely Portugal and Italy, which literally stagnated during these years and have ended up at roughly the same point as they started.

A glance at the sectoral reactions to the recession reflects the aggregate picture described above. Manufacturing output initially fell steeply by some 20%, before recovering strongly over the last two years. However, manufacturing output is still some 9% below its peak and manufacturing jobs have fallen by around 11%. Construction of buildings (excluding civil engineering) has dropped by more than the average and has not yet begun to recover. Other sectors not directly related to the construction boom will recover relatively quickly. The way countries are performing along this recession, at the aggregate level, will depend on the relative importance of each of these sectors. However; performing sectors will do well wherever they are established in terms of sustained growth of productivity.

While acknowledging that the downturn requires an understanding of the contraction in construction and real estate, the key to the future competitiveness of the EU lies in performing sectors that already did well in the past years and will now lead the recovery together with new and emerging fast-growing sectors.

This line of reasoning also explains the apparent paradox of countries which have been hit hard by the recession, and yet have shown an overall reasonable performance over the decade. This is in principle a good sign for the medium-term recovery outlook and raises the issue of how to support innovation and productivity growth in the EU.

The focus here is on R&D and innovation, because it is regarded as an important source of sustained growth. The EU is characterized by a lower intensity than the US and a remarkable heterogeneity in R&D intensity across Member States. However, a closer look at the individual US states shows that the internal variability there is no different from that within the EU. This variability reflects patterns of regional specialization which may be optimal from the social point of view. In that sense, it is worth recalling that the new Europe 2020 strategy maintains the Lisbon strategy target of a 3 percent for R&D intensity for the EU as a whole (rather than for each individual Member State).

One possible explanation for these differences is that EU Member States tend to specialize in sectors characterized by a lower R&D intensity. However, a closer look at the figures shows that, even if the sectoral composition plays a role, most of the differences with the US can be associated with lower EU intensities in individual sectors rather than an over-representation of low-intensive sectors in the EU. Furthermore, when comparing similar firms from across the Atlantic, they turn out to be remarkably similar in that they are making similar efforts in terms of R&D. These two pieces of evidence together show the frequency with which we find innovative firms in the US being compared with the EU. Hence, the key area is the relatively poor commercialisation of R&D and non-technological innovation in the EU, rather than R&D per se. The EU must therefore do more than just foster basic research in order to create ideas, and it needs to create the right business conditions for new technologies and innovations to be developed and commercialised on the market. The whole process has to be complemented by an adequate level of intellectual property rights protection: enough to give incentives to innovators but not so much that it hampers the creation of new ideas or withdraws research too soon from academia by offering excessive incentives to privatise basic lines of research. The EU is currently working with a High Level Group of experts to examine how to improve the commercialisation of key enabling technologies.

3. Knowledge intensive services

The importance of services for the economy has steadily increased over time in most OECD countries. This process known as "tertiarization" means not only that services are taking up increasing shares of GDP, but also that they are playing an increasingly important role in intermediate inputs for manufacturing, and high-tech manufacturing in particular. Knowledge intensive business services (KIBS) are especially important in this development. KIBS are defined according to the NACE classification, NACE REV 1.1. as including the categories computer and related activities (NACE 72), research and development (NACE 73) and other business activities (NACE 74). Their importance as sources of innovation, technologies and inputs has increased steadily over time. As a consequence, linkages between KIBS and manufacturing industries in different countries have strengthened over time.

The tendency of KIBS firms to develop new services as part of a product package that includes physical, tangible goods is a prominent feature of what has been referred to as a "convergence process". This process encompasses manufacturing firms which have also begun to offer services as part of a package including both the physical product and services. High-tech products, for example, are often sold in combination with maintenance services.

The "convergence process" and the increasing role of KIBS for manufacturing have consequences for the external competitiveness of EU manufacturing firms as implied by the increasing share of KIBS in value added exports, especially for high-tech manufacturing goods. But KIBS are important for external competitiveness per se, since the share of the services trade in the overall trade has grown over time.

Growing importance of knowledge intensive sectors in the economy

Services industries have grown in importance over the last decades in terms of both output and employment. Within services, KIBS play an important role and have been the main source of job creation in Europe in the past decade and have also contributed substantially to value added growth. The share of services in GDP has grown over time and now amounts to some 70% in the EU and Japan and almost 80% in the US. While total services as a share of GDP have grown by 5 to 10% since1995, shares of KIBS have grown by around 30 to 40% in the EU, Japan and the US, although it should be pointed out that the shares were initially quite low. The share of KIBS in GDP now amounts to some 11% in the EU, 13% in the US and 8% in Japan.

The importance of KIBS can also be seen by their contribution to the growth of GDP. The total contribution of KIBS to GDP growth since 1996 has amounted to approximately 17% in the EU, 28% in Japan and 22% in the US. The largest contributions to GDP growth, within the EU, were recorded in the UK and Belgium where the KIBS contribution to growth has exceeded 25% since 1996.

Integration of KIBS in the value chains of other industries has become more important over time, as illustrated by the growing share of KIBS products in intermediate consumption. The KIBS share of intermediate consumption in high-technology manufacturing amounted to some 14% in EU-15 and 16% in Japan and the US.

Important technology flows between KIBS and manufacturing

The integration of KIBS in the value chains of other industries is not limited to intermediate consumption of KIBS products. Knowledge produced within KIBS is also used in other sectors. Knowledge also flows in the other direction, from other sectors to KIBS. In manufacturing, imported knowledge flows from other manufacturing and KIBS constitute the largest knowledge flows in every country, except for the USA and Japan. Foreign manufacturing sectors are the main sources of imported knowledge inputs for manufacturing in most countries. The exception is Ireland, where imports of KIBS for intermediate use in manufacturing are more important sources of knowledge.

Imported knowledge inputs to KIBS are larger than other technology flows from domestic sectors in almost every country. Estonia, Slovakia, Romania and Ireland are almost completely dominated by imported knowledge inputs. The EU-12 is heavily dependent on manufacturing knowledge imported from abroad in this sector.

Analyses show that the backward linkage from KIBS to manufacturing is not very strong. The backward linkage from manufacturing to KIBS appears to be substantially stronger. Conversely, the strength of the forward linkage from manufacturing to KIBS is substantially weaker than the forward linkage from KIBS to manufacturing. The reason is that the size of the KIBS sector is substantially smaller than the manufacturing sector as a whole. The measures of linkage strengths reflect this size difference.

Convergence of manufacturing and services

Manufacturing firms are increasingly offering services along with their traditional physical products. This trend is often called "convergence of manufacturing and services". The convergence of manufacturing and services is an opportunity for the European manufacturing sector to open up new markets, find new sources of revenue around their products, and increase competitiveness.

The output of manufacturing still consists of manufactured products to a very large extent. Service output of manufacturing, however, is growing quite fast, reaching annual growth rates of 5 to 10 % for the period 1995-2005. Between 2000 and 2005, which is the latest available year for data[1], service output of manufacturing grew in all Member States except the Czech Republic. Taking into account that the latest recession hit manufacturing industries relatively harder than services, the shares of service output of manufacturing are likely to have increased further.

The service output of manufacturing firms is related in various ways to research, development and innovation. Both R&D and complementary service offers are strategies of firms to differentiate their products from the products of their competitors. Services are produced predominantly by manufacturing industries with high and medium-high innovation intensity. KIBS account for more than two thirds of the service output of manufacturing in half of the Member States. Hence, not only is the manufacturing sector a main client of KIBS, it also produces KIBS to a considerable degree.

Trade in KIBS and the importance of KIBS for EU external competitiveness

EU-15 has on average stronger revealed comparative advantages in KIBS exports than in technology-intensive merchandise exports. The strongest comparative advantage for the EU-15 is found in R&D services. Also, EU-15 has also increasingly specialized in computer and information services exports, in contrast to the US, which has lost this specialization.

The importance of KIBS for the EU's external competitiveness can be measured both directly and indirectly. For both the EU-12 and EU-15, the shares of direct KIBS exports have increased over time. Measured directly, KIBS activities account for between 4% of EU exports for EU-12 and 11% for EU-15. Measured indirectly, KIBS exports account for between 9% for EU-12 and 18% for EU-15 exports.

4. European competitiveness in space manufacturing and operations

Europe has a rich heritage in space, going back a quarter of a century for the EU and even longer for several Member States as well as for the European Space Agency (ESA). The space sector contributes directly to the objectives of smart, sustainable and inclusive growth laid down in the Europe 2020 Strategy, which refers to the development of an ‘effective space policy to provide the tools to address some of the key global challenges and in particular to deliver Galileo and GMES’. This reflects the shared competence of

[1] The sources of the data are input-output tables which provide information on the structures of economies. Since the structure of the economy changes gradually over time, input-output tables are not published frequently, normally only every fifth year.

the EU and its Member States stemming from the introduction of Article 189 of the Treaty on the Functioning of the European Union, mandating the EU to draw up a European space policy with a view to promoting, among other things, EU competitiveness.

The most striking characteristics of the space sector worldwide as well as in the EU are the extent to which it is driven by public institutions; the small number of actors and Member States involved; the high financial and technological risks; and the limited production runs.

Bearing in mind these peculiarities of the space sector, the evolution of three manufacturing segments and four segments of operation or exploitation is analysed. The three manufacturing segments are satellite manufacturing, launcher manufacturing, and ground segment. The four operation/exploitation segments are launching services, satellite communication, earth observation, and satellite navigation. No downstream services or applications are included in the sector analysis as they are considered to be customers of the space sector, notwithstanding the fact that they represent the part of the value chain with potentially the greatest impact on the EU economy.

Strong European position globally, driven by public institutions

The space sector in the EU is a driving force for growth and innovation, generating employment and market opportunities for innovative products and services. Together with the US space sector it dominates the world market for satellites, launchers, ground segments and related operations and exploitation. It depends less on the requirements and funds of public institutions than in the United States, but even so the EU space sector is strongly driven by public policy, public procurement and public funding (BIS 2010). The relative importance of public institutions as customers has however decreased slightly in recent years.

Excluding downstream services and applications, the EU space sector generates direct sales in excess of EUR 10 billion per year and employs around 36.000 persons. Its direct contribution to EU GDP is relatively small but due to its high technology content and high value added, productivity is higher than in most other EU sectors. Most of the sales and employment are generated in satellite manufacturing and the operation of communication satellites. It is however important to note that the greatest impact on the EU economy is generated downstream by services and applications not covered by this report.

Most of the EU space sector is concentrated in a small number of locations in a handful of Member States such as France, Italy, Germany and the United Kingdom, while a number of Member States are hardly participating at all. The sector is also highly concentrated in terms of the number of manufacturers and operators, notably due to the small size of its market as well as high entry barriers: costs, infrastructure, know-how, risks. Another consequence of the high barriers to entry is that there are few SMEs in the sector.

The EU and the United States are the largest exporters on the world market, running sizeable trade surpluses against the rest of the world in the space sector (in spite of strict export control rules in the USA). The EU surplus of between half a billion and one billion euro a year is generated by exports mainly to the United States, Russia, Kazakhstan, Brazil, China and Turkey, and imports almost exclusively from the United States. There is also considerable intra-EU trade.

Importance of skills, R&D and innovation

Some of the expected benefits of space investment stem from its impact on innovation, not least indirectly in the form of spillover effects, spin-offs and technology transfer, including spin-ins. Setting ambitious objectives for the EU space sector will stimulate innovation and can make a real contribution to the Innovation Union. Those objectives can only be attained from a strong technological base, therefore basic space research needs to continue to be carried out in Europe and be properly funded by the EU, ESA and their members, which in the case of the EU includes the Framework Programme for research, technological development and demonstration activities. It is particularly vital to support research into critical and breakthrough technologies (European Commission 2011). On the other hand, it is crucial to maintain R&D funding for the development of satellite communication, given its importance for the space sector as a whole.

A major challenge facing the global space industry and the European space sector in particular is the supply of skills in the years ahead. In Europe a generation of space engineers and technicians is nearing retirement and it is not clear whether the EU education system will be able to deliver the skills needed in sufficient numbers and on time to replace them. If it is not, an underlying problem might be the relatively low attractiveness of space careers in comparison with other high-technology professions. EU policymakers may need to consider how to raise the profile of space in education and how to address any structural deficit in the supply of skills to the EU space sector.

Regulation

Standardisation improves industrial competitiveness and efficiency; together with inter-operability it is essential for the competitiveness of the EU space sector.

International Traffic in Arms Regulations (ITAR) are believed to hamper US exports of space products on the world market and even if the EU space sector is not directly targeted by ITAR, it may prove an obstacle also to the EU industry in cases of re-export. On the other hand it represents an opportunity for the EU space sector to offer ‘ITAR-free’ systems.

Natural resources

Space manufacturing requires specific and scarce raw materials due to the extreme environment in which the components will operate. As discussed elsewhere in the Report, the EU possesses some but not all of these raw materials of limited availability. The most important natural resource for satellite communication is radio frequency spectrum which is already becoming scarce due to the growth in space applications combined with increasing bandwidth. In the global allocation of frequencies, the interests of the EU space sector, and in particular of satellite communication, must be defended.

5. Access to non-energy raw materials and the competitiveness of EU industry

Non-energy raw materials can be seen as raw materials that are mainly used in industrial and manufacturing processes, semi-products, products and applications and that are not primarily used to generate energy. As such industrial minerals and purified elements (e.g. feldspar, silica), ores and their metals and metallic by-products (e.g. copper, iron but also germanium, rhenium, rare earth elements) and construction materials are within the scope as well as wood.

Global demand for these raw materials started to increase significantly in the last decade, driven by the strong growth of emerging economies in particular. Additionally, recent trends indicate that also the rapid dissemination of emerging technologies is expected to boost demand for raw materials. Accordingly, the growing need for consumer and investment goods in emerging countries and the spread of new technological applications will result in a high long-term demand for most of the non-energy raw materials. These developments are likely to have significant impacts on the European manufacturing sector.

Europe is highly dependent on raw materials imported from the rest of the world. While the EU has many raw material deposits, their exploration and extraction is hindered mainly by a highly regulated environment, high investment costs and increasingly competing land uses.

Non-energy raw materials inputs and competitiveness aspects

Access to and affordability of non-energy raw materials is crucial for the competitiveness of the EU industry. For sectors such as steel, pulp and paper, chemicals, aerospace, electronics, automotive or construction it can be hampered, directly or indirectly, by a limited or more costly supply of these raw materials.

As far as raw materials are concerned, two main competitiveness areas can be distinguished: the effects on costs for raw material inputs and the effects on the company strategies.

Cost effects

Rising prices for raw material inputs in manufacturing production, due to distortion of conditions of access and growing global demand, may lead to a deterioration of the competitiveness of European industries.

There are several reasons for rising raw materials costs. A large share of many raw materials is concentrated in a small number of countries, which often apply export restrictions, leading to higher prices and an insufficient supply of inputs for international producers. At the same time, countries imposing export barriers can benefit from lower input prices, creating an artificial support for domestic industry. Also the oligopolistic nature of several non-energy raw materials production has contributed to significant price increases. The time lags in the supply response to changes in demand, which often lead to price increases in the global market for metals and minerals, are yet another reason. When an increase in production costs is not matched in other regions of the world Europe faces a deterioration of its competitiveness position.

Solutions, strategies

The negative effects stemming from the scarcity of raw materials are in the form of pressures on the competitiveness of European industries. Companies active in the affected sectors have chosen a range of solutions to reduce the risks and costs of non-energy raw materials. In this regard, R&D and innovation play an important role in alleviating the vulnerability of material intensive EU industries.

Increasing use of recycled and recovered materials, more efficient use of materials and substitute/alternative materials are of key importance in improving the competitiveness of European manufacturing industries. Recycling rates vary widely, depending on the materials used in the production process. In certain sectors, recycling rates are very high (e.g. pulp and paper industry), while in others there is still some potential for further improvement (e.g. waste electronics). Some sectors make widespread use of resource efficient technologies (e.g. automotive industry) and substitute materials (e.g. chemical industry) in order to reduce their dependency on primary raw materials. From the competitiveness point of view, development of specific skills, R&D and innovation play a central role throughout the entire value chain, including extraction, sustainable processing, recycling and developing new materials, in addressing the challenges posed by the lack of non-energy raw materials.

Companies can use a range of different strategies to tackle import dependency even though not all of these are beneficial from the point of view of European growth and jobs. Vertical integration helps to circumvent the risks in the market thereby securing access to raw materials (for example in the steel industry). Relocation of the production processes to countries where the materials are produced makes it possible to secure access under more favourable economic conditions, because trade restrictions are avoided (e.g. the chemical industry). However, it is clear that this puts the EU and unfairly at a disadvantage in relation to those producing countries which impose such restrictions. Outsourcing of manufacturing can also be seen as one option to secure access to certain materials (e.g. the automotive industry).

The role of EU policies to reduce raw material dependency

Access to raw materials can be facilitated by different policy tools, such as ensuring a better operational and regulatory environment for industries affected by the scarcity of raw materials and fostering a global level playing field in trade and investment. Encouraging and supporting R&D and innovation for substitutes, better recycling techniques and sustainable production is of key importance in tackling the shortage of non-energy raw materials for EU manufacturing in the longer term. Furthermore, there is potential to reduce import dependency in the case of some of the non-energy raw materials of which Europe still has several large deposits. However, the non-energy extractive industry has to confront a number of challenges, such as competing land use. At the same time, innovation in resource efficient and sustainable production technologies can be important drivers for future competitiveness of the non-extractive industries.

6. EU industry in the sustainable growth context

In order to foster economic growth in a sustainable way, European industry and policymakers are facing strong pressures to reduce the negative impacts of economic activities on the environment (e.g. climate change, environmental degradation, etc.) and to address concerns about resource scarcity, security of supply and the EU’s reliance on external supplies of energy, raw and critical materials. The Europe 2020 strategy recognises this - in particular with the Flagship initiatives on Industrial Policy and Resource Efficiency - by setting out a new framework to promote the modernization of the industrial base and the transition to a low carbon, resource efficient economy. At the same time, European industry is already moving over to more sustainable methods of production, with particularly strong growth being achieved in what are known as "eco-industries". However, sustainable growth is not exclusive to certain sectors. Rather it represents a re-orientation of the entire economic landscape, where resource and eco-efficiency and innovation become the key for delivering environmental and other societal goals, whilst simultaneously reinforcing competitiveness and providing growth and jobs.

Relative decoupling of economic growth and environmental impact has been achieved

Significant progress has already been made on the road to a resource efficient and low carbon economy. Overall there has been relative decoupling of economic growth and environmental impact in the EU over the past two decades in terms of energy and resource use, emissions and waste generation. However, absolute decoupling remains a challenge in some areas and sectors, e.g. for households. EU industry overall has improved its resource efficiency, carbon and energy intensity during the period, being in many instances ahead of the US and having closed the gap on Japan – the world leader in many aspects of industrial efficiency. However, it is difficult to make a clear-cut analysis as to the extent in which the overall improvements achieved are the result of enhanced industry efficiency. Many of the most positive aspects of industry's eco-performance are based on improvements in emissions in the energy sector, but the evidence points to them being based on broader developments or policy interventions in the energy generation sector, rather than on industry action alone. Notwithstanding this qualification, the evidence does support the view that industry has increased its energy and resource efficiency over the period and that these trends are continuing in most sectors and Member States.

Overall there is broad evidence pointing to relative decoupling in industry

By and large, there is strong evidence of at least relative decoupling across industry, particularly as regards energy, greenhouse gas (GHG) and other emissions and water use. Relative decoupling is also apparent in material consumption, but not to the same extent as other areas.

Although total energy use has risen in the EU-27, it has increased more slowly than in the US. In fact, the EU has improved its energy intensity in recent times and has now closed the gap on Japan. However, the US has also narrowed its energy intensity gap. Meanwhile, China has overtaken the EU in terms of energy use. Although total EU energy use has risen, industrial energy use has remained broadly stable in the last 15 years. In parallel, there has been a decline in energy use in many of the EU-15 countries, while EU-12 Member States and others that experienced rapid industrial economic growth have seen their energy use increase. The EU-12 countries achieved a significant reduction in their industrial energy consumption intensity and also in the gap vis-à-vis the average industrial energy intensity of the EU-15.

From a sectoral perspective, the iron and steel and chemical sectors - the two biggest industrial energy users - have seen their energy use and intensity fall significantly. Industrial energy intensity has improved by 18% since 1995, and although the most significant improvements were achieved prior to 2000, the downward trends are continuing.

In the case of *GHG emissions* there is also strong evidence of decoupling, as overall GHG emissions are falling while the economy grows. Similar evidence exists for industrial emissions. GHG emissions are linked very closely to overall energy use and the emissions intensity of the energy mix, and these trends are broadly similar. The best available calculation of industrial emissions intensity reported a 30% decrease in emissions intensity for industry, which is slightly better than overall energy trends. This illustrates the emissions benefits resulting from changes to the energy mix, such as increased renewable energy, fuel switching from coal to gas and the impacts of policy such as the Large Combustion Plant Directive (LCPD).

The fact that EU-27 GHG emissions declined by 5.1% in the period where energy consumption rose again points to the de-carbonization of energy supply and decoupling of impacts. However, emissions reductions are generally concentrated in the EU-15, with most EU-12 Member States seeing overall emissions rise as their economies grow. At the sectoral level, the industrial (manufacturing and construction) GHG reduction - at 13% - is higher than the overall emissions reduction. This points to non-industrial GHG emissions growing faster than industrial emissions.

In the case of *materials* there is also some evidence for relative decoupling as materials usage has been increasing, but at a slower rate than the economy. Direct materials consumption (DMC) and direct materials inputs (DMI) increased over the period, but by less than overall or industrial gross value added (GVA) growth. Some countries (e.g. Germany, UK, and Italy) achieved reductions in materials use while industrial GVA was increasing, whereas the trends in EU-12 are pointing towards increased materials use.

Materials productivity has increased in the EU-27, albeit gradually and unevenly. The indications are that materials productivity is closely related to structural economic factors, which control the extent to which improvements can be achieved. This supports the view that decoupling is still relative in terms of resource use. The generation of waste by industry has declined significantly. Evidence also indicates that industry has better eco-performance than the wider economy in respect to waste.

In the case of *water* there is some evidence of at least a relative decoupling, but is hard to draw any hard and fast conclusions as data is sparse. Overall water abstraction (i.e. the volume of water that is taken from surface and ground water sources) is down in the countries for which data are available, with a particular improvement recorded in Germany. Abstraction by the manufacturing industry is also down and typically the decline in manufacturing abstraction tends to be greater than the decline in overall abstraction.

As far as *other emissions* are concerned, there is evidence of absolute decoupling – emissions have been falling while industry has been growing. Measures of acidification and particulate emissions (PM10) were very closely related to energy supply. It is therefore likely that a large proportion of emissions reductions are a result of policy actions to clean up large combustion plants.

Effects of the recent crisis are not yet clear

Many of the fastest and most significant improvements in eco-performance occurred in the 1990s, partly in response to a number of one-off events and historical developments. These events included the transition from a 'planned' to a market based economy in central and eastern Europe, the closure of significant parts of heavy industry, a major switch from coal to gas and the implementation of the LCPD and associated air-quality legislation.

Achieving levels of progress similar to those seen in the 1990s, and speeding up the improvements in eco-performance will require effective policies and actions. Certainly the policy framework in the EU has been strengthened significantly over the past decade and it is possible that similar large scale changes may come about - for example – as result of the widespread deployment of renewable energy or the tightening and expansion of the EU ETS (Emissions Trading System) emissions caps. At the same time there is the possibility that the one-off benefit of the transition from a 'planned' to a market based industry may start to erode, as the new Member States grow faster while their eco-performance, even though rapidly improving, remains weaker than in the rest of the EU. This could act as a drag on the eco-performance of EU industry in the future.

The majority of the datasets available to analyse the eco-performance of industry are only fully updated to 2007. The recent economic and financial crisis is likely to have had a significant impact on both industry and its eco-performance. So far, however, it is unclear whether these effects are positive or negative.

7. EU industrial policy and global competition: recent lessons and the way forward

In 2002, the European Competitiveness report analysed the relationships between enterprise and competition policies. The complementarity of these policies and the potential for further synergies were well established at that time. However, the last decade has seen several developments which point towards a need to shift from a predominantly intra-European focus of the two policies towards a global perspective. This calls for a renewed assessment of the overlap between industrial policy, competition policy and including also trade policy.

Four major developments played a key role in triggering this shift. The first is the enlargement and the emergence of the EU as the biggest trading bloc, with an imperfectly developed single market. The second important change is the recent financial and economic crisis which had a profound impact on the European economy. The third aspect is globalisation, which defines the agenda for the next decade. Lastly, there is the new EU industrial policy.

These changes create real challenges for European enterprises. As far as the internal market is concerned, there is much unused potential for developing the strength of

European companies and of enhancing their competitiveness. This thinking also underpinned the 2010 Industrial Policy Communication. The report further makes it clear that the key challenge is to create a framework that accompanies firms through all phases of their life cycle and provides the right incentives for them to increase their competitiveness in a globalised environment. The remaining challenges involve refocusing on the needs of the real economy, in particular on its access to finance - which has been the key lesson learnt during the recent crisis - and creating a global level playing field.

After defining the notions of “European company” and “European Common Interest”, the analysis focuses on situations where such an approach could usefully be applied. It concerns companies' access to resources, be they raw materials or finance, and the improvement of competitiveness through increased innovation. In this context, while the approach of the EU and national administrations is to provide complementary solutions, more targeted involvement by the EU can be beneficial. The new approach concerns the ways in which European companies can optimise their access to foreign markets on the basis of permanent reciprocity. It also applies to restructuring processes, which reflect the constant need of all enterprises and sectors to adjust to the changing economic circumstances. There is a need to support prompt and adequate reactions in order to help companies avoid getting deeper into difficulties. At the same time, their exit - where necessary - should not be prevented, as this would lead to adverse effects on the economy.

8. Conclusions

The analysis in this report shows that the experience of the recession varies according to the way in which countries were involved in the building up of imbalances in the pre-crisis period 2000-2007. It also argues that competitive sectors that grew in a balanced manner before the crisis will also lead the recovery. In any case, a strong and sustained recovery will depend on their capacity to create the environment in which firms can thrive and innovation is created and taken to the market. Achieving this aim will require the careful design of public policies: from basic research in universities to generate ideas to the making it easer to do business, so as to have start-ups bringing innovations to the market.

The importance of services for the economy has increased steadily over time in most OECD countries. Especially important in this development are knowledge intensive business services (KIBS) which have become increasingly important over time as sources of innovation, technologies and as inputs for the whole economy. The importance of KIBS for the rest of the economy has become visible through the tendency of firms to develop new services as part of a product package that includes physical, tangible goods. This is a prominent feature of what has been referred to as a "convergence process". The process encompasses manufacturing firms which have also begun to offer services as part of a package including both the physical product and services. The convergence of manufacturing and services is an opportunity for the European manufacturing sector to increase its competitiveness. The importance of KIBS for the EU's external competitiveness can be measured both directly and indirectly. The shares of direct KIBS exports have increased over time for both the EU-12 and the EU-15. Measured directly, KIBS for EU-12 account for 4% and for EU-15 11% in terms of exports. Measured indirectly, KIBS activities account for 9% of EU-12 exports and 18% of EU-15 exports.

The EU space sector enjoys a strong competitive position internationally and is the world technology leader in certain segments. Together with the United States the EU is a major net exporter of space products, but is less hampered than its US competitor by export control rules. The EU space sector is heavily influenced by public policies, funding and procurement, but the share of commercial customers is increasing. In order to remain competitive the sector needs to secure its supply of skills and keep a watchful eye on competition from emerging space nations that are eager to build up their own space industries and become less dependent on the EU and US space sectors.

The accessibility and affordability of non-energy raw materials is crucial for ensuring the competitiveness of EU industry. Several European industries are affected by a limited or more costly supply of certain raw materials. Access to raw materials can be facilitated by a range of policy tools. Firstly, existing regulations and directives at the EU level should be made internally consistent, which would promote a better operational and regulatory environment for industries affected by the scarcity of raw materials. Internal consistency should be in line with sustainability objectives and policies. Secondly, promoting a global level playing field in trade and investment is essential in order to ensure a fair and sustainable supply of non-energy raw materials from international markets. Thirdly, intelligent development of the further exploration and exploitation of the European non-energy raw materials resources can play an important role in providing certain materials for production. Finally, encouraging and supporting R&D and innovation for substitutes, better recycling techniques and sustainable production (material efficiency) are all of key importance in tackling the relative shortage of raw materials in the EU manufacturing sector.

The transition to a more sustainable, resource efficient, low carbon industry is key for the competitiveness of the European economy in the future. The overview of public policy instruments currently in use has shown that, at the EU level, policy attention has recently been strongly focused on energy and the control of carbon emissions. However, the number of policy initiatives is rising, and the emphasis of policy attention is shifting to sustainable consumption and production, green public procurement and - more recently – resource efficiency. Choosing and designing a coherent and effective mix of policies (including market based instruments, such as taxes, subsidies or trading schemes, environmental regulations and standards, voluntary agreements, co-regulation, communication and information, etc) is crucial as a means of improving eco-performance and facilitating the simultaneous transformation of industry towards more sustainable ways of production and improved competitiveness. Aspects such as the whole life cycle of the products, interactions between the different stages of the supply chains, complementarity with the existing national and regional regulatory frameworks, enforcement and monitoring costs, compliance burdens for firms and SMEs, market structure and effects on competitiveness of EU industry need to be taken into account in the selection and design of these policies.

The analysis confirms that the main findings on the relationship between enterprise and competition policies in the 2002 Competitiveness Report remain valid. This applies to the complementarity between these policies and the scope that still exists for improved use of unexploited synergies. At the same time, the existing approach needs to be extended and supplemented. In particular, as the global focus and global consequences of policy action have become more important, trade policy considerations need to be systematically included. Indeed, key developments over the last decade, such as enlargement, the financial and economic crisis, the rise of new non-EU competitors and the formulation of a new EU industrial policy, need to be taken into account in policy formulation. Policy should continue to focus on the general EU interest, including by facilitating the functioning of EU companies in the global economy.

1. CRISIS, RECOVERY AND THE ROLE OF INNOVATION

The period 2008-10 has foreseen a large global recession. While individual countries had of course experienced similar recessions in the past, this time was unprecedented because of the depth (overall magnitude of the downturn) and scope (the number of countries severely affected).

Box 1.1: Competitiveness

A competitive economy is one that raises living standards sustainably and provides access to jobs for people who want to work. At the roots of competitiveness are the institutional and microeconomic policy arrangements that create conditions under which businesses can emerge and thrive, and individual creativity and effort are rewarded. Other factors that support competitiveness are macroeconomic policies promoting a safe and stable business environment and the transition to a low-carbon and resource-efficient economy. Ultimately, competitiveness is about stepping up productivity, as this is the only way to achieve sustained growth in per capita income — which, in turn, raises living standards.

The notion of living standards encompasses many social aspects, so this broad definition of competitiveness comprises elements of all three pillars of the Lisbon Strategy — prosperity, social welfare and environmental protection.

In the context of international trade, the (external) competitiveness of a country or sector is an elusive concept. Indeed, some indexes aiming to reflect this notion of competitiveness, such as the real effective exchange rate, have to be interpreted with care, because 'loss of competitiveness' in an individual industry may well reflect the outstanding export performance of other domestic industries. For example, a rise in the value of the euro may worsen the competitive position of a given industry, but this may simply reflect strong productivity growth in other industries, and hence strong exports and an increasing demand for the euro.

1.1. Recovery of output

By the beginning of 2011, fears of a double dip recession vanished but recovery proved slow. This is particularly true for employment and for the countries most affected by speculative bubbles during the 2000-07 period. The origins of the recession are imbalances accumulated during the boom period, notably the inflation of house prices in some Member States and the subsequent external imbalance.[2] Consequently, not all EU Member States have been affected in the same way or with the same intensity. On the one hand, countries like Estonia, Ireland and Spain were severely affected by a housing bubble and are now going through a major correction, with considerable downsizing of the construction sector. It is therefore not surprising that these are also the countries with the largest rises in unemployment during the recession (see Figure 1.1). On the other hand, the economies of countries like Austria, Belgium and Germany are largely victims of the readjustment in the US and the other Member States — whether because their financial system was exposed to loans from bubble countries or because of a drop in international trade. The prospects of recovery also vary according to the way each country has been involved in this crisis. While countries not directly affected by internal imbalances can expect a prompt recovery, countries affected by the

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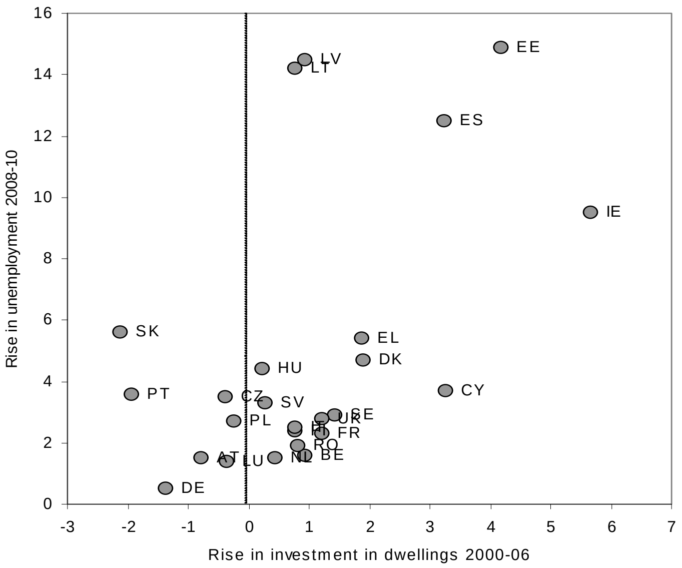
[2] See Chapter 1 "Growing imbalances and European industry," in European Competitiveness Report 2010 (European Commission (2010a)); or the monograph "Economic Crisis in Europe: Causes, Consequences and Responses," in European Commission (2009b).

bubble find themselves in a process of deleveraging that will slow down the recovery as long as households and firms are immersed in their balance sheet correction (OECD (2011)).

Figure 1.1: The recession as a correction: The housing boom and the contraction in employment

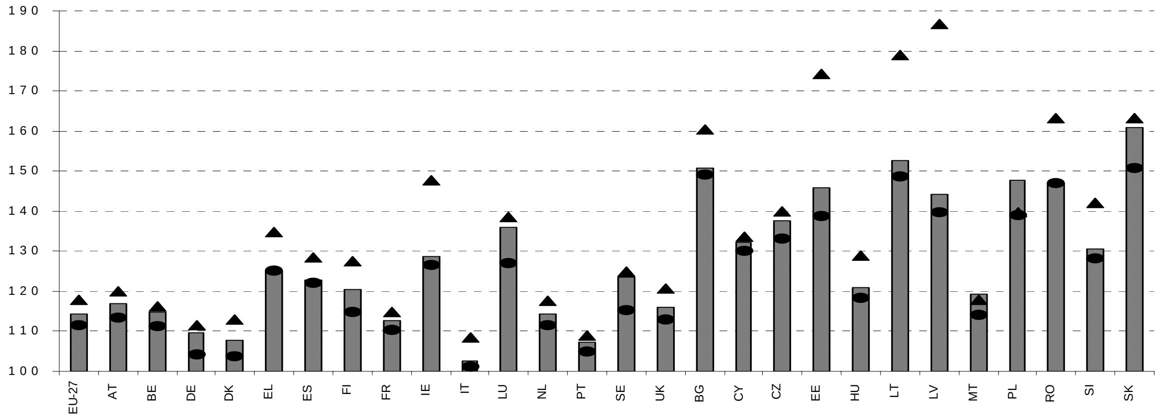


Note: The rise in investment in dwellings is the increase in % points of GDP of investment in dwellings from 2000 to 2006. The rise of unemployment is the difference between the minimum rate of unemployment before the crisis and the maximum (for some countries the current, by 2010Q3) during the crisis.

Source: Unemployment rate: Eurostat, Quarterly LFS statistics for employment, Unemployment - LFS adjusted series (une_rt_q). Investment in dwellings: AMECO database, European Commission, investment in dwellings (UIGDW) as a percentage of GDP (UVGD).

Table 1.1 gives an idea of magnitude and scope of the downturn but also of the differences across EU Member States. With the exception of Poland and Slovakia, no Member State experienced less than a full year recession. Even if by mid-2009 most countries started to recover, some Member States like Greece or Romania were still in recession by the beginning of 2011: almost three consecutive years of decreasing income. The experience is also mixed when it comes to the depth of the recession. From a tiny one-quarter drop in Poland to a 25 percent loss along a more than two years recession in Latvia, there are many and diverse experiences. In general EU-15 countries can be divided among those more affected by a real estate bubble —Spain, Denmark, United Kingdom or Ireland— with drops in real activity up to 14 percent, and the rest of countries displaying considerable but more moderate contractions. EU-12 Member States, with the exception of Poland, have all suffered a sharp contraction of GDP, on average larger than that observed in the EU-15: most EU-12 countries are close or well above the double-digit contraction, with the Baltic Republics suffering the deepest cuts.

Figure 1.2: Real GDP in 2010Q3 with peak and trough value (2000 = 100)



Source: Eurostat, Quarterly National Accounts.

