European Competitiveness Report 2011

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List of country abbreviations

AT	Austria
BE	Belgium
BG	Bulgaria
CY	Cyprus
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
EL	Greece
ES	Spain
FI	Finland
FR	France
HU	Hungary
IE	Ireland
IS	Iceland
IT	Italy
LI	Liechtenstein
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LV	Latvia
MT	Malta
NL	Netherlands
NO	Norway
PL	Poland
PT	Portugal
RO	Romania
SE	Sweden
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 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

[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.

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 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)).

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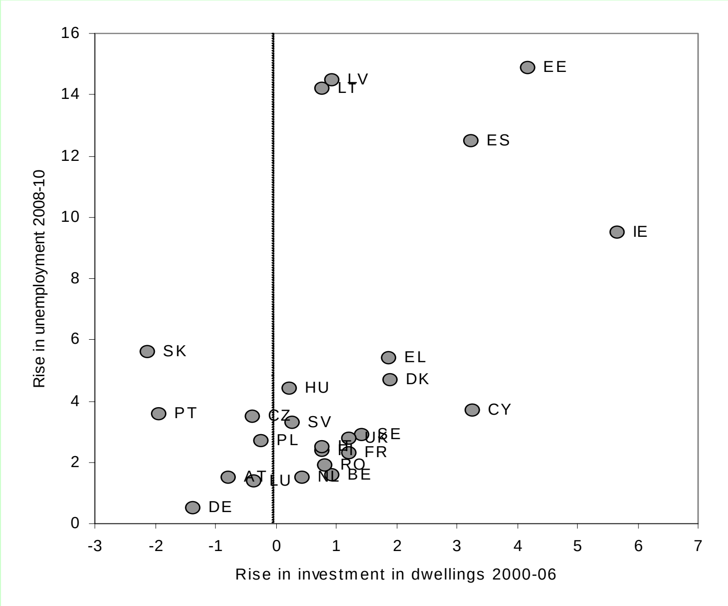
2 See Chapter 1 "Growing imbalances and European industry," in European Competitiveness Report 2010 (European Commission (2010a)); or the monograph "Economic Crisis in Europe: Causes, Consequences and Responses," in European Commission (2009b).

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

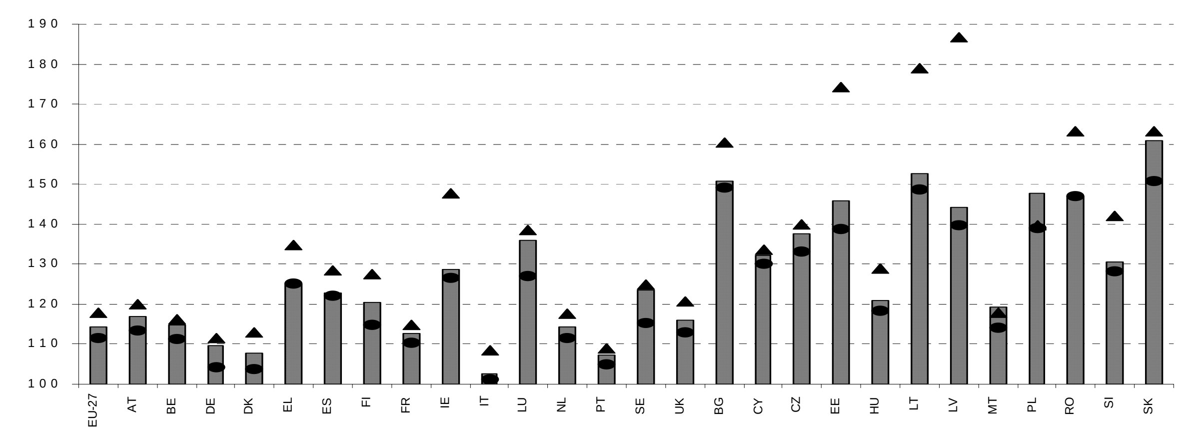


Note: The rise in investment in dwellings is the increase in % points of GDP of investment in dwellings from 2000 to 2006. The rise of unemployment is the difference between the minimum rate of unemployment before the crisis and the maximum (for some countries the current, by 2010Q3) during the crisis.

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 Q1	Q2	Q3	Q4	2008 Q1	Q2	Q3	Q4	2009 Q1	Q2	Q3	Q4	2010 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]

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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

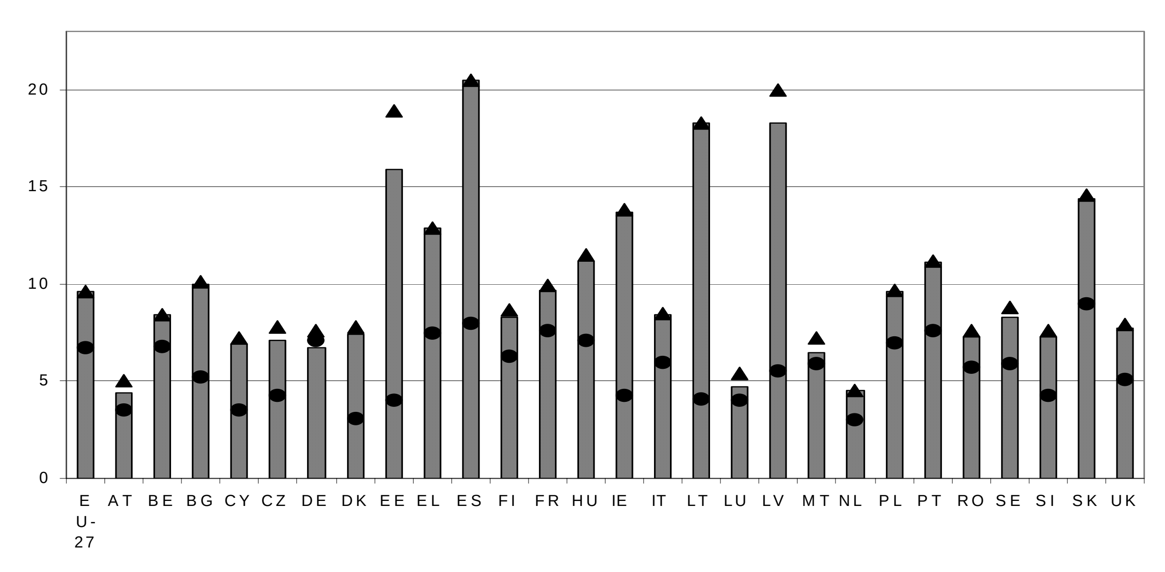
Country	2000-10			2000-08			2000-08			
	Real GDP per head	Real GDP	Population	Real GDP per head	Real GDP	Population	Real GDP per hour	Average hours	Employment rate	Activity rate
European Union	9.8	14.0	3.9	13.2	16.9	3.3	:	:	:	:
Belgium	8.0	14.5	6.0	10.4	15.4	4.5	4.9	1.3	-0.1	4.0
Bulgaria	62.0	49.3	-7.8	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]

[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)).

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



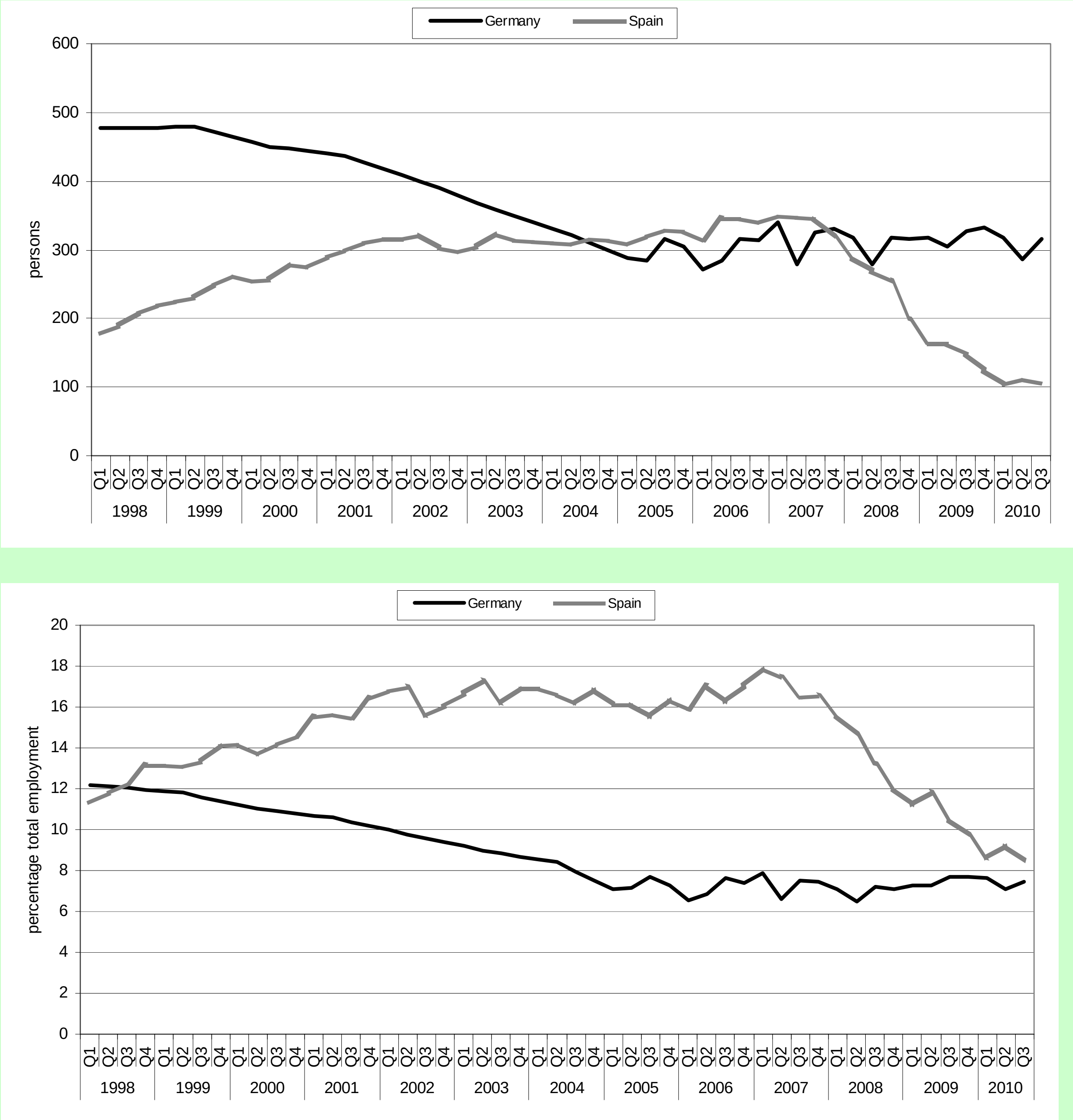
Source: Eurostat, Quarterly LFS statistics for employment, Unemployment - LFS adjusted series,une_rt_q.

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).