Table 1.1: An overview of the recession, real GDP during 2007-10; index, 2000=100

	2007				2008				2009				2010				
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Drop*	Relative drop
EU-27	115.4	115.9	116.6	117.2	117.9	117.6	116.9	114.7	111.9	111.6	111.9	112.2	112.6	113.8	114.3	6.3	5.3
BE	113.7	114	114.4	114.6	115.5	116.1	115.6	113.1	111.2	111.4	112.5	113	113.1	114.3	114.8	4.9	4.2
BG	145.4	147.9	149.9	153	155.4	157.4	159.6	160.4	150.3	150.2	150	149.7	149	149.7	150.8	11.4	7.1
CZ	134.4	135.2	136.9	138.3	138.8	139.8	140	138.8	133.8	133.1	133.8	134.3	135.2	136.2	137.5	6.9	4.9
DK	111.5	110.6	112.2	112.9	111.2	112	110.9	108.1	106.4	103.8	104.2	104.7	105.4	106.7	107.8	9.1	8.1
DE	108.7	109.1	109.9	110.1	111.6	110.9	110.4	108	104.3	104.8	105.5	105.8	106.4	108.9	109.6	7.3	6.5
EE	172.1	172.8	173.5	174.2	170.3	168.5	164	154.7	146.1	140.6	138.8	140.7	142.2	144.8	145.8	35.4	20.3
IE	145.8	144.1	142.7	147.6	143.9	141.2	140.4	134.1	130.7	130.3	129.6	126.6	129.3	128	128.7	21	14.2
EL	131.6	132.2	133.2	134.1	134.4	134.8	134.5	134	132.5	132.1	131.2	129.7	128.9	126.7	125.1	9.7	7.2
ES	125.1	126.1	127.1	127.9	128.5	128.4	127.4	126	124	122.7	122.4	122.2	122.3	122.7	122.7	6.3	4.9
FR	112.8	113.3	114	114.3	114.8	114.1	113.8	112	110.4	110.6	110.8	111.4	111.7	112.3	112.7	4.4	3.8
IT	108.1	108.2	108.4	107.9	108.4	107.7	106.5	104.3	101.3	101.1	101.5	101.4	101.8	102.3	102.6	7.3	6.7
CY	126	127.7	129.2	130.5	131.7	133.2	133.5	133.5	132.2	131	130	130	130.6	131.4	132.2	3.5	2.6
LV	176.7	181.6	185	186.7	181.2	177.9	174.8	167.8	148.8	146.8	140.7	139.8	141.3	143	144.2	46.9	25.1
LT	164.4	170.2	175.9	176.5	178.2	179	175.7	173.5	153.5	150.3	150.2	148.6	150.6	152.1	152.6	30.4	17.0
LU	130.9	132.9	134.1	136.1	138.6	137.8	135.3	130.1	130.9	127	131.2	132.9	132.8	134	135.9	11.6	8.4
HU	126.5	126.4	126.8	127.5	129	128.7	127.5	124.7	120.8	119.3	118.3	118.3	119.5	119.9	120.9	10.7	8.3
MT	113.1	113.7	114.5	115.1	116.8	117.9	117.8	116	114	114	115	116.8	118.5	118.6	119.2	3.9	3.3
NL	113.2	113.8	115.1	116.7	117.6	117.3	117	115.6	112.9	111.4	112.2	112.8	113.4	114.4	114.3	6.2	5.3
AT	115.8	116.1	116	117.5	119.7	120	118.8	116.9	114.5	113.5	114.1	114.6	114.6	115.9	117	6.5	5.4
PL	128.8	131	132.7	135.6	137.5	138.5	139.6	139	139.6	140.3	140.9	142.9	143.9	145.7	147.6	0.6	0.4
PT	107.9	107.9	107.8	108.8	108.9	108.8	108.1	106.7	104.9	105.5	105.8	105.6	106.7	107	107.3	4	3.7
RO	147.1	148.9	150.1	155	160.9	163.3	162.6	159	152.4	150.2	150.3	148	147.5	148	147	16.3	10.0
SI	132.5	134.7	137.4	138.5	140.8	141.8	142.1	137.4	129.1	128.3	128.8	128.9	128.8	130.1	130.5	13.8	9.7
SK	145.7	149.4	153.2	161.2	158.9	160.4	162.4	163.3	150.8	152.5	154.3	156.4	157.7	159.3	160.8	12.5	7.7
FI	122.9	124.6	125.8	127	127.4	127.6	127.1	123.1	116.2	114.9	116.4	116.8	116.9	119.9	120.5	12.7	10.0
SE	121.9	122.6	123.4	124.8	123.5	123.5	123.5	118.4	115.3	115.7	115.6	116.5	118.5	120.9	123.4	9.5	7.6
UK	118.5	119.2	119.8	120.1	120.7	120.4	119.3	116.8	114.2	113.3	113	113.5	113.9	115.2	116	7.7	6.4

Note: Shaded cells denote period from peak to trough. * The drop is in percentage of 2000 income while the relative drop expresses the drop at the trough in percentage of the peak.

Source: Eurostat, Quarterly National Accounts.

Table 1.2: An overview of the recession, employment during 2007-10; index, 2000Q2=100(a)

	2007				2008				2009				2010				
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Drop	Rel. Drop (b)
EU-27	106.5	108.2	109.4	109.0	108.6	109.6	110.5	109.5	107.5	107.9	107.9	107.3	105.9	107.2	107.7	4.5	4.1
BE	105.5	105.4	106.3	107.9	107.9	107.0	108.4	108.2	107.3	106.8	107.1	108.0	108.3	107.8	108.8	1.6	1.5
BG	109.3	113.3	115.5	115.2	114.5	117.3	119.0	117.1	113.7	115.0	114.3	110.5	105.0	107.1	108.2	14.0	11.8
CZ	104.0	105.1	105.6	106.2	106.0	107.0	107.2	107.6	105.8	105.6	105.2	105.3	103.2	104.3	105.0	4.5	4.1
DK	102.7	103.7	103.3	103.2	103.4	105.5	105.5	105.1	103.1	102.6	102.9	100.1	99.5	100.9	100.4	6.0	5.7
DE	103.1	104.8	106.3	106.5	105.5	105.9	108.3	108.3	106.0	106.3	106.5	108.2	105.5	106.2	107.0	2.8	2.6
EE	113.8	115.9	116.5	115.0	115.5	115.5	116.2	114.8	107.7	104.3	105.2	102.1	97.4	98.3	101.7	19.1	16.4
IE	124.5	125.8	128.5	128.0	127.8	126.2	126.6	122.4	116.8	115.4	114.5	112.2	110.2	111.3	110.8	18.4	14.3
EL	108.8	110.2	110.7	110.2	110.0	111.7	111.9	111.0	109.4	110.5	110.7	109.2	107.9	107.9	107.3	4.6	4.1
ES	129.9	131.9	132.8	132.6	132.1	132.3	131.8	128.6	123.6	122.7	122.2	120.7	119.1	119.6	120.1	13.7	10.3
FR	108.9	110.5	111.6	111.2	111.3	112.3	112.8	111.8	110.8	111.7	111.6	110.5	110.5	111.6	112.1	2.3	2.1
IT	109.2	111.4	111.9	111.5	110.7	112.7	112.4	111.6	109.8	110.9	110.0	109.6	108.8	109.9	108.9	3.9	3.5
CY	125.9	128.7	129.3	130.9	129.0	130.6	129.9	131.2	128.3	130.3	130.1	130.4	129.1	131.8	131.1	2.9	2.2
LV	115.4	117.9	120.3	122.3	121.1	121.5	120.5	115.5	111.4	106.3	101.5	99.2	97.6	99.6	102.2	24.7	20.2
LT	106.6	109.2	110.4	107.7	106.8	107.9	108.8	106.6	101.3	100.5	100.8	97.9	94.0	94.0	95.6	16.4	14.9
LU	112.0	111.0	113.3	112.6	109.8	115.3	112.5	110.0	118.6	120.8	120.5	119.7	121.1	121.1	122.6	3.4	3.0
HU	102.6	103.6	103.7	102.7	101.0	101.6	103.1	101.9	98.9	99.8	99.4	99.4	97.7	99.3	100.4	6.0	5.8
MT	107.1	110.2	110.2	109.7	110.3	111.9	113.9	112.2	112.8	112.7	113.6	113.8	114.7	115.6	115.2	1.7	1.5
NL	106.3	107.6	108.3	108.1	108.1	109.0	109.7	110.1	109.9	109.4	108.9	108.8	107.5	108.6	106.7	3.4	3.1
AT	106.2	108.5	110.1	108.4	108.0	110.4	111.2	110.2	108.1	109.7	110.7	109.9	108.1	109.7	111.5	3.1	2.8
PL	102.3	104.5	106.4	107.1	107.0	108.2	110.2	110.3	108.3	109.2	110.4	109.6	107.4	110.2	111.7	3.0	2.8
PT	102.3	102.6	103.5	103.4	103.4	104.1	103.4	103.0	101.6	101.2	99.8	99.9	99.6	99.3	98.7	5.4	5.2
RO	85.8	89.0	91.3	86.4	85.9	89.5	90.7	87.0	85.2	88.4	89.8	85.1	84.2	89.4	89.4	7.1	7.8
SI	107.0	110.8	112.3	109.8	108.7	110.9	114.3	112.0	107.6	109.4	111.1	109.7	108.0	108.3	108.2	6.7	5.9
SK	111.7	112.2	113.6	115.1	114.8	115.4	118.7	118.3	114.7	114.1	113.6	111.8	109.5	111.0	112.0	9.1	7.7
FI	102.0	106.6	107.4	105.0	104.5	108.7	108.4	106.0	103.4	105.5	104.6	101.7	100.9	105.0	105.2	7.8	7.2
SE	107.4	110.1	112.4	110.3	109.6	112.1	113.3	110.4	108.3	109.7	110.2	108.1	107.5	110.4	112.3	5.8	5.1
UK	105.9	106.3	107.2	107.7	107.5	107.7	107.8	107.6	106.5	105.6	106.1	106.1	105.1	105.7	106.9	2.7	2.5

Note: shaded cells denote period from peak to trough. (a) France is 2000Q1. (b) Drop in percentage of 2000Q2 employment; relative drop compares the trough with the peak.

Source: Eurostat, Labor Force Survey (LFS) quarterly data.

Despite the severity of the recession, however, the regression in GDP has not come close to wiping out a decade of relatively strong growth. Tables 1.1 and 1.2 show how all countries grew over the decade despite the sharp downturn in 2008-10. Some countries (such as Germany or Denmark) have a poor track record over the decade, with an annual average growth rate below one percent. Most EU countries, however, end the decade with significant improvements in real income: Spain, Ireland and Sweden grew annually by an average of more than 2 percent, while some EU-12 countries show an average annual growth rate of more than 4 percent, despite the large contraction experienced during the recession.[3] Two exceptions stand out: Italy and, to a lesser extent, Portugal. In Italy, the meagre outcome of a decade of weak growth was wiped out by the recession, so that by the end of the decade real GDP is virtually at the same level as in 2000.

1.2. The boom period in the labour market

Some of these growing countries, however, saw large increases in their workforce, either through migration or because of an increase in the activity rate. In other words, increases in output do not necessarily reflect increases in productivity.

An extreme case is Spain, where employment increased by 32 percent from 2000 to its peak in 2007. (This compares with 10 percent in the EU-27 as a whole). Thus, despite a considerable contraction, Spain ends the decade 20 percent above its initial level (see Table 1.2). This expansion is partly explained by large flows of migrants: in the boom period, the proportion of foreign workers grew from 2 to 14 percent of Spain's total active workforce.[4]

[3] Indeed, the accession triggered an impressive catch-up process with some EU-12 Member States displaying rates of growth of productivity above 50 percent in 2000-07. The downturn was severe but did not get close to compensate accumulated growth in the boom period. For details, see section 1.3 in European Competitiveness Report 2010 (European Commission (2010a)).

[4] All figures mentioned in this section come from the Labour Force Survey, Eurostat.

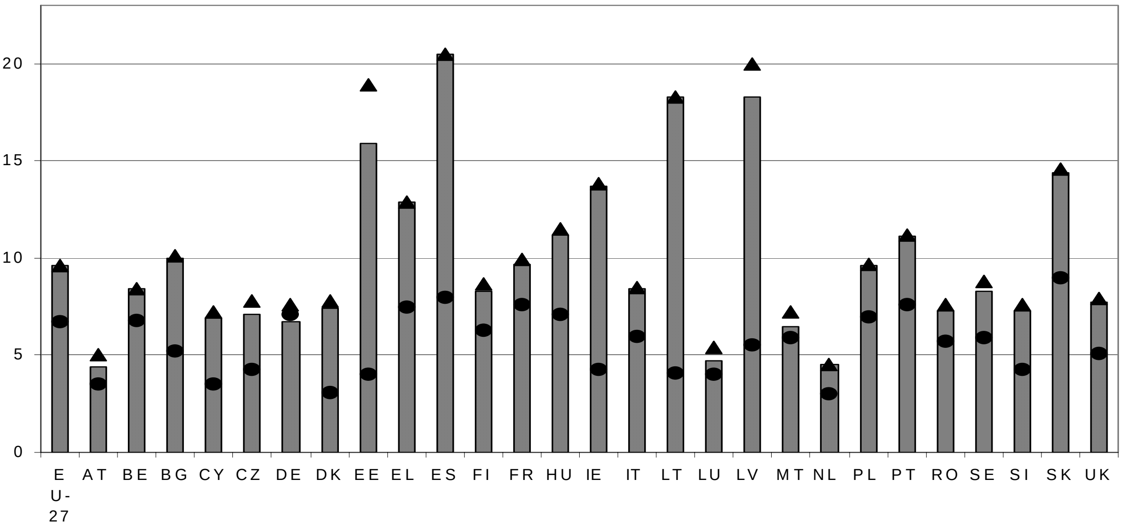
Table 1.3: Decomposing changes in real GDP per head, 2000-08 and 2000-10

	2000-10			2000-08			2000-08			
	Real GDP per head	Real GDP	Population	Real GDP per head	Real GDP	Population	Real GDP per hour	Average hours	Employment rate	Activity rate
European Union	9.8	14.0	3.9	13.2	16.9	3.3	:	:	:	:
Belgium	8.0	14.5	6.0	10.4	15.4	4.5	4.9	1.3	-0.1	4.0
Bulgaria	62.0	49.3	-7.8	68.8	57.2	-6.9	31.8	1.0	11.5	13.8
Czech Republic	33.5	36.9	2.6	37.4	39.6	1.5	36.6	-5.0	4.6	1.2
Denmark	3.3	7.2	3.7	7.4	10.5	2.9	4.1	0.7	1.0	1.4
Germany	9.8	9.0	-0.7	10.5	10.4	-0.1	10.8	-3.3	0.2	2.9
Estonia	48.4	44.9	-2.3	68.2	64.4	-2.3	47.6	-2.8	9.3	7.2
Ireland	9.7	29.0	17.6	19.8	39.9	16.8	20.3	-6.0	-2.2	8.3
Greece	20.7	25.9	4.3	30.6	34.4	3.0	19.7	-0.3	4.0	5.3
Spain	7.1	22.6	14.5	12.7	27.6	13.2	7.1	-4.9	-0.5	11.1
France	5.6	12.7	6.7	7.8	13.9	5.6	9.2	-2.0	1.1	-0.4
Italy	-3.6	2.5	6.3	1.6	6.8	5.1	-0.3	-3.8	3.6	2.2
Cyprus	13.4	31.3	15.8	16.4	33.0	14.3	10.2	-4.0	1.2	8.7
Latvia	51.4	43.1	-5.5	83.5	75.2	-4.5	61.0	-9.1	7.3	16.8
Lithuania	61.4	51.9	-5.9	84.9	77.4	-4.0	58.3	3.3	12.8	0.3
Luxembourg	16.3	34.6	15.7	21.0	35.4	11.9	6.9	9.4	-2.5	6.1
Hungary	22.7	20.3	-1.9	29.8	27.6	-1.7	35.4	-2.7	-1.7	0.2
Malta	10.8	17.5	6.0	10.1	16.4	5.7	7.9	-3.5	0.9	4.8
Netherlands	9.5	14.2	4.3	13.2	16.9	3.3	13.1	-3.9	0.0	4.1
Austria	11.3	16.5	4.7	14.2	18.8	4.1	12.4	-2.8	-0.3	4.7
Poland	46.3	46.0	-0.2	39.3	38.8	-0.4	28.7	-0.8	10.7	-1.4
Portugal	2.4	6.7	4.1	4.1	8.1	3.9	8.2	-2.3	-3.9	2.5
Romania	55.1	48.1	-4.5	69.6	62.6	-4.1	84.4	1.4	1.4	-10.5
Slovenia	27.8	30.7	2.2	38.1	40.6	1.8	..	..	2.4	4.4
Slovakia	59.4	59.9	0.3	61.1	61.2	0.1	49.7	-7.0	11.4	3.9
Finland	15.3	19.5	3.7	23.1	26.3	2.7	17.9	-2.5	3.9	3.0
Sweden	15.5	21.8	5.5	17.5	22.5	4.3	16.4	-1.0	-0.7	2.7
United Kingdom	9.2	15.4	5.7	14.4	19.3	4.3	15.4	-3.5	-0.3	3.0

Note, however, that employment (except in Romania and Portugal) increased over the decade, despite the recent downturn. Other than in Estonia, Luxembourg and Spain, the share of foreign workers remained fairly stable during this strong cycle — which is quite surprising. More strikingly, the recession has not changed that share. In some cases it has not even reversed the increasing trend. This suggests that foreigners do not constitute a disposable work force but are well-integrated into the economic tissue of their host countries. The same goes for the share of part-time workers in total employment, which remained roughly constant, ranging from low values like 4 percent in Hungary to 46 percent in the Netherlands, with an average of 18 percent for the EU-27.

The behaviour of temporary contracts depends on how (and why) such contracts are used. In Germany the share is a constant 14 percent but in Spain it reaches a peak in 34.6 percent in 2006 and then drops to 24 percent.[5]

Figure 1.3: Unemployment rate in 2010Q3 with minimum and maximum value before and during the recession



Source: Eurostat, Quarterly LFS statistics for employment, Unemployment - LFS adjusted series,une_rt_q.

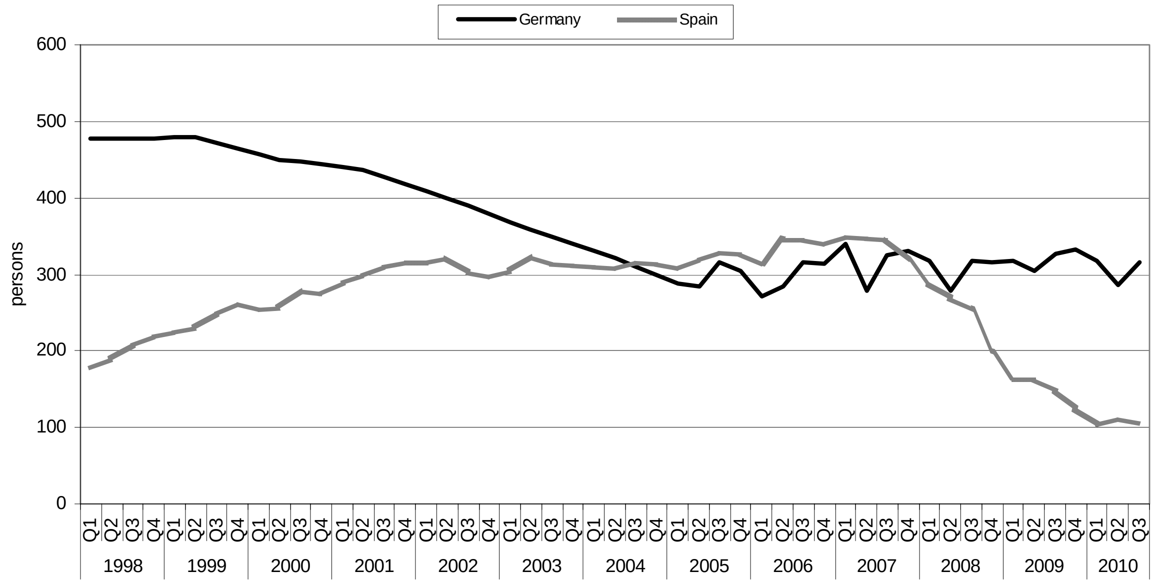
5 Here again Spain constitutes an exception. It had by far the larger proportion of temporary contracts at the peak of the cycle, 34 percent of its employment in 2008, and this share dropped to 24 by 2010. This is reflecting the dual Spanish labor market, in which youngsters with temporary contracts constitute disposable labor in bad times, and is discussed in depth in the report Employment in Europe 2010 (European Commission (2010e)).

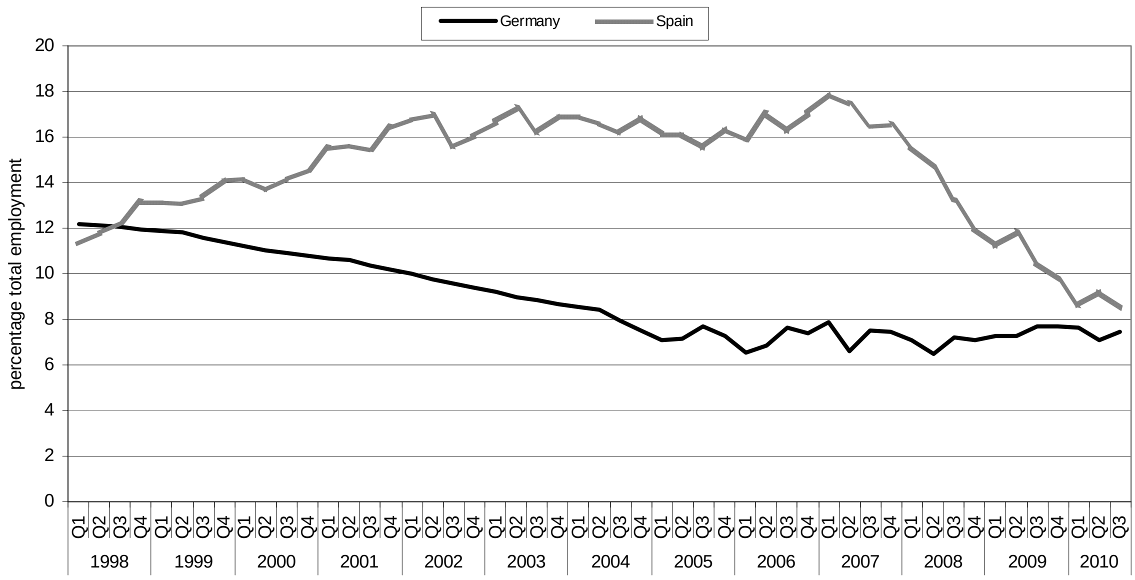
Box 1.2: Employment: Conjunctural versus structural readjustment

Countries affected by housing bubbles or other imbalances have seen their unemployment rates soar in comparison to other Member States. The reason is to be found in the different prospects faced by firms in these countries. In bubble countries there are two reasons why unemployment has risen more than the average. First, they are undergoing a major structural readjustment, namely the downsizing of their construction sector. Second, as mentioned above, households and firms are trying to deleverage, cutting down consumption and increasing savings. This slows down the recovery and worsens the situation for businesses, which are then reluctant to hire new workers. In contrast, in countries not directly affected by these imbalances, the better prospects of a swift recovery made possible for employers to hoard labour rather than firing workers. Indeed, if resizing the labour force entails adjustment costs, firms will react by hoarding labour to preserve good matches as well as firm-specific human capital. In turn, workers kept in employment help maintain internal demand, making these countries' prospects even better by comparison with bubble countries.

It thus appears that labour hoarding is a natural response to a good business outlook in the short-term. The government should not force firms to respond in the same way if major structural readjustments are taking place because it would just delay an inevitable adjustment. Figure 1.4 takes two of the most obvious cases at both extremes of the spectrum and is self-explanatory.

Figure 1.4: Germany and Spain compared: Employment in the construction sector in persons and in percentage of total employment





Note: Until 2008Q4 NACE rev.1, thereon NACE rev.2. In both cases construction is epigraph F. Until 2004 German data only available one quarter per year: the missing observations are linearly interpolated to build the graph.

Source: Eurostat, Labour Force Survey, LFS series - Detailed quarterly survey results (lfsq_egana).

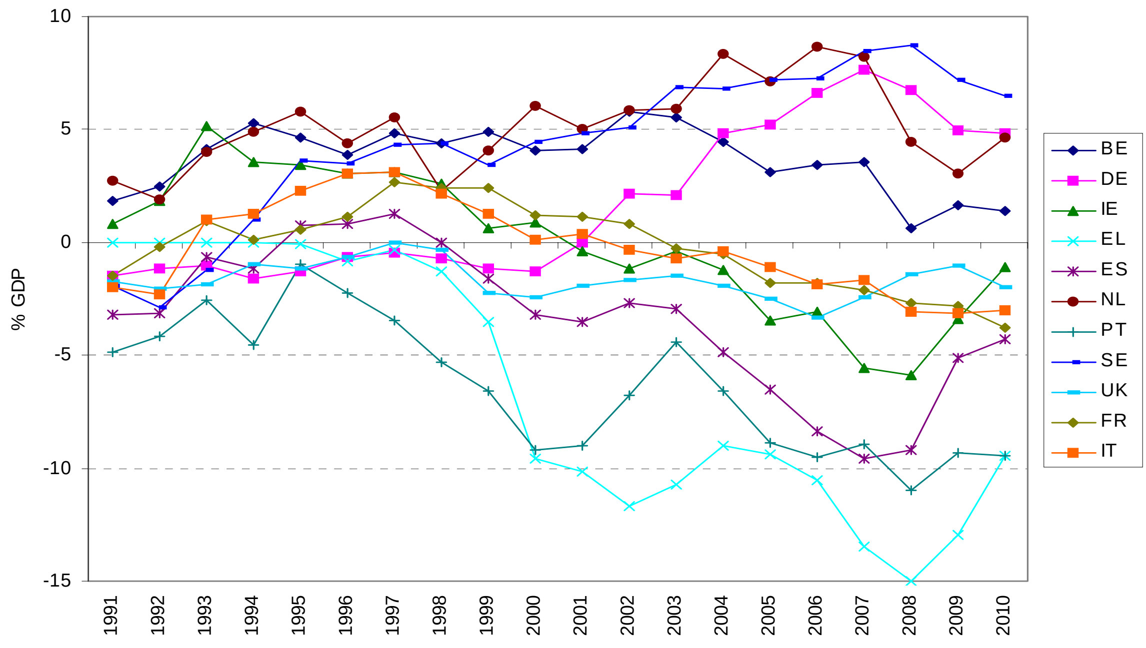
1.3. Borrowing, lending and the exit from the recession

While there is still some debate on the origin of these imbalances, there is already a degree of consensus on the role of the euro in their development (see European Commission (2010c). The boom years saw a notable increase in capital flows in all European countries. The way net lending and borrowing (Figure 1.5) behaved gives an idea of how countries were affected throughout this period, and may indicate how they will get out of the recession.

There are four types of countries. In the first group one finds countries like Belgium or the Netherlands. They have traditionally been net lenders and the boom period, if anything, intensified this trend. In the second group are countries like Germany or Sweden that started being borrowers and became major lenders. In the case of Sweden this change occurred after the financial crisis in the 1990s: in the case of Germany it happened approximately when the euro was introduced. A third group comprises those countries that have seen their levels of borrowing increase to unsustainable levels. They include Greece, which in 2008 borrowed an amount equivalent to 15 percent of its GDP, and Spain which went from being a net lender in the late 1990s to borrowing almost 10 percent of its GDP for three consecutive years between 2006 and 2008. These countries will find it harder to recover since they will face substantial sectoral readjustments in addition to the deleveraging of households and firms. Greece, Spain and Ireland are showing signs of this readjustment in that their net borrowing is decreasing very fast, mirroring the decrease in lending by Germany and Belgium.

Finally, the fourth group comprises Portugal and Italy, neither of which had a bubble but both of which show weak growth. More intriguingly, neither of them has really managed to reduce its dependence on foreign capital after the crisis. They differ only in that Italy does not have a significant external imbalance while Portugal does, and it started twenty years ago.

Figure 1.5: Net lending (+) / net borrowing (-) for selected EU Member States

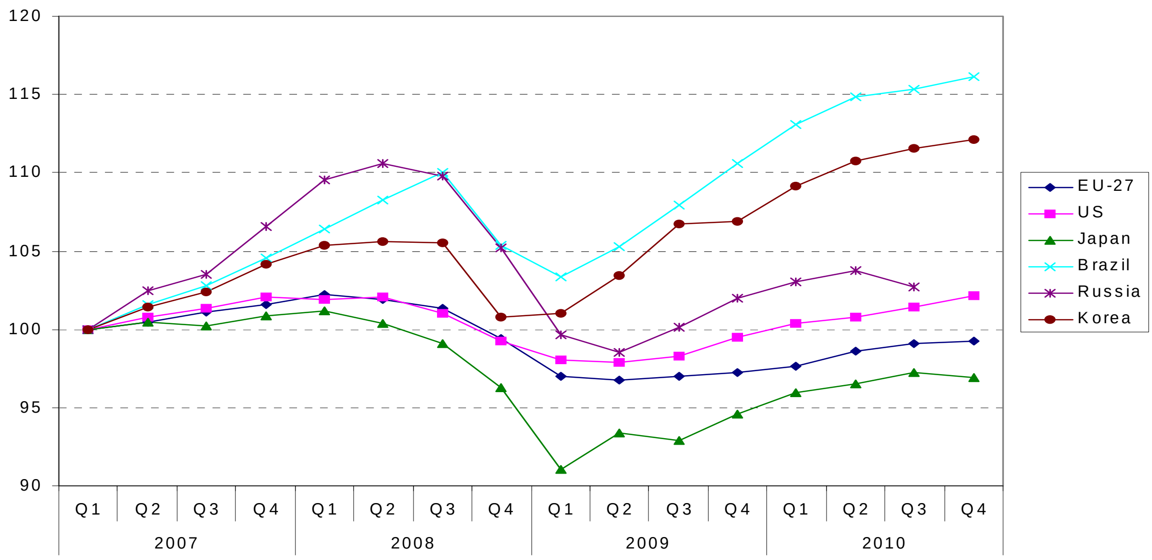


Source: AMECO database, European Commission; Net lending (+) - net borrowing (-), total economy (UBLA).

In short, countries like Germany and Sweden will recover very fast, France and the UK more slowly. Greece and Spain will follow a path of modest growth while deleveraging is ongoing; Italy and Portugal are likely to face persistent stagnation unless they undertake structural reforms.

If Europe is set on a path of recovery, it is a slow one compared to the US and even more so when compared with emerging economies. Estimates of real growth rates for the last three years tend to indicate that the EU's income has not yet returned to its 2007 level while its main Asian competitors have seen their income rise well above pre-crisis levels (Figure 1.6): South Korea 10 percent higher, India 23 percent and China 32 percent.[6] Note that East Asian economies can be seen as victims of the imbalances in the US and the EU: they were not affected by internal imbalances; it was a conjunctural downturn, hence the strength of their recovery is not surprising and it will in turn help the European recovery.

Figure 1.6: Real GDP in EU-27 and selected economies (2007 = 100)



Source: OECD Quarterly National Accounts.

1.4. Restructuring versus conjunctural downturn

From Table 1.3 it is clear that there is no obvious connection between the severity of the recession and recent productivity developments. To understand this, and in connection with all of the above, we need to note that different sectors have been affected in very different ways.

As is usual in recessions, consumer durable goods and investment are the most sensitive items. Consumers postpone purchases of items like cars and household appliances while continuing to consume energy and non-durable items like food (see Table 1.4). This would explain the marked difference in the drop in 2009, which for the EU was around 15 percent for durables and barely 2.7 percent for non-durables.

More interesting, however, is the large contraction of building (not civil engineering). It has dropped more than the average and by March 2011 it had not yet started to recover; see the Monthly Note March 2011 (European Commission (2011c). This is a sign of the correction taking place after a decade of overinvestment in the housing sector. Indeed, the recession can be seen as a correction or readjustment once the prices of certain assets are deemed unsustainable. Other sectors not directly related to the construction boom will recover

6 Figures for India and China are from the International Monetary Fund, World Economic Outlook Database, October 2010. For the strong recovery of emerging economies, see again OECD (2011).

relatively faster. Those more cyclical like Basic metal, Motor vehicles, etc., display in table 1.4 double digit positive growth since the trough. The way countries perform, overall, during this recession will depend on the relative importance of each of these sectors. But high performing sectors, those who performed well before the crisis, will in all likelihood do well in the future in every Member State. This line of reasoning explains the apparent paradox of countries hit hard by the recession, and yet with an overall reasonable performance over the decade (see again Table 1.3). In other words, that the construction sector was oversized in 2007 does not mean that it was at the expense of other productive sectors that may be driving growth of productivity, maintaining international market shares, and leading now the recovery.[7]

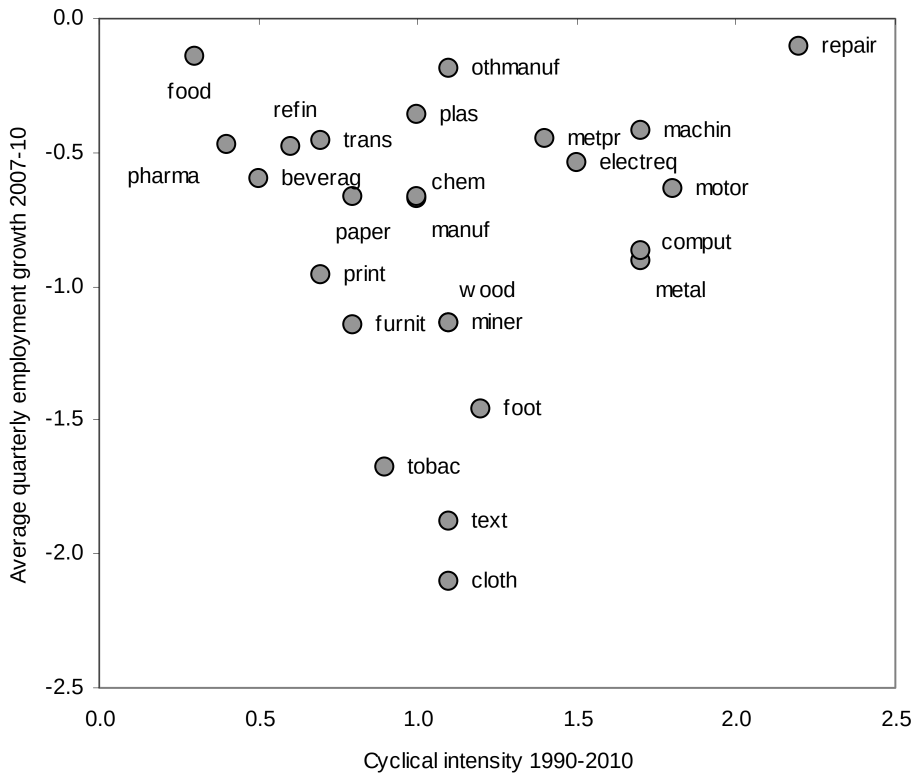
Indeed, the recovery of other sectors, notably manufacturing, is already under way, and it is benefiting from the steady growth of economic activity in emerging countries. As noted in the previous section, GDP outside the EU and the US was not much affected and is now growing fast, attracting European exports. By January 2011 the value of EU exports was 33 percent above its level a year earlier.

On the finance side, according to the Monthly Note March 2011, recovery from the credit squeeze is lagging behind the recovery of manufacturing activity but is not worsening.[8] Less encouraging are the grim prospects for European venture capital. According to Coller Capital (2011), a recent survey of the private equity industry, large investors will be moving away from venture capital in Europe in the coming years. In the US, 50 percent of investors consider venture capital a promising investment. The corresponding figure in Europe is less than 10 percent. Hardly anyone who answered the survey believes that venture capital will generate consistently strong results over the next decade, given its poor performance in the last ten years. As discussed below, this may handicap the EU's ability to bring innovations to the market through start-ups.

[7] For an argumentation along these lines, see EEAG (2011, chapter 4). In the previous edition of the European Competitiveness Report 2010, chapter 1 noted how the evolution of international market shares in 2000-10 bears a less than obvious relation with the adjustments suffered during the 2008-10 crisis.

[8] At this point it may be worth noting that there is no consensus in the literature on the role of tightening credit conditions and the recovery after a deep recession. For instance, Hayashi and Prescott (2002) show how bank loans remained depressed in Japan long after economic activity, and notably investment, started to recover. See the discussion in Claessens, Kose and Terrones (2009).

Figure 1.7: Cyclical intensity and the drop during the downturn in the EU-27



Note: Cyclical intensity is defined as the standard deviation of output from trend for each sector relative to that of total manufacturing. The trend is extracted with the Christiano-Fitzgerald band-pass filter and the period is 1990-2010. The drop is measured as the percentage difference between the peak and the trough.

Source: European Union Industrial Structure 2011.

Table 1.4: Recent developments in EU-27 sectors. Percentage changes in value add

NACE Rev.2 Growth 2008 Growth 2009 Last
six months Post trough growth Spread last six months

	Capital	0	-19.4	9.4	13.8	1.1
	Consumer	-2	-4.3	3.7	4.7	-4
	Durable consumer	-5	-15.1	6.3	7.7	-0.7
	Nondurable consumer	-1.5	-2.7	3.1	4.4	-4.6
	Intermediate	-3.6	-17.8	11	15.1	3.1
B	Mining & quarrying	-3.6	-11.1	1.2	0.5	-4.9
C	Manufacturing	-1.9	-14.5	8.1	9	-
C10	Food	-0.6	-0.9	1.7	3.8	-6.5
C11	Beverages	-1.9	-2.7	-1.6	0.1	-9.5
C12	Tobacco	-16.2	-1.9	-5.9	0	-9.6
C13	Textiles	-10.1	-16.4	8.9	14.4	4.8
C14	Clothing	-3.4	-11	2.4	6	-0.2
C15	Leather and footwear	-7.9	-12.4	5.4	8.4	2.4
C16	Wood	-8.8	-14	4.2	5	-3
C17	Paper	-3.4	-8.9	7.3	9	-0.9
C18	Printing & publishing	-2.3	-7.4	0.4	2.5	-6.9
C19	Refined petroleum	3.2	-7.9	1.1	7.9	-6.1
C20	Chemicals	-3.3	-10.7	11.3	19.7	2.6
C21	Pharmaceuticals	1.6	3.1	6.9	13.6	-5.3
C22	Rubber & plastics	-4.8	-12.9	8	11	-0.3
C23	Non metallic mineral products	-6.7	-18.4	4.7	6.3	-2.1
C24	Basic metals	-2.8	-25.6	21	42.4	13.7
C25	Metal products	-2.4	-21.8	8.9	11.1	1.3
C26	Computers, electronic & optical	2.7	-16.7	10.6	11.5	0.7
C27	Electrical equipment	-0.1	-20.2	13.8	14.6	5.7
C28	Machinery n.e.c.	1.4	-25.9	12.2	18	4.7
C29	Motor vehicles	-6.1	-21.8	19	48.3	9.6
C30	Other transport eq.	4.3	-5.9	-3.2	2.2	-10.7
C31	Furniture	-1.1	-5.9	8.6	1.2	1
C32	Other manufacturing	-4.9	-16.5	0	9	-6.2
C33	Repair of machinery	5.5	-8.5	2.3	6.5	-3.4
D	Electricity, gas & water	0.3	-4.9	3.7	7.7	-4.8
F	Construction	-3.7	-9	-2.8	4.8	-10.4
F41	Buildings	-4.4	-11.4	-3.4	4.1	-11.2
F42	Civil engineering	-1.2	1.8	2.2	7.3	-4.9

Source: European Union Industrial Structure 2011.