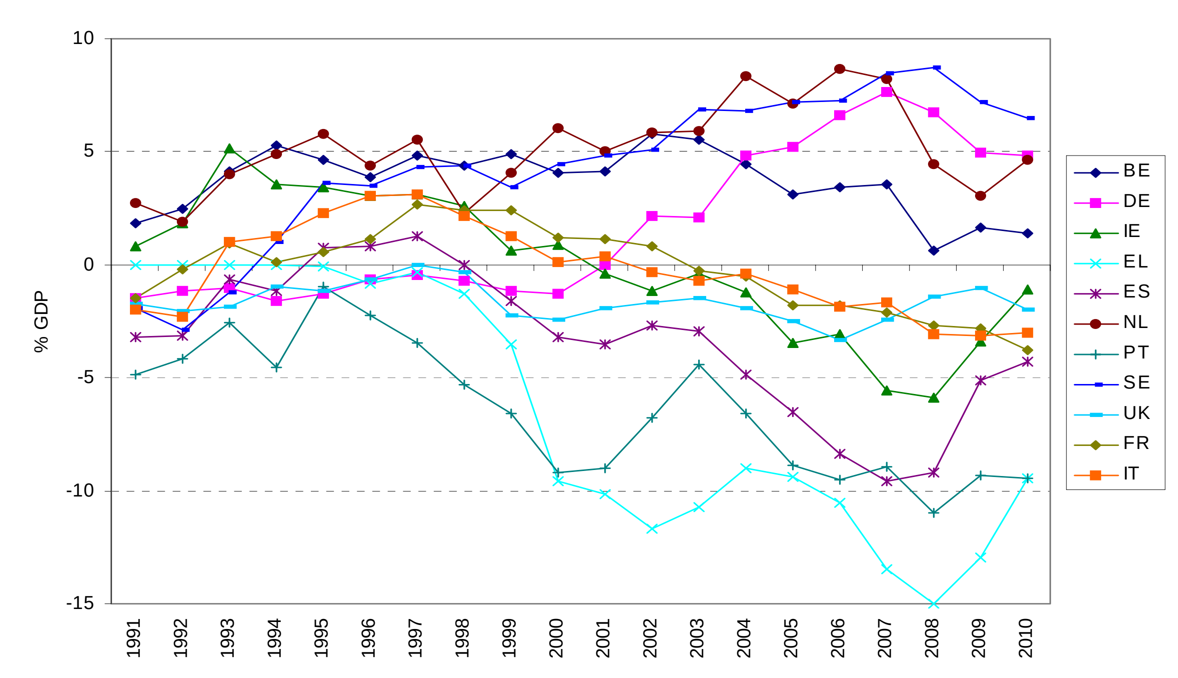
1.3. Borrowing, lending and the exit from the recession

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

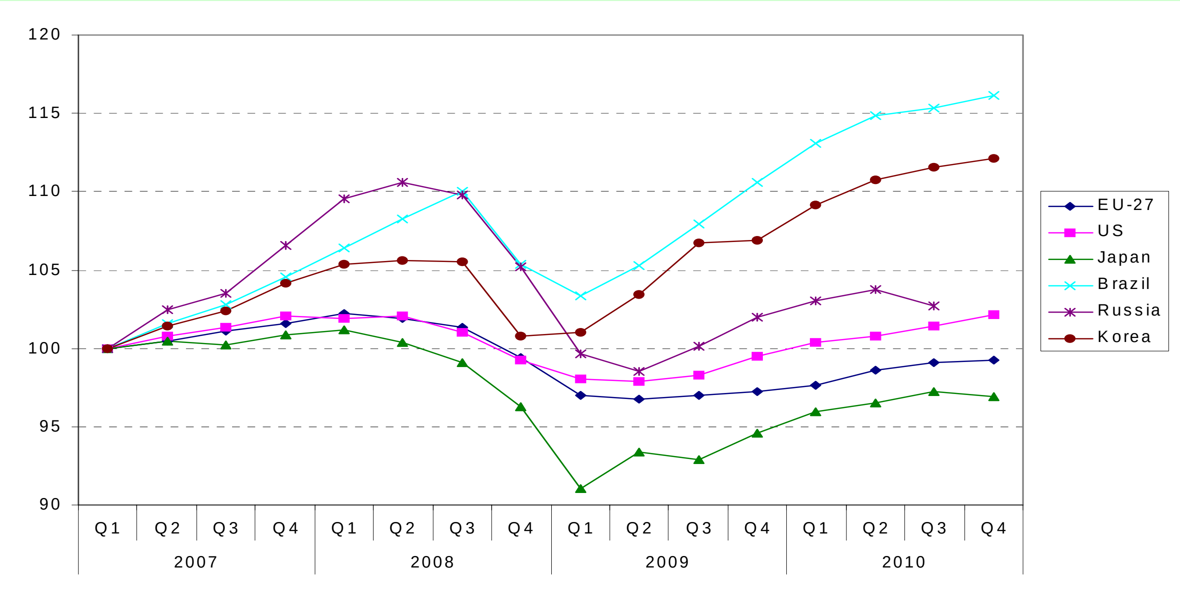


Source: AMECO database, European Commission; Net lending (+) - net borrowing (-), total economy (UBLA).

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 relatively faster. Those more cyclical like Basic metal, Motor vehicles, etc., display in table

[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).

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]

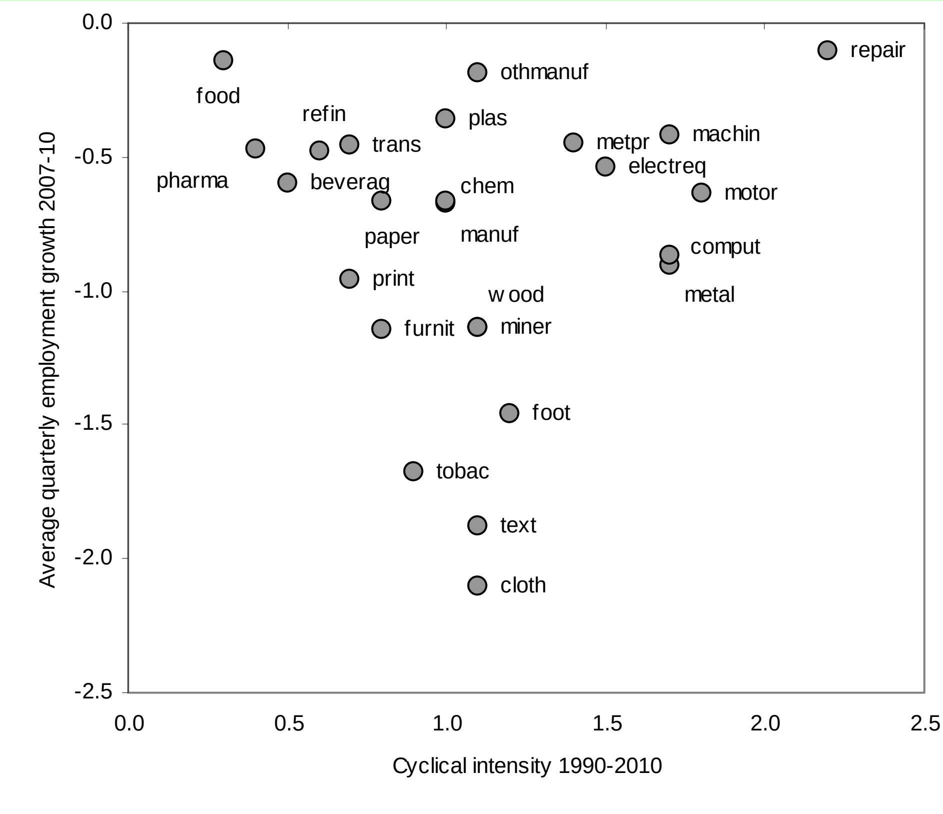
Indeed, the recovery of other sectors, notably manufacturing, is already under way, and it is benefiting from the steady growth of economic activity in emerging countries. As noted in the previous section, GDP outside the EU and the US was not much affected and is now growing fast, attracting European 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 added

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 1995-2007

		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 labour. 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.

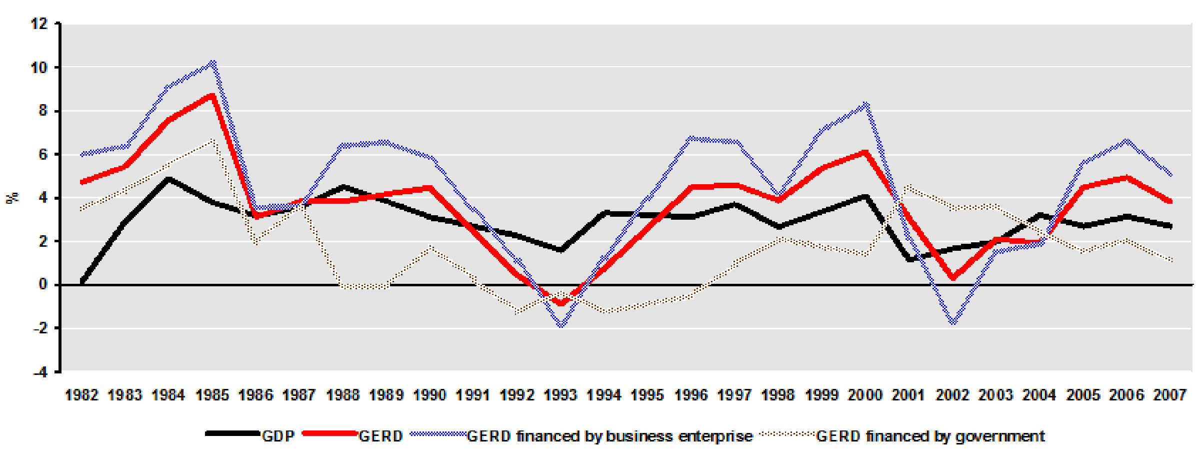
Indeed, innovation and technical change are two faces of the same phenomenon. Innovations stem from experience (learning-by-doing), the accumulation of human capital through formal education (learning-or-doing) and from research and development (R&D) activities. R&D can be seen as the purposeful allocation 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



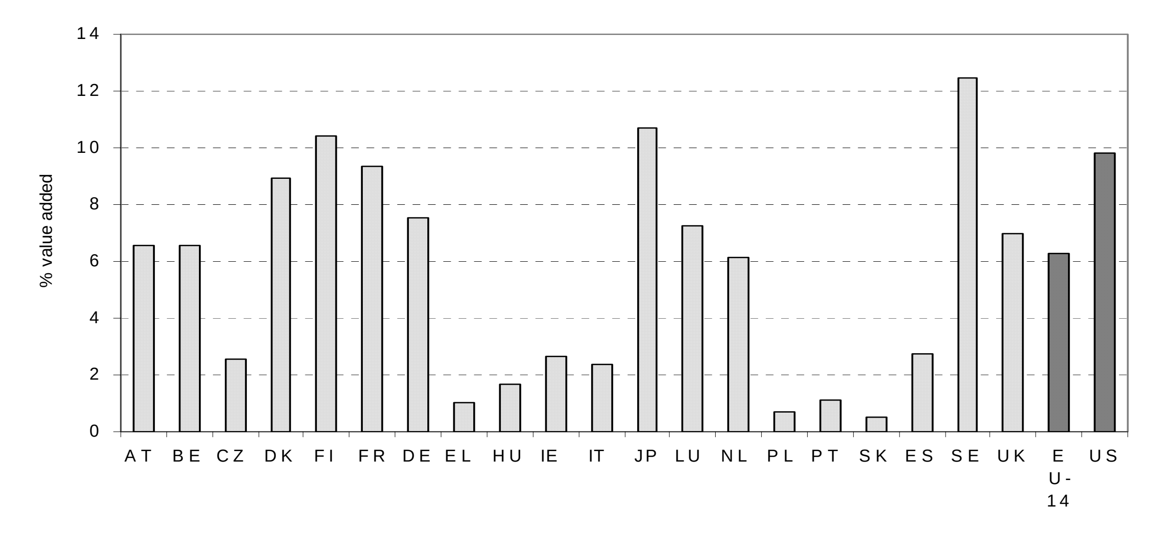
Source: Figure I.2.1 in *Innovation Union Competitiveness Report 2011* (European Commission (2011b)).