Table 1.5: Trends in productivity and hours worked. Percentage changes in 1995-20(

		per person in employment			per
hour worked		hours per person in employment			
TOT	Total	14.11	18.59	-3.77	
AtB	Agriculture	34.67	38.40	-2.69	
C	Mining and quarrying	14.54	13.53	0.89	
D	Total manufacturing	34.83	40.10	-3.76	
15t16	Food, beverages and tobacco	6.02	12.23	-5.53	
17t19	Textiles	23.63	26.00	-1.87	
20	Wood	33.29	39.99	-4.79	
21t22	Pulp, paper and printing	32.27	32.29	-0.02	
23	Coke, refined petroleum	-11.14	-4.11	-7.33	
24	Chemicals	51.39	58.71	-4.62	
25	Rubber and plastics	43.27	48.91	-3.79	
26	Other non-metallic mineral	26.66	32.03	-4.07	
27t28	Basic metals	18.57	20.98	-1.99	
29	Machinery, nec	23.56	28.43	-3.79	
30t33	Electrical and optical equipment	97.19	106.34	-4.43	
34t35	Transport equipment	35.11	46.10	-7.52	
36t37	manufacturing nec; recycling	15.23	18.52	-2.78	
E	Electricity, gas and water supply	42.90	50.46	-5.02	
F	Construction	-0.48	-0.80	0.33	
G	Wholesale and retail trade	17.69	23.95	-5.05	
50	Retail trade of motor vehicles	13.31	19.64	-5.29	
51	Wholesale trade; no motor	26.28	31.47	-3.94	
52	Retail trade; no motor vehicles	9.98	16.67	-5.73	
H	Hotels and restaurants	-8.31	-1.01	-7.38	
I	Transport, storage, communication	49.18	53.57	-2.86	
60t63	Transport and storage	21.74	26.44	-3.72	
64	Post and telecommunications	129.81	135.95	-2.60	
JtK	Finance, real estate and business services	-3.18	-0.80	-2.40	
J	Financial intermediation	45.02	48.97	-2.65	
70	Real estate activities	-9.83	-5.94	-4.14	
71t74	Renting of m&eq and other business activities		-1.60	0.75	-2.34
LtQ	Community and social services	-0.13	2.85	-2.90	
L	Public admin and defence	12.20	15.83	-3.14	
M	Education	-7.95	-8.27	0.35	
N	Health and social work	6.09	9.01	-2.68	
O	Other community	-7.00	-3.42	-3.70	
P	Private households	-9.85	-4.94	-5.16	

Note: Numbers are percentages.
Source: European Union Industrial Structure 2011.

1.5. The role of innovation in the recovery

If the recession is about restructuring some sectors, but does not affect the capacity of competitive sectors to thrive, the outlook for the medium-term recovery is good, and leads to the issue of how to support innovation and productivity growth in the EU. The focus here is on R&D, for it is considered an important source of innovation and therefore sustained growth.

Despite the emphasis on R&D intensity of the Lisbon strategy, progress in the past decade has been modest. The Innovation Union Competitiveness Report 2011 (European Commission

(2011b)) reports that some countries (Estonia, Portugal, Ireland, Spain and Cyprus) have doubled or more their R&D intensity since 2000 while most countries have increased it by 50% or less and a last group (Greece, Belgium and Slovakia) has shown no change or a small decrease. Of course, the departure point was very different across countries: the larger Member States are among the slowest progressing countries, which explains the limited progress of the EU aggregate R&D intensity. Hence, albeit good progress has been made in several countries, the EU as a whole is still far from the target set in the Lisbon strategy.

The crisis will not help either although it is expected that R&D expenditures financed by the business sector will rebound for they are known to be strongly procyclical. In times of crisis firms cut down spending in R&D and there is evidence that financial constraints play an important role. Indeed, during a recession, most efforts are directed to cost-saving innovations. Even without financial constraints, it may be optimal from the individually point of view for R&D expenditures to be procyclical. However, because of positive externalities of R&D it may be too procyclical (see the discussion in section 1.4, European Competitiveness Report 2009). This would be a case for counter-cyclical public funding of R&D, and indeed, actual R&D financed by the government appears to go counter the cycle in Figure 1.8.

Box 1.3: Technical change

In the economic jargon technical change refers to any new process or commodity that allows increasing the value of production per unit value of inputs (including factors of production, like capital and labour, and intermediates). Examples include the refinement of a process that allows reducing the consumption of energy, given the level of production, or the introduction of a new good, like mobile phones, that fulfils a consumer demand so far unsatisfied.

Robert M. Solow (1956) noted how physical capital (machines) could not reproduce itself indefinitely.[9] He then concluded that observed sustained growth of income had to be explained by technical change: by the ability to add more value sustainably with the same amount of labor. In other words, the importance of innovation stems from the fact that, ultimately, it is the only source of long-run growth or productivity, in turn the only source of raising living standards.

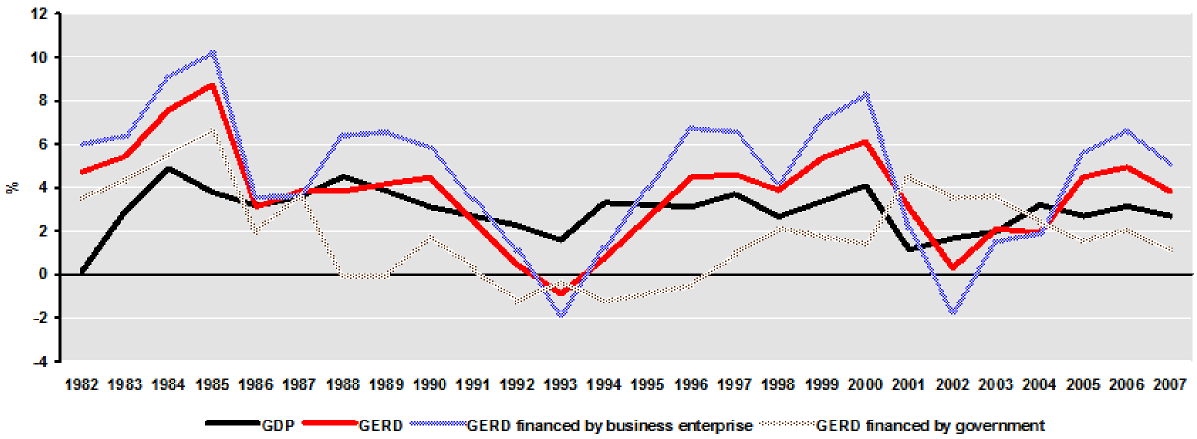
Indeed, innovation and technical change are two faces of the same phenomenon. Innovations stem from experience (learning-by-doing), the accumulation of human capital through formal education (learning-or-doing) and from research and development (R&D) activities. R&D can be seen as the purposeful allocation of resources (labor, capital) to the generation or adaption of innovations: new goods, new processes and new knowledge. From the moment in which firms devote resources to R&D, these have to be innovations with (at least) a (potential) commercial value. In turn, if it has a market value one can conclude that R&D induces technical change: the ability to produce more value given the inputs. It should be noted, however, that private R&D does not include all forms of “purposeful” innovation: it also

9 To be precise, the paper notes that physical capital cannot reproduce itself indefinitively under the assumption of decreasing returns to capital. There has to be some (technical) change that increases returns to capital indefinitively.

10 See Abraham García (JRC-European Commission), “The importance of marketing expenditures and other tangible assets on firms' innovation performance,” and Anders Sørensen, “Education as a Determinant for Innovation and Productivity,” Enterprise and Industry brown-bag seminars, Brussels, January 2011 and June 2011 respectively.

includes basic research, public R&D, or even other steps in the innovation process such as marketing, a key step in taking effectively an innovation to the market and therefore give it in effect a commercial value.[10]

Figure 1.8: Real growth rates for R&D and GDP, OECD area, 1982-2007



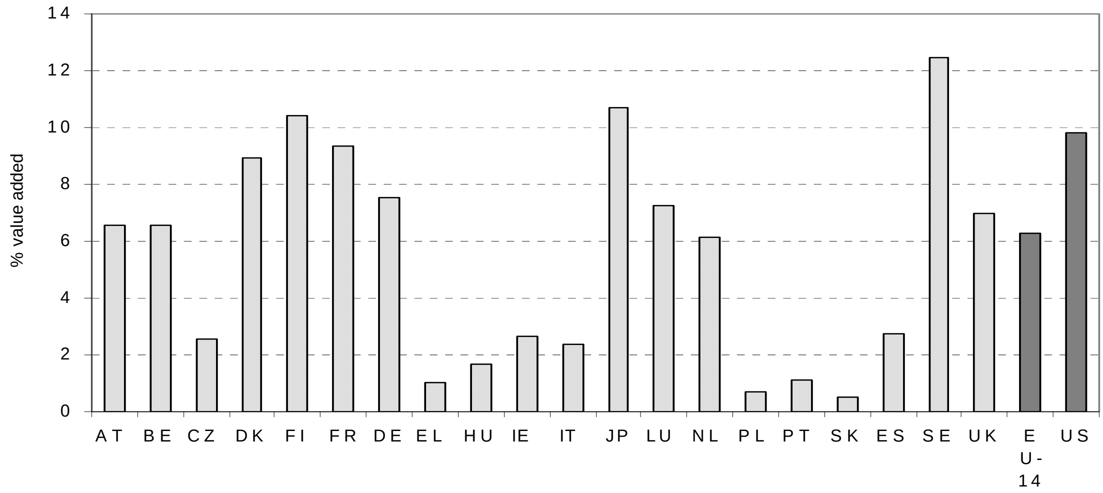
Source: Figure I.2.1 in *Innovation Union Competitiveness Report 2011 (*European Commission (2011b)).

1.6. Overview of R&D in Europe

The extent to which a society is committed to innovation can be captured by R&D intensity: the share of R&D expenditures in value added. R&D intensity is for innovation what the saving rate represents for physical capital, a measure of foregone resources today for a promise of a return tomorrow, in this case in the form of new technologies or goods or services.

If one feature characterizes business R&D intensities across countries, it is the large variability observed. Figure 1.9 illustrates this variability for the manufacturing sector; from 0.5 percent in Slovakia to 12.4 in Sweden. Furthermore, it is also clear that the US invests significantly more in R&D than the EU-14. It should be noted, however, that the differences between the US and the EU lie in the business enterprise activities: R&D funded by the government, typically performed in universities and other research organizations as well as by the government itself, is already similar across the Atlantic.

Figure 1.9: R&D intensity (R&D expenditures over value added) of the manufacturing sector, year 2005



Note: R&D expenditure is ANBERD, i.e.: it includes R&D activities carried out in the business enterprise sector, regardless of the origin of funding; EU-14 is the EU-15 minus Luxembourg.

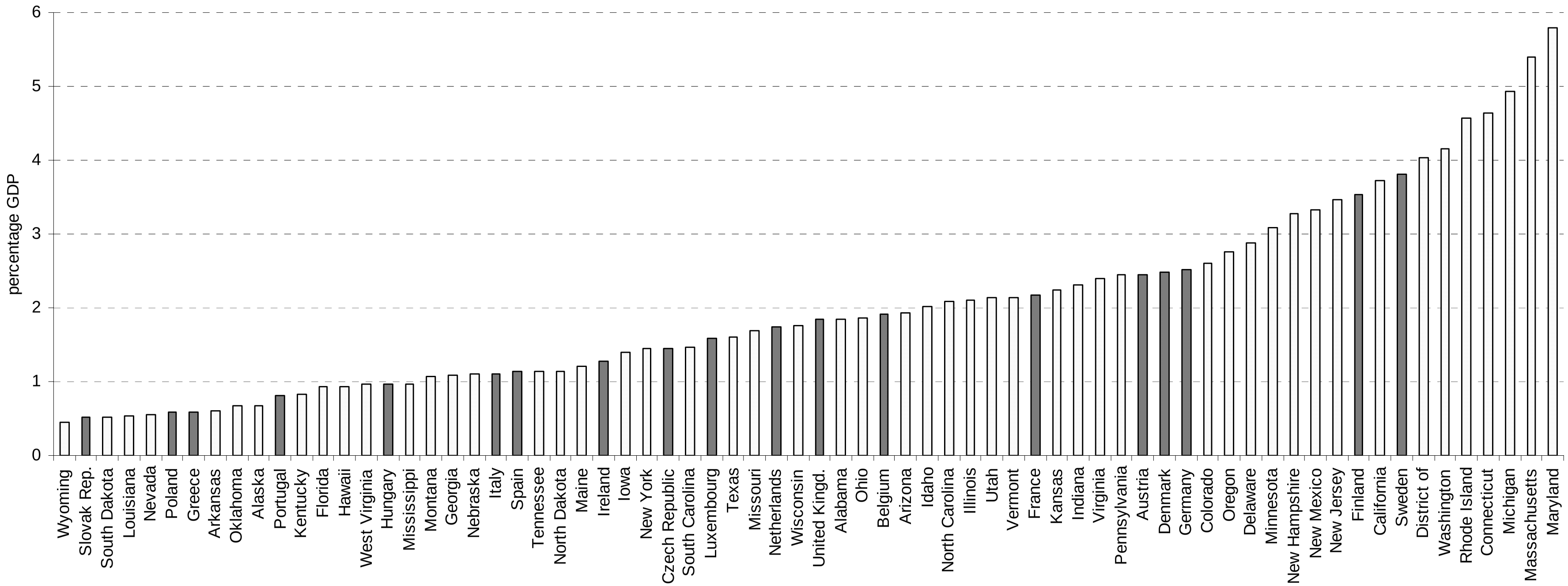
Source: OECD, STAN indicators 2009.

A second remark concerns regional or within-country variability. Figure 1.10 shows how US states display a similar range of variability to that of EU Member States: from the extremely low investment of Wyoming, a scarcely populated rural state, to the extreme case of Maryland with close to a 6 percent of GDP of expenditures in R&D.[11] This variability, of course, reflects patterns of regional specialization that may be optimal from the social point of view. If spillovers and other positive externalities typical of knowledge-intensive activities apply to R&D, it may pay off to invest more in Silicon Valley rather than in Wyoming.[12] These numbers also illustrate the reason why the EU —the Lisbon strategy first and the EU 2020 strategy now— has always set the 3 percent R&D intensity target for the EU as a whole and not for individual Member States.

11 Maryland is an outlier in that half of its R&D is public, as opposed to 80 percent of business enterprise R&D expenditures for most R&D intensive states. The reason is this state is the home to the National Institutes of Health. See: OECD Regions at a Glance: 2009 Edition; and InfoBrief, National Science Foundation, June 2010.

12 For an argumentation along these lines see Dijkstra (2010).

Figure 1.10: R&D intensity in US states and EU Member States



Source: OECD Main Science and Technology Indicators Database.

In any case, a glance at this figure shows that the EU and the US are reasonably similar as for geographic patterns: it does not seem that the aggregate differences observed correspond to a consistently lower investment in EU Member States. It does not seem either to be related to some environmental factor directly affecting RDI: empirical evidence shows that similar firms across the Atlantic behave similarly (in the sense of having similar RDI, profits, etc.).[13]

1.7. Sectoral dimension of innovation

Observed differences in R&D intensities across Member States and between the EU and the US may have different explanations. One possibility is that EU Member States tend to specialize in sectors characterized by a lower R&D intensity. Indeed, different sectors will be characterized by different intensities because of intrinsic and extrinsic characteristics. For example, different sectors of economic activity are characterized by different technologies. To the extent that these technologies have different degrees of codability,[14] one should observe different degrees of R&D intensity to the extent that R&D is directed towards patentable discoveries. This would explain differences in levels across sectors. A clear examples of an extrinsic trait would be the degree of competition: Laing et al. (1995) suggest that the level of market integration (increased competition) affects both the incentives to engage in R&D and the returns to this investment, but the degree of competition may well be different per sector given the nature of the commodities produced and traded. Along the same lines, Baily and Laurence (2001) link competitive markets to the adoption of information technologies (IT) in the US.

What about the differences between the EU and the US? When examining the distribution of R&D expenditures across sectors, the EU Industrial R&D Investment Scoreboard (European Commission (2010d)) shows that medium-tech sectors are overrepresented in R&D expenditures by EU firms compared to US firms. This would be consistent with the observation that EU economies show some sectoral structure sluggishness compared to the US, a rigidity that would explain why in the US investment in high-tech sectors has soared in the past 20 years while the distribution of expenditures in the EU looks today similar to that of the 1980's.

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13 See Moncada (2010). Note, however, that this paper refers to the EU Industrial R&D Investment Scoreboard, and hence focuses on large firms active in international markets. Smaller firms across the Atlantic focused on domestic markets may behave differently.

14 In the sense given in Nelson (1980) to codability: the extent to which is possibly to codify the new technique in order to produce a blueprint that can be afterwards used by anyone to reproduce the technique.

Table 1.6: An overview of differences EU-US in R&D

% total	Distribution of R&D across sectors,		R&D intensity (over value added)	
	EU-14	US	EU-14	US
C15T37 MANUFACTURING	81.53	70.30	6.26	9.79
C15T16 Food products, beverages and tobacco	1.76	1.44	1.14	2.04
C17T19 Textiles, textile products, leather and footwear	0.59	0.36	1.04	2.02
C23T25 Chemical, rubber, plastics and fuel products	21.72	20.43	9.75	13.61
C26 Other non-metallic mineral products	0.78	0.40	1.31	1.69
C27 Basic metals	1.08	0.28	1.98	1.12
C28 Fabricated metal products, except machinery and equipment	1.12	0.61	0.89	1.11
C29T33 Machinery and equipment	28.78	28.79	9.69	22.33
C30 Office, accounting and computing machinery	1.92	2.19	18.47	24.66
C31 Electrical machinery and apparatus, n.e.c.	2.96	1.07	5.00	5.24
C32 Radio, television and communication equipment	10.74	13.10	29.67	43.06
C33 Medical, precision and optical instruments	5.08	8.66	11.62	43.68
C34 Motor vehicles, trailers and semi-trailers	16.03	7.12	15.44	16.38
C35 Other transport equipment	8.47	8.82	23.33	24.75
C36T37 Manufacturing n.e.c. and recycling	0.56	0.52	1.09	1.13
C40T41 ELECTRICITY GAS AND, WATER SUPPLY	0.58	0.09	0.39	0.09
C45 CONSTRUCTION	0.41	0.56	0.09	0.21
C60T64 TRANSPORT, STORAGE AND COMMUNICATIONS	3.02	1.26	0.58	0.39
C72 Computer and related activities	5.94	13.49	3.99	15.52
C74 Other business activities	2.20	..	0.35	..
C75T99 COMMUNITY, SOCIAL AND PERSONAL SERVICES	0.37	..	0.02	..
C50T99 TOTAL SERVICES	16.42	29.04	0.30	0.68

Notes: R&D expenditure is ANBERD, i.e.: it includes R&D activities carried out in the business enterprise sector, regardless of the origin of funding; EU-14 is the EU-15 minus Luxembourg.

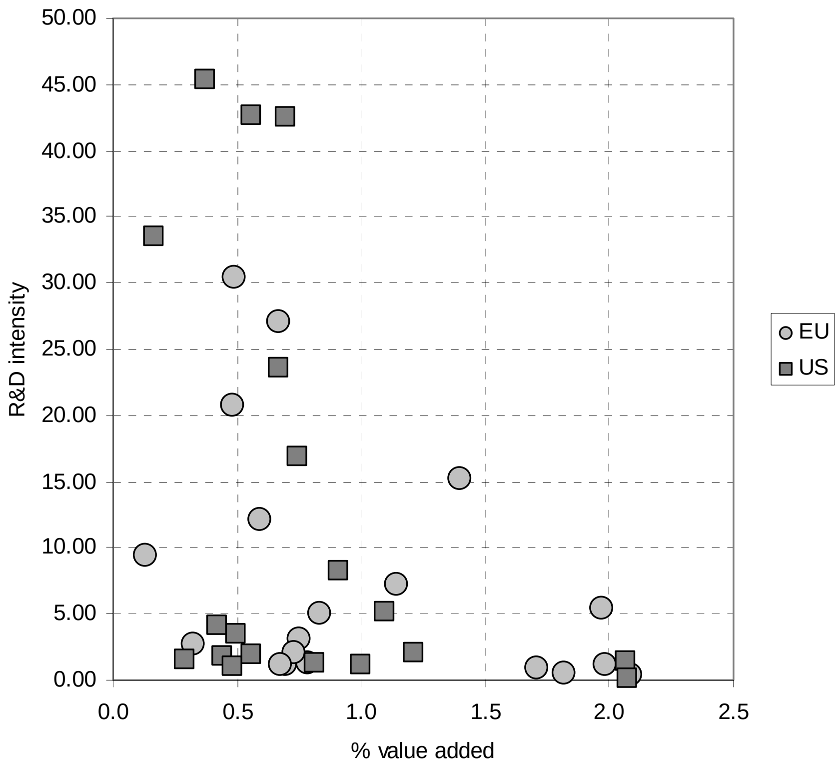
Source: OECD, STAN indicators 2009.

A problem with the scoreboard, however, is that it is a sample constituted of the largest R&D investors.[15] Looking at OECD aggregate data (Table 1.6), focusing on R&D performed in a given region by all firms regardless their nationality, there is no extraordinary difference between the EU and the US as for the distribution of R&D across sectors within manufacturing.[16] Furthermore, these sectors account for similar shares of total value added in the economy (Figure 1.11). In short, differences are to be found rather in the amount invested, particularly in high-tech sectors like Radio, television and communication equipment or medium-high-tech sectors like Machinery and equipment.

[15] Another important point to mention is that the scoreboard looks at R&D investment by companies, whatever the location of the R&D performed. The Scoreboard is not about business R&D in the EU versus in the US but it is about R&D by EU and US companies. Hence, US companies may in fact maintain significant R&D activities in the EU. See chapter 4 "Foreign corporate R&D and innovation in the European Union," in the European Competitiveness Report 2010.

[16] The relatively larger share of services in the US is due to different statistical criteria that yield larger investments in services sectors in the US vis-à-vis the EU.

Figure 1.11: Economic sectors: R&D intensity and the weight in total value added 2006



Note: R&D expenditure is ANBERD, i.e.: it includes R&D activities carried out in the business enterprise sector, regardless of the origin of funding. The EU is AT, BE, CZ, DK, FI, FR, DE, EL, HU, IE, IT, NL, PL, PT, ES, SE, UK. Data corresponds to 2006 except EL, IE and PT that use 2005.

Source: OECD, STAN database for structural analysis and STAN indicators 2009.

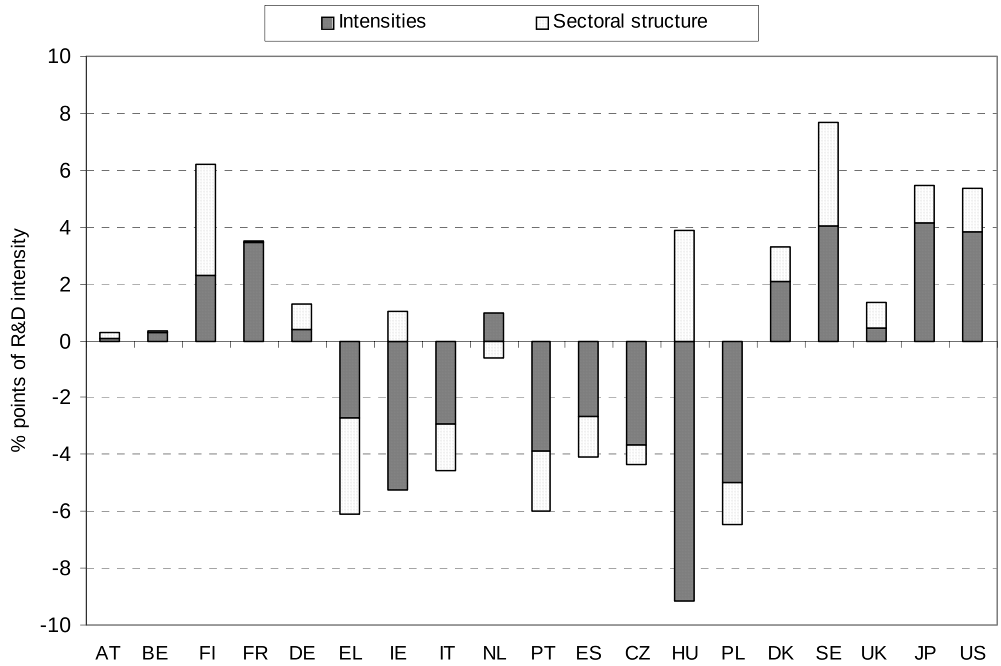
A more systematic and synthetic look at the differences in R&D intensities confirms the intrinsic smaller intensity of European sectors (and allows to have a good glance at all Member States).

Box 1.4 Sectoral structure versus individual intensities

Differences in R&D intensities across countries can be attributed to differences in the industrial structure or to differences in sectoral intensities. Indeed, on one hand, it could be that one of the countries specializes in sectors that are relative more (or less) R&D intensive (the sectoral factor). On the other hand, it may also be that the same sectors of economic activity display a different intensity (the intensity factor).

The literature uses a common additive decomposition (e.g., Moncada et al. (2010)) that has the inconvenient of assuming that the country of reference has, in a sense, the “right” sectoral intensities. In this section an alternative way to decompose aggregate differences into sectoral and intensity differences is applied. This decomposition uses the Fisher ideal index. Being defined as the geometric average of the Laspeyres and Paasche index, the sectoral intensities of any given two countries or regions are treated symmetrically: no region is assumed to have the “right” intensities, and hence the choice of the reference country is unimportant (for the details see Durán (2011)). The factorial decomposition is then linearized to obtain the aggregate differences in intensities additively decomposed in a sectoral and an intensities component as in Figure 1.12.

Figure 1.12: The role of sector intensities and sectoral structure in differences in business R&D intensity (with respect to the EU)



Note: The total difference is the difference in business R&D intensity in percentage points of value added. The sectoral structure and individual intensities factors add up to the total difference. Hence, for example, AT and BE are shown to be close to the EU average. The EU here is the current selection of Member States; countries are chosen as a function of data availability.
Source: OECD STAN database for structural analysis.

In general, aggregate intensity in R&D is determined by both the sectoral structure, the weight of more intensive sectors in total value added, and the intensities of individual sectors, how intensive a given sector is across countries. Hence, observed aggregate differences can be decomposed into a sectoral structure and an individual intensities factor (see Box 1.4). Figure 1.12 shows how the bulk of the differences with the US are associated to higher intensities in given sectors in accordance to the preliminary evidence of the previous section.

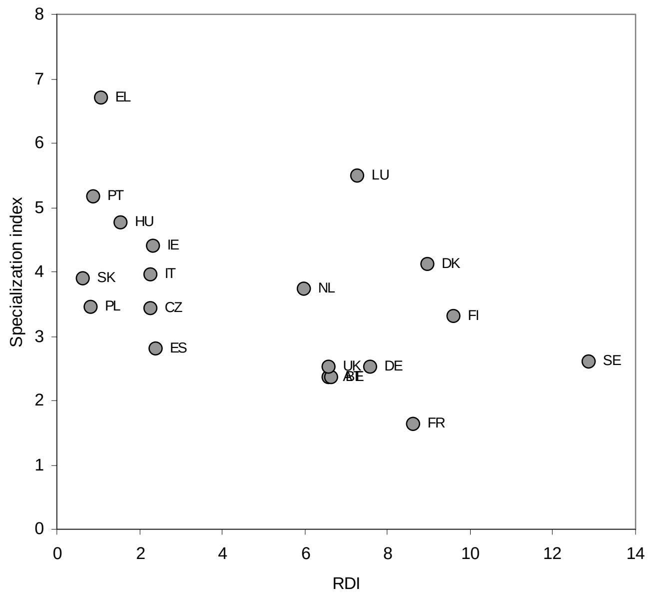
It also provides in a simple glance a picture of the different ways in which EU Member States depart from the EU average. From the intensities perspective, the case of Hungary stands out for its extreme decomposition. The combination of the "right" sectoral structure (R&D intensive sectors weight a lot in the economy) and the very low intensity denotes an assembly economy that indeed exports high-tech commodities produced for foreign corporations (so that the associated R&D is performed somewhere else).

1.8. The returns to R&D and policy considerations

Examining these differences in R&D intensity across countries and regions leads to the question of whether there is anything to do about it. This is particularly true in times of distress with budgetary pressures exacerbating the tension between the need to support growth strategies and the balance of public finances.

As discussed above, R&D is an important source of innovation and therefore sustained growth. Investment in R&D is associated with important private returns but also with significant spillovers that would justify public intervention; McMorrow and Röger (2009) includes a comprehensive review of the vast literature on the returns to R&D. Indeed, public support to R&D, typically in the form of tax relief or direct subsidies, has been traditionally justified in terms of spillovers: if the social returns are larger than the private ones, there remains the possibility that the market underinvests in R&D compared to the social optimum. Furthermore, as noted above, private R&D may tend to be excessively volatile, again from the social optimal point of view, which motivates increasing public support to R&D in bad times to smooth investment over the cycle.

Figure 1.13: R&D intensity and specialization

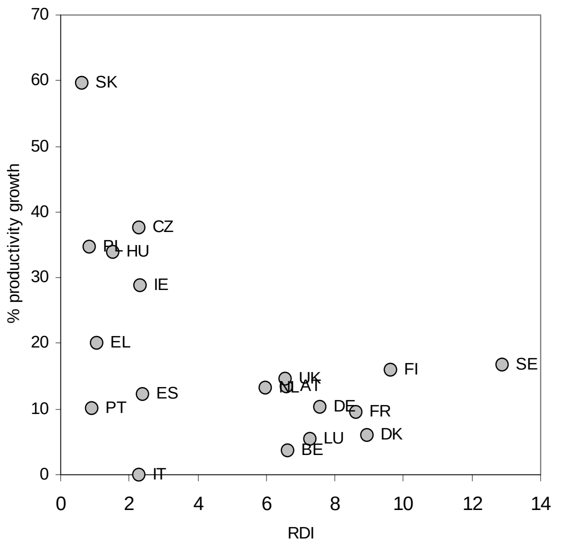


Note: The indicator of sectoral specialisation compares the share of a given sector in one country with the share of the same sector in the EU as a whole. The country index of specialization is the Euclidean distance to the EU average. Hence, more diversified economies have smaller indexes of specialization.

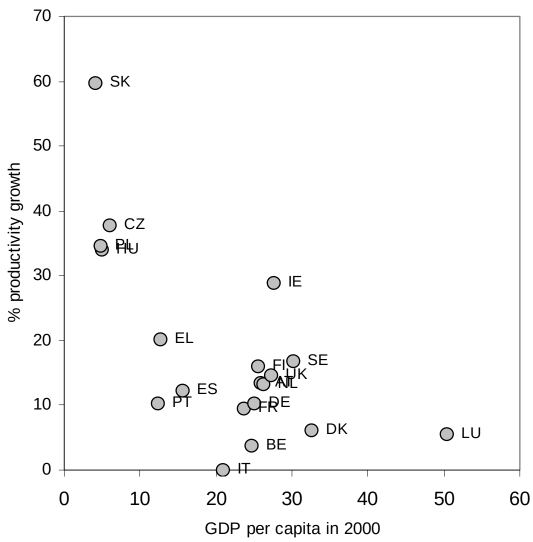
Source: Specialization index: *EU Industrial Structure 2011*. RDI: OECD, STAN database for structural analysis and STAN indicators 2009, own calculations.

Finally, the variability across Member States can be seen either as room for improvement in those regions with less R&D intensity or as reflecting a natural process of regional specialization. The second interpretation seems reinforced in regard of the similar variability observed across US states. This means that the traditional support to R&D may help cover the gap between private and social returns to R&D but may not help close the gap across regions. Indeed, regions with lower intensity are not necessarily regions where individual firms invest less in R&D because similar firms (in terms of size, sector, turnover, etc.) tend to be similar as well as regards R&D intensity (see again Moncada (2010)). Hence, aggregate differences seem to respond to the less frequent observation of R&D intensive firms. More intriguing is the fact that differences in R&D intensity are not translated into differences in trend growth rates. Indeed, despite large differences in R&D intensities, in the longer term countries tend to grow on average at similar rates. The role of technology adoption and trade in technical change diffusion may be the key explanation for this apparent paradox (see, e.g., Guellec and van Pottelsberghe (2001)). To illustrate this, consider the last decade in Europe: in Figure 1.14(a) we can see that there is a connection between R&D expenditures and productivity growth; however, the catch-up process of the EU-12 Member States is a far stronger driver of technical change.

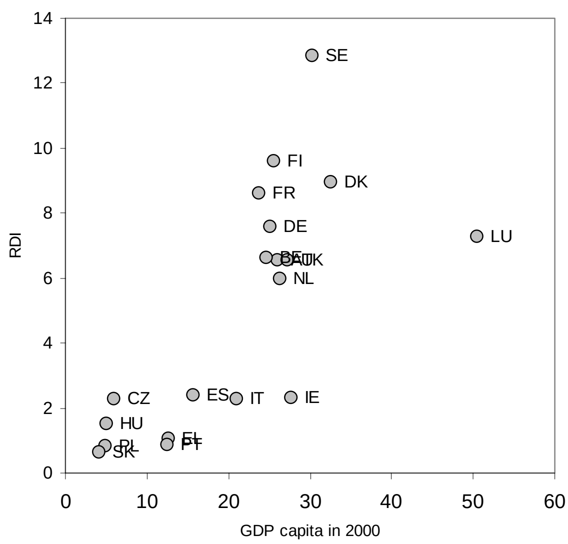
Figure 1.14: RDI, productivity growth and catch-up



(a)



(b)



(c)

Note: Variables are average RDI (over value added) in 2000-05, percentage growth of GDP per hour worked in 2000-10, and GDP per capital in Euros in 2000. A simple regression of productivity against RDI and the level of income at the beginning of the period (and its square) yields the estimates 0.80 (0.79), -2.53 (-3.34) and 0.03 (2.48) where the number in parenthesis is the t-statistic (and the adjusted R-square is 0.53).

Source: AMECO database, European Commission, for productivity; OECD, STAN indicators 2009, for RDI.

These pieces of evidence together indicate that besides the importance of traditional R&D activities, there are other important sources of innovation. The EU Industrial R&D Scoreboard points out that the EU has fewer young innovative firms than the US; and that these young firms, on average, invest less in R&D than their US counterparts. This suggests that part of the observed differences in R&D intensity may lie in differences in the creation of firms, the intensity of start-ups, the growth and the survival of these firms.[17] Hence, besides the traditional support to R&D in incumbent firms, other policy instruments could focus in supporting the creation and survival of innovative firms, be it entirely new establishments or spin-offs from universities or corporations.

All these facts together suggest that an important fraction of innovations are vague ideas difficult to transmit or codify, and hence posing two problems: they make it difficult to finance by nature[18] and difficult to protect by patents or other means of intellectual protection. Indeed, their ambiguity is connected with its incodificability, difficult to turn into a patent. The only alternative is "do it yourself" and be the first mover creating the firm. In such case, *entrepreneurs* turn out to be key innovators bringing new ideas to the market in the form of start-ups. But then the key issue when it comes to these innovators turns out to be framework conditions and, in particular, the easy to do business. Add the evidence mentioned above about the lower R&D intensity of young innovators, and the support to start-ups appears as a potentially effective policy target.

The protection of these innovators requires as well the fine-tuning of intellectual property rights (IPR). The importance of the protection and promotion of IPR is obvious. IPR is necessary to protect creators of new industrial ideas (patents), artists and media (copyrights) or the reputation of a company (trademarks). Nevertheless, in this field more in not necessarily better: an excessive protection can hamper the creation, development and commercialization of new ideas. For instance, the European Commission advocates the monitoring of competition services to prevent "the abuse of IPR which can hamper innovation or exclude new entrants, and specially SMEs, from markets."[19] For example, an excessive protection may seriously distort incentives and use patents as an offensive device. In a world in which physical capital and other inalienable assets are less important, patents seem to be one of the main assets behind a company's value (Kaplan et al. (2005)). This has the potential to distort the market in two ways. On one hand, firm managers have an incentive to patent in excess to reduce competition[20] and increase the value of the firm in the short-term. On the other hand, and for the same reasons, managers have incentives to buy out other firms just to take control of their patent portfolio to hamper the development of outside new ideas that may harm their business model and to increase the price of shares in the stock exchange.[21] Finally, another possibility, at least in theory, pointed out in Aghion et al. (2008) is that we "privatize" research lines sooner than it would be optimal from the social point of view in two senses: too expensive and preventing potential ideas to arise because the kind speculative research that gives origin to many breakthroughs is typically not pursued in private sector, much more focus on the development of commercial applications.

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17 See the discussion in box I.5.3 in the Innovation Union Competitiveness Report 2011.

18 The key feature of Phelps' (2006) attempt theory of innovation and growth is the (uninsurable) uncertainty (as opposed to insurable risk) inherent to any entrepreneurial project. A critical step is that of obtaining finance when facing uncertainty rather than risk, and hence the importance of "intuition" and of long-term relationships between entrepreneurs and financiers.

19 European Commission communication "A Single Market for Intellectual Property Rights. Boosting creativity and innovation to provide economic growth, high quality jobs and first class products and services in Europe," COM (2011) 287.

20 A case in point is that of "patent clusters" in the pharma industry. An "important objective of this approach [patent clusters] is to delay or block the market entry of generic medicines"; excerpted from the European Commission communication summarizing the "Pharmaceutical Sector Inquiry Report."

21 In a move to purchase Nortel's patent portfolio, Google's declared intention was to be "[b]ulking up on its patent holdings [to have] a stronger defence against such attacks [lawsuits over the software]." See "Google bids $900m for Nortel patents," Financial Times, 4 April 2011. Nortel was finally purchased by a consortium for $3500m. See the software patent debate in en.wikipedia.org/wiki/Software_patent_debate. In the EU software patents were rejected by the European Parliament in 2005.

Public support to R&D is a key element of any broad innovation policy. If anything, the evidence reviewed above calls for a careful choice of the targets. For instance, there is evidence that public support to private R&D is more effective in small firms, probably because they are more likely to be credit-constraint.[22] Support to small enterprises is even more important in times of crisis because small liquidity-constraint firms tend to cut expenditures in activities like R&D that have non-immediate returns (see section 1.4 in the ECR 2009 and references therein). Furthermore, in light of the discussion above, focusing on start-ups and young innovative firms may prove to be a more effective way of fostering innovation. Recent examples following this logic is the new focus of the Canadian NSERC on small firms partnering with scientists or the focus of the Western Sweden region on a "systemic vision of innovation" that favours "initiatives targeting public bodies and research institutions" where private firms are not the main target. [23] Finally, an important aspect of innovation is education: if R&D represents the demand for high-skilled labor, support to higher education should guarantee that the supply-side meets the demand from businesses. Conte et al. (2009) present evidence that the efficiency of policies supporting R&D relies in related education policies.[24] In that respect it may be worth noting that the EU spends significantly less than the US in higher education: 1.1% of GDP versus 2.9% respectively; increasing support to R&D without education may risk distorting the market for scientists and engineers.[25]

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22 Exploiting data from an interesting natural experiment, Bronzini and Iachini (2011) conclude that R&D subsidies do not change the investment behaviour of large firms, who receive the subsidy as a windfall gain, but they find a positive effect for smaller firms, the interpretation being that these are more likely liquidity- and credit-constrained.

23 In the Canadian case, the president of the NSERC stated "Big firms like Bombardier or Research In Motion can afford to take the long view. But small companies are at a demanding stage of their growth," quoted in Monocle, February 2011, page 87. For the Swedish example, see Riché (2011).

24 It should not be regarded as a mere coincidence that those factors are also those signaled by Caselli and Coleman (2001) as being determinants explaining the adoption of IT.

25 Goolsbee (1998) finds evidence that public expenditures in R&D harm private R&D by raising the wages of scientists and engineers, at least in the short run and because of the low elasticity of the supply of high-skilled labour.

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2. CONVERGENCE OF KNOWLEDGE INTENSIVE SECTORS AND THE EU'S EXTERNAL COMPETITIVENESS

2.1. Introduction

The share of knowledge-intensive services and products in the total demand and production of both advanced and also less advanced or emerging economies has steadily increased over time. This is documented in a large number of publications studying 'tertiarisation' (e.g. Peneder et al. 2003, Montresor and Marzetti, 2010), especially emphasising the role of knowledge-intensive services. Though the rising share of services along with a declining share of manufacturing is undisputed, some studies raise questions about future developments. Pender et al. (2003), for example, use the term 'quaternisation' stressing the role of knowledge-intensive services and their steadily rising importance as sources of innovation and technology and as inputs. As there are still large cross-country differences in this process, however, it is still too early to conclude that 'quaternisation' has yet manifested itself in the majority of advanced countries.

The study presented here analyses the roles of knowledge-intensive business services (KIBS) over the more recent period and covers a larger set of countries compared to the studies mentioned above. It stresses the role of the service output of manufacturing firms, a phenomenon, also termed a 'convergence process', which so far has not received so much attention in the literature. Knowledge-intensive service firms are increasingly developing new services as a part of a product package that includes physical, tangible goods. Firms developing new products also offer additional services as part of a package including both the physical product and the services (see Monti, 2010). For example, high-tech products are often sold in combination with maintenance services.

These developments give rise to technology and product flows between the services and manufacturing sectors, which deepen inter-industry linkages. The study also analyses the role of knowledge-intensive business services (KIBS) in generating embodied knowledge flows and linkages between KIBS and manufacturing sectors. This underpins the further growing evidence in the literature that services have been playing an increasing role in boosting the productivity of manufacturing sectors (e.g. Arnold, Javorcik and Mattoo, 2006, and Javorcik, 2004).

Finally, the analyses in this chapter document that the share of such products in total world trade has been steadily increasing over time as well. Simultaneously, technology flows within and between different firms and industries seem to have become more important. Due to more intensive international economic integration, these technology flows have also increased between different parts of the world as firms outsource and choose to locate parts of their production in locations according to comparative advantages. These trends have led to changes in industrial structure worldwide.

As the *definition of KIBS* is still not standard across the literature, one can find various attempts to describe the term (e.g. den Hertog, 2000; Bettencourt et al., 2002). On the other hand, the classification often follows the NACE classification system, covering the sectors 'computer and related activities' (NACE 72), 'research and development' (73), and 'other business services' (NACE 74). However, whether the sub-sectors of 'other business services' are included or not is again not uniform across studies (compare e.g. Muller and Doloreux, 2007; European Commission, 2009).

Based on this background the study addresses the following issues:

- To which extent have services become more important over time and how does Europe differ from other major economies like the US and Japan in this respect? Therein is the specific role of knowledge intensive business services (KIBS) addressed.

- How important are the direct and indirect flows of knowledge between KIBS and manufacturing industries? How have these developed over time and are there important differences across countries and in relation to the US and Japan in particular?

- To which extent is there a tendency towards an increase in the share of services in the output of manufacturing industries and firms? How does this relate to firms performance and innovation?

- Finally, the study focuses on the importance of trade in knowledge intensive manufacturing and services (overall and KIBS in particular) regarding the competitiveness of the EU with respect to trade in services in general and trade in knowledge intensive business services in particular.

2.2. The rising importance of service sectors in the economy. A comparison of the EU with the US and Japan

2.2.1. Introduction

Services industries have grown in importance over the last decades both in terms of output and employment. Within services, KIBS play an important role and have been the main source of job creation in Europe in the last decade and also contributed substantially to value added growth as pointed out in the literature (see e.g. European Commission, 2009).

This section provides a comparative overview of the relevance and trends in these service activities across countries and over time. Major advanced non-EU countries (in particular the US and Japan) are also included in the cross-country comparison. The analysis is mainly based on the EU KLEMS dataset. This section will in particular address the following points:

- What is the role of service activities and output in Europe, the US and Japan and what are the trends over time? Specifically, the question whether there has been some kind of convergence process in structures across countries is addressed.

- Additional information on the role of services can be derived from the EU KLEMS data set. In particular, the importance of services in value added growth across countries is discussed.

- The use of input-output tables further allows for analysis of the importance of KIBS industries as inputs in the production process of manufacturing industries. This will be addressed in this section as well in a descriptive manner providing also information on linkage indicators between industries.

2.2.2. KIBS services and classification

Stehrer et al. (2011) show in the background study that the share of services in general increased in all countries considered over a long period of time. The aim of this section is to look more closely at a particular part of services, the knowledge intensive business services as defined above. Specifically the focus is on the NACE rev. 1.1 categories computer and related activities (72), research and development (73) and other business activities (74). In this overview which is based on the EU KLEMS data, also the industry renting of machinery and equipment (NACE rev. 1.1 71) is included since it is not separable from the other industries for all countries in the database. For the comparison across countries the limited data therefore only allows for the use of the category 71t74. Table 2.1 provides the respective shares of value added and employment in the total economy.

Table 2.1: Share of KIBS (incl. 71) in total economy (in %), 1975-2007

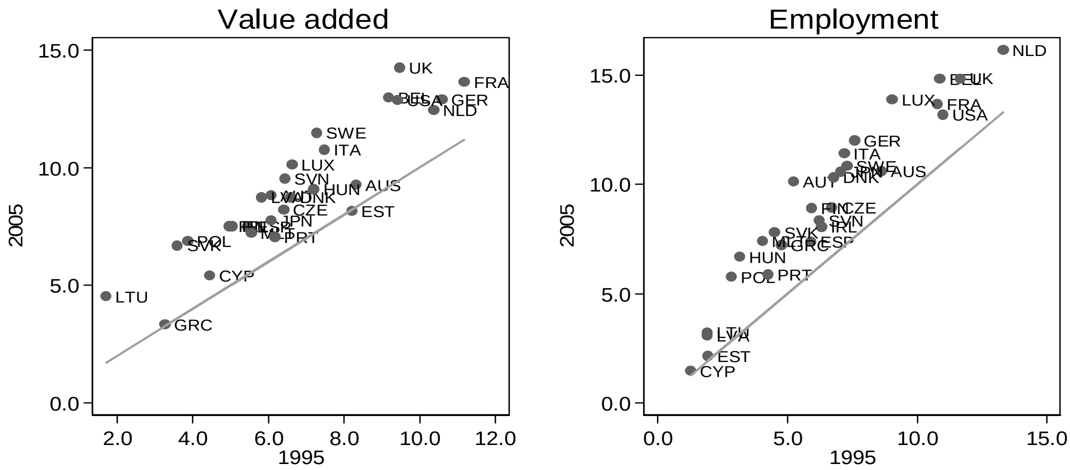
		1975	1985	1995	2005	2006	2007
Value added	EU-25			8.3	11.0	11.1	11.4
	EU-15	4.7	6.7	8.7	11.5	11.7	12.0
	EU-10			4.4	5.9	6.1	
	USA		7.2	9.4	12.9	13.0	13.3
	JPN	2.3	4.3	6.1	7.7	7.8	
Employment	EU-25			7.8	11.1	11.4	11.7
	EU-15	4.0	5.6	8.6	11.9	12.2	12.6
	EU-10			3.7	6.3	6.6	
	USA		8.2	11.0	13.2	13.4	13.5
	JPN	2.9	4.9	7.1	10.6	10.9	

Source: EU KLEMS, Release 2009, own calculations.

The value added share of KIBS increased by about 7 percentage points in the EU-15 from 4.7 to 12% between 1995 and 2007. In relative terms the increase was even larger in Japan, from 2.3 to 8%. The value added share of KIBS in the US was slightly larger in 1985 compared to the EU-15 (7.2 compared to 6.7%). However the share increased faster in the US to 13.3% in 2007, thus 2 percentage points above the share in the EU-15. The value added share of KIBS in the EU-10 was only 6% in 2006, starting from a share of 4.4% in 1995. The figures are similar for employment patterns as well, with Japan showing a stronger increase, reaching about 11% in 2006. Employment shares in the US are about 2 percentage points above those found for the EU-15. Again the share for the EU-10 is well below that for the EU-15.[26]

[26] Since the database does not contain data which separates data for the industry renting of machinery and equipment (NACE Rev. 1.1 71), also this industry is included in the definition of KIBS in Figure 2.1.

Figure 2.1: KIBS shares in total economy (in %), 1995 and 2005



Source: EU KLEMS, Release 2009, own calculations.

The divergence, w.r.t. to the size of KIBS shares, was driven by some countries at the upper end of the distribution like UK, France, Germany and the Netherlands whereas for the other countries the shares increased less, cf. Figure 2.1, which shows the share of KIBS in the total economy. This is even more evident when for employment shares in which case also productivity developments play a particular role especially for the countries at the lower end which are mostly EU-10 countries. A possible explanation behind this pattern is the relatively lower labour productivity growth rates in KIBS which imply increasing employment shares for this sector. This is slightly different from the pattern emerging from the shares of KIBS in business services. Disregarding Cyprus and Estonia, employment shares increased more in those countries with lower shares in 1995 which again are the EU-10 countries. There is some divergence of value added with the countries at the upper part gaining shares in relative terms though the picture looks more diverse when considering some outlying countries like Lithuania, Slovak Republic and Estonia.

2.2.3. KIBS contributions to growth

This section discusses the contribution of the KIBS industries to overall value added growth. The contribution of a sector can be calculated by multiplying the respective growth rates of value added in constant prices (1995 prices were used) with the share of the sector's in the economy (the average shares for the time period considered were used). The results for the groups of countries considered are provided in Table 2.2.

Table 2.2: Growth contributions of KIBS, 1975-2007

	1975-1985		1986-1995		1996-2007	
	Share	Contribution to growth	Share	Contribution to growth	Share	Contribution to growth
EU-25					9.5	16.8
EU-15	6.4	12.8	8.1	14.9	10.0	18.2
EU-10					5.0	7.6
USA	6.8	14.5	8.9	16.0	11.1	21.9
JPN	4.1	7.1	5.2	8.5	7.7	27.6

Source: EU KLEMS, Release 2009, own calculations.

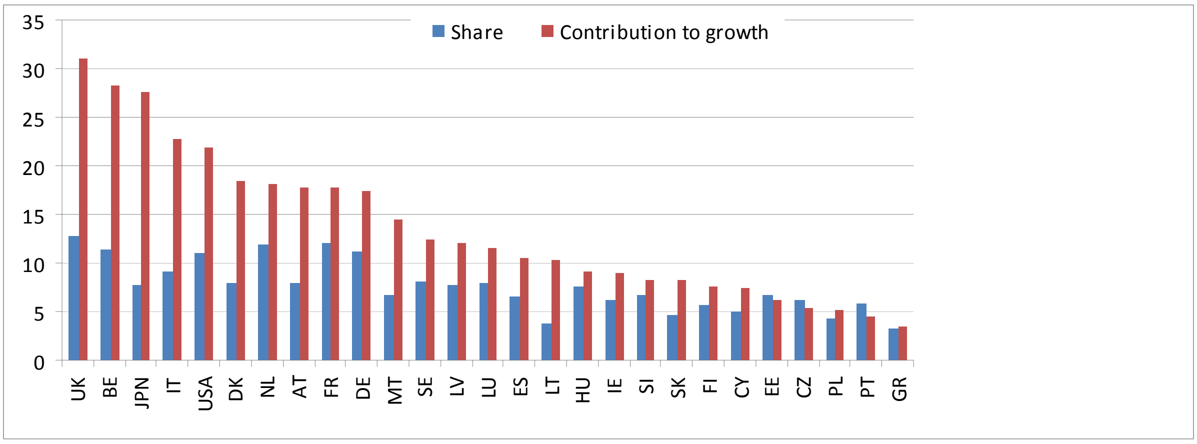
First, the contribution to growth of the KIBS in all periods was much larger than its share in value added at constant prices. In the EU-15 the average share over 1975-1985 was 6.4%

whereas the contribution to growth was 12.8%. Over the period 1995-2007 the share of KIBS sectors in value added at constant prices was 10% whereas the contribution to growth was 18.2%. Thus, though the KIBS industries account for about a tenth of value added the contribution to growth accounts for about one fifth. This can be contrasted with the USA where the contribution to growth was almost 22% with an average share of 11%, not much larger than the one in the EU-15. Over time, the contribution to growth was relatively larger in the USA compared to the EU-15. The opposite is true for Japan where the contribution to growth was relatively low with 7.1 and 8.5% in the first two periods, respectively. Only in the last period 1995-2007 the contribution peaked to 27.6%. The EU-10 countries are again exceptional in the way that on top of the relatively low share of KIBS the contribution to growth was also relatively low with 7.6% only. The relatively low shares of KIBS and their contribution to growth in the EU-10, can at least partly be explained by restructuring of the economies that have taken place in many of these countries following the transformation to market economies and later integration into the EU. The industrial structure in the EU-10 had and has in comparison a relatively lower share of market services, including KIBS, and a relatively larger share of manufacturing industries. With a relatively lower share of high-tech in manufacturing and a lower share of skilled labour, the potential for using KIBS is lower.

The end of the time period is studied in more detail across countries below. Figure 2.2 presents the average share of KIBS and the contribution to growth for the EU-25 countries plus USA and Japan.

First, the overall shares of KIBS vary from about 13% in the UK, Netherlands and France to less than 5% in Greece, Portugal, and Poland. However, the contribution to value added growth in all countries with the exception of Estonia, Czech Republic and Portugal are larger than this share would suggest. The contribution of KIBS to growth was much larger than the shares of KIBS in the UK, Belgium, Japan, Italy, and Austria. The ratios of the contributions to growth and the shares of KIBS were much lower for Hungary, Ireland, Slovenia, Cyprus, Finland, Estonia, Czech Republic, Poland, Portugal and Greece. This could be explained by the fact that manufacturing, and other sectors, which occupy larger shares in most of the latter countries than KIBS, have displayed stronger growth. The catching-up effects of manufacturing have been larger thus limiting the role of KIBS in overall growth.

Figure 2.2 - Contributions to growth by country, 1995-2007



Source: EU KLEMS, Release 2009, own calculations.

2.2.4. *The role of KIBS as an intermediate input in the EU, US and Japan*

Services and KIBS in particular play an important and growing role as inputs into manufacturing processes. The focus in this section is on this important aspect of KIBS. For this purpose, the role of KIBS as intermediate inputs in the EU is examined compared to that in the US and Japan. 'Knowledge-intensive services' can be described by their knowledge-intensity, relative capital intensity and high degree of specialisation (European Commission, 2009, p.19). Business services again cover a wide range of services, which serve as intermediate inputs in value chains of companies. They often complement or substitute in-house service functions of their clients. In this function, they contribute to the competitiveness of companies, stemming from quality and innovation gains coming from the interaction between suppliers and clients (European Commission, 2009, p.15). The questions to be addressed are whether the EU-countries use more or less KIBS in their economy compared to the US and Japan as inputs in other sectors? It is further interesting to study how do KIBS shares vary for the total economy, for manufacturing and for high-tech sectors.

Input-output tables are used to analyse the importance of KIBS sectors as inputs in the total economy and the manufacturing sector in particular. Input-output data are an appropriate tool for investigating inter-industrial relationships and the composition of supply and use of goods and services. The OECD Stan Input-Output database-2009 edition covering 21 EU countries, the US and Japan is used.[27] The database supplies symmetric industry-by-industry input output tables for the whole economy, for the domestic economy and for imports. The shares of KIBS in total intermediate inputs, in manufacturing and in certain high-tech manufacturing sectors for the years 1995, 2000 and 2005 are calculated. Data are provided only at the 2-digit ISIC rev. 3 (which is compatible to NACE rev.1) level. The following activities are subsumed under the term 'knowledge-intensive business services: computer and related activities (72), research and development (73) and other business services (74).

KIBS are important intermediate inputs for the total economy (see Figure 2.4.1a): In 2005, KIBS accounted for almost 15% of total intermediate consumption in the EU-15, but only 9% in the EU-6.[28] In Japan, this share was about 12%, while in the US it reached 14% in that year – slightly below the EU-15 share. Development trends differed between Japan and the other countries over the last 10-years: While in Japan the share increased substantially between 1995 and 2000 (though this might be due to a methodological change) and fell again until 2005 according to the data, in the EU and US shares increased continuously. However, the share expanded slightly more in the US than in the EU-15. There is however a substantial differentiation across EU economies which is documented in detail in the background study (Stehrer et al., 2011).

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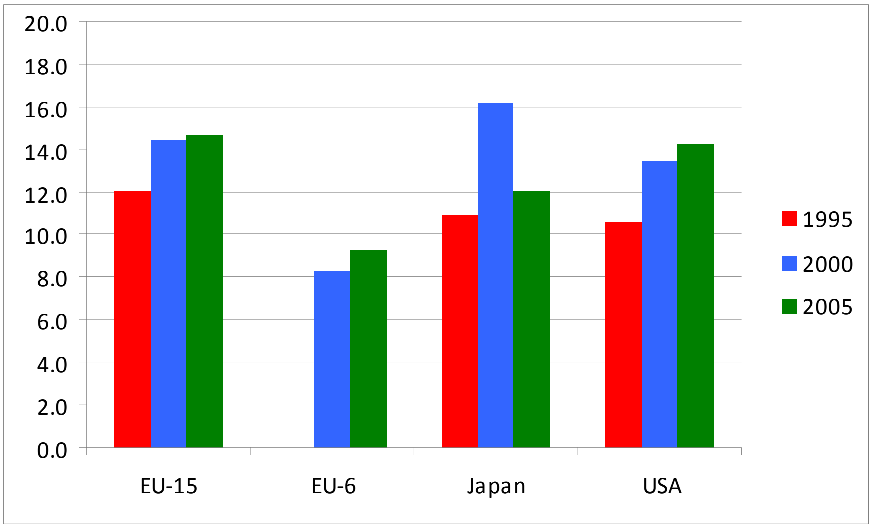
[27] The 21 EU countries are EU-15 plus Czech Republic, Estonia, Hungary, Poland, Slovakia and Slovenia.

[28] The EU-6 is here defined as Czech Republic, Estonia, Hungary, Poland, Slovakia and Slovenia. This definition, or aggregation of countries, is only used for illustrating the share of KIBS in intermediate consumption.

Figure 2.3.a: Share of KIBS in total intermediate consumption

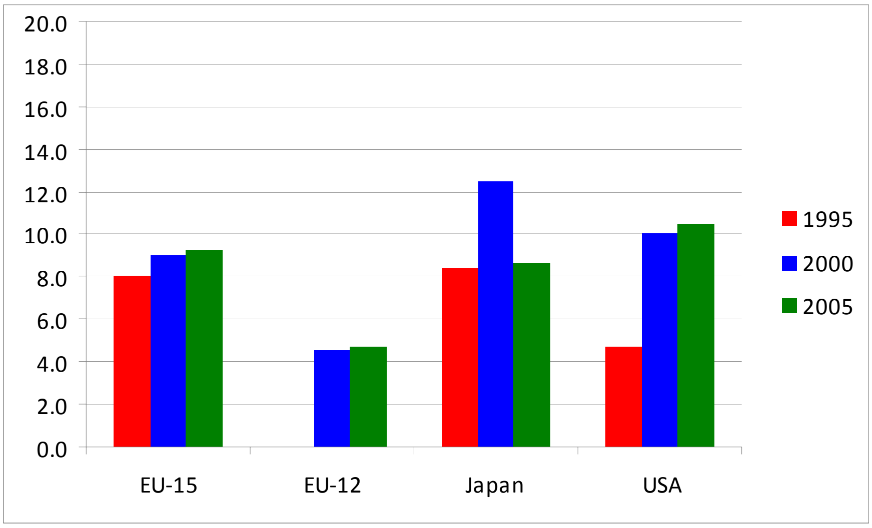


Source: OECD Input-Output tables.

Also when only looking at the manufacturing sector, KIBS prove to be important inputs: In 2005, the share of KIBS used by manufacturing industries amounted to 9% in the EU-15, 5% in the EU-6, roughly 9% in Japan and 10.5% in the US, in this case above the EU-15 level. Development trends between 1995 and 2005 resembled those in the total economy: In Japan, the share of KIBS first increased but then fell again, while in the EU-15, the EU-6 and the US shares increased during the whole period, with the US experiencing a sharp rise between 1995 and 2005 (see Figure 2.3b). The large increase of KIBS in the US in intermediate consumption has come around without any significant changes of industry structure. Earlier and more intensive outsourcing of certain activities by the US manufacturing industry compared to the EU and Japanese manufacturing industries could explain this pattern.[29]

[29] Even though not explicitly investigating this, the findings of Kakabadse, A. & Kakabadse, N. (2002) imply that American firms' outsourcing strategies are more advanced than European firms due to for example more experience.

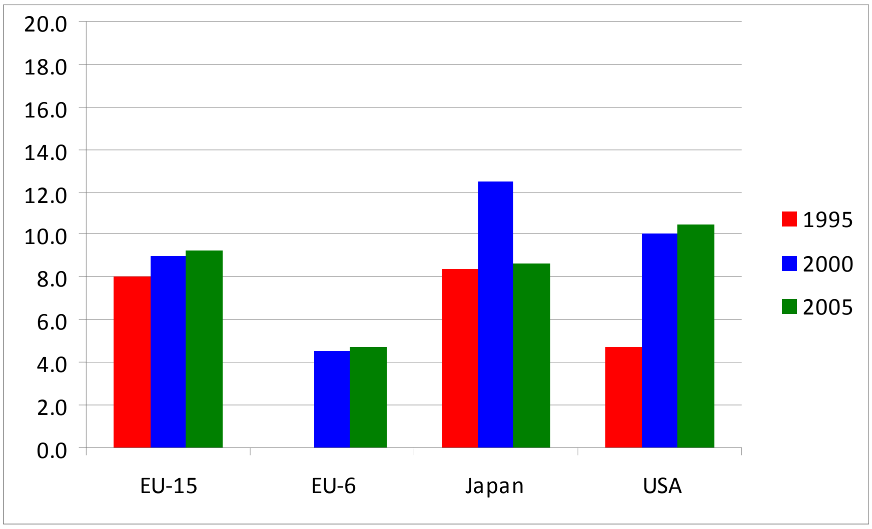
Figure 2.3.b: Share of KIBS in manufacturing intermediate consumption



Source: OECD Input-Output tables.

Knowledge-intensive business services play a significant role especially in the input structure of high-tech manufacturing industries, under which NACE rev.1 categories 30-33 (including office machinery, electrical machinery, communication equipment and medical & optical instruments) are subsumed. Indeed, these industries use a larger share of KIBS than manufacturing on average: In the EU-15, KIBS accounted for 14% of all intermediates in high-tech industries, compared to only 5% in the EU-6. However, this share was even larger in Japan and the US with about 16%. Trends between 1995 and 2005 were largely the same as in manufacturing; however, the share in the EU-6 countries slightly decreased between 2000 and 2005 due to an increased share of industries which used relatively less of KIBS' products for intermediate consumption (see Figure 2.3c).

Figure 2.3.c: Share of KIBS in high-tech manufacturing (NACE 30-33) intermediate consumption



Source: OECD Input-Output tables.

Overall, when comparing the KIBS usage between the EU-average and the US, it is about the same in the total economy, slightly less in manufacturing and somewhat lower in high-tech industries. When compared to Japan, KIBS usage is higher in the EU in the total economy, about the same in manufacturing and somewhat lower in high-tech industries in which Japan is more specialised. What is more striking than differences between these three countries/regions are distinct differences within Europe: The difference between EU-15 and EU-6 is pronounced and takes about 5 percentage points difference in the share of KIBS in total intermediates and in manufacturing intermediates and almost 9% in high-tech industries' intermediates. While this difference between the EU-15 and the EU-6 seems to have become somewhat smaller for the use of KIBS in the total economy between 2000 and 2005 or at least remained the same in manufacturing, the difference increased in high-tech manufacturing where the EU-15 is more specialised in than the EU-6.

2.3. Embodied and sectoral linkages between Manufacturing and the Knowledge-intensive services

2.3.1. Introduction

The analyses in this section concern direct and indirect flows of knowledge between the manufacturing industries and knowledge-intensive business services (KIBS). Flows of knowledge between these two sectors represent a bilateral learning process or what might be called a coproduction of capabilities. KIBS often facilitates the innovation process in the manufacturing industries and they have considerable potential in creating new knowledge and transforming firms into learning organisations (Hauknes, 1998). Statistical evidence, particularly from input-output tables, shows that global technological and organisational capacity is a function of its use of software and other business services.

While manufacturing appears to be an engine of productivity growth, this growth depends to a great extent on services in general and KIBS in particular. Kaldor (1966) and later Cornwall (1977) suggested that manufacturing is the main source of new technical knowledge and that this knowledge diffuses from there into other sectors, including the service sector. This argument presumes that the backward and forward linkage effects from manufacturing to services are strong. Hauknes (1998) and Fagerberg and Verspagen (2002), however, suggest that manufacturing may no longer be the 'engine of growth' and that services have become much more important. This argument would imply that the direction of the linkage between manufacturing and services is the other way around. This chapter shows that the interlinkages go both ways and are tending to become stronger, which suggests that the distinction between manufacturing and services is becoming less relevant.

2.3.2. Inter-industry technology flows

Input-output analysis provides a way to measure the interdependence of the manufacturing industries and the service sector (Miller and Blair, 2009). By combining business expenditures on R&D activity with input-output tables, it is possible to measure inter-industry technology flows and linkages. It should be noted that public sector expenditures on R%D allocated directly or indirectly to the business sector are not included. This might give rise to a bias in the analyses below. Some sectors may be more likely to receive public funding than others and some countries may be more prone to use public R%D expenditures to promote the private sector.

Having this reservation in mind, this section makes use of the OECD Input-Output and ANBERD Databases to measure the total R&D content of an industry and the embodied flows between manufacturing and KIBS. The analysis covers twenty-two Member States of the

European Union plus Norway, the United States, Canada, Japan, Korea and China during the year 2005 (see Stehrer et al., 2011, for details).

Product-embodied knowledge resides in intermediate inputs that originate from both domestic and foreign sources, and can flow both directly and indirectly through the production of all other commodities. The total technology intensity therefore contains five components:

(1) 1sectoral (own) R&D;

(2) direct R&D flows from all other domestic sectors into any recipient industry;

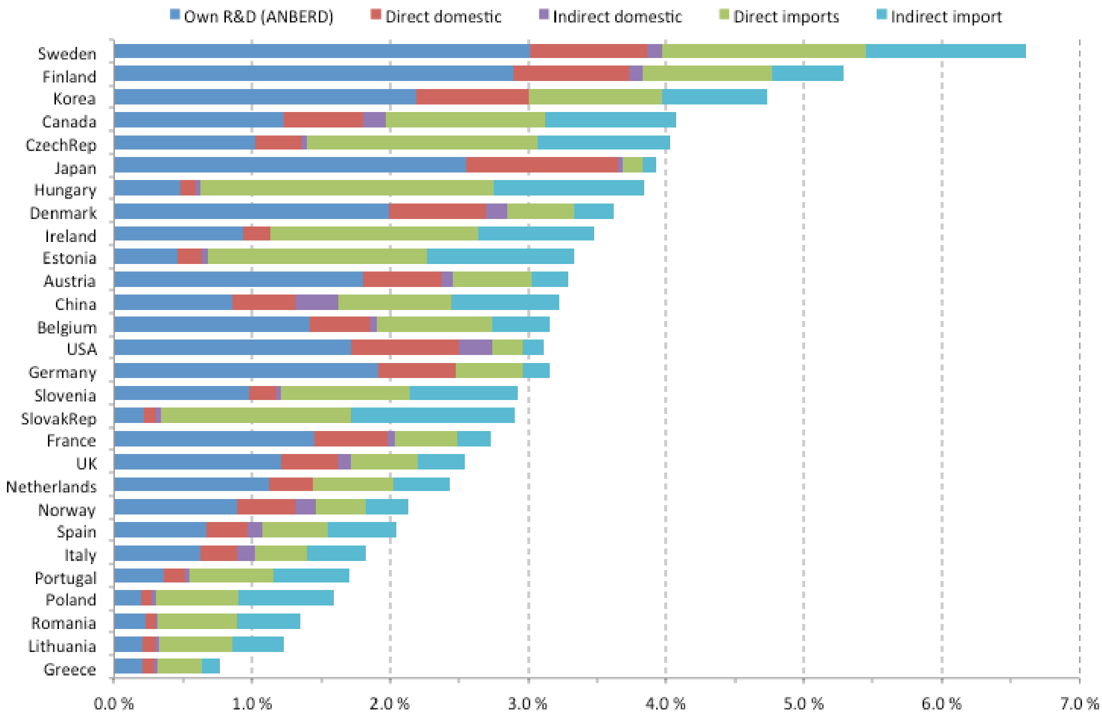
(3) indirect R&D flows from domestic sectors into a recipient industry via one or more intermediate sectors;

(4) direct R&D flows from foreign sectors into any recipient industry; and

(5) indirect R&D flows from international sectors.

Figure 2.4 ranks countries according to total business technology intensity and shows that the share of own R&D activity of business enterprises is about one-half of the total business R&D content in countries with a relatively high level of GDP per capita and below this share in countries with lower level of income.[30]

Figure 2.4: Technology intensity relative to total value added by source, 2005



Source: OECD Input-Output tables. ANBERD. Eurostat Input-output tables for Lithuania.

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30 Papaconstantinou et al. (1998), Knell (2008) and Hauknes and Knell (2009) confirm these findings. The background paper to this chapter provides an outline of the simple mathematics behind this analysis.

The direct R&D flows from all other domestic source sectors into any recipient industry are positively (and highly) correlated with R&D performed within an industry.[31] Countries with a high share of R&D activity performed within the sector are generally considered to be knowledge creators. Hence, the strong correlation indicates that major knowledge creating sectors are also the major users of knowledge generated in other sectors in the domestic economy. Sectors with weak R&D performance, and hence weak knowledge creation, are also small users of knowledge from other sectors. Rather than suggesting that these sectors are 'knowledge poor', it is likely that this is caused by the more frequent use of non-R&D based competences, skills and knowledge in these industries. More than 60% of the total technology intensity in Japan and Germany has its origin in the own R&D performance of the industry, and Denmark, USA, Austria, Finland and France depend on own R&D performance for more than half its technical knowledge. Countries with a low share of R&D activity performed within the sector are generally considered to be knowledge users. Estonia, Hungary, Lithuania, Poland, Romania and Slovakia depend on knowledge embodied in inter-industry trade for more than 80% of the total technology intensity, whereas Japan and the USA relied on imported knowledge for only 6% and 12% of total knowledge inputs, respectively. The size of the country also matters as to whether the embodied technology comes from domestic or international sources. Germany, Japan and the USA depend more on domestic flows of embodied knowledge, whereas Ireland, Estonia and Slovenia depend more on international flows. In general, smaller countries depend more on international sources of knowledge than larger ones. Countries where assembly production looms high in the national economic structure, such as most of the east European countries and Ireland, have a very high share of knowledge sourced from abroad. Finally, differences in the industrial structure and in the way each country create and use technical knowledge can also be an important factor behind the observed patterns. Countries with a relatively higher share of knowledge-intensive industries are more prone to perform their own R&D than countries where the knowledge-intensive industries occupy smaller shares.

In manufacturing, imported knowledge flows from other manufacturing and KIBS constitute the largest share of knowledge flows (direct and indirect domestic and imported) in every country, except in the USA and Japan.[32] For most countries the main source of imported knowledge inputs comes from foreign manufacturing sectors, except for Ireland, where the imports of KIBS to intermediate use in manufacturing are more important. There are vast differences across the countries, which are explained by differences in the way knowledge is generated in other manufacturing industries and sourced abroad. Three observations are made in this sector. First, the level of development is important in manufacturing. With the possible exception of Ireland, the manufacturing technology multiplier is highly correlated to GDP per capita, with low income countries having a very large multiplier and the high income countries having a very low multiplier. Second, relatively little knowledge appears to flow from the KIBS sector, whether domestic or foreign, to the manufacturing industries, except in Ireland where there appears to be a significant flow from abroad. Third, size also determines whether the embodied technology comes from domestic or international sources. Domestic sources appear dominantly important in Japan and the United States. In all other countries imported flows dominate over domestic flows, though domestic flows are more important in China than in other countries. International sources of knowledge into the manufacturing industries are much more important for the new Member States, along with Portugal and Greece.

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31 Across the 28 countries the correlation coefficient between the two components is as high as about 0.87.

32 This is documented in detail in the background study (Stehrer et al., 2011).

In KIBS, imported knowledge inputs to KIBS dominate over technology flows from other domestic sectors in almost every country. Estonia, Slovakia, Romania and Ireland are almost completely dominated by imported knowledge inputs. Imports from manufacturing and KIBS abroad are the largest source of knowledge inputs for most countries. EU-12 Member States depend heavily on manufacturing knowledge imported from abroad in this sector. The KIBS sector in China not only depends on imported knowledge from manufacturing, but also domestic knowledge from the sector. Ireland and Sweden, and perhaps Belgium and the Netherlands appear different in that they depend relatively more on knowledge imported through the KIBS sectors.

2.3.3. Backward and forward linkages between manufacturing and KIBS

This section focuses on the strength of the linkages from manufacturing sectors to domestic KIBS sectors and from KIBS sectors to domestic manufacturing sectors, which Rasmussen (1956) described as backward and forward linkages[33]. Flows within the domestic economy are thus distinguished from total flows including technology flows from foreign sources. However, Rasmussen's forward and backward linkage measures do not adequately take into account the industry-to-industry interaction within technology flows, as this may lead to double accounting (Hauknes and Knell, 2009)[34]. The backward linkages used here are the intersectoral technology flows as a share of technology flows into the recipient sector, while the forward linkages are the intersectoral technology flows as a share of total technology flows out of the source sector. These measures are constructed for domestic and total flows, where total flows are the sum of domestic and import flows.

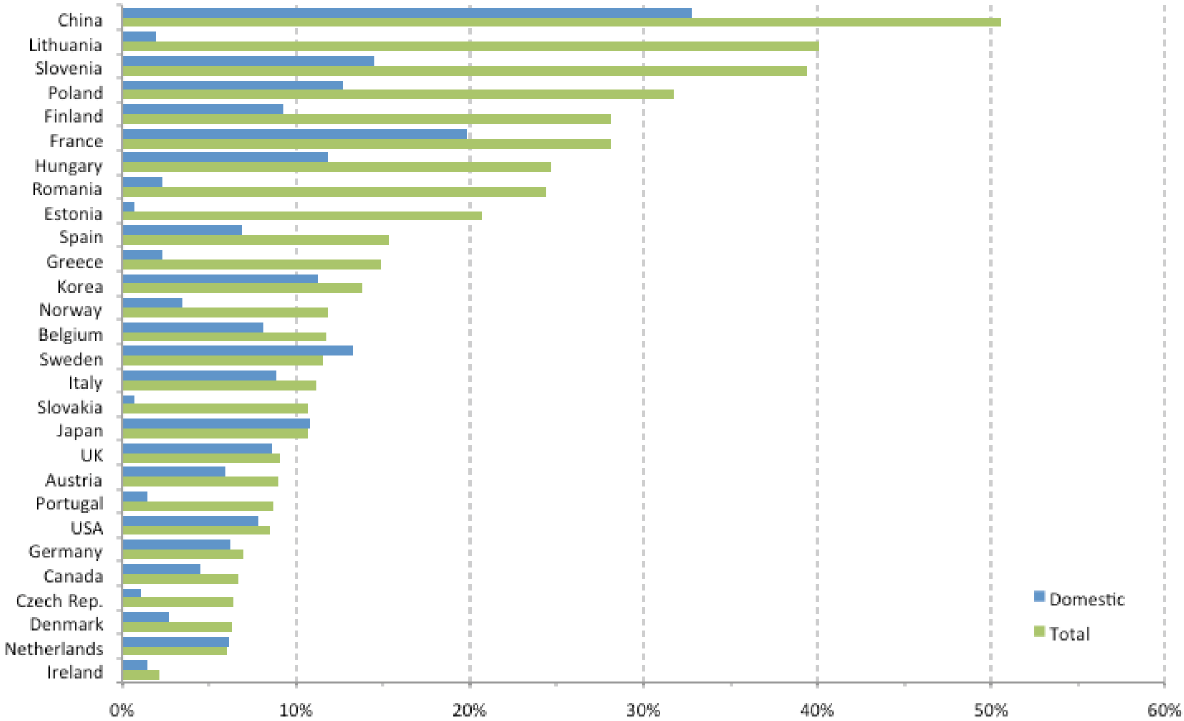
Figures 2.5 and 2.6 show the backward linkages between manufacturing and KIBS, and Figures 2.7 and 2.8 show the forward linkages. The backward technology linkage measures the technology flows from a particular sector (e.g. manufacturing) into a recipient sector (e.g. KIBS), relative to total knowledge inputs into recipient sector. In other words, it gives the relative size of knowledge inputs from this particular sector as measured from the perspective of recipient sector. And the forward technology linkage on the other hand measures the technology flows from one sector into another, relative to total knowledge inputs from the source sector to all other sectors. In other words, it gives the relative size of knowledge inputs into the recipient sector, as measured from the perspective of source sector.