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.

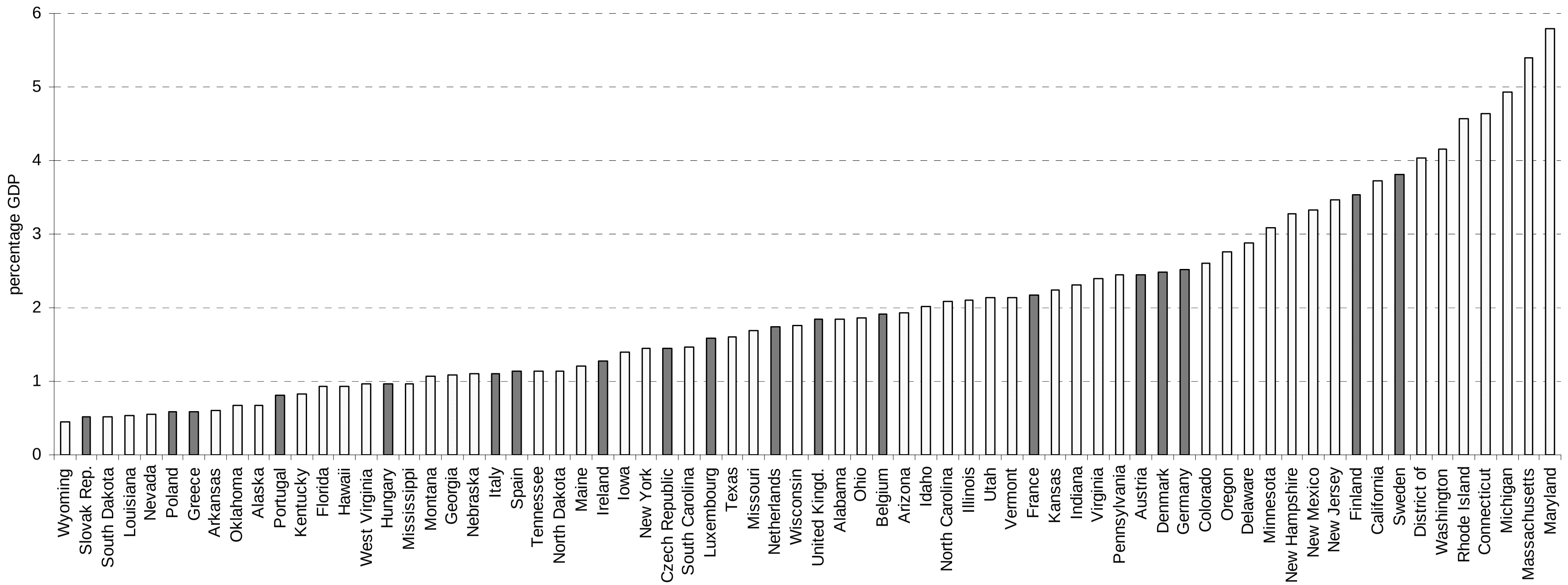
Source: OECD, STAN indicators 2009.

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

	Distribution of R&D across sectors, % total		**R&D**
intensity (over value added)			
	EU-14	**US**	**EU-**
14	**US**		
C15T37 MANUFACTURING		81.53	70.30
C15T16 Food products, beverages and tobacco		1.76	1.44
C17T19 Textiles, textile products, leather and footwear		0.59	0.36
C23T25 Chemical, rubber, plastics and fuel products		21.72	20.43
C26 Other non-metallic mineral products		0.78	0.40
C27 Basic metals	1.08	0.28	1.98
C28 Fabricated metal products, except machinery and equipment			1.12
C29T33 Machinery and equipment		28.78	28.79
C30 Office, accounting and computing machinery		1.92	2.19
C31 Electrical machinery and apparatus, n.e.c.		2.96	1.07
C32 Radio, television and communication equipment		10.74	13.10
C33 Medical, precision and optical instruments		5.08	8.66
C34 Motor vehicles, trailers and semi-trailers		16.03	7.12
C35 Other transport equipment		8.47	8.82
C36T37 Manufacturing n.e.c. and recycling		0.56	0.52
C40T41 ELECTRICITY GAS AND, WATER SUPPLY		0.58	0.09
C45 CONSTRUCTION	0.41	0.56	0.09
C60T64 TRANSPORT, STORAGE AND COMMUNICATIONS			3.02
C72 Computer and related activities		5.94	13.49
C74 Other business activities		2.20	..
C75T99 COMMUNITY, SOCIAL AND PERSONAL SERVICES			0.37
C50T99 TOTAL SERVICES		16.42	29.04

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.

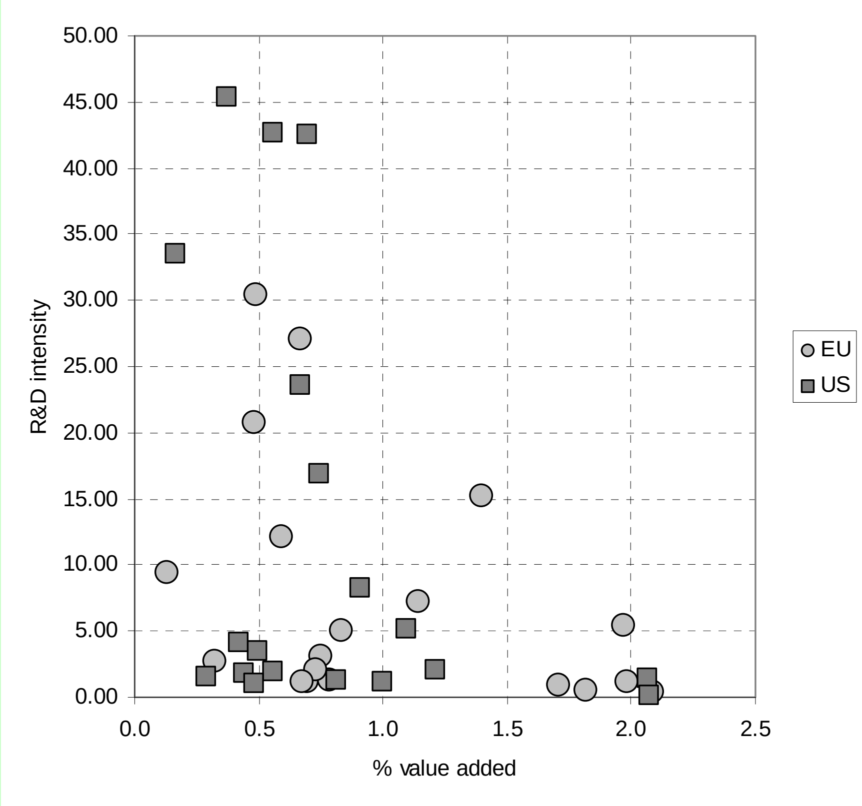
A problem with the scoreboard, however, is that it is a sample constituted of the largest R&D investors.[15] Looking at OECD aggregate data (Table 1.6), focusing on R&D performed in a given region by all firms regardless their nationality, there is no extraordinary difference between the EU and the US

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.

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.

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.

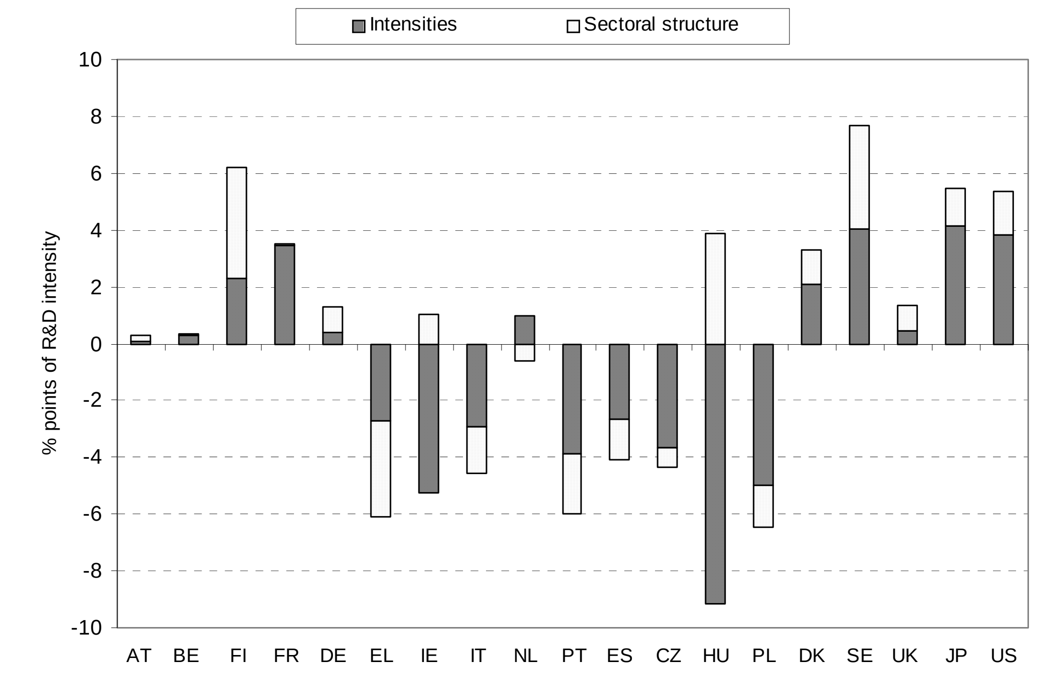
A more systematic and synthetic look at the differences in R&D intensities confirms the intrinsic smaller intensity of European sectors (and allows to have a good glance at all Member States).

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.