The backward linkages shown in Figure 2.5, measured in terms of the total technology content of KIBS, are rather small in countries on the technology frontier, defined as the average R&D intensity of the OECD;[35] 10% or less, and with domestic and total backward linkages being more or less of the same size. There is substantially larger variance between the technology using economies, reflecting the higher dependence on imported technology flows. The variance between domestic and total flow strengths appears to be driven by the size of the economy, reflecting the negative correlation between size and openness of countries on the technology frontier. This suggests that size and national income levels are two main underlying variables. The data does not allow pinpointing the explanation of why Finland and France lie high up in Figure 2.5, and the Czech Republic lies down towards the lower end of the figure. However, it is likely that this reflects the high technology intensity of ICT-related Finnish and French KIBS services, with major inputs of foreign and domestic

33 See Annex 3.1.
34 See Annex 3.2, which details the modified technology linkage measure used in this section.
35 See Annex 2.1 for details.

high-tech manufactures. The Czech case can in a similar vein be explained by Czech KIBS sectors being dominated by traditional labour and client intensive consultancy.

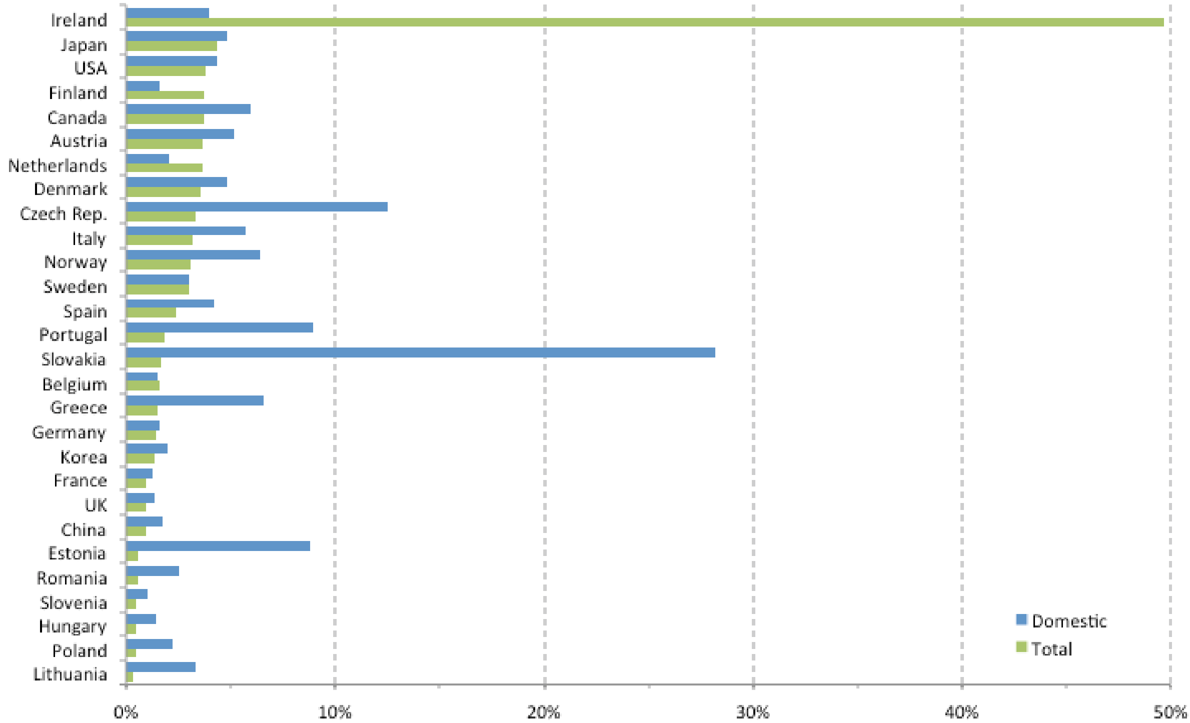
Figure 2.5: Backward linkage of manufacturing embodied inputs into KIBS sectors, domestic and imported supply. Ranked by total linkage, 2005



Source: OECD Input-Output tables. ANBERD. Eurostat Input-output tables for Lithuania.

Domestic sources of KIBS embodied inputs into manufacturing dominate over imported KIBS inputs in most countries, as Figure 2.6 illustrates. Ireland is a notable exception as they source almost everything internationally, most probably from other English speaking countries. These linkages, measured in terms of the total technology content of manufacturing, is rather small in almost all countries, and to the lowest order do not appear to be dependent on the size of the economy. In virtually every country, except Ireland, the total linkage is less than 5%. In countries at the global technology frontier, including Sweden, the United States, and Japan the domestic linkages are also marginal, and are more evenly distributed between domestic and total backward linkages. The only countries showing a notable technology linkage of domestic KIBS are Estonia, Slovakia and the Czech Republic.

Figure 2.6: Backward linkage of KIBS embodied inputs into manufacturing sectors, domestic and total supply. Ranked by total linkage, 2005

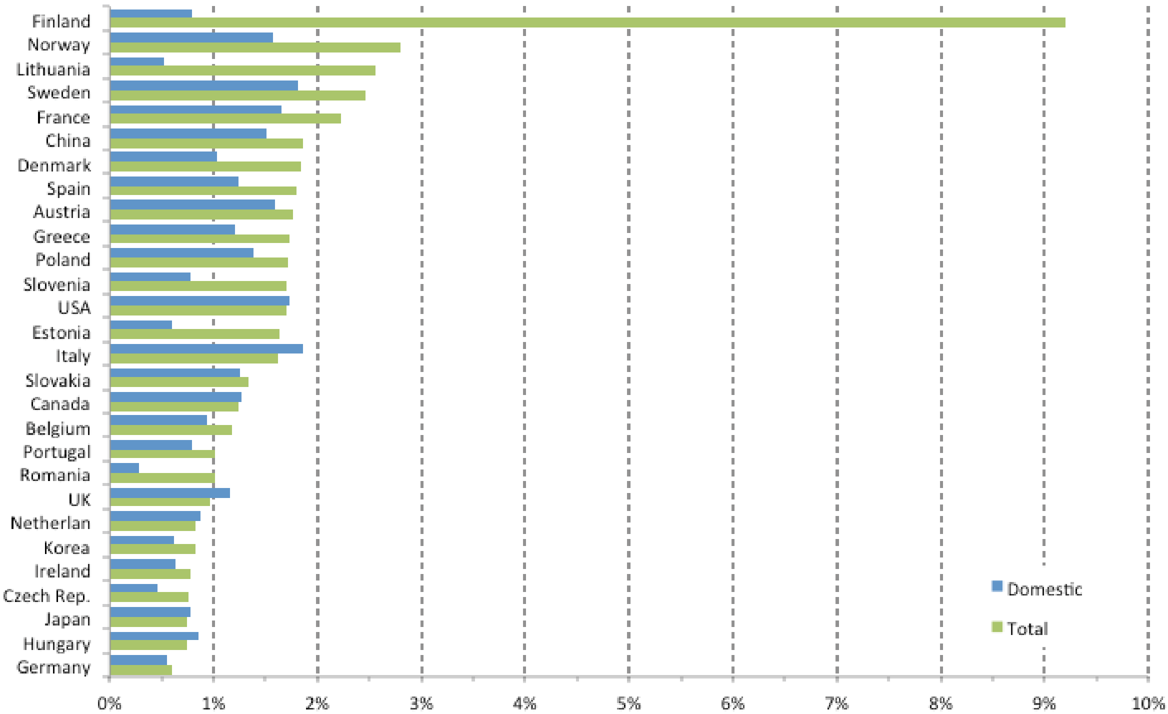


Source: OECD Input-Output tables. ANBERD. Eurostat Input-output tables for Lithuania.

Forward linkages from manufacturing into KIBS are relatively small, when compared with the other three linkage measures. Figure 2.7 shows that the linkage never exceeds the 3% level for any country, except in Finland, whether in terms of domestic or total linkages. This suggests that KIBS are knowledge supplying relative to most manufacturing industries.[36] There is a general tendency for the forward linkages between domestic manufacturing to KIBS to be small in EU-12 Member States, but it also appears to be the case for the Nordic countries. The reason for this may be that some of these countries, especially Sweden and Finland, rely heavily on the science-based industries. Most countries on the technology frontier have a fairly even distribution of forward linkages.

36 Hauknes and Knell (2009) show that this applies to manufacturing, except for the science-based industries.

Figure 2.7: Forward linkage of manufacturing embodied inputs into KIBS sectors, domestic and imported supply. Ranked by total linkage, 2005

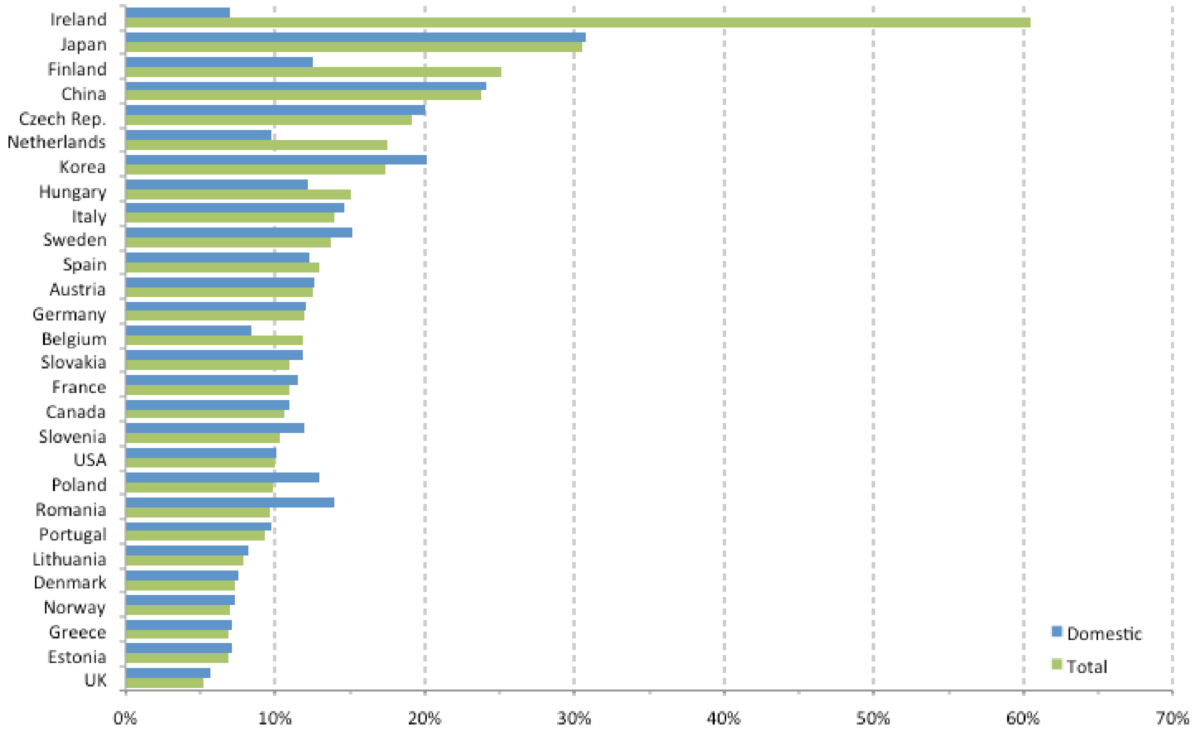


Source: OECD Input-Output tables. ANBERD. Eurostat Input-output tables for Lithuania.

Figure 2.8 shows that the forward linkages from KIBS to manufacturing appear rather large when compared to the opposite forward linkage from manufacturing to KIBS. The domestic and total forward linkages are also more evenly distributed across all countries. Ireland, Finland, and the Netherlands, and possibly Belgium and Hungary, are notable exceptions to this pattern, alongside with Poland and Romania.[37] The reason for the different pattern in Ireland is that embodied knowledge R&D services sourced abroad into Irish chemical industries are particularly high.

[37] Ireland becomes an outlier because of foreign KIBS inputs into domestic manufacturing, and Finland becomes an outlier because of foreign manufacturing inputs into KIBS sectors. R&D performed in the R&D sector that was not distributed to the other industries may result in an overestimation of the impact of KIBS on manufacturing. These problems appear mostly in the EU-12, which still rely heavily on the government for performing and funding R&D activity. Remnants of the old science and technology system remain in these countries and appear as active research organizations in the R&D sector.

Figure 2.8: Forward linkages of KIBS embodied inputs into manufacturing sectors, domestic and total supply. Ranked by total linkage, 2005.



Source: OECD Input-Output tables. ANBERD. Eurostat Input-output tables for Lithuania.

The backward linkage from KIBS to manufacturing appears weak, while the backward linkage from manufacturing to KIBS appears to be substantially stronger. Conversely, the strength of the forward linkage from manufacturing to KIBS is substantially weaker than the forward linkage from KIBS to manufacturing. The reason is that the size of the KIBS sector is substantially smaller than the manufacturing sector as a whole. The measures of linkage strengths reflect this size difference. When this is taken this consideration, domestic KIBS inputs into manufacturing outweigh domestic manufacturing inputs into KIBS in virtually every country, except France. Total linkages from manufacturing to KIBS are, by far, the dominant linkage in Lithuania, Slovenia, Poland and Estonia. Romania, China, Hungary and Greece are also dominated by manufacturing inputs to KIBS. France remains an exception among the high-income economies, although the balance of total flows suggests that the UK, Finland and Norway may also be exceptions. The most KIBS-intensive economies are Ireland, Japan and the Netherlands.

2.4. Services as output of manufacturing

2.4.1. Introduction

Services, in particular knowledge-intensive services, have become an important direct and indirect input for manufacturing as documented in the previous sections. The previous chapter demonstrated that knowledge-intensive business services (KIBS) are important carriers of new knowledge developed in upstream sectors that diffuses into manufacturing. Manufacturing increasingly relies on knowledge-intensives services as inputs to their production processes. But this is only one aspect of the changing relationship between manufacturing and services industries. Manufacturing firms themselves more and more offer services along with - or even instead of - their traditional physical products. This trend is often labelled 'convergence between manufacturing and services'.[38] The convergence between manufacturing and services is an opportunity for the European manufacturing sector to open up new markets, find new sources of revenue around their products, and increase competitiveness. This opportunity is recognized in policy debates:

"European industry must move further into the provision of services in order to remain competitive at the global level. Companies operating in industry sectors and manufacturing need to develop new business opportunities by spurring related services such as maintenance, support, training and financing. In general, the growth potential of these services is much higher than that of the product business itself." (Monti 2010, p. 54)

This section first provides a discussion of the motives of manufacturing firms to offer services and then an analysis of convergence at the sectoral level with input-output data. The end of this section provides additional evidence of convergence on firm-level.

2.4.2. Why do manufacturing firms offer services?

Convergence and the phenomenon of manufacturers becoming service providers have gained considerable attention in the last decade, mainly in the management literature. Convergence has been discussed in the context of product-related services (e.g. Lalonde and Zinszer, 1976; Frambach et al., 1997), product-service systems (e.g. Mont, 2002; Tukker and Tischner, 2006), integrated solutions (e.g. Brax and Jonsson, 2009; Davis et al., 2007; Windahl, 2007; Davies, 2004) or, more generally, 'servitisation' (e.g. Vandermerwe and Rada, 1988; Rothenberg, 2007; Neely, 2008; Baines et al., 2009). Up to now, there has been neither a common term nor a standard definition of convergence in the literature. Research on convergence has developed independently and mostly in isolation (e.g. Baines et al., 2009; Tukker and Tischner, 2006). Lay et al. (2009) identified three basic strands in the literature: first, convergence has become a topic in the marketing literature; second, there is growing attention to convergence in the sustainability literature; third, there are various sector-specific publications that analyse how firms are adding services to their range of physical products.

The literature offers three basic explanations or motives for firms to introduce services in addition to their physical products: A first motive is to gain additional *financial benefits*. Services can generate additional revenues for firms and open up new sources of income. This

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38 See European Commission (2011), 'Databases from socio-economic research project for policymaking', especially section 1.2 for a thorough discussion of the subject.

diversification may also help to reduce the vulnerability and volatility of cash flows. Moreover, services may offer higher margins and have a lower price elasticity than physical products, because services are often more difficult to compare than physical products. A second motive is to gain *strategic advantages*. The provision of services allows firms to differentiate their product range from the products of their competitors by offering product-service combinations ('solutions'). A higher degree of product differentiation may also hamper potential market entrants. Finally, there are also *marketing benefits* from service offers. Complementary services may generate additional value for customers and lead to a higher degree of customer satisfaction. Interaction with customers in the provision of additional services may help to maintain and foster customer relationships. Moreover, complementary services may also promote demand for the physical goods of the firm.

2.4.3. Macroeconomic evidence

There is a general trend towards a higher share of service products in manufacturing output (service content) across countries and over time. The analysis of supply tables taken from input-output statistics compiled by EUROSTAT and national statistical offices provides compelling evidence that the share of services in total manufacturing output has increased in most of the EU countries and in the US.[39] As shown in Figure 2.9, the service output of manufacturing is highest in Finland and the Netherlands, Luxembourg, Sweden, and the UK. Services constitute around five to eight percentage of total manufacturing output[40] in these countries. In most other EU countries, the service share on manufacturing output is around 2%. Countries with higher service content tend to be small, open economies in Western Europe.

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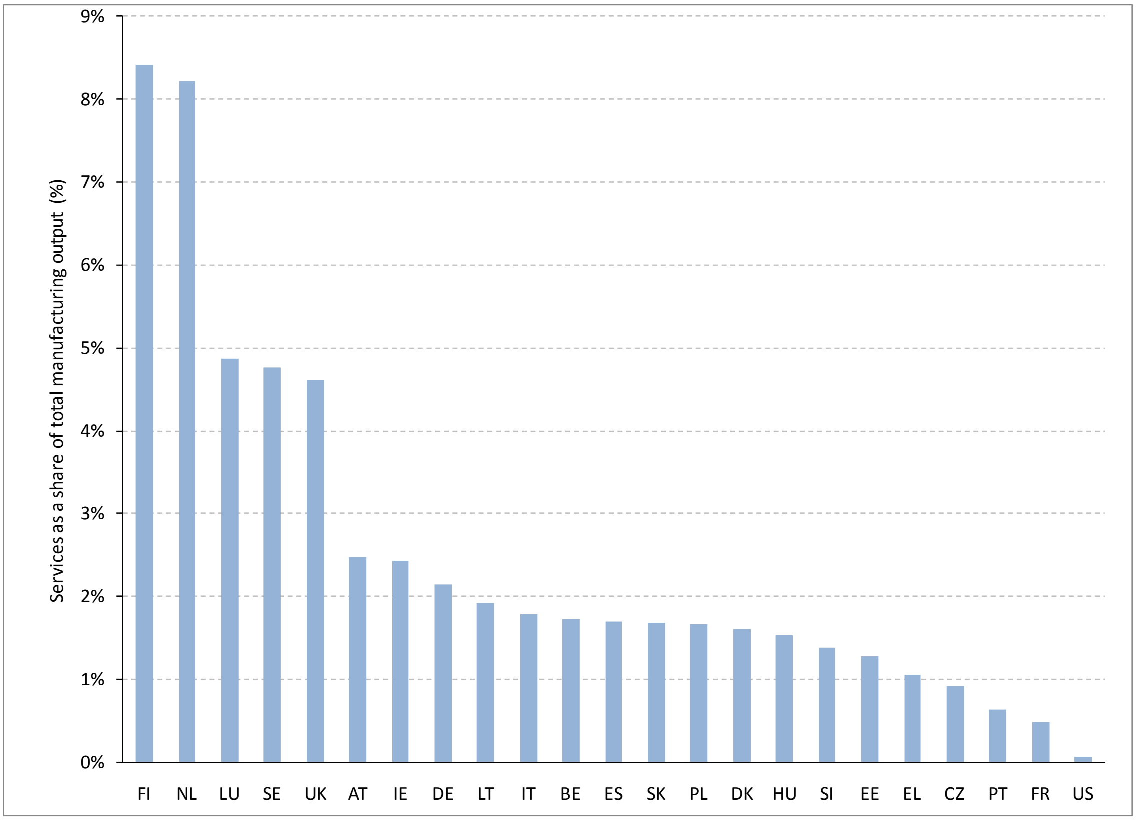
39 The analyses in this part utilise Eurostat supply and use tables as input-output tables (as provided by Eurostat) do not allow for analyses of the service output of manufacturing sectors for which supply tables (which are of dimension product by industry) are necessary.

40 Trade services offered by manufacturing firms are excluded because it is simply an extension of the firm's product range by offering third-party products.

Figure 2.9: Service share of manufacturing output in various countries, 2005

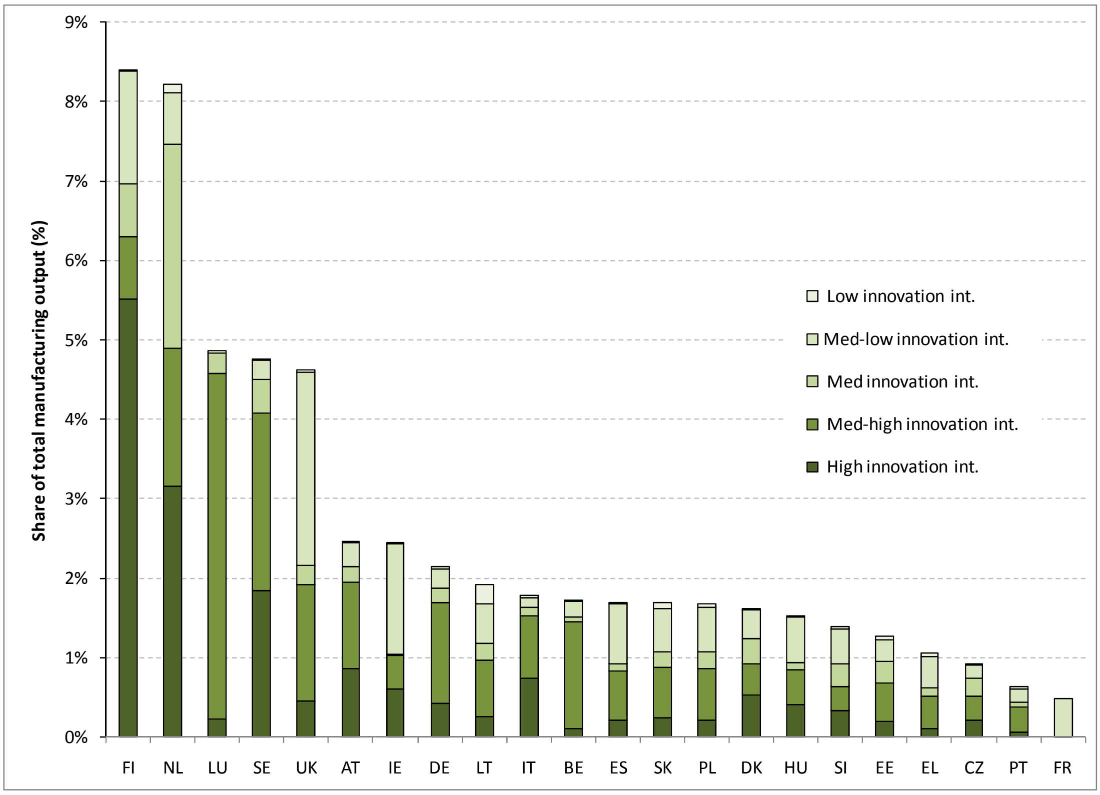


Note: latest available data: the US and the UK until 2002 and 2003, respectively. Services cover CPA 55 to 95 for the EU Member States and NAICS 48 to 92 for the US. Data for France is incomplete and covers only CPA 72 to 95.

Source: Eurostat and US Bureau of Economic Analysis supply tables; author's calculations.

The output of manufacturing still consists mostly of manufactured products. The service output of manufacturing is, however, growing quite fast, displaying annual growth rates of five to ten per cent for the years between 1995 and 2005. It grew in all countries under study between 2000 and 2005. The only exception is the Czech Republic. Convergence between manufacturing and services is therefore a uniform development across countries. It should, however, be noted that the figures from input-output tables reported here are most likely a conservative estimate of the service output of European manufacturing industries. Firm-level evidence from the European Manufacturing Survey (see below) suggests that most revenues from services are not invoiced directly, but included in the prices of the physical goods of the firm. Firms often charge for a service/product package, instead of invoicing services and physical products separately. Adding these indirect revenues to the direct revenues yields an amount for the service output of manufacturing that is considerably higher than the values reported here.

Figure 2.10: Service share of manufacturing output broken down according to innovation intensity, 2005



Note: latest available data for the UK is 2003. Data excludes wholesale and retail trade. Data for France covers only service products CPA 72 to 95.

Source: Eurostat; author's calculations.

The service output of manufacturing firms is in various ways related to research, development (R&D) and innovation. Both, R&D and complementary service offers are strategies of firms to differentiate their products from the products of their competitors. Moreover, countries with high service content – examples are Finland, the Netherlands, Luxembourg, Sweden, and the UK - have also high R&D expenditures as percentage of GDP. In contrast, the countries with the lowest service shares in the figure above – Romania, Portugal, Greece, or the Czech Republic – have also low aggregate R&D intensities. However, there are also some countries, for example, Austria, Belgium, Denmark, France, and Germany, which have a lower service share than their R&D intensity would suggest. The relationship between R&D, innovation and service output is stronger at the sectoral level. Services are predominantly produced by manufacturing industries with high and medium-high innovation intensity[41] (see Figure 2.10). These industries include, for example, machinery and equipment (NACE 29), office machinery and computers (NACE 30), radio, television and communication equipment (NACE 32) and other sectors. In Austria, Belgium, Denmark, Finland, Germany, Italy, Luxembourg, and Sweden, more than two thirds of the service output of manufacturing comes from high or medium-high innovation intensive sectors. In a second group of countries, including the Czech Republic, Estonia, Greece, Hungary, Lithuania, the Netherlands, Poland, Portugal, Slovakia, Slovenia, and Spain, high and medium-high innovation intense sectors explain approximately 50% of the service output. One interpretation of this relationship is that sectors which are more innovation-intensive are also more service-intensive, because the

[41] The classification of innovation intensity follows the sectoral taxonomy of Peneder (2010).

knowledge base of the sector is cumulative and complex so that customers often do not have all necessary knowledge available and require additional services.

But also low and medium innovation-intensive industries produce services. Examples are the UK and Ireland, where manufacturing industries with medium-low innovation intensity account for more than 50 % of service output. 'Publishing, printing and reproduction of recorded media' (NACE 22) accounts for a large share of total manufacturing service output. Similar links between innovation and service output can also be found in other industries. In general, manufacturing firms predominantly produce knowledge-intensive business services. KIBS account for more than two thirds of the service output of manufacturing in 14 of the 24 countries included in the analysis. Hence, the manufacturing sector is not only a main client of KIBS — as demonstrated in the previous section — but also produces KIBS to a considerable degree. Evidence from firm-level surveys such as the EMS (see below) suggests that most such KIBS are related to the physical products of a firm.

In addition, there is also evidence that a considerable share of the KIBS produced by manufacturing is exported. A study by the Austrian Central Bank (Walter and Dell'mour, 2009) suggests that manufacturing industries accounted for 15 % of total Austrian service exports in 2006. This is about the size of service exports by the KIBS industries. In this perspective, trade in services and trade in KIBS in particular is not only a result of higher exports from the service sectors, but also a consequence of the internationalisation of manufacturing industries. This may explain why service output is highest in small, open economies with a high innovation and R&D intensity (see Stehrer et al., 2011, for details).

2.4.4. Which manufacturing firms offer services?

The input-output analysis above revealed that services are predominantly offered by firms in innovation-intensive sectors. Small countries with a high R&D intensity tend to have higher shares of services on manufacturing output. In this section, product-related services are further analysed with firm-level data from the *European Manufacturing Survey (EMS).* The EMS investigates product, process, service and organisational innovation in the European manufacturing sectors. This section presents results from the last round of EMS conducted in 2009.[42]

Firm-level data allows for testing hypotheses about how the share of services on total output of manufacturing firms relates to firm size, sector, and the characteristics of the main product of the firm. A regression analysis is used to explain manufacturing service output. The regression analysis is based on 2, 264 observations on firm level from the EMS. The sample consists of information on manufacturing firms in nine countries.[43] Around 85% of the sample consists of SMEs.[44]

The dependent variable in the regression analysis, **service output** of the manufacturing companies is measured as the share of turnover generated with services. The following independent variables are assumed to be important to explain manufacturing service output.

[42] EMS is organized by a consortium of research institutes and universities co-ordinated by the Fraunhofer Institute for Systems and Innovation Research (ISI) and takes place every three years.
[43] Austria, Croatia, Denmark, France, Germany, Netherlands, Slovenia, Spain and Switzerland.
[44] See Annex 2.3 for a description of the population.

First of all, it is assumed that **firm size** has a relevant influence on the service output of manufacturing firms. The literature on product innovation points out that there are different advantages and disadvantages of small and large firms in the innovation process, leading to a U-shaped relationship between size and innovativeness (Kleinknecht 1989; Cohen 1995). Small firms can react very quickly to changes in demand and are often focussed on the needs of their clients, while large firms can benefit from diversification and economics of scope and often have specialized departments for continuous innovation and product development. A similar relationship for manufacturing service output which is also a type of innovation is assumed. To operationalize the size of the companies, the number of employees (emp) and the number of employees squared (emp2) are chosen, both in logarithmic form, to allow for a non-linear relationship between employment and service offerings.

Buyers of bespoke customized products, which are manufactured in **small batches** or even as single products, may be more open to complementary services than buyers of mass-produced goods. The reason for this can be seen in the distribution channels and consequently in the customer-producer-relationship. Whilst high-volume producers often sell their products anonymously to end customers, the producers of single units are in closer contact to their customers and are consequently able to first identify service needs of their customers, to customize service offers for them and to promote and sell these service concepts to their customers. This hypothesis is operationalised by a dummy variable indicating whether the main product of the firm is produced in small batches opposed to large batch production (sbatch). However, as it is not possible to identify the products' target group merely based on the batch size, a variable that indicates if the firm is a supplier for other industries or a producer of consumer goods (supply) is also included.

The **type of products** offered is generally seen as a potential determinant of service output and servitization. Concerning product complexity, it can be argued that a customer firm that buys a complex product which incorporates many parts and offers various functionalities may need more training, consulting, and maintenance or operation services than a buyer of simple parts (e. g. Oliva and Kallenberg, 2003). This hypothesis is tested by including a dummy variable indicating whether the products are complex (complex) and consist of many parts as opposed to simple products.

Stehrer et. al (2011) observed that **younger firms** seem to be slightly more innovative in terms of services than firms formed before 2000, although these younger firms are less product innovative. A potential explanation for this finding might lie in the innovativeness of younger companies mindset and hence their open-mindedness towards innovative service offerings. This hypothesis is tested by using a variable that indicates if the firm has been established after 2005 (newfirm).

The discussion above indicates that there is a relationship between the innovative propensity of manufacturing industries and the share of services of manufacturing output in the industries. The hypothesis of **innovativeness** of firms and industries is operationalized by two variables. Sectoral dummies that represent sectoral innovation intensity according to Peneder (2010) are used. For this, the base case is the high-innovation intensity sector. However, there is also evidence that firms within a sector differ considerably with respect to innovativeness. A variable which shows the innovativeness on a firm level is therefore included. This additional variable for innovativeness at the firm level indicates if a company has introduced a new product to the market within the last two years (inmar).

In order to control for differences w.r.t. to servitization across countries, country dummies are included. The base is Germany.

The table below describes all variables in detail:

Variables	**Description**
Sshare	Turnover with services as a fraction of total turnover of the firm
lemp and lemp2	ln of the total number of employees in the reference year 2009 and ln squared
Sbatch	1 if a firm predominantly produces in small batches or single products; 0 if the firm predominantly produces in large batches
Supply	1 if the firm is predominantly a supplier of other firms; 0 if the firm predominantly supplies final demand
Complex	1 if the main product of the firm is a complex product consisting of many parts and offering various functionalities; 0 if the main product is simple and consists of few parts
Newfirm	1 if the firm has been established after 2005; 0 otherwise
Inmar	1 if the firm has introduced a new product to the market since 2007; 0 otherwise
se_low	1 if the firm is assigned to the Low innovation sector in Peneder's taxonomy; 0 if the firm is assigned to the High innovation sector
se_medlow	1 if the firm is assigned to the Medium-low innovation sector in Peneder's taxonomy; 0 if the firm is assigned to the High innovation sector
se_med	1 if the firm is assigned to the Medium innovation sector in Peneder's taxonomy; 0 if the firm is assigned to the High innovation sector
se_medhigh	1 if the firm is assigned to the Medium-high innovation sector in Peneder's taxonomy; 0 1 if the firm is assigned to the High innovation sector
Country	Country dummies at, ch, nl, fr, dk, hr, es, si for the location of the firm. Reference case is Germany
α	Is a constant
U	Are the residuals

The dependent variable can only take values between 0 and 100. The appropriate estimation for this type for dependent variable is a generalized linear model (GLM), which is basically a more general form of the well-known ordinary least squares regression (see Papke and Wooldridge 1996). The generalized linear model allows the linear model to be related to the dependent variable, i.e. the variance function describes the relationship between the variance of the explained variable and its mean, which yields a non-biased estimation of the variance under non-normal conditions. In this case, it is assumed that the dependent variable is distributed by a binomial process and that the log of the mean of the dependent variable is linearly associated with the explanatory variables. Therefore, the normality assumption is violated, revoking the use of least-squares parameter estimation.

The model is specified as follows:

$$sshare = \alpha + \gamma_1 lemp + \gamma_2 lemp2 + \gamma_3 sbatch + \gamma_4 supply + \gamma_5 complex + \gamma_6 newfirm + \gamma_7 inmar + \gamma_8 se_{low} + \gamma_9 se_{medlow} + \gamma_{10} se_{med} + \gamma_{11} se_{medhigh} + \gamma_{12-19} country + u$$

Regression results

The Table 2.3 below reports the results of the analysis. For each independent variable, the table gives the estimated coefficient γ , the robust standard error, the probability that the coefficient is zero. ***, **, * denote statistical significance of the coefficient at the 1%, 5% and 10% test level.

Table 2.3: Determinants of the share of services on turnover of manufacturing firms, results from a Generalized Linear Model

Variable	Coefficient	Standard Error	P>|z|	Sig.
lemp	-0.636	0.109	0.000	***
lemp2	0.058	0.010	0.000	***
se_low	-0.425	0.295	0.151	
se_medlow	-0.610	0.120	0.000	***
se_med	-0.221	0.063	0.000	***
se_medhigh	-0.327	0.067	0.000	***
inmar	0.132	0.052	0.011	**
sbatch	0.266	0.056	0.000	***
complex	0.158	0.054	0.003	***
supply	-0.035	0.051	0.495	
newfirm	0.015	0.354	0.965	
At	-0.108	0.088	0.222	
Ch	0.002	0.064	0.966	
Nl	0.043	0.115	0.713	
Fr	-0.551	0.129	0.000	***
Dk	0.170	0.108	0.116	
Hr	-0.005	0.165	0.978	
Es	-0.351	0.182	0.054	*
Si	0.459	0.192	0.016	**
constant	-0.321	0.282	0.261	
No. of obs	2264			
Residual df	2244			
(1/df) Deviance	.1383103			

Note: (1/df) deviance measures the fit of the model and measures the actual deviance of the estimated value from the observed value of the dependent variable. It should be as small as possible, and zero in the case of a perfect fit. The value of (1/df) Deviance is 0.1383.

Source: EMS 2009, own calculations.

Firm size had a large explanatory value in the regression analysis. There is a U-shaped relationship between firm size and service share on turnover. As discussed above, this points to different advantages of small and large firms in offering services. It also indicates that, all other things equal, service output decreases first with rising firm size and then increases again. The small coefficient of lemp2, however, indicates that increases can only be seen beyond a very high threshold.

The relationship between service output and innovation intensity of the sector is confirmed by the regression analysis. When holding all other factors constant, firms in innovation-intensive sectors are more likely to realize a higher share of turnover with services than firms in less innovation-intensive sectors. The sector with low innovation intensity is an exception in that the negative relationship is not significant. Taking into account that this sector only constitutes 1.5% of the sample this result is not surprising. Due to the low number of firms in this category the variance of the variable is small.[45]

The relationship between service output and innovation intensity is also supported by the significant influence of product innovativeness. Firms which have launched new products during the last two years are more likely to realize higher shares of turnover generated with services compared to companies who stated to not have introduced new products. Product innovativeness seems to reinforce service delivery.

The hypotheses that firms which produce in small batch or/and produce complex products are more likely to make more turnover with services than firms with large batches and/or simple products are also accepted. Both coefficients are highly significant, the coefficient for single batch production is considerably higher.

The position of the firm in the supply chain does not seem to have a significant influence on the service output. Suppliers to industrial users have no higher service output than firms which mainly supply consumers. Furthermore, the regression provides no evidence that newly established firms or firms that are mainly suppliers to industrial clients would have a higher share of services on output. This effect may partially be gauged by the size variables. The fact that new firms constitute less than 1% also affects the result. Since there are a very low number of new firms in the sample, the variation of this variable is limited.[46]

The hypothesis that the degree of servitization depends on the region of the firms is rejected by the multivariate analysis. The country dummies are not significant at a level of at least 95%, except for France and Slovenia.

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45 See the description of the population in Annex 2.3.
46 See Annex 2.3 for a description of the population.

2.5. European's position in trade in goods and services and EU's external competitiveness

2.5.1. Introduction

The previous sections showed that there is a relationship between service content, technology intensity and openness to trade. It has also been demonstrated that KIBS play a vital role in this context. This section takes a closer look at the EU's external competitiveness with respect to technology-intensive goods and particularly KIBS trade. It begins with a description of trends in KIBS trade and technology-intensive merchandise trade over 1996-2007. There follows a section on cross-country comparisons and examinations of specialisation patterns and revealed comparative advantage in EU merchandise and services trade. A third section assesses KIBS intensity with respect to imports of production and trade, with the aid of information from input-output tables. The imported-service intensities of different sectors across countries are compared and analysed over time. Also, the role of imported versus domestically produced KIBS is analysed. This section also includes an analysis of the value added structure of EU exports.

2.5.2. Trends in KIBS trade

The present analysis of KIBS trade focuses on cross-border trade (which includes services sold cross-border through local affiliates).[47] It compares old EU Member States (EU-15) and new EU Member States (EU-12), and also both these groups with other markets, in particular Japan and the US. It looks at total EU trade (meaning both extra- and intra-EU trade), as the bulk of trade in KIBS is with third countries (80%–90% of trade in KIBS) — in contrast to total services exports, where the extra-EU share has been steadily decreasing and was less than 50% in 2007.

As can be seen from Figure 2.11, the EU-15 is the major player on the KIBS market — its share in global KIBS exports is around 50%. In global imports, its share is slightly lower, but it still is the key importer. The US has the second biggest share in KIBS exports (15%), while India is in third place with a 6% share. The EU-15 is also the biggest player in the market for technology-intensive goods. However, its share is much smaller than for KIBS — 35% in 2007. The second biggest exporter in this market is China, with a share of 12% in 2007. The US is the third biggest exporter with an 11% share. The EU-12, though having a small share in the market for technology-intensive goods, has been increasing it quite fast — from 1% in 1996 to 3.6% in 2007. The EU-15, US and India are net exporters of KIBS, while Japan is a net importer. The EU-12 and China have approximately equal volumes of exports and imports of KIBS. In the market for technology-intensive merchandise goods, the EU-15 is again a net exporter, along with Japan, while the US, China and India are net importers.

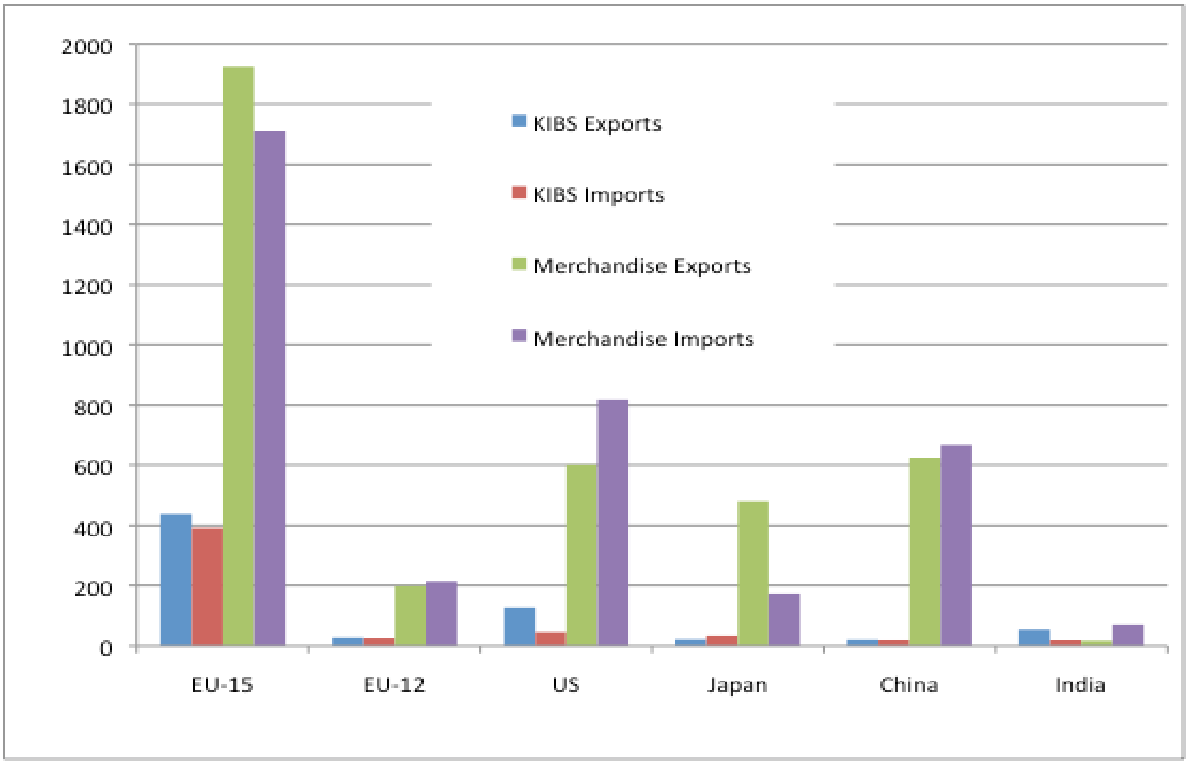
The value of KIBS trade is relatively low compared to technology-intensive merchandise trade in all the regions.[48] In 2007, the share of KIBS in global exports of technology-intensive goods plus KIBS was only 14% — which is about 7 percentage points lower than the share of total services trade in cross-border trade. However, it is important to recognise that KIBS

47 In this section, KIBS are also defined as NACE codes 72, 73 and 74, which are related to categories 262, 279 and 268-269-279 in the Extended Balance of Payments Services Classification (EBOPS). See the background study for details.

48 Sectors 29-35 in the ISIC 3 classification are considered to be technology-intensive.

activities represent a large share of the total cost of production in manufacturing. The KIBS intensity of both EU-15 and EU-12 exports has risen substantially on a value added basis, once it is recognised that KIBS are inputs into manufacturing and are not only exported directly, but also indirectly through goods.

Figure 2.11: KIBS and technology-intensive merchandise exports in 2007, USD bn

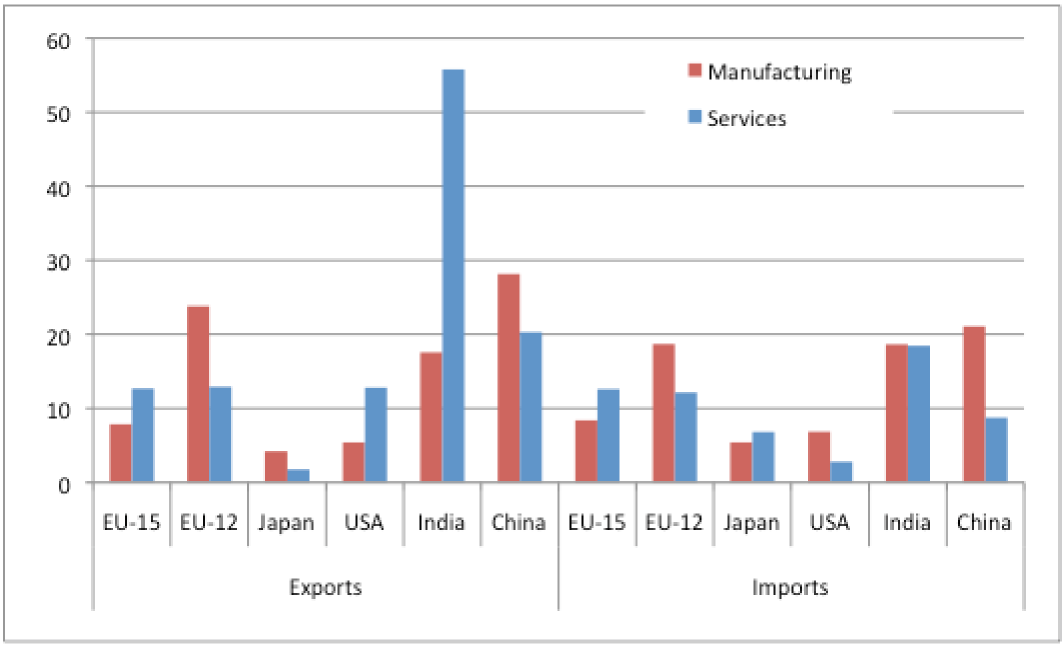


Source: TSD, UN COMTRADE

As Figure 2.12 shows, the fastest average annual growth for KIBS exports in 2007 was recorded in India. China had the second highest growth rate. The EU-15, US, and EU-12 had been increasing their exports of KIBS at approximately the same average rate during 1996-2007, while Japanese growth had been considerably lower. In technology-intensive merchandise exports, trends were different — here, China and EU-12 had the highest growth rates, while India had the third highest growth rate. The EU-15 increased its exports on average by 8% per year. Japan again showed the slowest average annual growth. The US performed only slightly better with 5% average annual growth.

The fastest growth of KIBS imports during that period was recorded in India, the EU-15 and the EU-12 while the slowest rate was seen in the US. Japan was more active in the KIBS import market as compared to the export market, with KIBS imports growing on average by 7% a year. In technology-intensive merchandise imports, China, India and the EU-12 again displayed the highest growth rates with average annual growth rates of 19%-21%. In other regions, imports were increasing at an average annual rate of 5%-8%.

Figure 2.12: Average annual growth of exports and imports of KIBS and technology-intensive manufacturing, 1996-2007, %



Source: TSD, UN COMTRADE

Turning to individual KIBS sectors, in 2007, KIBS exports in all the regions were dominated by other business services, which accounted for about 70% of EU-12 and EU-15 exports, and more than 80% of US and Japan exports (see Table 2.4). The common trend, though, is a decline in the share of other business services in exports, the biggest occurring in the EU-12 — 23 percentage points — and the smallest in the US — 5 percentage points. This is mirrored by increased export shares for computer and information services (apart from the US) and R&D (apart from the EU-15).

The EU-12 had the highest increase in the share of R&D services in KIBS exports — 10 percentage points. As a result, in 2007, the EU-12 had the highest share of R&D in KIBS exports, the lowest share being held by Japan. The structure of KIBS imports for the EU-12 and EU-15 in 2007 was similar to the structure for exports, and had undergone similar transformations. The US, however, had a very different import structure. The share of other business services in imports for the US was only 49%, with 31% in computer and information services and 20% in R&D. For the US, the share of other business services also decreased by about 41 percentage points during the period 1996-2007. Japan, in contrast, saw a decrease in the share of computer and information services in its KIBS imports — by 4 percentage points. The shares of both R&D and other business services increased.

Table 2.4: KIBS export and import structure, %

	USA		Japan		EU-15		EU-12	
	1996	**2007**	**1996**	**2007**	**1996**	**2007**	**1996**	**2007**
				Exports				
72 (computer)	9.2	9.9	7.0	16.9	6.6	20.3	3.5	17.0
73 (R&D)	4.3	8.7	0.4	1.7	13.3	8.6	0.6	10.3
74 (other business)	86.5	81.4	92.6	81.4	80.1	71.1	95.9	72.7
				Imports				
72 (computer)	5.5	31.4	15.7	11.3	6.7	20.3	4.0	19.7
73 (R&D)	4.0	19.6	0.8	3.0	11.2	9.7	0.9	5.9
74 (other business)	90.5	49.0	83.5	85.8	82.1	70.1	95.1	74.4

Source: TSD, UN COMTRADE.

The EU-15 is the biggest exporter in all KIBS sectors (see Figure 2.13). It accounts for between 55% and 67% of global exports of other business services, computer and information services and R&D. The EU-12 has a very low share in global KIBS trade, but has been seeing very fast export growth in computer and information services and R&D[49]. In other business services, the EU-15 outperformed the EU-12 in terms of export growth. This is consistent with the EU-12 emphasis on trade in merchandise rather than services in the knowledge-intensive sectors.

India had the second largest share of exports in computer and information services (72) in 2007. It also increased its exports the fastest — on average by 92% year-on-year. China, though currently a small player in this market (3% market share), has been increasing its exports of computer and information services at a rate second only to India's (48% average annual growth). The EU-12 was number three with 31% average annual growth. The average annual growth of computer and information services in the EU-15 was on a par with the world average (25%), while other advanced economies — the US, Canada, Japan — had much slower growth.

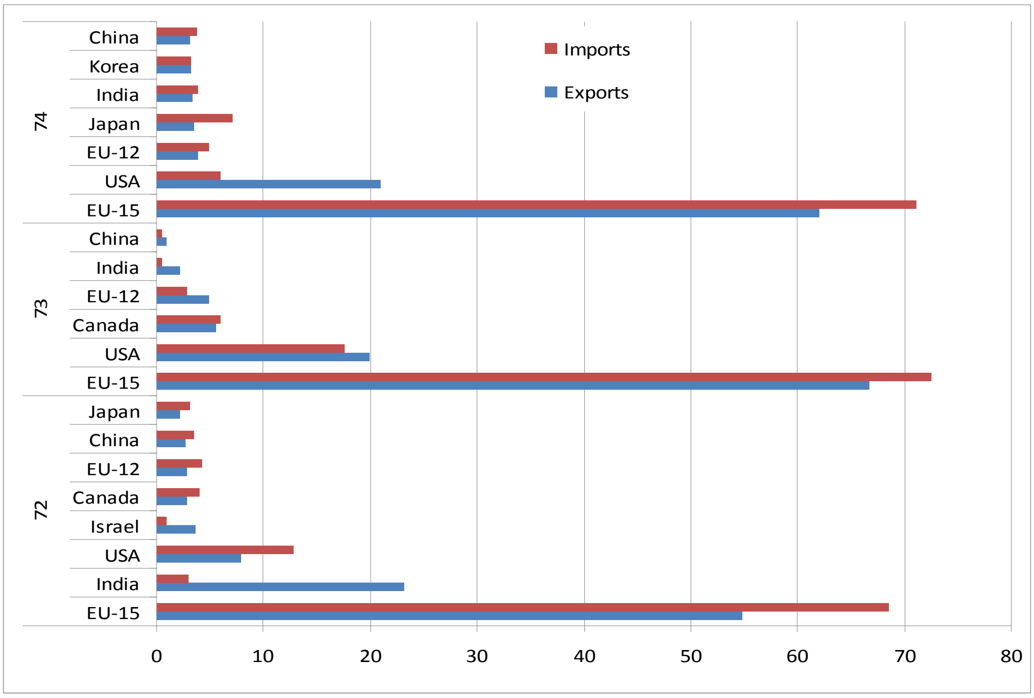
The R&D (73) market is dominated by the EU-15 and the US (the latter having an 18% share of global exports in 2007). It is worth noting that the EU-12 has been seeing the fastest growth of exports in this sector — on average 46% per year. On the one hand, this can be partially explained by the low starting base. On the other hand, the share of the EU-12 in the global R&D market is currently almost on a par with Canada's, which makes it an important player in the world market. In contrast, the EU-15 has been seeing relatively sluggish growth in R&D exports — on average 8% per year, which is lower than the world average. The US outperformed the EU-15 on this indicator.

In the market for other business services (74), the US is again the second biggest player after the EU-15. The market share of the EU-12 is comparable to those of India, Korea, and China. China has been establishing itself as a serious player in the market, with the fastest export growth — during 1996-2007 its annual exports of other business services increased at an annual average rate of 52%. India had the second highest growth rate — 27%. The EU-12, along with the advanced economies of the EU-15 and the US, showed moderate growth for

49 See Stehrer, R. et al. (2011) for more details concerning annual growth rates.

exports in this sector — around 10%-12% per year. Japan had the most sluggish dynamics in exports of other business services — less than 1% average growth per year.

Figure 2.13: Shares of global exports and import in 1997 (%)



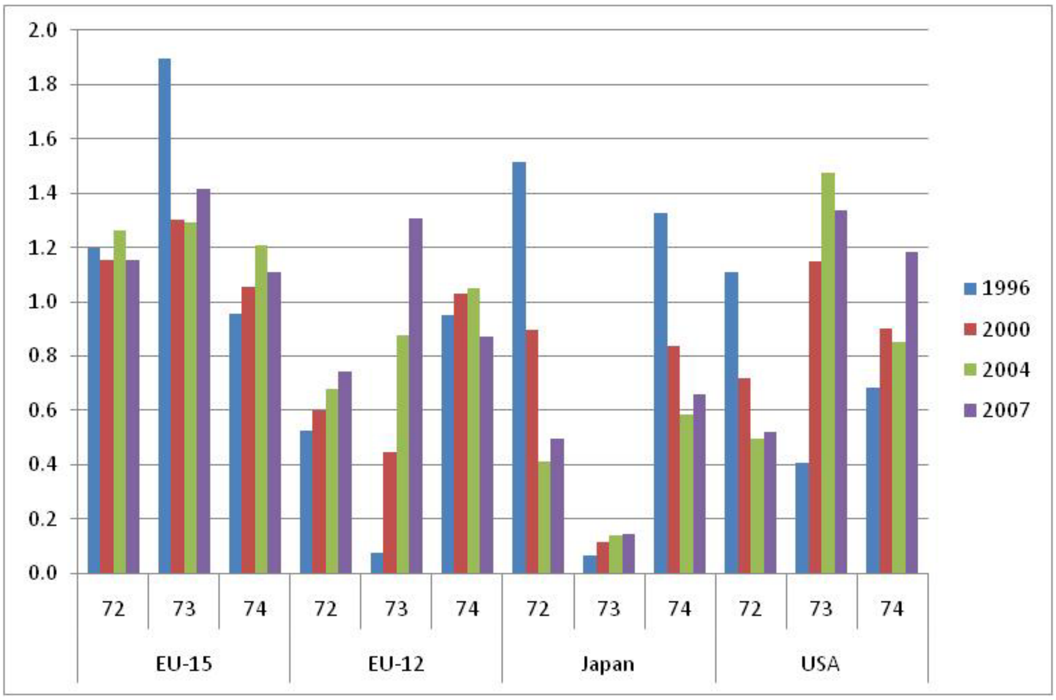
2.5.3. Patterns of specialisation

Patterns of specialisation in the EU's technology-intensive merchandise and KIBS trade are analysed with Balassa's Revealed Comparative Advantage (RCA) index, also known as an export specialisation index.[50] According to the calculated indices (see Figures 2.14, 2.15), the EU-15 has on average stronger revealed comparative advantages in KIBS exports than in technology-intensive merchandise exports. The strongest comparative advantage for the EU-15 is found for R&D. Comparative advantages in R&D gradually declined during 1996-2003, but have picked up after 2004, which might be related to efficiency gains brought by EU enlargement. Also, the EU-15 has increasingly specialised in computer and information services exports, in contrast to the US, which has lost this specialisation. At the same time, the EU-15 has the weakest comparative advantages in all the technology-intensive merchandise sectors as compared with the US and Japan. Only in exports of machinery n.e.c. (NACE 29) and motor vehicles (NACE 34) does the EU-15 display strong RCAs. The EU-12, in contrast to the EU-15, seems to have more comparative advantages in technology-intensive merchandise trade than in KIBS. Among the KIBS sectors, it has revealed comparative advantages only in R&D, which is a new specialisation pattern that has developed since 2004. The conclusion that the EU-12 has a higher specialisation in manufacturing than in services is also confirmed by a comparison of the dynamics of KIBS and technology-intensive

50 The index for country i good j is RCAij = (Xij /Xit)/(Xwj /Xwt), where w=world and t=total for all services. The RCA does not show true comparative advantages, but simply compares the composition of exports of one country to a certain market with the composition of total exports that are absorbed by the market. A region is considered to have a revealed comparative advantage in a certain type of services or goods if a value of the RCA index for this sector is higher than 1.

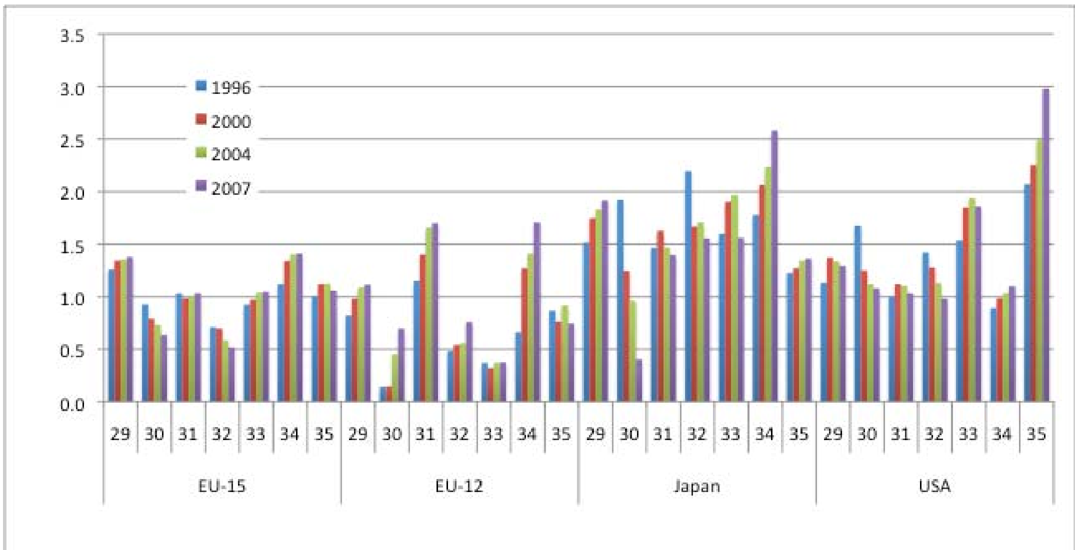
merchandise exports during 1996-2007, which shows that KIBS exports grew more dynamically than merchandise trade in the old Member States, while in EU-12 the situation was the reverse. Japan has no RCAs in KIBS exports, but has the strongest specialisation of all the regions in motor vehicles (34) and radio and television equipment (32). Overall, the country tends to specialise in all the technology-intensive goods sectors, apart from office and computing machinery (30), where it lost export specialisation after 2003 — apparently reflecting the relocation of computer equipment production to other Asian countries. The US has the strongest specialisation in other transport equipment (35) and medical instruments (33). The country also appears to have recently developed a stronger export specialisation in motor vehicles (34), while revealed comparative advantages in office and computing equipment (30) and radio and television equipment (32) seem to be gradually fading away.

Figure 2.14: RCAs in KIBS



Source: TSD, authors' calculations

Figure 2.15: RCAs in technology-intensive goods



Source: UN COMTRADE, authors' calculations

2.5.4. KIBS intensity of production and trade

KIBS shares in gross production costs accounted for between 5% and 15% of total direct costs in manufacturing in EU-15 in 2007, and from 3% to 9% of total direct costs in manufacturing in the EU-12. In this context, KIBS are particularly important for competitiveness in electrical machinery in the EU-15, and in other transport equipment and paper and printing in the EU-12. A notable feature is that KIBS intensity increased in all the industries of both regions as compared with 2001.

While technology-intensive trade is much greater than direct KIBS trade as shown above, it is also important to recognise that KIBS activities also represent a major share of the total cost of production in manufacturing. Indeed, in this chapter it is shown that, on a value added basis, KIBS are highly important to the competitiveness of European manufacturing, and to the overall value added embodied in European exports. Indeed, the KIBS intensity of both EU-15 and EU-12 exports has risen substantially on a value added basis, once it is recognised that KIBS are inputs into manufacturing, so are exported not only directly, but also indirectly through goods.

Cross-border KIBS trade is important in both the EU-15 and EU-12 in terms of the impact on manufacturing costs. In the background study (Stehrer et al., 2011), cost shares of 9.8 per cent in the EU-15 and 4.5 per cent in the EU-12 are reported.[51] As noted earlier, the EU is more KIBS-intensive than the US or Japan. Imports account for between 5.3 per cent (EU-12) and 5.5 per cent (EU-15) of these total costs. Together, the data in this chapter point to the importance of KIBS for the competitiveness of European manufacturing, especially in comparison to the US and Japan. This is particularly true for electrical machinery and equipment in the EU-15, though KIBS is an important aspect of the cost structure across manufacturing. There has been a rapid growth in imports in KIBS-intensive service categories. Indeed, the growth in the EU has been 12.2 to 12.6 per cent per year from 1996 to 2007. This is far greater than the KIBS import growth rate in Japan and the US, which was

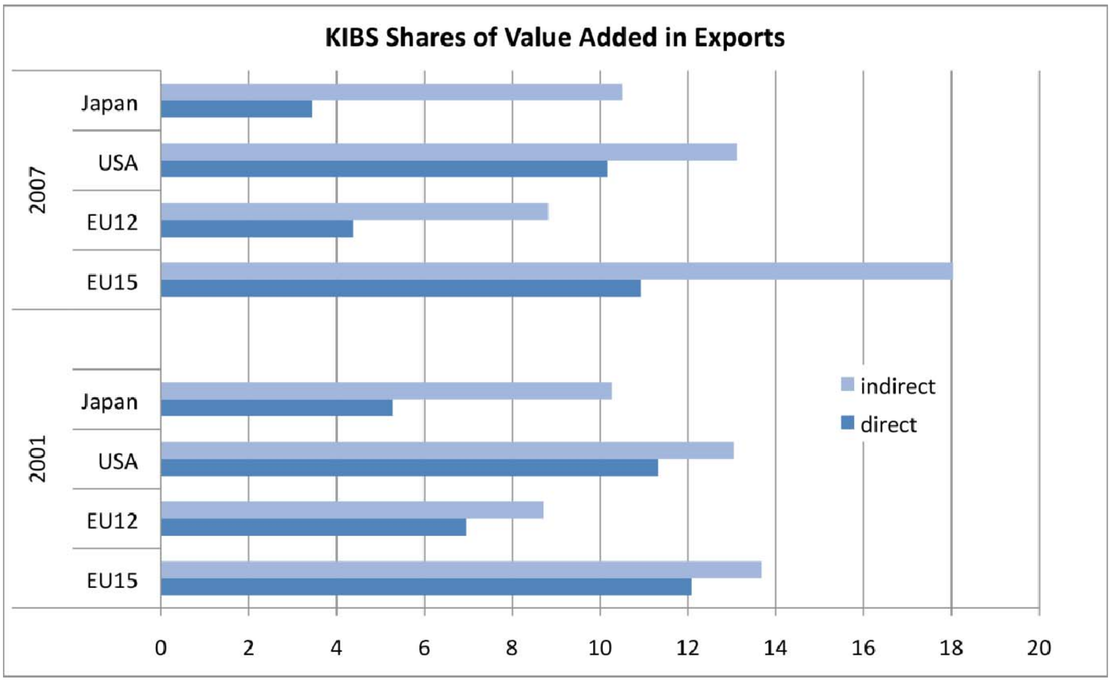
[51] Figures in this section are based on GTAP data.

only 6.8 per cent and 2.8 per cent, respectively. This means the EU has become increasingly dependent on imported service inputs in order to maintain the cost-competitiveness of its KIBS-intensive industry, in comparison to both the US and Japan.

The KIBS intensity of trade is also analysed in terms of the contribution of KIBS to the value added contained in European exports. Focusing on value added emphasises the direct contribution made by exports to demand for labour and capital in Europe, rather than counting the value of imported (extra-EU) inputs in production costs. Also, focusing on value added makes it easier to trace the indirect linkages between KIBS demand in manufacturing and the value added contained in exports.

Figure 2.16 presents the share of KIBS in total EU value added contained in exports. Two sets of figures are presented. The first set of figures presents KIBS as a share of direct exports, measured in terms of sector value added — see Stehrer et al. (2011) for technical details. This is the share of direct value added, following from the value added (capital and labour) needed to produce direct EU exports in KIBS sectors and ignoring the EU value added in intermediates that feed into the sector. However, this is not a complete picture. Because, as seen above, KIBS are also important inputs to manufacturing, this means that the value added in KIBS activities that feed into manufacturing is also reflected in the exports of the manufacturing sector. Therefore, the second measure presented, which reflects forward linkages from KIBS production into other downstream sectors, includes not only the value added of direct exports but also the KIBS value added embodied in other European exports, such as machinery and equipment.

Figure 2.16 — KIBS shares of direct costs in manufacturing, 2007



Source: GTAP

On a direct basis, KIBS activities accounted for between 4.4 per cent (EU-12) and 10.9 per cent (EU-15) of EU exports on a value added basis in 2007. This differs from gross export shares, because gross exports also reflect the cost of intermediate inputs. For both the EU-12 and EU-15, these value added shares of direct KIBS exports have risen from 2001 levels. Including indirect exports, where the KIBS value added is embodied in manufacturing exports, the KIBS intensity of EU exports is even greater, ranging from 8.8 (EU-12) to 18 per cent (EU-15) of the value added contained in European exports in 2007. Like the direct shares, these values are up from 2001 levels. These trends underscore the importance of KIBS activities for EU competitiveness, in this case as measured by exports.

2.5.5. Conclusions

This chapter considered the role of knowledge intensive service sectors in the EU economies as compared to other major economies like the US and Japan. This was done from different perspectives pointing towards the various trajectories the phenomenon of 'quarternisation' (Peneder et al. 2003) might take. Particularly, it was outlined that, first, this 'quarternisation' process is not to be seen as a mere increase of the shares of services in the overall economy but that these services play an increasingly important role of intermediate inputs into manufacturing and into high-tech manufacturing in particular. This was documented by studying the overall shares of intermediate inputs, the respective backward and forward linkages between KIBS and manufacturing and their role in carrying product embodied knowledge flows. Second, there is also an important role of manufacturing industries and firms in the process of an increase of the general share of services as there is evidence that more and more manufacturing firms (in particular firms in high-tech innovation intensive sectors) provide more and more service outputs along their manufacturing goods. Finally, the analyses pointed towards the increasing role of service trade in overall trade, related it to the patterns of trade in high-tech manufacturing goods and the relative importance of imported KIBS services in production costs and the increasing share of KIBS in value added exports.

In more detail, the analyses in Section 2 pointed towards the increasing importance of KIBS in the EU economies and compared these to Japan and the US. Though the increasing importance of KIBS for all economies considered here is clearly seen in terms of rising shares in employment and value added, the regions having lower shares have not increased them in a particularly faster way. The second issue covered in this section was on the role of KIBS as inputs into the total economy and into high-tech manufacturing in particular. The analyses found some evidence on the growing importance of KIBS as inputs in the total economy and particular subsectors, but also a difference between the EU and the US with the EU lagging behind in high-tech manufacturing.

Section 3 outlined the structure and strengths of domestic and international inter-industry knowledge flows. R&D performed within the sector determines only part of the total technology flows in the economy. Technical knowledge embedded in intermediate goods, sourced both domestically and abroad, makes up an important part of the total technology flows, especially in those countries attempting to catch-up with the technological leaders. It is equally important for countries on the global technology frontier and considerably more important for those countries below it. Product embodied knowledge plays an important role in the catching-up of economies below the global technology frontier. At the frontier, economies rely more on domestic R&D performance than on inter industry, domestic or international, technology flows, while for the countries below the frontier, international embodied technology flows are relatively more important. Two dimensions determine the structure of embodied technology flows and their relative importance to intra-industrial R&D performance. The first is the openness of the national economy to international trade, having a strong co-linearity with the size of the economy, and the second is the national position vis-à-vis the global technology frontier. For the catching-up knowledge users, Kaldor's argument that manufacturing is the engine of productivity growth remains valid, as shown by downstream links from manufacturing to KIBS sectors. Inter-industry technology flows from abroad are particularly important. However, for the knowledge supplying economies at the technology frontier, the forward impact of manufacturing on KIBS is substantially diminished relative to the catching-up economies. KIBS have a stronger forward, downstream impact on manufacturing. In these economies KIBS appears to be a significant source of knowledge into the manufacturing industries, alongside the technology generation within these manufacturing industries along with their own R&D performance.

The next section, Section 4, then provided evidence that European manufacturing firms increasingly offer services along with their physical products. The share of services in the output of manufacturing industries increased in the large majority of countries over time. However, service output is still small compared to the output of physical products. The service share tends to be larger in smaller countries and higher in countries with a higher R&D-intensity. EU-12 Member States have lower shares of service output compared to the EU-15. At the sectoral level, there is a higher service share in innovation-intensive sectors, such as the manufacturers of electrical and optical equipment, machinery, or the chemical and pharmaceutical industry. Service output is highest among small and among large firms. Producers of complex, customized products tend to have a higher share of services in output than producers of simple, mass-produced goods. The results clearly show the manifold interactions between KIBS and manufacturing. KIBS are not only an important input for manufacturing, but are also offered by manufacturing firms to gain competitiveness, increase profitability, and generate additional value for customers by offering product-service combinations. KIBS produced by manufacturing firms have a considerable share on total KIBS exports and contribute to trade in services.

Finally, in Section 5 the analyses pointed towards the increasing importance of trade in services and the particular role EU countries play in this field. In particular, the EU-15 has on average stronger revealed comparative advantages in KIBS exports, than in technology-intensive merchandise exports. Further the analyses pointed towards the increasing importance of imported KIBS in the costs structures of manufacturing and the KIBS shares of European and other countries value added exports. The latter show an increasing tendency which points to the particular role KIBS play in EU's external competitiveness.

From a policy perspective this study therefore pointed towards the increasing importance of KIBS in various respects and that, overall, the EU and particularly the EU-15 does not underperform to other major economies like the US and Japan. However, the study also pointed towards the significant differences across EU member states and the lack of any kind of convergence process which might be expected to take place. Thus, the investigated structures and relationships seem to be quite persistent thus that one might be allowed to speak of a general 'quarternisation' process across countries. With respect to the EU countries there have been however significant achievements with respect to the Service Directive which has been fully implemented in most countries over the last years. There are however differences as regards the comprehensiveness and quality of implementation, and these will need to be thoroughly assessed.

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ANNEX 2.1

Measuring direct and indirect flows of R&D activity in the Input-Output framework

Input-Output analysis is ideal for measuring the diffusion of product-embodied R&D. The open Leontief model is best suited for the task as it considers technology and final demand separately. Assuming that the economy is composed of n industries, the output vector x is either consumed as final demand y or used by other industries. In matrix notation, it appears as:

$$x = \mathrm{A}x + y,$$

where A is the technical coefficients matrix. If A is non-singular, it is possible to obtain the Leontief inverse or total requirements matrix B through matrix algebra:

$$x = (1 - \mathrm{A})^{-1} y \equiv \mathrm{B}y,$$

which shows the input requirements, both direct and indirect, for all other producers, generated by one unit of output.

It is assumed that R&D intensity is the vector with components r_i in each industry i measuring gross R&D expenditures over gross output. The intensity vector of *direct* and *indirect* flows of R&D activity t_i into each industry i is obtained as:

$$t = r\mathrm{B}$$

However, this relationship measures intensity relative to final demand, and not to total output. The expression thus implies a double-counting, when the purpose is to estimate the technology intensity of the sector as a whole. Both the backward linkages to industry j and the forward linkages from industry j determine the intensity of product-embodied R&D, before ending up in the exogenous final demand categories of industry j in this expression. Hauknes and Knell (2009), following Miller and Blair (1985), get around this problem by using a modified input-output matrix B^*:

$$t^* = r\mathrm{B}^*,$$

which measures the technology intensity per unit of total output rather than per unit of final demand of the recipient sector j. The elements of B* are given directly by the elements of the ordinary Leontief inverse B, but scaled by the diagonal elements of the B matrix (Hauknes (2011)).

Total knowledge flows k_j into industry j, measured relative to total output, are in this study composed of the domestic R&D intensity within the industry r_j^d, the intensity of domestically generated embodied technical knowledge t_j^d from other sectors, and the intensity of embodied technical knowledge t_j^m contained in imported commodities:

$$k_j = r_j^d + t_j^d + t_j^m = \sum_{i=1}^{n} \left(r_i^d b^*_{ij} + r_i^f m_{ij} \right) = \sum_{i=1}^{n} \left(r_i^d \frac{b_{ij}}{b_{jj}} + r_i^f m_{ij} \right)$$

where b^*_{ij} and b_{ij} are the elements of B* and B, respectively, r_i^f represents the global technology frontier for industry i, defined as the average R&D intensity of the OECD, and m_{ij} is based on imports of inputs from industry i going into industry j. This formulation of the global technology frontier contains a small upward bias in the estimates of international R&D flows, as about one fourth of total trade is with countries below the frontier. Value-added intensities can be obtained by dividing the individual components of R&D in industry j by y_i.

The formulation of the import vector is not obvious. The choice of formulation in this study is to let imports be multiplied in the importing country, i.e. imported R&D flows in the transnational context are treated as similar to own R&D in the domestic context. More explicitly

$$t^m = r^f (A_m B_d^* x + A_m B_d^* A_m B_d^* A_m B_d^* x + \ldots)$$

where A_m is the matrix of import coefficients relative to domestic total output, and B_d^* is the domestic B* matrix for the importing country. This series expansion is rapidly converging; here, just the stated two terms are retained.

The analysis also distinguishes between *direct* and *indirect* flows of knowledge. Embodied knowledge can flow directly from industry i to industry j, or indirectly through other intermediate sectors. Direct knowledge flows from domestic sources are identified as $t_j^d(direct) = r_i^d \frac{a_{ij}}{b_{jj}}$ and indirect linkages as the residual: $t_j^d(indirect) = t_j^d - t_j^d(direct)$. Similarly, direct knowledge flows from international sources are identified as t^m(direct) = $r^f A_m x$. Indirect linkages appear as a residual: t^m(indirect) = $t^m - t^m$(direct). The total knowledge or technology intensity of any domestic sector j, relative to total domestic output of this sector, can therefore be written as:

$$k_j = r_j^d + t_j^d(direct) + t_j^d(indirect) + t_j^m(direct) + t_j^m(indirect)$$

ANNEX 2.2

Measuring intersectoral forward and backward linkages

Rasmussen (1957) and Hirschman (1958) focus on the 'use' of inputs in a single downstream sector *j* to measure backward linkages. They measure the total technology intensity of sector *j,* but do not consider the originating sector. The backward linkage measure of sector *j*, described in Annex 1, overestimates the pairwise inter-linkages between a source sector *i* and a different recipient sector *j* of the economy. The measure $t^* = r\mathrm{B}^*$ gives the total technology intensity of the downstream recipient sector *j*, across all originating upstream sectors *i*. B* gives rise to double counting when the analysis focuses on the intersectoral linkage between *i* and *j*. This suggests that it is necessary to extract the impact of paths that include upstream sectors relative to sector *i* to capture the true total inter-linkage of the pair of sectors *i* and *j*. Given the inter-industrial network structure, the Leontief matrix, the task is then to sum up all direct and indirect paths between the two sectors that start in the source sector and end in the recipient sector, and never pass through any of them along the way. From the perspective of the upstream industry *i*, this is the *forward linkage* (in the sense of *along the flows of traded goods*) of this sector into sector *j*, while from the perspective of the (relative) downstream sector *j*, the same measure describes the *backward linkage* — in the *opposite direction* of trade flows — of *j* into sector *i*.