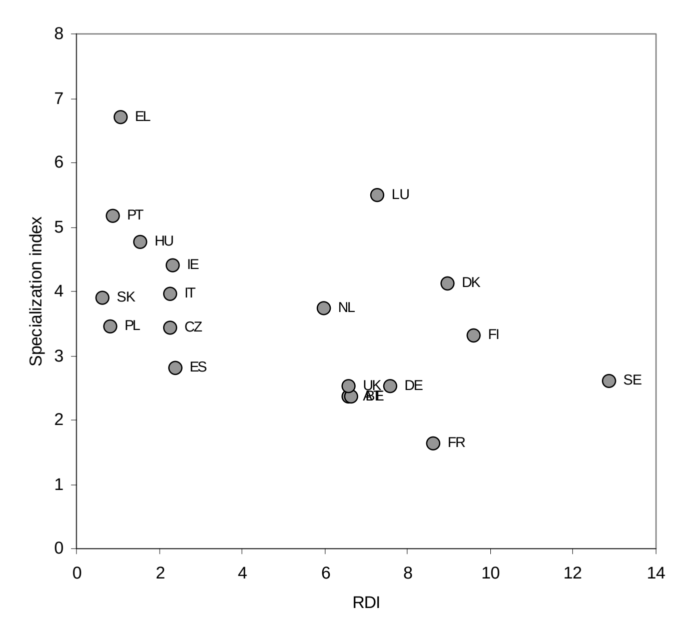
It also provides in a simple glance a picture of the different ways in which EU Member States depart from the EU average. From the intensities perspective, the case of Hungary stands out for its extreme decomposition. The combination of the "right" sectoral structure (R&D intensive sectors weight a lot 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

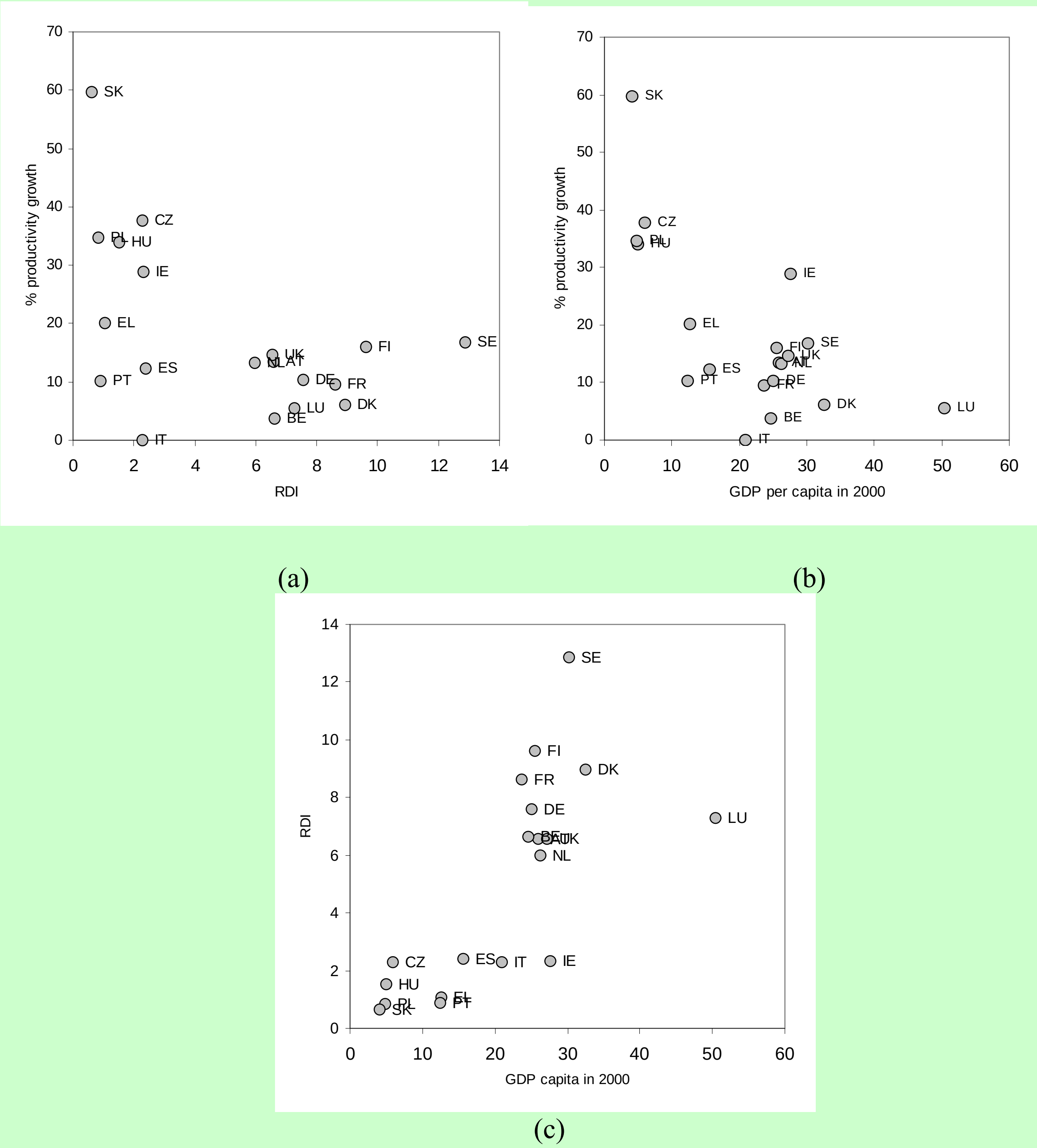


Note: The indicator of sectoral specialisation compares the share of a given sector in one country with the share of the same sector in the EU as a whole. The country index of specialization is the Euclidean distance to the EU average. Hence, more diversified economies have smaller indexes of specialization.

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



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

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

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.

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

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.

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]

[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.

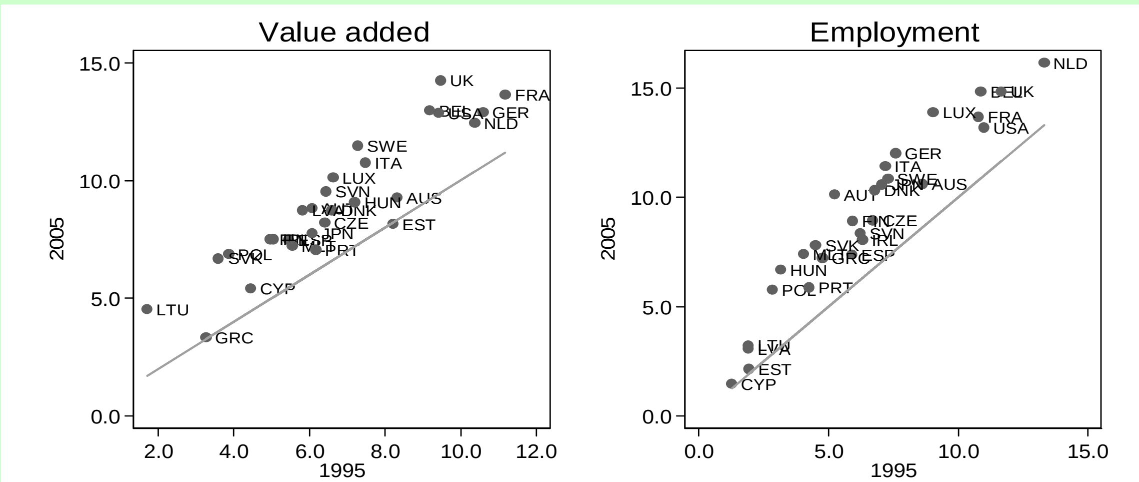
Table 2.1: Share of KIBS (incl. 71) in total economy (in %), 1975-2007

		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]

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

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.

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

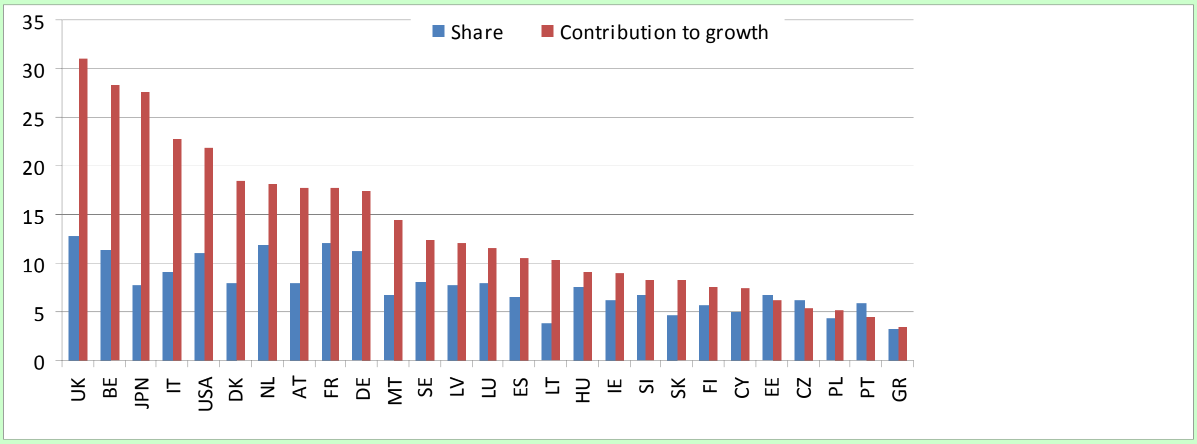
Source: EU KLEMS, Release 2009, own calculations.

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.

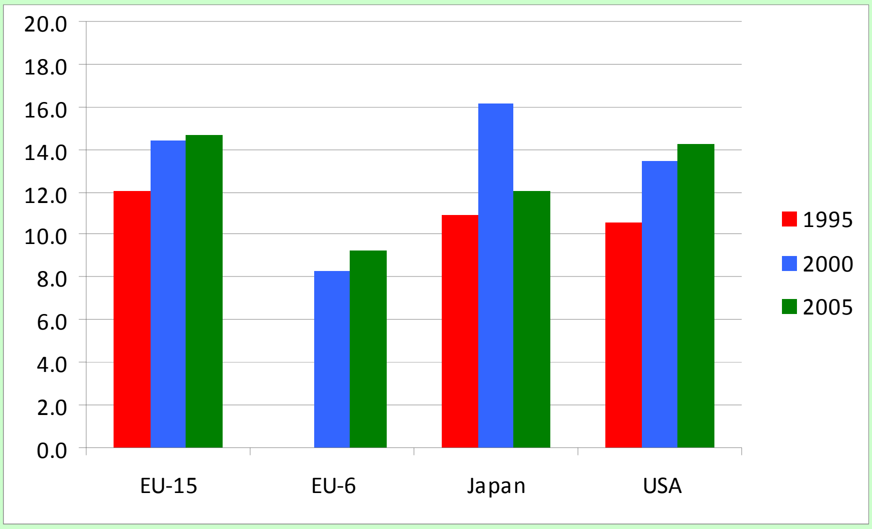
2.2.4. *The role of KIBS as an intermediate input in the EU, US and Japan*

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).