B^+ is a matrix very similar to B* and measures the downstream impact of R&D performed in any industry *i.* The *i*-component of the total downstream impact t^+ in units of total output of sector *i* is:

$$t^+{}_i = \frac{r_i}{x_i}\sum_k b^+{}_i^k x_k = \frac{r_i}{x_i}\sum_k \frac{b_i^k}{b_i^i} x_k$$

The full *intersectoral linkage matrix* of the economy, given the basic input-output matrix A, is described by a matrix L, whose matrix elements l_{ij} measure the aggregate linkage amplitude l between any two industries *i* and *j*:

$$l_{ij} = \frac{b_{ij}}{b_{ii}b_{jj} - b_{ij}b_{ji}}$$

with b_{ij} being as before the matrix elements of the Leontief inverse B of A (see Hauknes, 2011, for derivation). The denominator is the determinant of the (i, j) 2 x 2 submatrix of B:

$$\mathbf{B}_2(i,j) = \begin{pmatrix} b_{ii} & b_{ij} \\ b_{ji} & b_{jj} \end{pmatrix}$$

Scaling the components of the B matrix eliminates the double counting that results from the interaction between sectors *i* and *j*. The components of the matrix B* (see Box 1) make mathematical sense, but do not make economic sense, because a sum over rows is always assumed to produce a measure of economy-wide impacts on sector *j*. The linkage matrix L above, however, is economically meaningful at the component level, measuring the strength of interaction for the link $i \rightarrow j$, but not when summed. Sums along rows or columns of L have no direct economic meaning.

Import flows need to be included to close the economy. Adding the domestic and import flows together does this, which creates a Leontief A matrix of 'total' flows. Standard procedure generates a total Leontief inverse B, which is then used to calculate the total L matrix. Producer or backward linkages are calculated on the basis of the total connections. Following Jones (1976), the analysis uses the domestic linkages for calculating the user or forward linkages. This procedure implies that imports are treated at the same level as domestic inputs, i.e. the input-output flow structure and its accumulation of the exporting country by the same structures in the importing country is mimicked. The implicit assumption is that all countries are structurally similar in a certain sense. Though conventional and valuable, this is a rough first-order approximation. However, an extension along these lines quickly runs into large data and estimation challenges, even though it is a fairly straightforward extension.

The following modified Rasmussen measures are created in order to describe the strength of intersectoral technology linkages. The relative forward linkages p_a^b and backward linkages u_a^b between the two industry groups *a* and *b* (with the trade flow direction $a \rightarrow b$) can be constructed as:

$$p_a^b = \frac{\sum_{\substack{i \in a \\ j \in b}} r_i l_i^j x_j}{\sum_{\substack{i \in a \\ \forall k}} r_i b^{+}{}_i^k x_k}$$

and

$$u_a^b = \frac{\sum_{\substack{i \in a \\ j \in b}} r_i l_i^j x_j}{\sum_{\substack{j \in b \\ \forall k}} r_k b^{+}{}_k^j x_j}$$

The forward linkage *p* measures the accumulated technology volume from *a* to *b* as a share of the total technology deposits emanating from source sector *a*. The backward linkage *u* measures the same nominator as a share of the total economy-wide deposits into the recipient sector *u*.

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ANNEX 2.3

Description of the dataset used in the regression analysis.

The tables below show the distribution of the firm-level observations across countries, manufacturing industries, sizes of the firms and formation of the firms for different time periods. A taxonomy of firms in different innovation intensities is also provided. This taxonomy builds upon Peneder (2010).

Table A – 2.3.1 Population of the data set. Distribution across countries

Country	Number of observations	Percent
Austria (AT)	188	8.3
Croatia (HR)	63	2.8
Denmark (DK)	154	6.8
Finland (FIN)	0	0.0
France (FR)	93	4.1
Germany (DE)	993	43.9
Netherlands (NL)	186	8.2
Slovenia (SI)	43	1.9
Spain (ES)	56	2.5
Switzerland (CH)	488	21.6
Sum	2,264	100

Table A – 2.3.2. Distribution of population over industries

NACE Rev. 1.1	Sector	Percent
15+16	Food and drink and tobacco	4.8
17-19	Textiles, clothing and leather and footwear	3.0
20+36	Wood and wood products and furniture	7.5
21+22	Pulp and paper and printing and publishing	4.6
23+26+37	Refined petroleum, non-metallic mineral products and recycling	5.3
24	Chemicals	5.1
25	Rubber and plastics	8.0
27+28	Basic metals and metal products	21.1
29	Machinery n.e.c.	21.0
30-32	Office machinery, electrical machinery and Radio, TV & communic. Eq.	8.6
33	Scientific and other instruments	7.9
34+35	Transport equipment	3.1
		100.0

Table A – 2.3.3. Distribution of population across sectoral innovation intensity

Innovation intensity	Percent
Low	1.6
Med-low	8.1
Med	26.9
Med-high	25.8
High	37.5
	100.0

Table A – 2.3.4. Distribution of population across firm sizes

Firm size	Percent
up to 49 employees	39.7
50 to 249 employees	46.4
250 and more employees	13.9
	100.0

Table A – 2.3.5. Distribution of population across firm age

Firm age	Percent
Formed before 1991	74.9
Formed in 1991 to 2000	18.6
Formed in 2001 to 2001	5.8
Formed in 2006 to 2009	0.8
	100.0

3. EUROPEAN COMPETITIVENESS IN SPACE MANUFACTURING AND OPERATION

3.1. Introduction

Two of the momentous events of 1957 were the signing of the Treaty of Rome and, a couple of months later, the start of the space age. In other words, the space age and the EU are the same age and are both now in their sixth decade. It is however only in the last quarter of a century that the EU has developed an interest in space policies, starting with a 1988 communication in which the Commission outlined a coherent EU approach to space (European Commission 1988). Member States had by that time developed their own space policies, as had the European Space Agency (ESA) and its predecessors, the European Space Research Organisation (ESRO) and the European Launch Development Organisation (ELDO), both established in 1964.

Following the 1988 communication, a common EU approach to space gradually took shape (European Commission 1992, 1996, 2000) and the cooperation between the EU and ESA intensified, manifesting itself in joint task forces, joint preparation of ESA and Commission documents (e.g. European Commission 2003a), the 2004 framework agreement on cooperation and coordination, and the creation of the European Space Council drawing together ministers from EU and ESA Member States. The Space Council held its first meeting in 2004 and has since met on six more occasions.

Over the years, as the EU approach to space progressively crystallised there was a growing insight among European policymakers about the need to step up space cooperation activities and establish a truly European space policy (European Commission 2001, 2003a, b). This insight should also be seen in the context of the decisions by the EU to create large-scale development programmes for two flagship projects, Galileo (satellite navigation) and GMES (Earth observation), as well as EGNOS (European Geostationary Navigation Overlay Service). In 2007, the 4th Space Council gave its political blessing to the first European Space Policy (European Commission 2007a). This represented a real step change: prior to 2007 the strategic importance of space had been expressed in several EU documents, whereas the European Space Policy is the first common political framework for space activities in Europe. The resolutions adopted by the 4th and 5th Space Councils in 2007 and 2008 formulated priority areas for Europe with respect to space. More recently, the new role of the EU in space policy is reflected in the Treaty on the Functioning of the European Union which gives the European Space Policy a legal basis and confers on the EU competence, shared with its Member States, to 'draw up a European space policy' in order to promote, among other things, industrial competitiveness (Article 189 TFEU). The same article also mandates the European Parliament and the Council to 'establish the necessary procedures, which may take the form of a European space programme'.

Against the backdrop of these developments and with a view to the future, this chapter reviews the competitiveness of EU space manufacturing and operations. It also identifies the factors that are key to the future competitiveness of the sector, as well as potential obstacles to further development.

3.1.1. Recent developments reflecting the new Treaty provisions

In 2011 the Commission adopted a communication taking stock of the new situation and outlining the way forward. It listed the following objectives of the European Space Policy: the promotion of technological and scientific progress; industrial innovation and competitiveness; enabling European citizens to reap the benefits of space applications; and a higher European profile on the international stage in the area of space (European Commission 2011). Moreover, it made the case for a European space *industrial* policy, the main objectives of which would be 'the steady, balanced development of the industrial base as a whole, including SMEs, greater competitiveness on the world stage, non-dependence for strategic sub-sectors such as launching, which require special attention, and the development of the market for space products and services' (European Commission 2011).

In response to the Commission communication, the Council on 31 May 2011 adopted a set of conclusions in which it confirmed as the top EU priority the implementation of its two flagship programmes: on the one hand GMES (Global Monitoring System for Environment and Security), on the other EGNOS and Galileo. Security and space exploration were also mentioned as priority areas. The Council lent its support to the Commission with regard to the need for a space industrial policy along the lines outlined in the Commission communication. The conclusions ended with an invitation to the Commission to organise broad consultations and discussions on the main elements of a possible future European space programme.

3.1.2. Interaction with other EU policies

The European Space Policy is intrinsically linked to other EU policies and should be seen in the context of the Europe 2020 strategy (European Commission 2010a). Two of the flagship initiatives of the strategy are the Innovation Union (European Commission 2010c), to which the space sector contributes by virtue of its innovative potential, and the new industrial policy for the globalisation era (European Commission 2010d) which singled out the space sector as a target for sector-specific initiatives under the new competences conferred by Article 189 of the Treaty.

Other EU policy areas which the European Space Policy supports include transport, agriculture, security, crisis management and humanitarian aid, telecommunications, environment and climate change. In these and other areas, there is an opportunity for the European Space Policy to help achieve policy objectives.

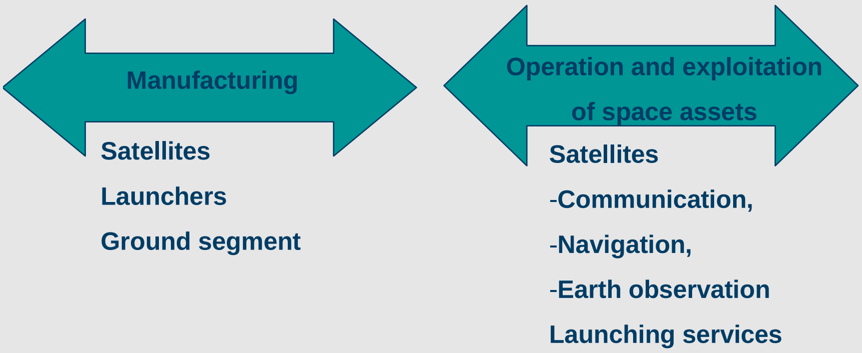
3.1.3. Defining the EU space sector: space manufacturing and operations

Before defining the sector, it is important to underline that the atypical character of the space sector means that an analysis of its competitiveness will differ from more traditional analyses and will need to take into account its specificities. The most striking difference is that the space sector is to a large degree financed by public funds while at the same time many of its customers are public institutions. Another distinguishing feature is that production series are often very short and sometimes a single unique product is required. The technical and financial risks in space activities are higher than in most other sectors (BIS 2010). Finally, specific and divergent procurement policies are in place, in Europe as well as globally, and there is a growing trend towards self-sufficiency, notably due to the strategic and dual-use character of the space sector and the arrival on the international stage of emerging space-faring nations.

Notwithstanding the specific characteristics of the EU space sector, this chapter will illustrate its performance in comparison with its competitors and how it contributes to EU competitiveness in general.

Box 3.1: Definition of the EU space sector

For the purposes of this chapter the EU space sector is defined as three manufacturing segments – satellite, launcher, ground segment manufacturers – and four operation or exploitation segments: communication satellites, navigation satellites, Earth observation satellites, launching services. This definition is illustrated below.



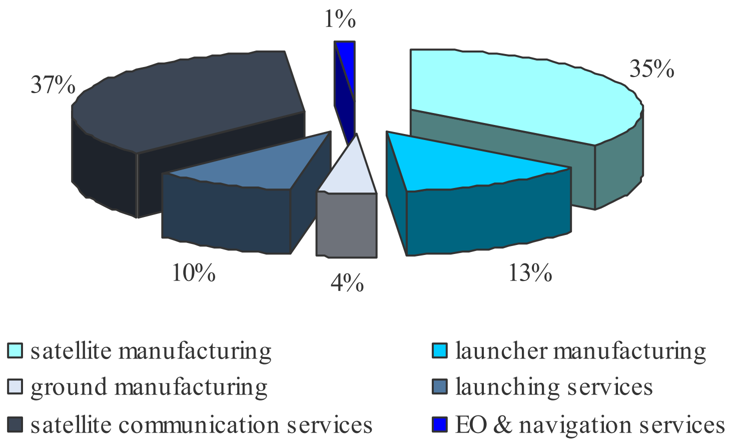
The definition excludes upstream suppliers (for instance of electronic components) as well as downstream service providers and applications based on space data but operating without space assets of their own. In several previous analyses of the space sector, such downstream service providers and application producers have been defined as part of the space sector by virtue of their importance in terms of turnover, job creation, etc. In this chapter they are defined as customers of the space sector. In other words, the sector definition used in this chapter excludes the part of the value chain with possibly the greatest impact on the EU economy: space-enabled services and applications.

3.2. Characteristics of the EU space sector

3.2.1. Turnover

In 2009, the consolidated turnover of the EU space sector as defined in Box 3.1 was EUR 10.3 billion (final sales), an increase of 1.9% from 2008. The breakdown by segment is illustrated in Figure 3.1. Satellite manufacturing and communication satellite services are the most important segments, between them generating more than two thirds of total final sales, followed by launcher manufacturing and launching services with almost a quarter of total final sales between them. Ground segment manufacturing, Earth observation services and satellite navigation services are much smaller in terms of turnover.

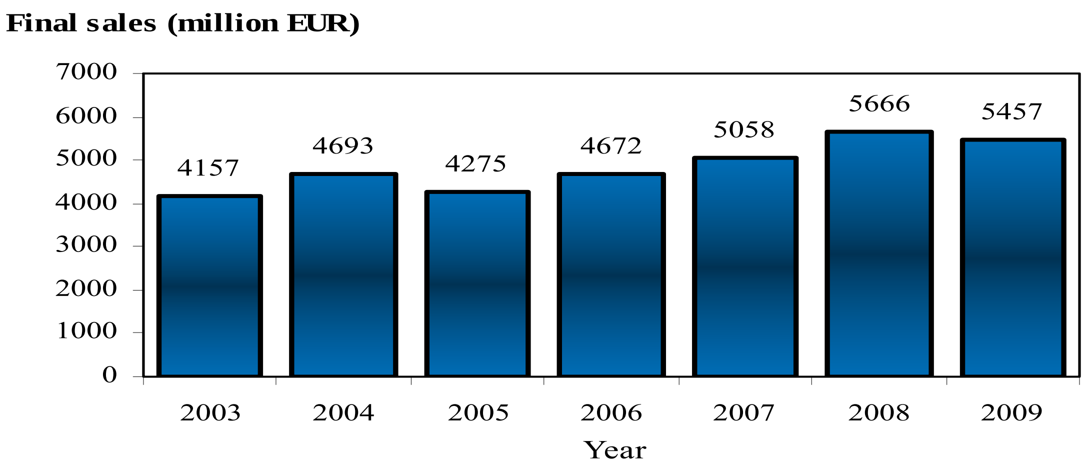
Figure 3.1: Final sales 2009, EU space sector by segment



Source: Background study.

Turning specifically to the three manufacturing segments, for which better data are available than for the operation segments, Figure 3.2 illustrates annual turnover from 2003 to 2009. Turnover in manufacturing was considerably higher in recent years than in 2003–2006 (also in volume terms when expressed in constant prices) but sales have not yet reached the same volumes as the peak in 1999–2001 (not shown in Figure 3.2).

Figure 3.2: Consolidated final sales of the EU space manufacturing segments, 2003–2009



Source: Eurospace (2010).

The three manufacturing segments make up just over half of total sector turnover, the four operation and exploitation segments making up slightly less than half. In spite of data on the latter four segments not being available to produce a graph such as in Figure 3.2, the general impression is that sales in those four segments have been increasing over time in line with the three manufacturing segments depicted in Figure 3.2.

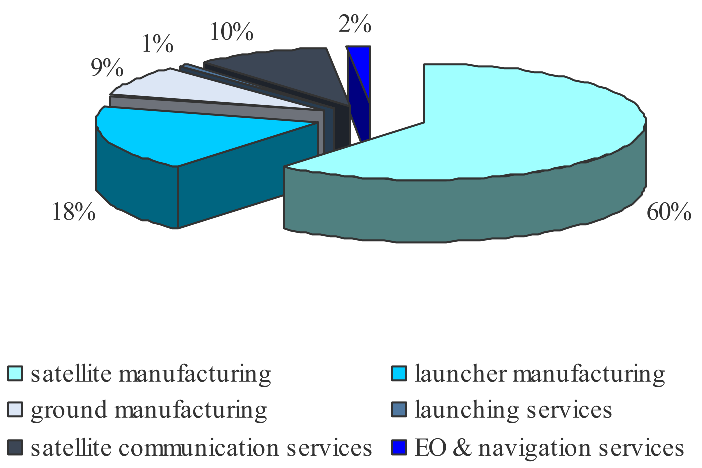
3.2.2. Profitability

No profit margins for the different segments of the EU space sector are available, but according to estimates the average profit margin (as a percentage of turnover) is low, around 3 per cent. This comparatively low level is due less to fierce international competition than to the structure of the sector, with a large proportion of public funding and influence (see 3.4.1 below) resulting in contractual profit agreements.

3.2.3. Employment

The EU space sector as defined in Box 3.1 is estimated to have directly employed around 35 730 persons in 2009 (full-time equivalents). Figure 3.3 illustrates how the vast majority are employed in satellite manufacturing, followed by launcher manufacturing. The operation and exploitation segments account for a relatively small part of employment despite generating nearly half the turnover of the sector.

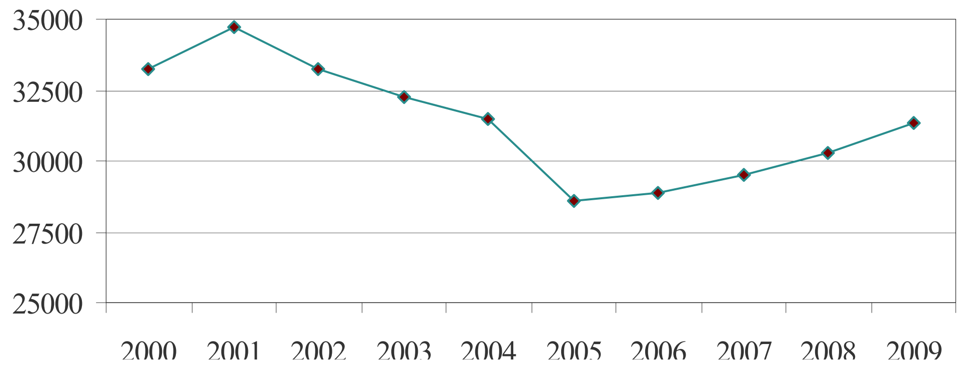
Figure 3.3: Direct employment in the EU space sector, 2009



Source: Background study.

Again concentrating on the three manufacturing segments, Figure 3.4 illustrates how employment in space manufacturing has evolved from 2000 to 2009. Since 2005, direct employment in space manufacturing is increasing again after years of consecutive job cuts, but even so the number of jobs in 2009 stood around 10 per cent lower than at the peak in 2001.

Figure 3.4: Direct employment in EU space manufacturing, 2000–2009



Source: Eurospace (2010).

From a geographical perspective, employment in space manufacturing is relatively concentrated in a few countries. In 2009, France employed more people in the space sector than any other Member State (11 225), followed by Germany (5 270) and Italy (4 490).

3.2.4. *Turnover per employee as proxy for labour productivity*

A major shortcoming of most analysis of the space industry, including this chapter, is the lack of data on productivity. Because space manufacturing is capital-intensive rather than labour–intensive, the best measure of productivity would be total factor productivity but unfortunately data on capital intensities are not available. Labour productivity therefore is only a small part of the picture, but even there data availability is a problem. Ideally, it ought to be calculated as value added per hour worked, but neither is available for the space sector. Analysts have in the past resorted to using turnover per full-time equivalent employee as a proxy for value added per hour worked, but as a proxy it has several potential shortcomings (apart from ignoring the capital intensive-nature of the sector as outlined above):

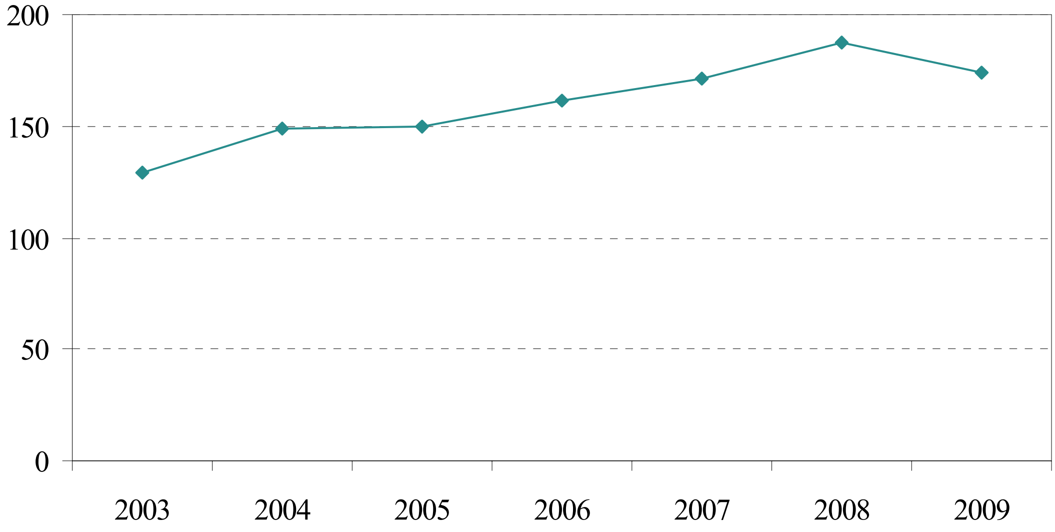
- Turnover in a high-technology sector such as space is higher than in other sectors because the value of inputs is higher. Any comparison across sectors based on turnover per employee is therefore flawed, as is any comparison of segments within the space sector.

- Turnover encapsulates a multitude of factors unrelated to labour productivity such as the business cycle, market developments, and competition.

- Specifically for a sector driven by public institutions such as space (or defence), turnover can go up or down depending on political decisions and as a consequence of contractual price agreements between public institutions.

With these caveats in mind, Figure 3.5 depicts the evolution of turnover per employee in EU space manufacturing (full-time equivalents) in recent years. It can be seen that turnover per employee has increased in all years except 2005, when it was unchanged, and 2009, when it fell. Falling labour productivity in 2009 is however only one of several possible causes for the fall in turnover per employee.

Figure 3.5: Turnover per employee (thousand €) in EU space manufacturing, 2003–2009



Source: Background study.

Average turnover per employee in EU space manufacturing in recent years has been around € 160 000 per year. This is comparable with international figures for space manufacturing but clearly higher than other sectors of the EU economy, for the reasons outlined above.

3.3. Policy and regulatory environment of the EU space sector and framework conditions

3.3.1. Policies

In 1975, the European Space Agency (ESA) succeeded the European Space Research Organisation and the European Launch Development Organisation, both with their origins in the 1960s. ESA is an intergovernmental organisation providing and promoting cooperation among European states in space research and technology and their space applications. Since the establishment of ESA, European space policy has been successfully developed within its framework by its Member States. At the brink of the new millennium European leaders recognised the need for a more comprehensive and truly European space policy. In 1999, ministers asked the ESA Executive and the Commission to develop a coherent European strategy for space (European Commission 2000). The strategy was built around three objectives:

- Strengthening the foundations for space research
- Enhancing scientific knowledge
- Reaping benefits for market and society

This was followed by the establishment of a joint Commission-ESA task force to further develop the strategy and draw up proposals for its implementation (European Commission 2001). The cooperation between ESA and the Commission was strengthened through the establishment of a framework agreement between the two parties formalising their cooperation and coordination. The agreement entered into force in 2004 and has since been extended until 2012. The framework agreement defines the roles of ESA and the Commission as follows:

- ESA will continue to focus on space launches, science, exploration and human space flight.

- The Commission will concentrate on space applications and the overall coordination of the European Space Policy.

ESA has made significant research efforts, including in the Ariane and ARTES (Advanced Research on Telecommunication Satellite Systems) programmes which have driven research, development and innovation in the relevant parts of the EU space sector.

The European Space Policy concerns the medium and long-term use of space for the benefit of Europe, notably in terms of the environment, security and competitiveness. In this respect, the development of flagship programmes such as the satellite navigation system Galileo/EGNOS and the Global Monitoring System for Environment and Security (GMES) has been a cornerstone and has influenced the EU space sector tremendously, in particular through the vast research effort that has gone into these two programmes (Alberti 2008). As set out in European Commission (2011), the aims of the space policy are to promote technological and scientific progress, stimulate industrial innovation and competitiveness, enable European citizens to reap the benefits of space applications, and raise Europe's profile on the international stage in the area of space. In order to achieve these goals, Europe needs to ensure independent access to space.

3.3.2. Regulatory conditions

There are six regulatory conditions with a major impact on the European space sector:

- Standardisation and interoperability with respect to satellite operations. Standardisation improves industrial competitiveness and efficiency and is important for all three application sectors of the satellite industry (communication, navigation, Earth observation).

- The national space law of the Member States, which is not uniform across the EU.

- Export control rules, especially concerning dual-use goods.

- WTO law concerning space goods and services (Euroconsult 2010).

- Legislation on the transfer of space objects.

- Code of conduct for outer space activities (Listner 2011).

Additionally, procurement policy is an important regulatory condition, as the principle of geographical return (applied by ESA) has an important impact on the space sector, while at the same time current EU procurement rules may not be ideally suited for major flagship programmes such as Galileo and GMES (Hobe et al. 2010).

Finally, the availability of radio frequency spectrum is a factor which might hamper the development of satellite communication and satellite navigation. On the one hand, there are spectrum shortages in terms of competition between space users as well as with terrestrial technologies; on the other hand there is a risk of potential overlaps on certain bands used for satellite navigation (US National Security Space Strategy 2011).

3.3.3. Framework conditions

The most relevant framework conditions affecting the sector are:

- Labour market: the high-technology engineering industry depends on the availability of a flexible and highly skilled labour force, the supply of which is scarce in the EU.
- Openness of third markets: main parts of the non-European market are closed to European manufacturers and operators, for instance the satellite and launch segments of the market.
- Access to finance: a range of financial instruments can offer a competitive advantage.
- Research, development and innovation are also essential for the functioning of the space industry, have made the EU industry what it is today, and are key to maintaining its position in a competitive environment in which emerging space nations with their own space industry are trying to gain market shares.

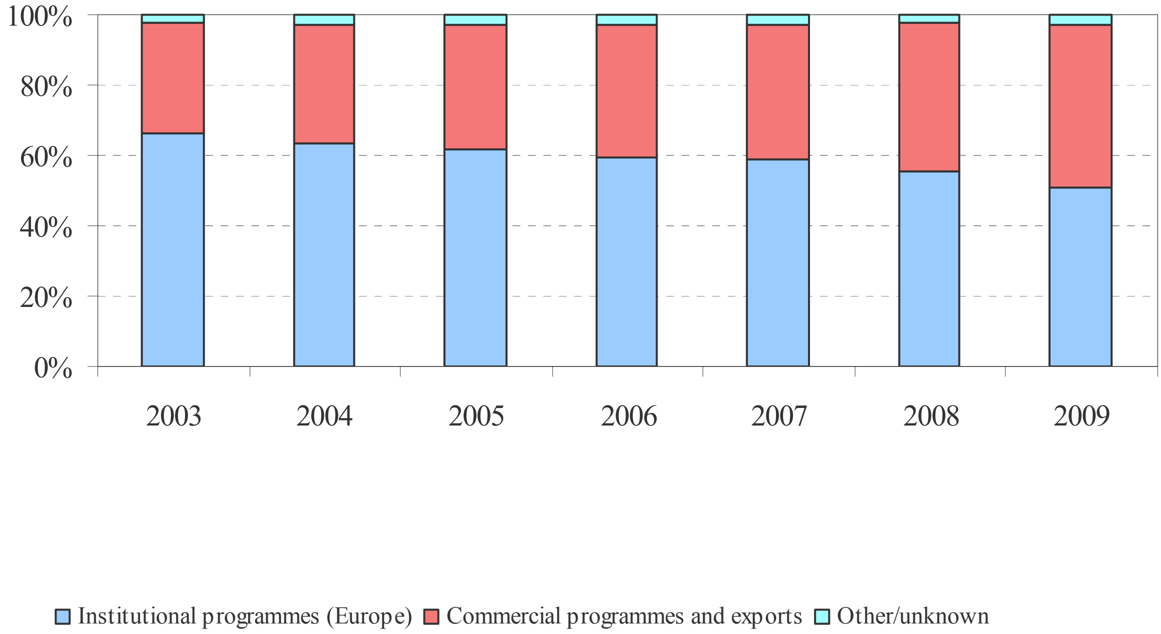
3.4. Results of the analysis

This section addresses the competitiveness of the EU space sector, its industry structure and, in that context, customer types and concentration developments in the sector. Furthermore, the topic of R&D and innovation in the space sector is reviewed. In addition, the EU space sector is benchmarked against its US competitor as well as against two reference EU sectors, followed by an assessment of its strengths and weaknesses, as well as the opportunities and threats facing the sector.

3.4.1. Largely institutional customer base

The space sector is to a large extent driven by public funding and institutional customers, globally more so than in the EU. As Figure 3.6 illustrates, half of final sales of the space manufacturing industry in 2009 went to European institutional customers. However, the share of European institutional customers for the European space sector as a whole declined from 2003 to 2009. The figure shows that as a percentage of total turnover, the share of institutional programmes has declined, while sales to commercial programmes and exports have become more important (sales to non-European institutional customers are included in the export share). That only half of final sales go to institutional customers is unique by international standards: in other parts of the world, the industry depends much more on institutional orders.

Figure 3.6: EU space manufacturing, final sales by customer category, 2003–2009



Source: Eurospace (2010).

The operation and exploitation segments of the EU space sector are less institutionalised than the manufacturing segment. This is due to the satellite communication industry which serves many commercial customers. Earth observation and satellite navigation, on the other hand, are characterised more by institutional than commercial demand.

A more detailed look into the composition of final sales in 2009, the final year in Figure 3.6, reveals that launchers and communication satellites between them made up virtually all sales to commercial customers and around a quarter of sales to European institutional customers. Earth observation systems made up roughly another quarter of institutional sales. Navigation systems, science systems, ground stations and human space infrastructure (notably the International Space Station) accounted for most of the remaining half of final sales to European institutional customers in 2009.

Of all institutional sales within the EU, roughly two thirds were destined for ESA, here again mainly in areas such as Earth observation, human space infrastructure, scientific systems and launcher systems.

Unlike its competitors, by far the largest share of sales of the European space industry is accounted for by civilian systems. Table 3.1 shows that in 2009 military systems made up only 12.7 percent of total final sales of nearly EUR 5.5 billion. Half of the military systems were purchased by military customers (6 per cent of final sales) while the other half (also 6 per cent of final sales) were sold to civilian customers.

Table 3.1: Sales of civilian and military systems to civilian and military customers 2009

Final sales (EUR million)	Civilian systems	Military systems	Total
Civilian customers	4766	341	5107
Military customers	–	350	350
Total	4766	691	5457

Source: Background study.

3.4.2. High degree of concentration

The EU space sector is dominated by a few large companies, a direct result of the special nature of this niche sector with relatively high intensities of technology and capital, producing strategically important output with in many cases dual uses, and a high reliance on specific technology components along the value chain. Consolidation and industry verticalisation have been the logical responses to such characteristics – over the past decade there have been a high number of mergers and acquisitions within the sector, both in the manufacturing segments and in operations and exploitation. The 30 largest space business units in the EU space sector account for 78 per cent of total sector employment. A large number of smaller players employ the remaining 22 per cent. On the whole though, the barriers to entry – costs, infrastructure, know-how and risks – are very high and this is a sector where SMEs are rare, notably due to the small market. The sector also has a history of SMEs being acquired by and integrated into existing large companies. This process of vertical integration is driven by a desire to secure permanent access to strategically critical components and systems and deprive competitors of such access. On several occasions the integration process has been guided by EU competition rules.

For much the same reasons, and also for historical reasons, the EU space industry is mainly concentrated in a small number of Member States with a long-standing commitment to invest in it, notably France, Italy, Germany, the UK, Spain and Belgium. There are several Member States with virtually no involvement in the EU space sector as defined in Box 3.1.[52]

3.4.3. Strong EU research effort but modest by international standards

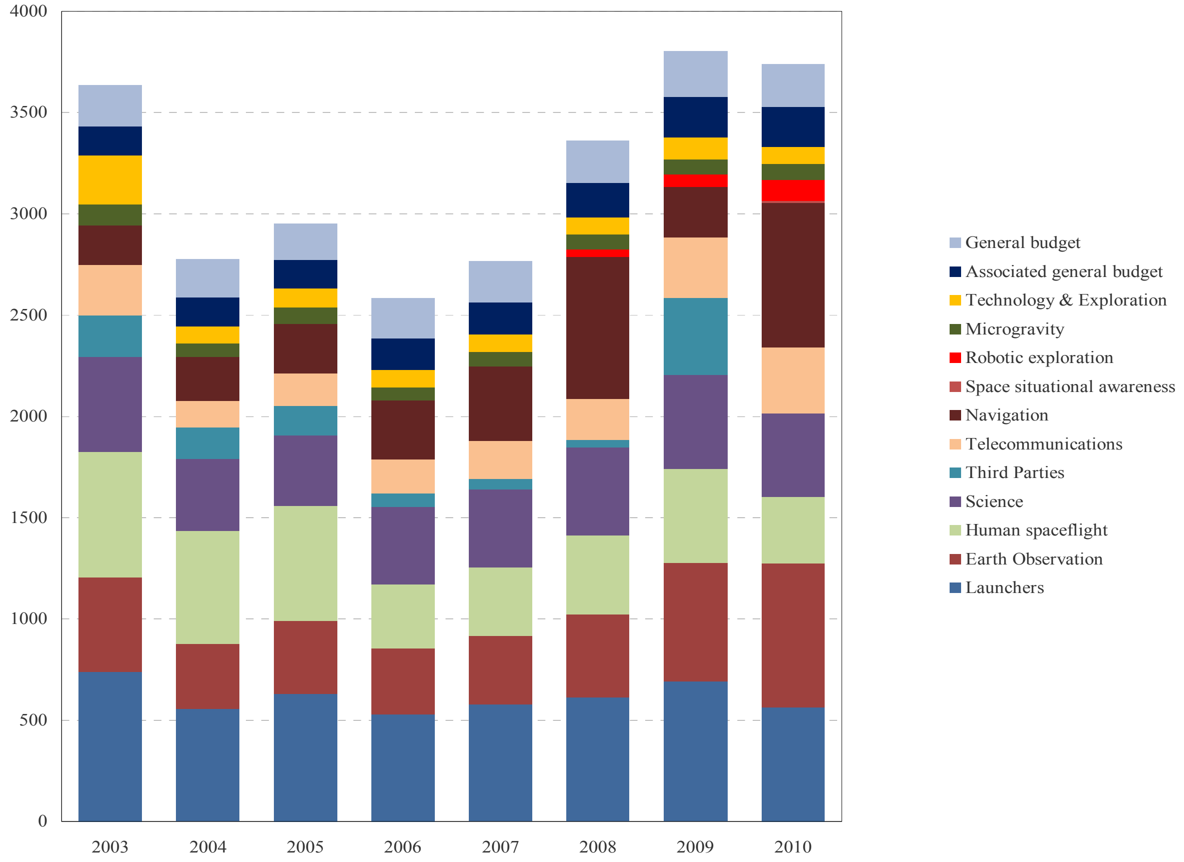
3.4.3.1. Research, development and innovation

Due to the innovative nature of the sector, research, development and innovation are of crucial importance. Total R&D is estimated to account for 10 per cent of unconsolidated sales turnover of the EU space sector. Internal R&D investments by companies in the sector account for roughly one third of the total. In general, the industry prefers improving existing products and technologies over inventing new groundbreaking technologies (ESA 2010), possibly due to the large scale of space project investments, which could cause companies to be more risk-averse, but possibly also due to the involvement of ESA in technology development. In fact, ESA is the source of most of the funding of R&D in the EU space sector.

[52] On a related note, only 17 EU Member States are members of ESA, while a number of the remaining EU Member States are 'European Cooperating States' in ESA terminology.

Figure 3.7 illustrates the priorities of ESA as reflected in its annual budgets 2003–2010, and in particular how its priorities have evolved over time. It shows how the budget resources allocated to human space flight have been cut in favour of areas such as Earth observation, telecommunications and navigation. It is also interesting to note that throughout the economic and financial crisis the members of ESA have made sure to maintain ESA funding at a higher level than in previous years (Euroconsult 2010). A similar development has taken place at other space agencies around the world in response to the crisis.

Figure 3.7: ESA budget, 2003–2010 (million €)



Source: ESA annual reports; ESA (2010).

In parallel with ESA, space continues to be an important thematic area in the EU framework programmes on research, technological development and demonstration activities, notably in the thematic area 'Space' under the current framework programme (FP7). Specifically, FP7 provides R&D support to the 'exploration of space' area as well as research and technological development support for facilitating the development of space foundations. Over the entire 2007–2013 period covered by FP7, around EUR 670 million will be allocated for services and strengthening space foundations, mainly for GMES development. A total of EUR 710 million will be spent on improving space infrastructure.

In an international context though, the funding of European R&D pales into insignificance in comparison with the US where the 2009 budget of NASA alone was more than USD 18 billion and a considerable share of public resources for space research comes not from NASA but directly from other public agencies. ESA is in second place in terms of budget, followed by its Japanese counterpart, whose budget was USD 3.7 billion in 2009. The space research budgets of China and Russia are not known but can be assumed to be of at least the same order of magnitude as those of ESA and Japan. India is in sixth place with a budget of just over USD 1 billion in 2009.

3.4.3.2. Technology development and non-dependence

Partly because of a desire to have unrestricted access to space and to downstream application markets, partly as a result of stricter US export control requirements – the USA being the leading space technology producer in the world – a growing trend towards non-dependence in space has been observed around the world over the last decade. The central piece of legislation in this context is the International Traffic in Arms Regulations (ITAR), designed and implemented by the United States in the 1970s but since the end of the Cold War extended to apply also to the export of US satellites and components.

The EU space sector uses a number of components and technologies produced outside Europe, mainly in the United States. These include state-of-the-art technologies that are essential for the optimal performance of the space systems produced in the EU. Less-than-perfect substitutes are occasionally available but compromise the overall performance of the systems. There is an increasing political awareness in the EU that the availability of critical technologies should not be subject to political or economic decisions beyond EU control. Although most US technologies are available to EU producers, significant delays and (administrative) costs can occur, as well as complications if systems containing ITAR components are re-exported. Such delays and complications have given rise to the trend towards EU non-dependence, which differs from independence in that its aim is for the EU space sector to have free, unrestricted access to any needed space technology. The purpose is to avoid depending on a single source of supplies.

A similar awareness has emerged also in other parts of the world, notably as a result of the stricter export control requirements in the United States. Emerging space nations such as China, India, South Korea and Brazil are therefore making great strides to develop their own space industries and become independent of the EU and US space sectors, until now the main exporters.

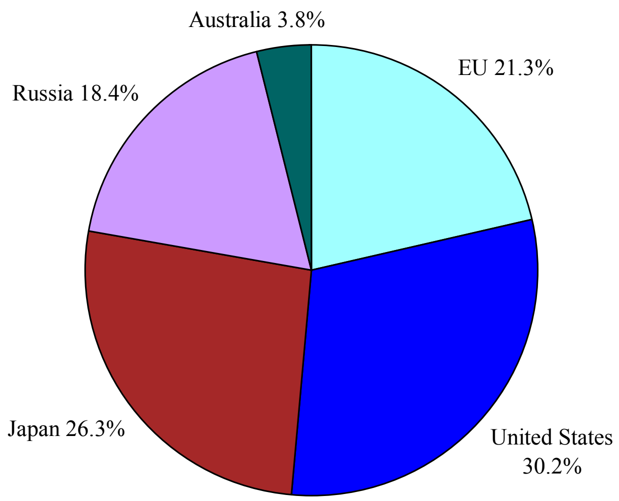
In 2008, the Commission, ESA and the European Defence Agency (EDA) set up a Joint Task Force with the aim of addressing critical space technologies for European strategic non-dependence. The task force drew up a list of priorities for critical space technologies for 2009 and proposed a methodology for a coherent EU-wide approach to technology development. For example, JTF (2010) lists 25 critical items for which immediate action is required. The overall aim of harmonising technology development at EU level is to fill strategic gaps and minimise unnecessary duplications, consolidate capabilities and arrive at a coordinated European space technology roadmap for the future. Given the role of technology as a crucial performance factor in the space sector, this effort aimed at achieving synergies in R&D investments and minimising duplications in technology development has consequences for the functioning of the sector. It underlines the special nature of the sector, driven more by political and public considerations and dual-use aspects than by economic factors, especially with regard to hardware development.

While politically such non-dependence efforts may be understandable, some might argue from a strictly free-trade point of view that such efforts lead to considerable inefficiencies globally, however from the point of view of the involved space-faring nations and regions it is rational. Technology development is expensive and so is parallel development of state-of-the-art technologies in several fields in several countries (reversing in part the earlier trend of specialisation). Even so, in all likelihood the political reality will continue to determine future developments of critical technologies and non-dependence, and the actions of China and the United States will influence future developments in this area more than any other space-faring nation or international organisation.

3.4.3.3. Patents

Patent analysis provides another means of assessing the innovative strength of the EU space sector. In particular, the number of patents filed at the European Patent Office (EPO) by country gives an indication of how many new successful technologies are brought to the market, bearing in mind that not all patents are commercialised. Figure 3.8 shows the total volume of patent applications filed by geographic location for the patent classification B64G, ‘Cosmonautics; Vehicles or equipment therefor’. Cosmonautics in this definition encompasses ‘all transport outside the Earth’s atmosphere, and thus includes artificial Earth satellites, and interplanetary and interstellar travel’. The scope of this analysis is limited to these rather technical products, but because patents are usually only required for innovative manufactured products, a more technically-oriented definition of the space sector is likely to capture most patent activity.

Figure 3.8: Space patent applications filed at EPO by country of applicant, 1999–2009



Source: European Patent Office Espacenet.

Japan and the United States filed the most EPO patents applications during the period 1999-2009, followed by the EU and Russia. This gives an indication of the relative innovative strength of these three countries and the EU in the cosmonautics sector, notwithstanding the well-known criticism of patent analysis that the number of patent applications does not say anything about the value of the innovations protected by the patents.

The contribution of European countries to total EPO patent applications filed in the industry is relatively small, around 21 per cent. In Europe, German applicants were the most active, having applied for 659 patents during the period (9.9 % of the world total), followed by France (333), Austria (137) and Spain (108). The dominance of German patent applications in this sector is somewhat surprising as France has the largest space manufacturing industry in Europe and the German space industry is relatively more focused on space services.

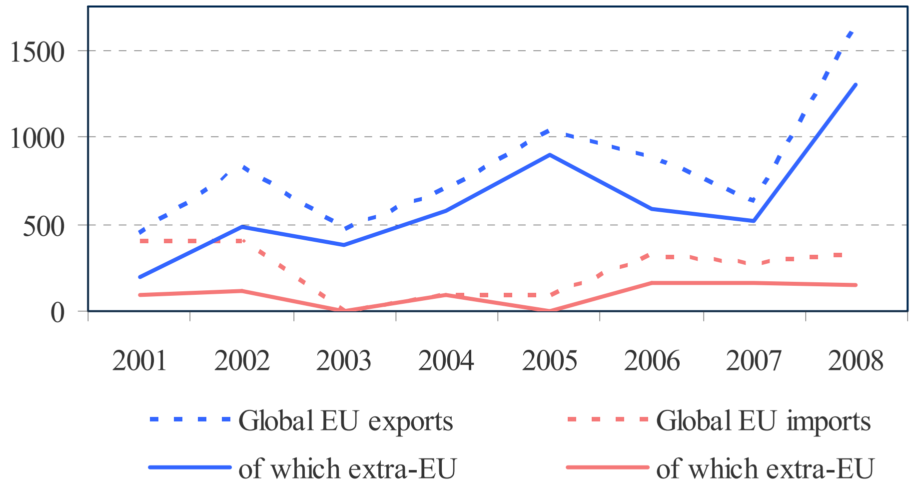
The share of patent applications emanating from EU applicants is surprisingly small, notably in comparison with other high-technology sectors such as nanotechnology, photonics, micro and nanoelectronics, industrial biotechnology, advanced materials, and advanced manufacturing technologies. As reported in last year's European Competitiveness Report, European researchers and institutes were behind between a quarter and half of all patent applications at EPO in these six key enabling technologies (European Commission 2010e). It would therefore be reasonable to expect a similar share of EPO patent applications in the space sector, in particular as several of the key enabling technologies are directly or indirectly linked to space applications (ESPI 2010b).

Finally, it needs to be borne in mind that although the European Patent Office is an internationally renowned patent office, there are other patent offices around the world with an international catchment area, notably the USPTO and Japan's JPO. Due to potential home bias, EPO data may actually exaggerate the importance of European applicants on the global market for patents. Therefore Figure 3.8 may exaggerate the true relative weight of Europe in international patenting in the space sector.

3.4.4. Trade balance of the EU space sector

The EU space sector has a strong export position on the world market. Figure 3.9 shows EU exports of space systems and components worldwide as well as to non-EU countries from 2001 to 2008. It also shows EU imports, worldwide as well as from non-EU countries, for the same period. The difference between the two export curves can be interpreted as intra-EU exports, while the gap between the two import curves shows intra-EU imports (and as such should be the same as the distance between the two export curves). The distance between the two solid lines represents Europe's trade surplus with the rest of the world.

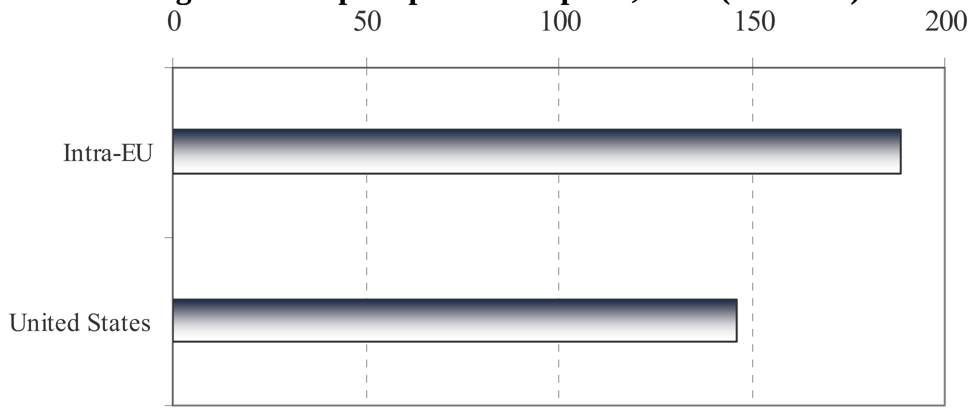
Figure 3.9: Total European exports and imports in value (million €), 2001–2008



Source: ITC Trademap.

In line with the findings for employment and turnover in the sector, the trade flow analysis shows that the EU space sector was growing strongly in 2008. Figures 3.10 and 3.11 below show the main trading partners of the EU in 2008. Figure 3.10 shows the countries of origin of the space products imported into the EU and indicates that apart from intra-EU imports, the only country with a significant export value in 2008 was the United States, which exported € 146 million worth of space systems and components to the EU. The importance of the internal EU market is highlighted by the fact that EU customers (final customers or the space industry) imported most of their final or intermediate products from other Member States (worth € 189 million). The predominance of intra-EU over US imports might give credence to complaints from the US space sector that its worsening competitive position is due to the US export control rules described in Section 3.4.3. According to the analysis presented here, EU companies import thirty per cent more from companies in other Member States than from the United States. Export control rules are however unlikely to be the only factor holding back US space exports to Europe.

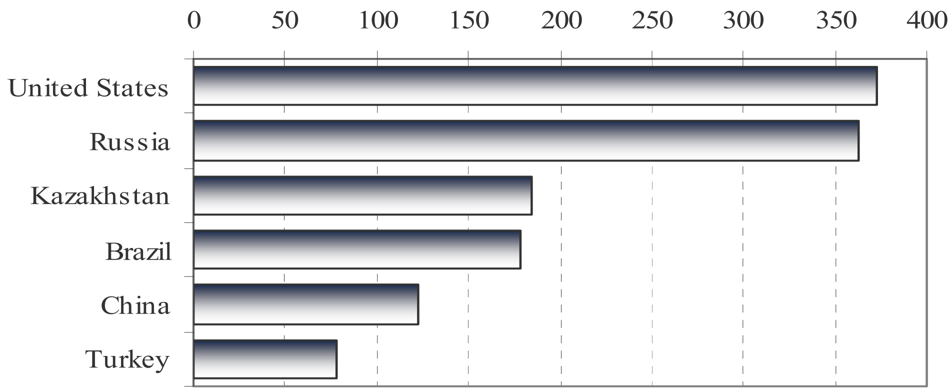
Figure 3.10: Main origins of EU space product imports, 2008 (million €)



Source: ITC Trademap.

Figure 3.11 shows the main trading partners for EU exporters of space systems and components. Out of the total EU export value of € 1.6 billion in 2008, most went to the United States and Russia. Unlike imports, EU exports were destined for a more diverse set of countries which included fast-developing space nations such as Kazakhstan, Brazil, China and Turkey. In addition to the six importing countries in Figure 3.11, there were also significant exports within the EU (not shown in Figure 3.11), as discussed in the context of Figure 3.10.

Figure 3.11: Main destinations for EU space product exports, 2008 (million €)



Source: ITC Trademap.

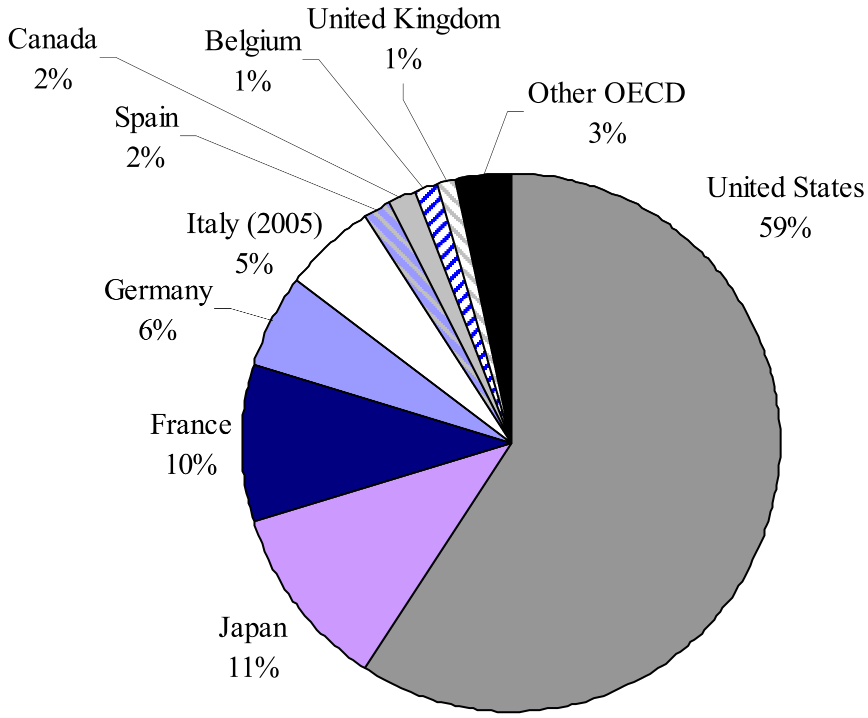
3.4.5. The EU space sector benchmarked against its US competitor

The US space manufacturing and operation sector is the world's largest and most established space industry with revenues of close to $ 40 billion in 2006, significantly more than the € 10 billion turnover of the EU space sector. However, the US space sector is heavily supported by domestic institutional spending. In 2009, the US government injected $ 64 billion into the space industry, almost ten times the $ 6.7 billion from the European Space Agency and the EU combined in support of the EU space sector. Such funding obviously helps inflate turnover of the US space sector, and because only part of the global space economy is accessible to European space companies, the spillover effects on the EU space sector are limited.

Concerning the ratio of R&D to turnover, the EU space sector seems to be investing slightly more in research and development than the average US firm, but the numbers are not strictly comparable. EU space firms spend on average 10 per cent of turnover on R&D compared to around 5 percent in the United States; however, the latter share increases if US (indirect) public funding via military projects or from other government sources is included.

In absolute terms though, Figure 3.12 shows that more than half of all publicly-funded space R&D in the world is funded by the United States, while EU public funding accounts for around a quarter of international public funding of space R&D (OECD 2007).

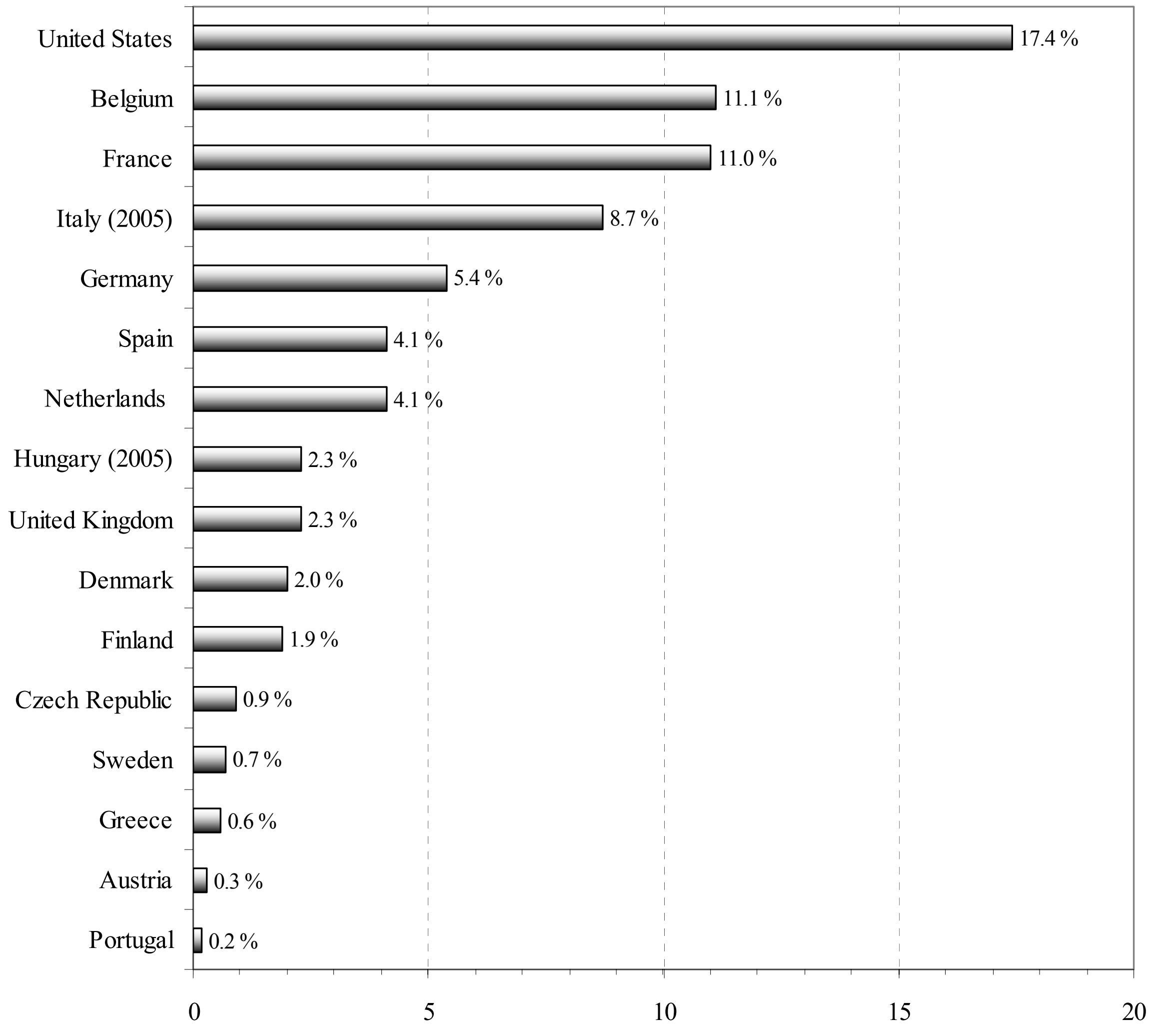
Figure 3.12: Breakdown of total OECD R&D for space, 2004



Source: OECD (2007).

The USA is also the country with the highest proportion of space research in the total composition of publicly-funded R&D, followed by Belgium, France and Italy as shown in Figure 3.13.

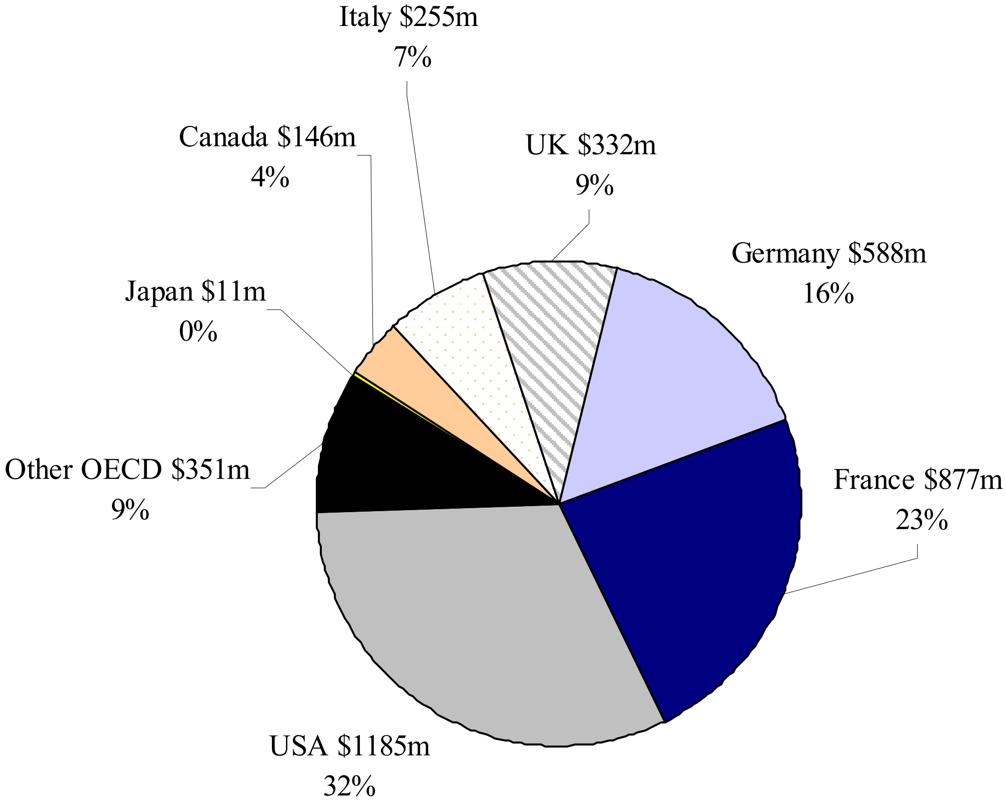
Figure 3.13: Space R&D as a share of government R&D budget in selected OECD countries, 2004



Source: OECD (2007).

As pointed out in Section 3.4.4, US companies claim to suffer from stringent export control rules and are only moderately optimistic about their future competitiveness in the world market. In a study of more than 200 companies or business units in the US space sector in 2007, 58 per cent gave US export control rules as the most important barrier to entering foreign markets (US Department of Commerce 2007). Even so, the United States is the largest exporter of space products in the world with a market share in 2004 of 32 per cent (OECD 2007), followed by France (23 %), Germany (16 %), the UK (9 %) and Italy (7 %). The EU as a whole exported considerably more than the US space sector and had a market share of more than 55 per cent. The EU and the United States are the only major exporters in the world, with a combined market share of almost 90 per cent.

Figure 3.14: Space product exports from selected OECD countries in 2004 (export value and share of total)



Source: OECD (2007).

In 2008, the bilateral trade balance between the EU and the USA showed a surplus for European companies, but in other years the United States has had a surplus in space products (in 2007, for instance). An analysis of the bilateral trade flows shows Europe and the United States to import and export more space products than any other part of the world, with large fluctuations in export and import values from year to year. The fact that the two main exporters run large trade surpluses with respect to the rest of the world is a signal of their importance on the world market. It is likely though that the export control requirements in place in the USA significantly hamper its export position on the world market, especially in satellite manufacturing and for certain export destinations. Without these strict requirements, it is reasonable to expect that the US position in global trade could be stronger. The EU space sector has to some extent been able to benefit from the self-imposed US restrictions by offering 'ITAR-free' systems and components for export to destinations affected by the restrictions. At the same time EU exports have been adversely affected by the restrictive rules as the rules make it difficult to re-export systems containing ITAR components.

3.4.6. The EU space sector benchmarked against the aeronautics and defence sectors

A comparison between three related and in some respects similar EU sectors – space, aeronautics, defence – reveals that the EU aeronautics industry is the largest of the three in terms of employment and turnover, while the space industry as defined in Box 3.1 is the smallest:

– EU space sector turnover: EUR 10 billion; employment: 36 000;

- EU defence industry turnover: EUR 55 billion; employment: 300 000 (European Commission 2007b);
- EU aeronautics industry turnover: EUR 105 billion; employment 467 000 (ECORYS 2009).

The EU space and aeronautics sectors face the same challenges of maintaining a highly skilled workforce and keeping up with a changing environment in such a way as to maintain or enhance their technological positions. R&D spending in these two industries is however considerably lower than in the defence industry.

The EU space and aeronautics sectors exhibit a number of similarities in trade patterns. In both sectors the EU internal market is of pivotal importance and the United States the most important non-EU trading partner. Nevertheless, the share of non-EU exports to turnover is higher in the aeronautics industry than in the space sector. Furthermore, the EU aeronautics industry has a slightly higher number of non-EU trading partners than the space sector. The EU defence sector imports heavily from its US counterpart but exports much less to the United States due to strict regulations (European Commission 2007b, Decision-CREST 2009).

The regulatory environment also influences the openness of third markets in the space and aeronautics industries, in particular through standardisation and technical requirements.

While the financial crisis has had little impact on the EU space sector – in fact the ESA budget has increased during the crisis – the EU aeronautics industry has been severely affected (ESPI 2010a, ECORYS 2009). In the defence industry, government expenditure has followed a declining trend since the end of the Cold War (European Commission 2007b); a trend which is set to continue. R&D expenditure is however considerably higher in the defence sector than in the other two industries, for example around 20 times higher than in the space sector, despite turnover being only five times larger (European Commission 2007b). The R&D intensity is consequently several times higher in the EU defence industry than in the EU space sector.

3.4.7. Strengths and weaknesses of the EU space sector

The EU space sector is a world technological leader in certain segments such as heavy launchers and satellite communication services. The sector has a number of strengths:

- Its strong heavy launching sector offers independent access to space, which is key to achieving the objectives of the European Space Policy,
- It can offer all types of products and services demanded by institutional and commercial customers,
- Its products are highly advanced,
- The strong satellite communication segment influences other sectors in the value chain,
- The sector combines major system integrators and innovative SMEs,
- The sector is not restricted by EU rules equivalent to ITAR.

At the same time the analysis has identified a series of weaknesses:

- The weak ability of the EU space sector to move from research to operational products,
- The sector remains dependent on critical components from the United States,
- The number of European launches each year is on the low side: a higher number would benefit the strongly linked launch services and launcher manufacturing segments,
- Other countries with launching capabilities – USA, Russia, China, Japan – use mainly their own launchers for institutional missions and are in many cases prepared to pay above going commercial rates for institutional launches.

Despite its weaknesses, the EU space sector has a number of opportunities in the future:

- Europe (EU, ESA, Member States) has high ambitions in space,
- New launchers (VEGA, Soyuz) have been added or will be added,
- The sector has access to financing, including innovative financial arrangements and venture capital, but could benefit from further instruments being developed,
- Demand for satellite communication bandwidth is expected to continue growing,
- Technological progress in the space sector will continue to spill over to other sectors, thereby benefiting the EU economy as a whole while at the same time providing secondary revenues for the EU space sector as well as spin-in opportunities.

There are however a number of challenges and risks for the EU space sector to address:

- The future supply of highly skilled staff in sufficient numbers,
- A potential risk of decreasing budgets for space,
- Emerging space nations such as China and India, with strategic aims for their space sectors,
- Technical dependence: on average 60 per cent of electronic components on board European satellites are imported from the United States,
- Radio frequency spectrum is a scarce resource and needs to be allocated with care and on a pan-European basis,
- Procurement rules differ between institutions and are not always ideally suited for large-scale operational programmes,
- The next generation of heavy launchers (succeeding Ariane V) needs to be developed,
- Communication satellites are the most important products but may come under pressure from competing technologies for communication, including terrestrial technologies,
- The sustainable use of space is not ensured (notably with respect to space debris and space weather) and the EU needs to develop its own space situation awareness capability.

3.5. Conclusions and policy implications

3.5.1. Conclusions

The following conclusions can be drawn on the basis of existing literature and the preceding analysis:

Turnover and employment: The EU space sector generates turnover of over EUR 10 billion (2009, consolidated) and directly employs nearly 36 000 persons (full-time equivalents). The operator services segment (not including downstream applications and services) makes up about half the turnover and is an important driver of the space economy. Turnover generated by manufacturing-oriented companies has been relatively stable in the past ten years. The contribution of the satellite communication segment (both satellite manufacturing and operator services) to total EU space sector turnover is important, more than 70 per cent of the total. In terms of employment though, satellite manufacturing accounts for the largest part, around 60 per cent, followed by launcher manufacturing. Operations and exploitation account for a much smaller share of employment. After a gradual decline in direct employment in space manufacturing between 2001 and 2005, the numbers have since been increasing again. Space manufacturing employment in the EU is concentrated mostly in France, followed by Germany and Italy. With respect to spacecraft produced, the EU is the second largest manufacturer in the world after the United States, with Russia in the lead as far as launcher production is concerned (Soyuz, Proton and other launchers).

Industry structure: The sector is to a large extent driven by public funding and institutional clients. However, the relative importance of institutional clients for the EU space industry has been declining over the past decade while its exposure to commercial markets and exports has increased. The military market in the EU is relatively small. The US industry is more heavily dominated by domestic institutional spending, including military spending. Commercial sales are concentrated mainly in telecommunications systems and launcher systems, while Earth observation systems make up a large part of institutional sales. The vast majority of EU space product exports consist of telecommunication systems. ESA is the largest institutional client in Europe, accounting for two thirds of institutional spending. Globally as well as in the EU, the space sector is characterised by high barriers to entry, considerable opportunities for economies of scale regarding technology development and know-how, and strategically important output with in many cases dual uses. Supply is largely dominated by a few large companies at the centre of clusters of smaller specialised suppliers. EADS Astrium, Thales Alenia Space, Finmeccanica, OHB, RUAG and Safran together account for over 75 per cent of employment in space manufacturing. The high entry barriers and a history of acquisitions and integration are reasons why SMEs represent only around 8 per cent of sector turnover, even though the smaller entities play an important role especially in (innovative) space services and software applications. Horizontal and vertical integration (concentration) in the sector has increased in the past decade, as illustrated by the various large mergers and acquisitions.

R&D and innovation: R&D intensity in the EU space sector as a whole is about 10 per cent (R&D as a percentage of total turnover). The launching industry is by far the most R&D intense of the different segments. Roughly half of R&D funding is corporate funding and half comes from public sources (mainly ESA). Public funding for the Earth observation (GMES) and navigation (Galileo) programmes has increased recently. Although absolute R&D investment by the US is the highest in the world and considerably higher than that of the EU, R&D intensity is slightly higher in the EU. The share of patent applications filed by EU applicants in the space industry in the last ten years is relatively small, 21 per cent. The United

States, Japan and Russia account for 75 per cent of patent applications. Within the EU, most patent applications are filed by German applicants, followed by France.

Technological non-dependence: Partly due to stricter US export control requirements, an increased political pressure for non-dependence in space has been observed over the last decade. The EU space sector uses a number of state-of-the-art components and technologies produced outside Europe, mainly in the United States. As a general rule these US components are available to EU industry (unlike for China, for instance) but with significant delays and (administrative) cost implications as well as subsequent complications if systems containing ITAR components are to be re-exported. In reaction to non-dependence considerations, Europe is coordinating the development of critical space technologies more strictly, in particular through the Commission-ESA-EDA Joint Task Force. The aim of such harmonisation is to fill strategic gaps and minimise duplications, consolidate capabilities and achieve a coordinated EU space technology roadmap for the future. Such considerations may be sound from a strategic political perspective but from a strictly economic perspective some might argue that such non-dependence efforts around the world lead to considerable inefficiencies due to parallel development of expensive state-of-the-art technologies in several countries. It is likely that US and Chinese activities in the political sphere will determine the road ahead for the whole world regarding non-dependence.

Trade: The EU runs a significant trade surplus with the rest of the world in the space sector. Extra-EU trade is larger than intra-EU trade. The United States and Russia are the two main export destinations for EU space products. The bilateral trade balance between the EU and the United States has been more or less in balance in recent years – both have shown bilateral surpluses and deficits three times over the past six years. Both the EU and the United States run considerable trade surpluses with the rest of the world. In relative terms, the export intensity of the EU industry (relative to total turnover) is considerably higher than for the US industry, mainly due to strict US export control requirements. On the one hand ITAR is hampering easy EU access to critical technology components made in the United States, on the other hand it is likely to give EU firms a relative advantage over their US competitors in the supply of specific products (notably telecommunication systems) and to specific countries.

3.5.2. Framework conditions and regulatory environment

The main issues relevant for the performance of the EU space sector as a result of the framework conditions and regulatory environment in which it operates are:

Impact of EU-US regulatory divergence: The global space sector is heavily regulated. The relative impact and restrictiveness resulting from regulatory divergence between the EU and its main competitor and partner is high in relation to other sectors (Berden et al. 2009). This restrictiveness results mainly from regulations in the areas of public procurement, government support for R&D activities, and safety and functional standards. In the aerospace sector analysed in Berden et al. (2009) this could result in considerable deadweight surplus losses, which may also be the case in the space sector as defined in Box 3.1.

Regulatory conditions with a major impact on the EU space sector: (*i*) Standardisation and interoperability with respect to satellite operations; standardisation improves industrial competitiveness and efficiency and is important for all application segments of the satellite industry. (*ii*) National space law of EU Member States. (*iii*) Export controls. (*iv*) WTO laws on space goods and services (Euroconsult 2010). (*v*) Legislation on the transfer of space objects.

(*vi*) Procurement policy. (*vii*) The global allocation and management of radio frequency spectrum. (*viii*) The code of conduct for outer space activities (Listner 2011).

Framework conditions: Regarding the labour market, the high-technology engineering industry depends on the availability of a flexible and highly skilled labour force, a scarce resource in the EU. The openness of third markets is another issue, as main parts of the non-European market are closed to European manufacturers and operators. Access to finance is crucial, as are R&D and innovation for the functioning of the space industry and for keeping its competitive position as emerging space nations are in the process of building up their own industries.

Policy: Starting from the ESA policy focused on major programmes with the aim for Europe to be one of the world's main space players, space policy has always had a large influence on the EU space sector. The Ariane programme in the 1970s and 1980s was prominent in this respect and laid the foundations for the current strong competitive position of Ariane V and Arianespace. The ARTES programme also had a positive impact on the ability to develop state-of-the-art communication satellites in Europe. In parallel, other European cooperation projects resulted in, for example, the establishment of Eutelsat, originally set up in 1977 as an intergovernmental organisation to develop and operate a satellite-based telecommunications infrastructure for Europe. These days the strong space sector in Europe drives demand for communication satellites from European industry and subsequent launching capabilities. This in turn enables the EU satellite manufacturing industry to apply part of the knowledge gained from producing communication satellites (such as knowledge about platforms) to the development of Earth observation/GMES and Galileo. Over the last decade or so, the EU space sector has been increasingly influenced by Commission policies, notably in the form of major EU flagship programmes such as Galileo and GMES but also other programmes (e.g. EGNOS).

3.5.3. Policy implications

Based on the preceding analysis and the conclusions on the current competitiveness of the EU space sector, the following seven factors can be identified as key for the future. They are accompanied by six policy recommendations.

1. Satellite communication drives the EU space sector along the value chain. The associated services segment has the highest turnover per employee in the EU space sector as well as a strong market position worldwide, and a strong demand for satellites and launching services. This in turn has enabled the EU satellite manufacturing industry to innovate and arrive at the qualitatively sound product portfolio it now offers and reach a strong worldwide market position, while also being able to apply key technologies in other satellite manufacturing domains. This position must not be lost. However, competition from outside the EU in the satellite communication segment is prominent in manufacturing and service provision. Given the critical dependence on state-of-the-art technology and know-how, insufficient investment might harm the sector permanently. Temporarily reducing budgets might have long-lasting effects on performance; such reductions should be avoided or at least considered with caution. In order to stay ahead, constant innovation is required, hence sufficient R&D funds must be secured to ensure that innovative satellite communication solutions are found that fulfil the new technological needs in the communication satellites sector.

Policy recommendation: secure R&D funding for satellite communication development in times when government budgets are under pressure and there is a tendency to cut down on R&D expenditure.

2. A weak point of the EU space sector is the transfer from the R&D phase to the operational phase and providing concrete products. For the communication satellite segment this concretely means that demonstrated flight heritage is required.

Policy recommendation: ensure that new satellite communication technology is actually put into orbit before reaching the market.

3. There is increasing demand for communication satellite bandwidth following digitisation in the TV market (HDTV, 3DTV) as well as growing broadband demand. There is also pressure from competing technologies (IPTV for TV distribution, fibre for broadband distribution) as well as competition for radio frequency spectrum use from terrestrial technologies.

Policy recommendation: increase the efficiency of radio spectrum management (European Commission 2010b), defending the interests of the EU space sector as far as possible in compliance with the common practice of technology neutrality. For the space sector as a whole, communication satellites are an essential driver and the interests of communication satellites for the competitiveness of the EU space sector need to be included in policy discussions on radio frequency spectrum management (European Commission 2010b).

4. The EU space sector is heavily institutionalised, half of its final sales going to European institutional clients. This concerns especially Earth observation, navigation satellites and related launches. Budgets cuts in these areas will reduce the performance of the sector significantly. Establishing an 'anchor tenancy' would represent an important step in the development of systems that can be sold outside Europe.

Policy recommendation: review whether it is feasible to put in place a stronger anchor tenancy policy, especially in areas where the EU space sector is weak. This would enable the industry to develop competences and competitive strengths that could strengthen its position on markets outside the EU.

5. The strong institutional demand for Earth observation and navigation systems stems from the GMES and Galileo flagship programmes. In order to ensure sound implementation of these programmes and enable the EU space sector to benefit as much as possible, EU and ESA procurement policies need to take into account from the start the requirements of these large operational programmes.

Policy recommendation: continue reviewing how procurement policies can be optimised in view of the new policy responsibilities in terms of realising large operational programmes such as Galileo and GMES.

6. The heavy launcher segment is competitive but under pressure. As a result of the strong link between launch services and launcher manufacturing, close to 10 000 employees in the launching industry are dependent on a relatively small number of launches by Arianespace. One of the prerequisites for a competitive launch segment (manufacture as well as services) is as many launches as possible. As stated in European Commission (2011), independent access to space is a key prerequisite for achieving the objectives of the European Space Policy. These

key aspects will be addressed in the space industrial policy which the Commission is currently developing in close collaboration with Member States and ESA.

7. There is a general perception in the entire EU space sector that it is difficult to attract skilled labour and that this will become more difficult in the future. Many engineers will retire in the near future and the general perception of space engineering is unlikely to help trigger a swift influx of new engineers into the sector (Space Foundation 2010). This endangers the technological development and implementation capacity of the EU space sector.

Policy recommendations: initiate and coordinate between Member States the development of space academies (such as the space academy created in the UK); include in future R&D framework programmes dedicated actions in which part of the research must be done by PhD candidates. This would enable a certain number of annual PhD places in the EU dedicated to space (as is currently the case in air traffic management).

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