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

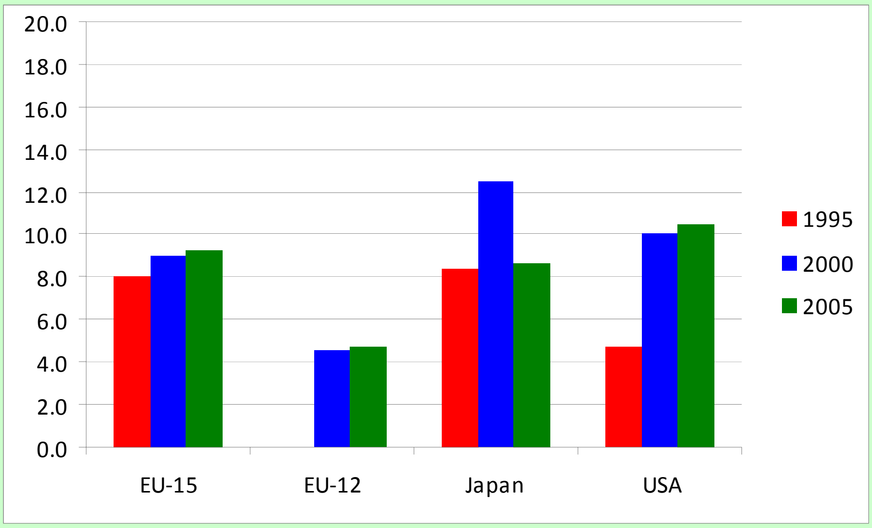
27 The 21 EU countries are EU-15 plus Czech Republic, Estonia, Hungary, Poland, Slovakia and Slovenia.

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.

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.

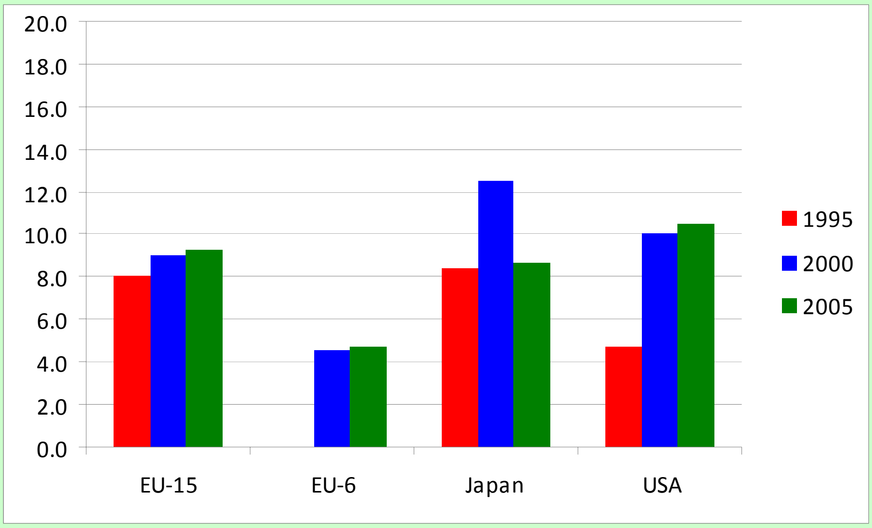
Figure 2.3.b: Share of KIBS in manufacturing intermediate consumption



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;

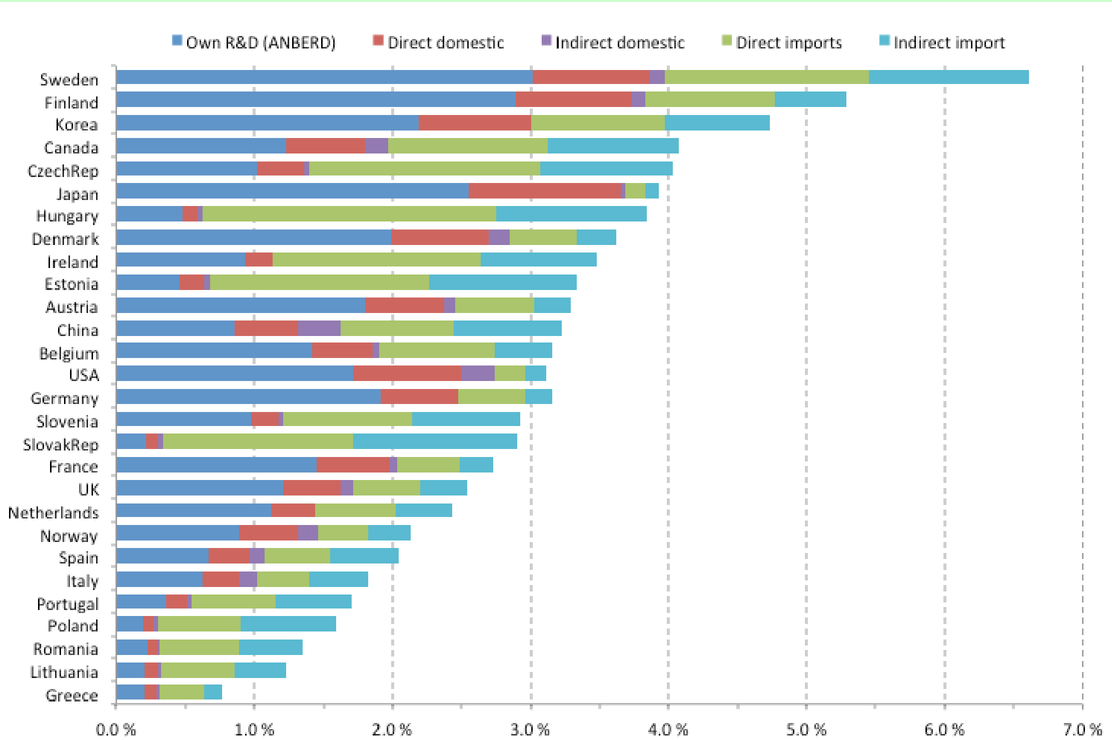
(3) indirect R&D flows from domestic sectors into a recipient industry via one or more intermediate sectors;

(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.

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

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.

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

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.

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

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

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.

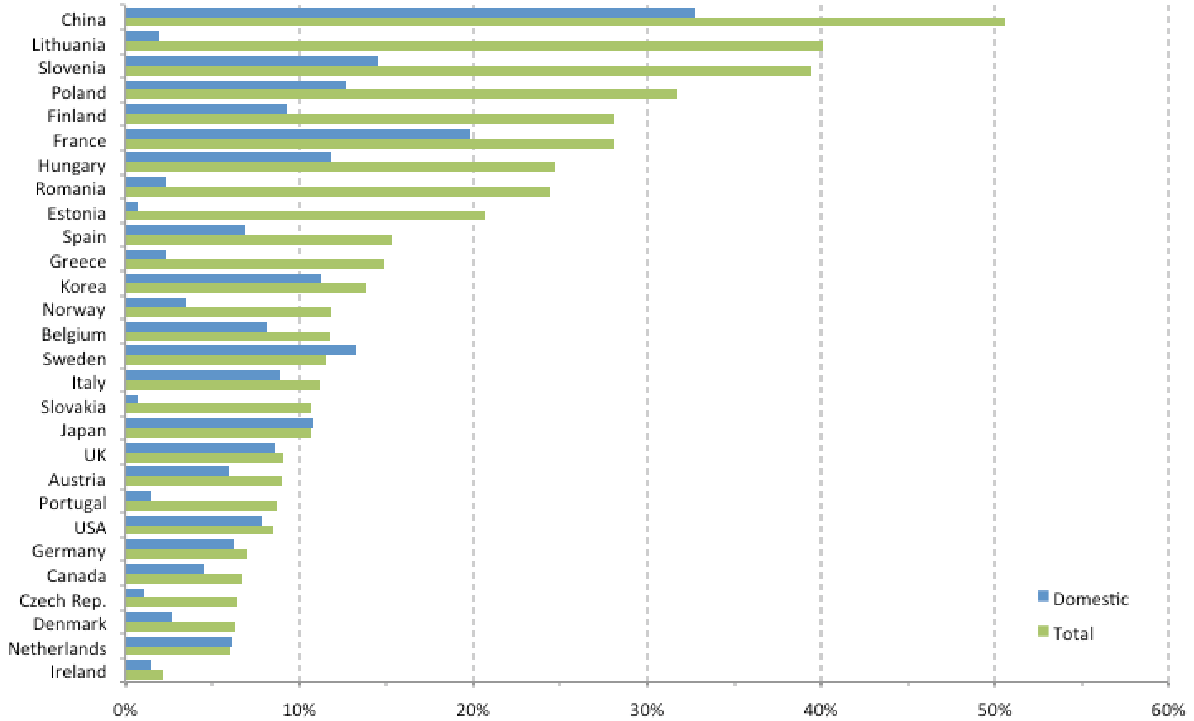
The backward linkages shown in Figure 2.5, measured in terms of the total technology content of KIBS, are rather small in countries on the technology frontier, defined as the average R&D intensity of the OECD;[35] 10% or less, and with domestic and total backward linkages being more or less of the same 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 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.

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.

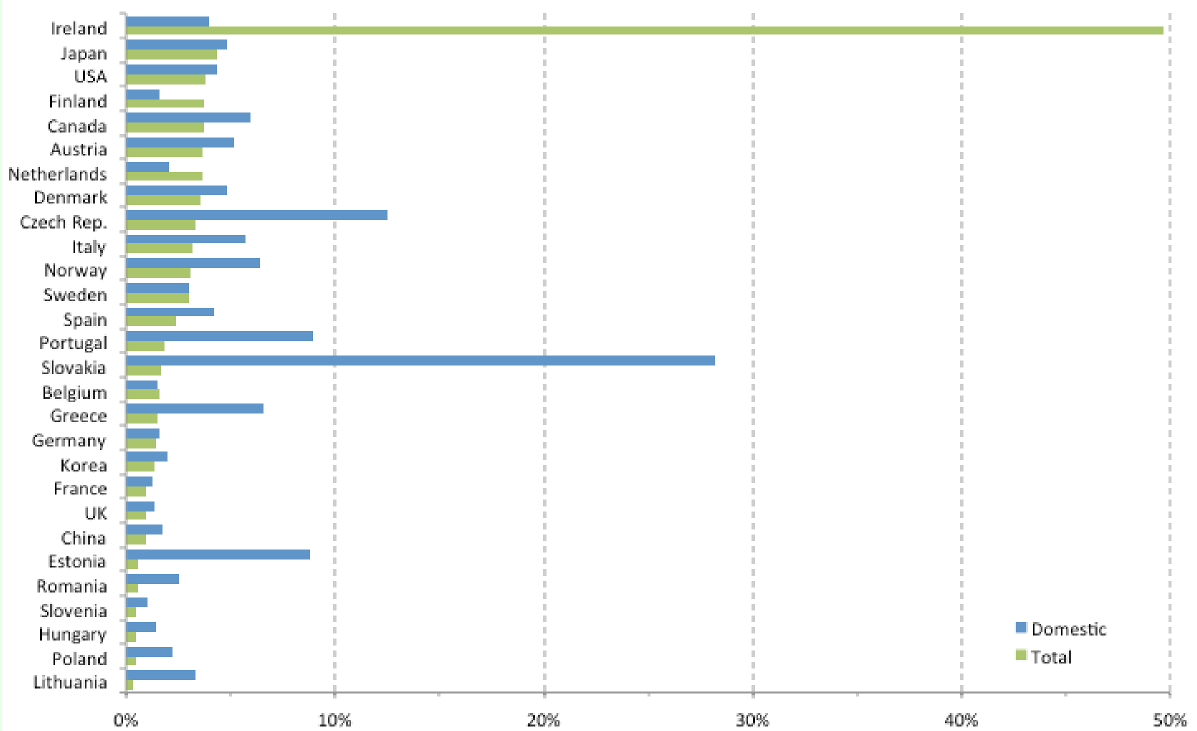
Figure 2.5: Backward linkage of manufacturing embodied inputs into KIBS sectors, domestic and imported supply. Ranked by total linkage, 2005



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

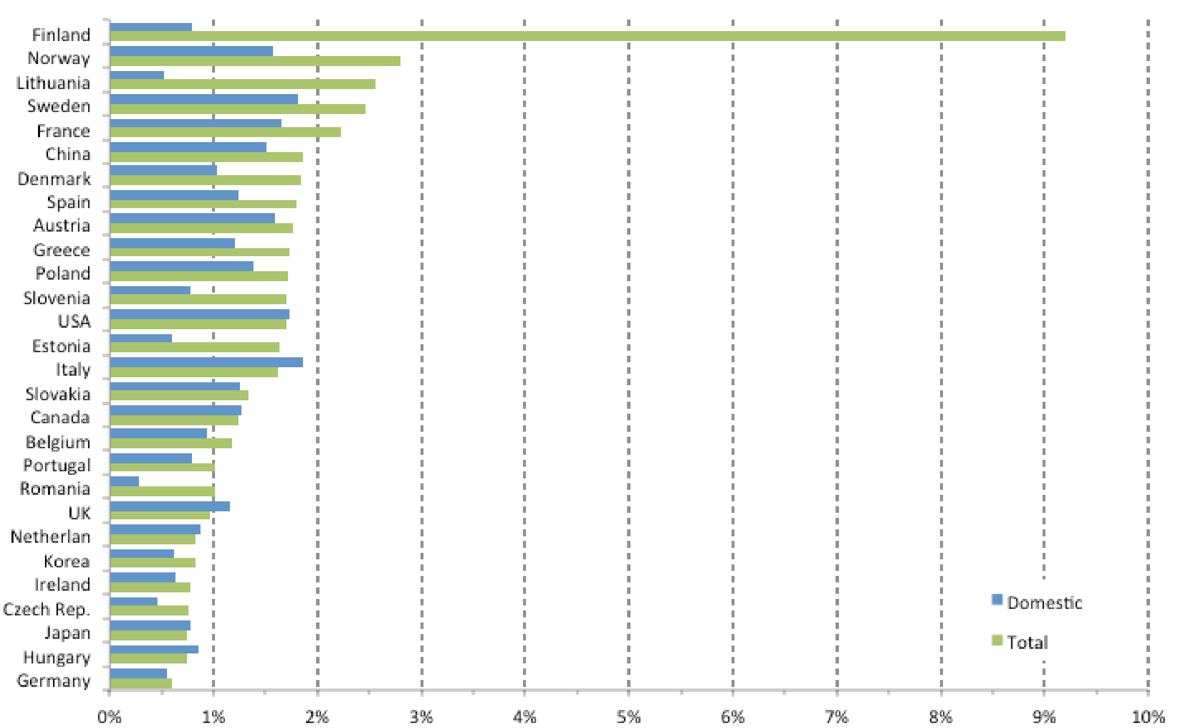


Source: OECD Input-Output tables. ANBERD. Eurostat Input-output tables for Lithuania.

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

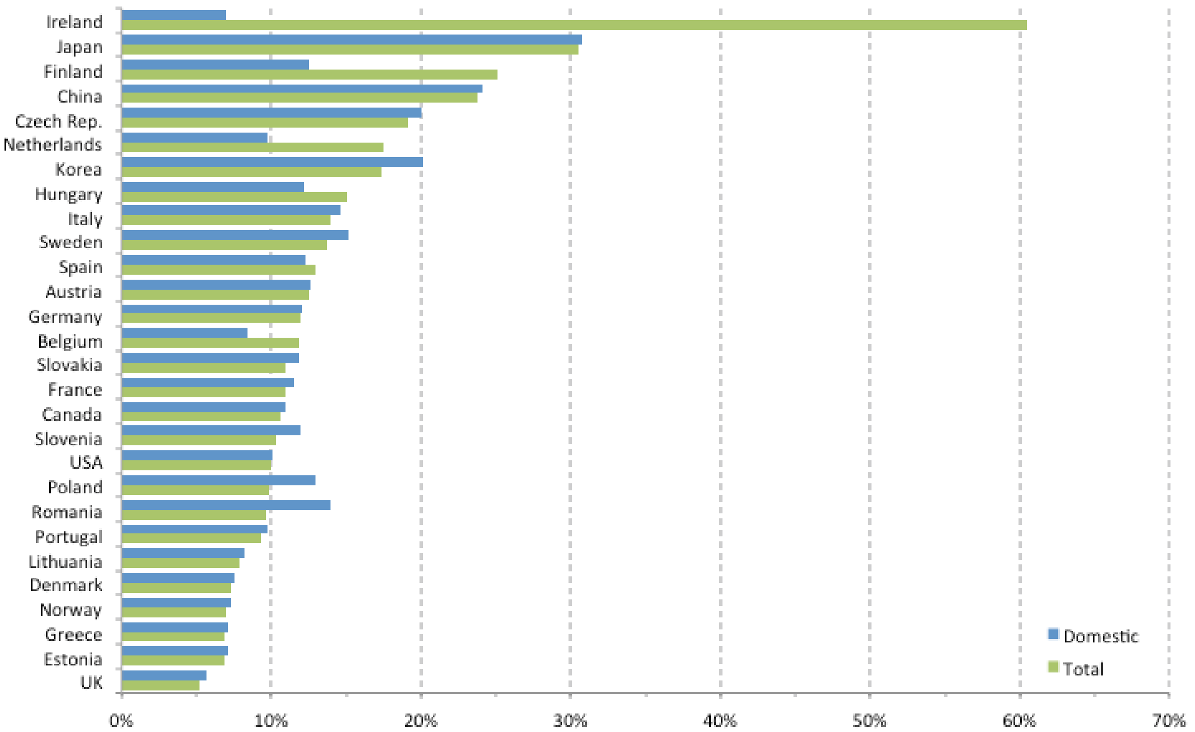


Source: OECD Input-Output tables. ANBERD. Eurostat Input-output tables for Lithuania.

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 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-

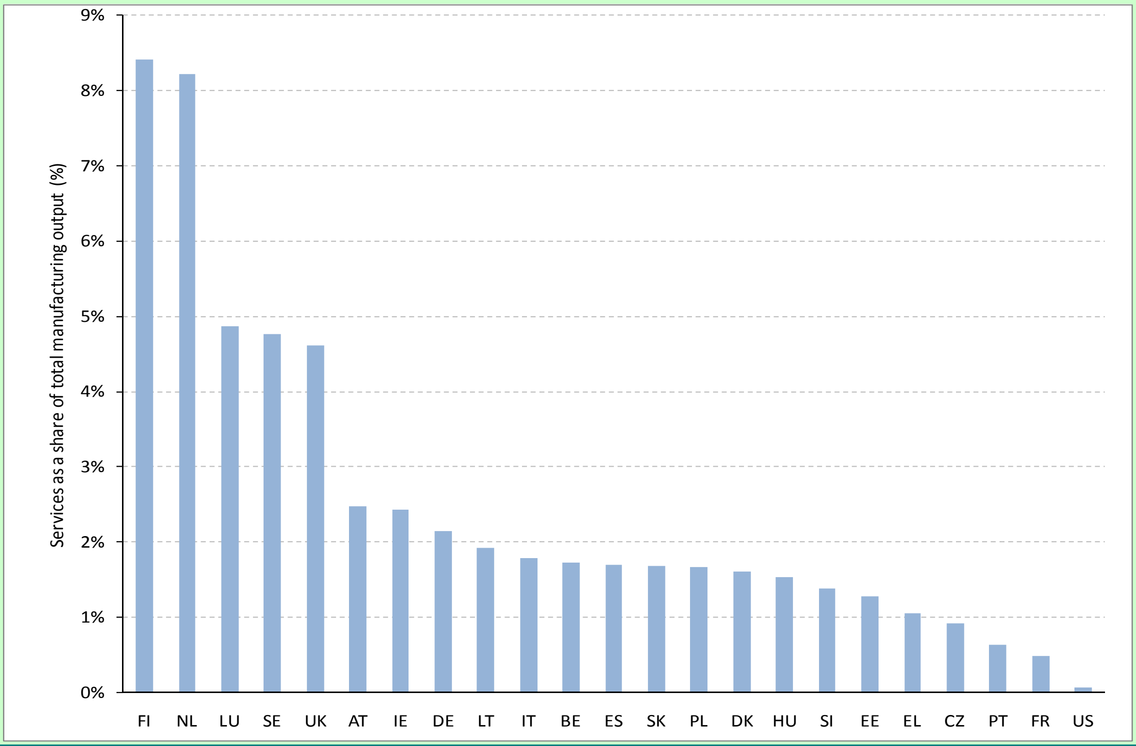
[38] See European Commission (2011), 'Databases from socio-economic research project for policymaking', especially section 1.2 for a thorough discussion of the subject.

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.

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.

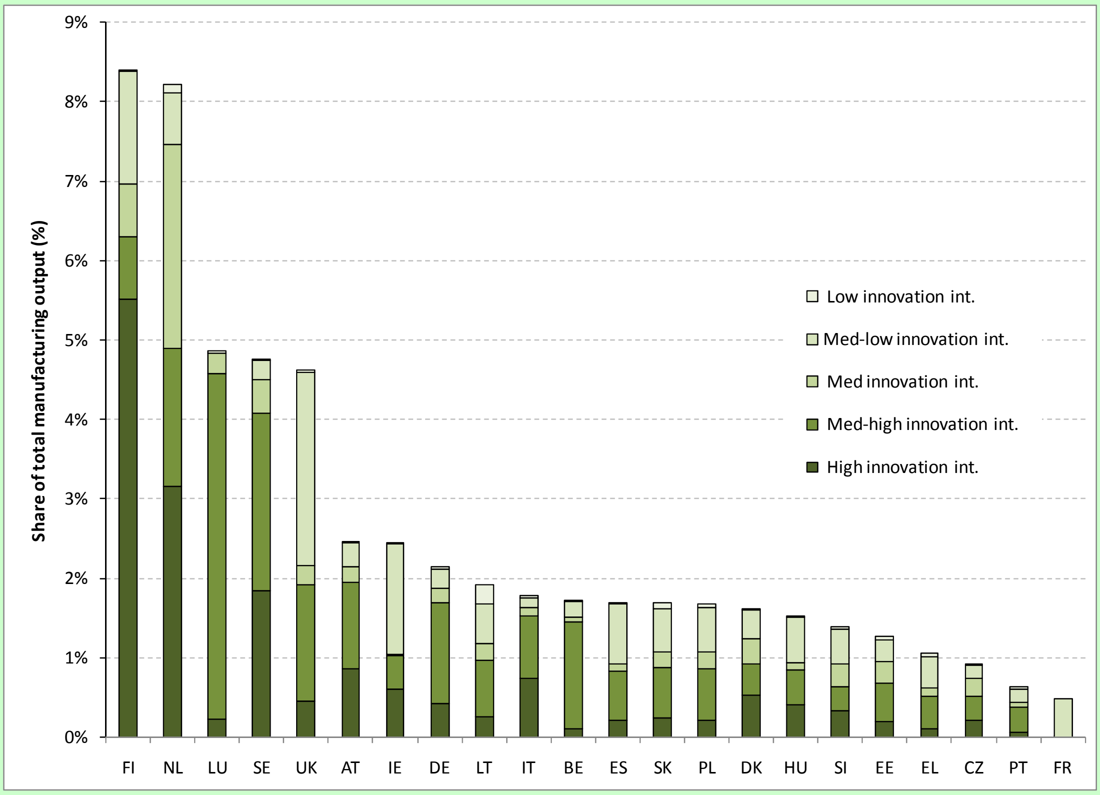
Source: Eurostat and US Bureau of Economic Analysis supply tables; author's calculations.

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.

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 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

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

[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.

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.
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

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[43] Austria, Croatia, Denmark, France, Germany, Netherlands, Slovenia, Spain and Switzerland.
[44] See Annex 2.3 for a description of the population.

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.

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 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,

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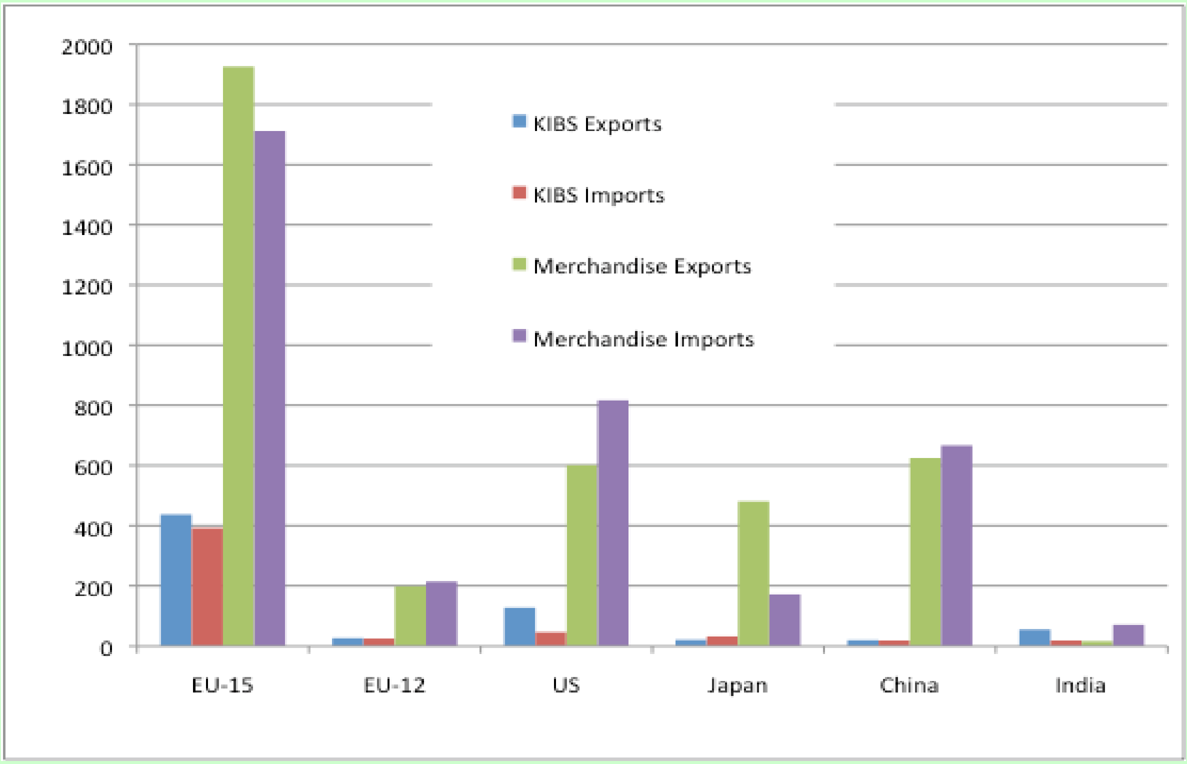
47 In this section, KIBS are also defined as NACE codes 72, 73 and 74, which are related to categories 262, 279 and 268-269-279 in the Extended Balance of Payments Services Classification (EBOPS). See the background study for details.

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

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

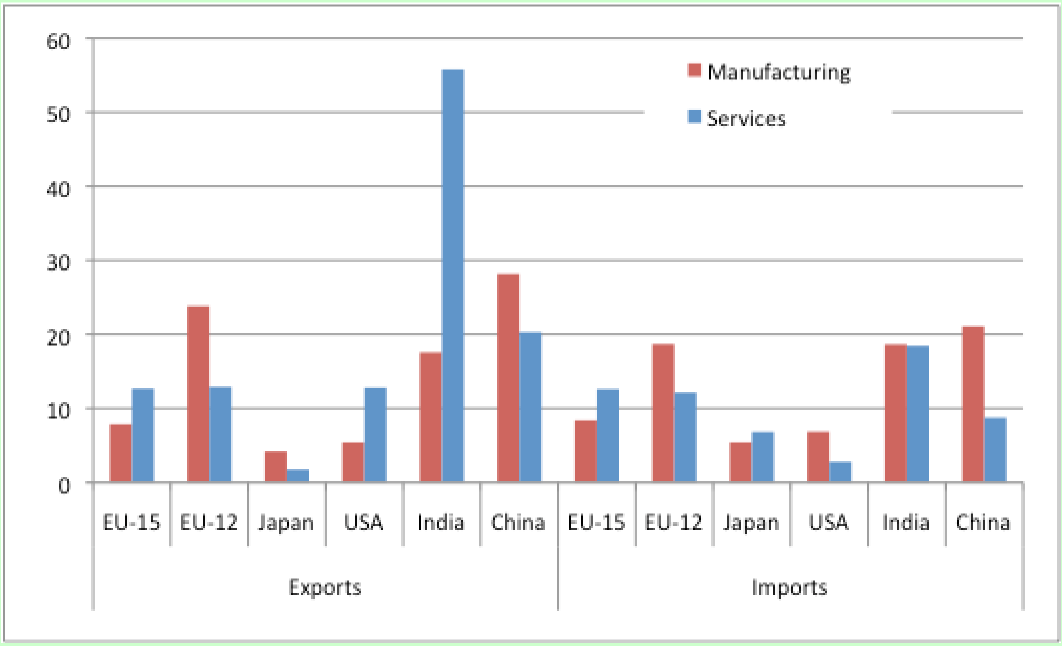


Source: TSD, UN COMTRADE.

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.

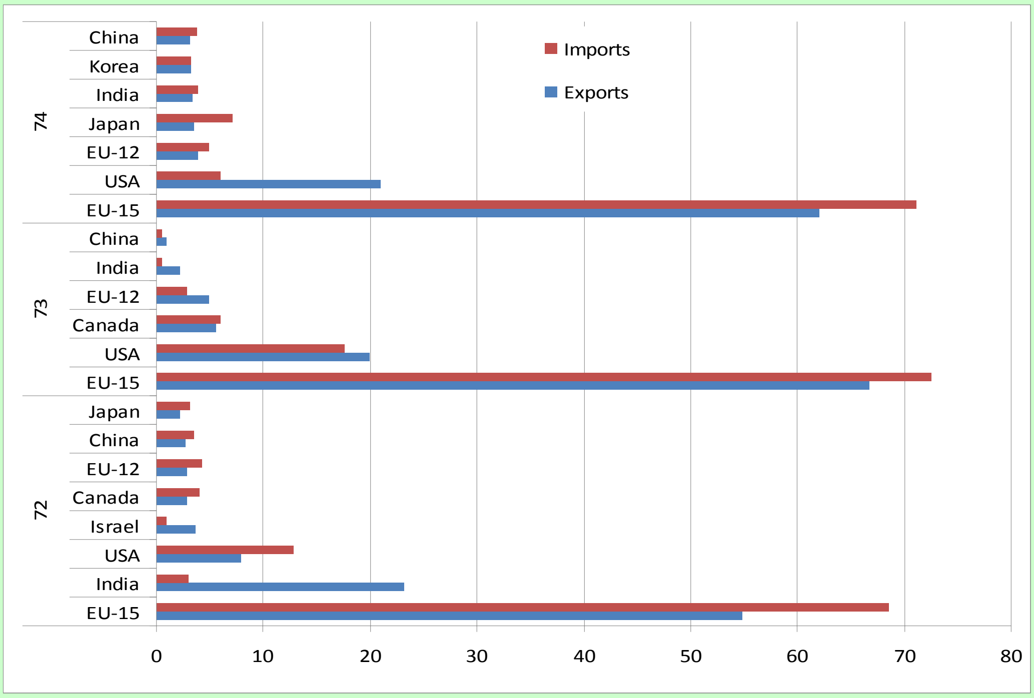
The R&D (73) market is dominated by the EU-15 and the US (the latter having an 18% share of global exports in 2007). It is worth noting that the EU-12 has been seeing the fastest growth of exports in this sector — on average 46% per year. On the one hand, this can be partially explained by the low starting 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 (%)



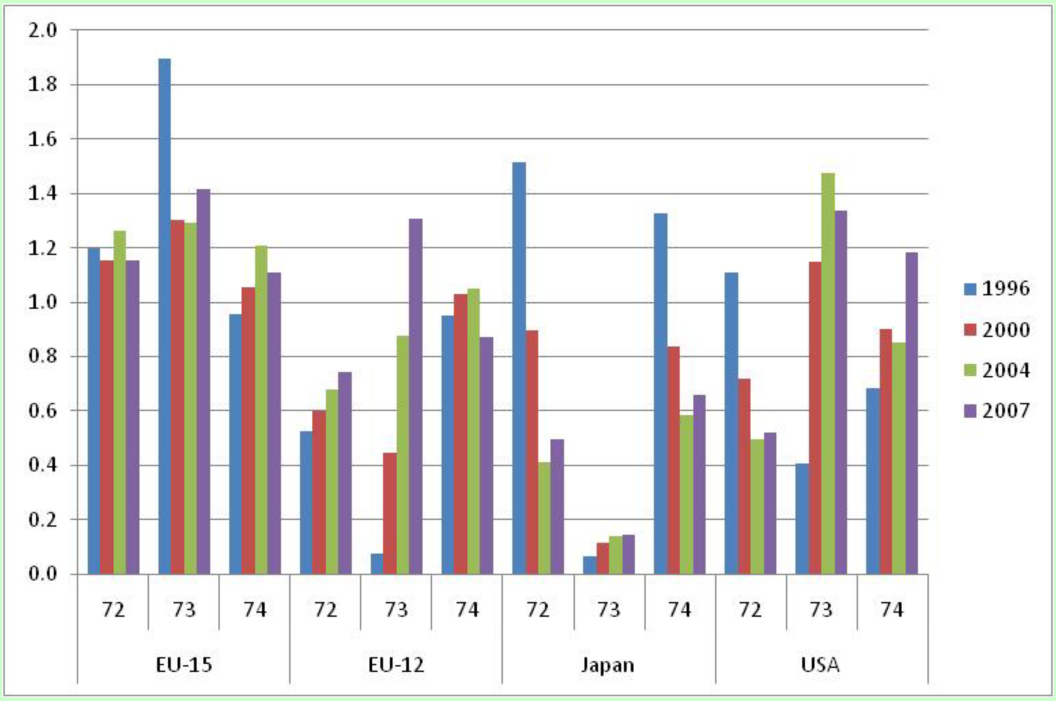
2.5.3. Patterns of specialisation

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.

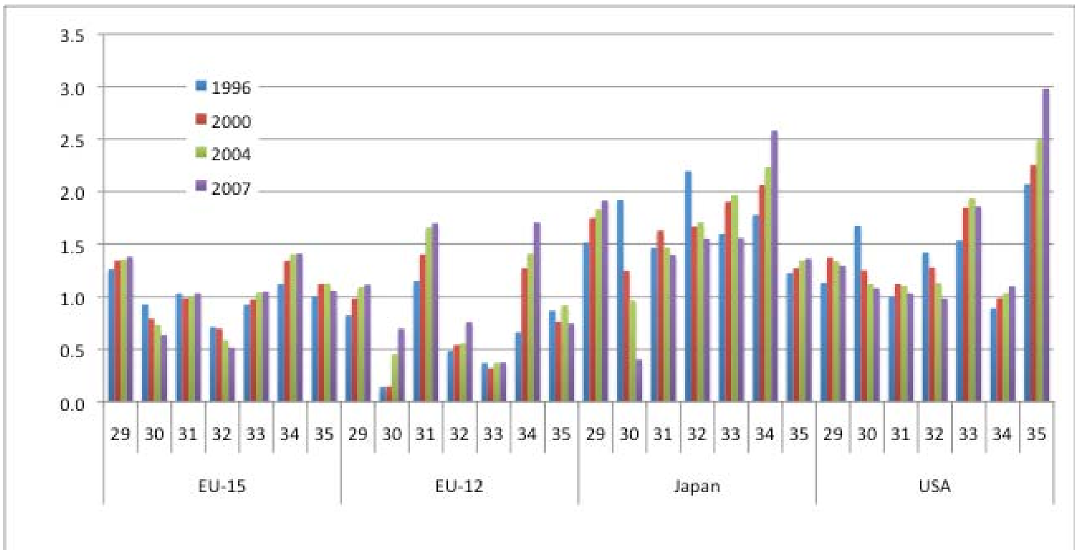
merchandise exports during 1996-2007, which shows that KIBS exports grew more dynamically than merchandise trade in the old Member States, while in EU-12 the situation was the reverse. Japan has no RCAs in KIBS exports, but has the strongest specialisation of all the regions in motor vehicles (34) and 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.

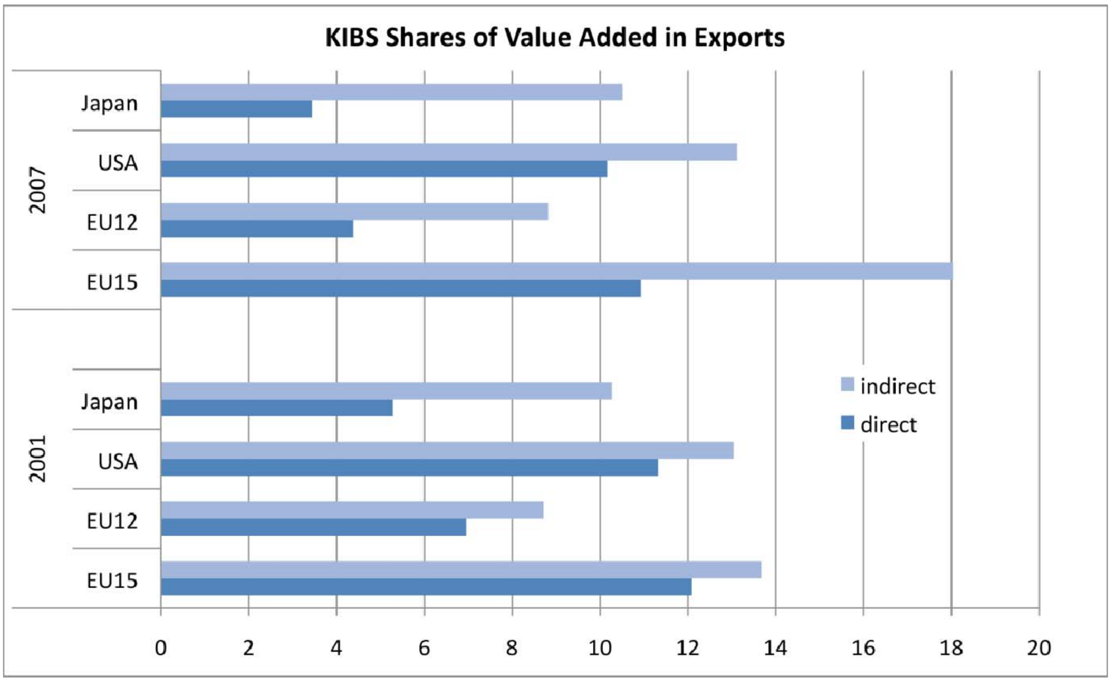
Cross-border KIBS trade is important in both the EU-15 and EU-12 in terms of the impact on manufacturing costs. In the background study (Stehrer et al., 2011), cost shares of 9.8 per cent in the EU-15 and 4.5 per cent in the EU-12 are reported.[51] As noted earlier, the EU is more KIBS-intensive than 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 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.

51 Figures in this section are based on GTAP data.

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 $t^m(\text{direct}) = r^f A_m x$. Indirect linkages appear as a residual: $t^m(\text{indirect}) = t^m - t^m(\text{direct})$. 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* → *b*) can be constructed as:

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

and

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

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 OPERATIONS

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.

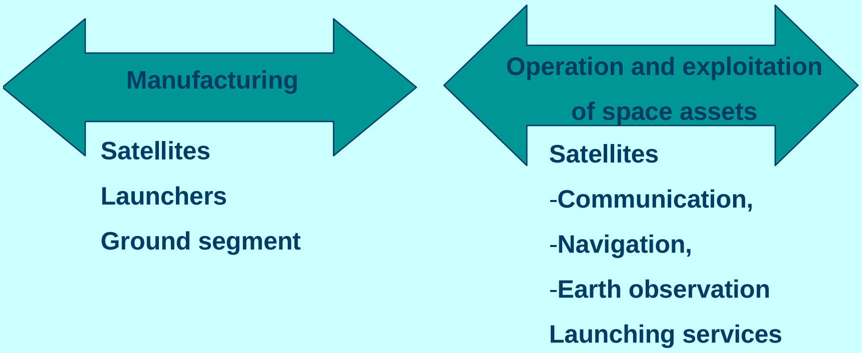
3.1.3. Defining the EU space sector: space manufacturing and operations

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.



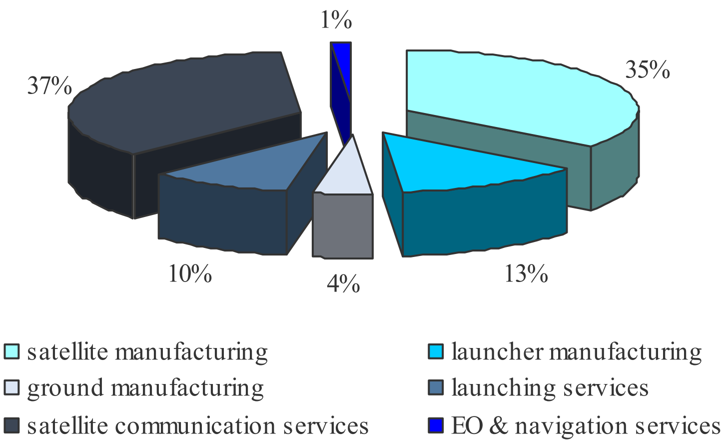
The definition excludes upstream suppliers (for instance of electronic components) as well as downstream service providers and applications based on space data but operating without space assets of their own. In several previous analyses of the space sector, such downstream service providers and application 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

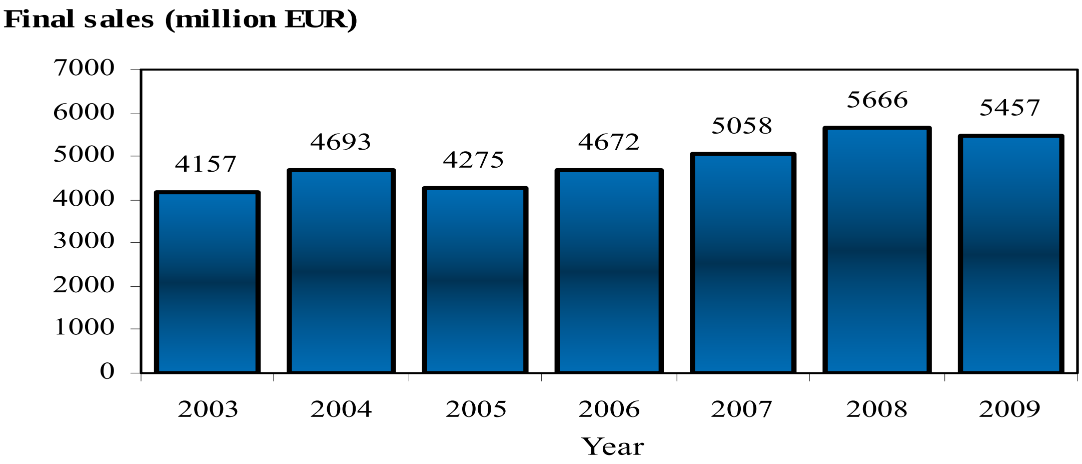


Source: Background study.

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.

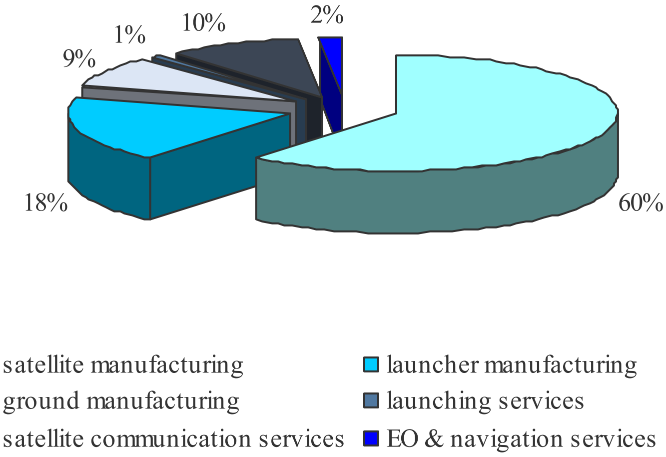
3.2.2. Profitability

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.

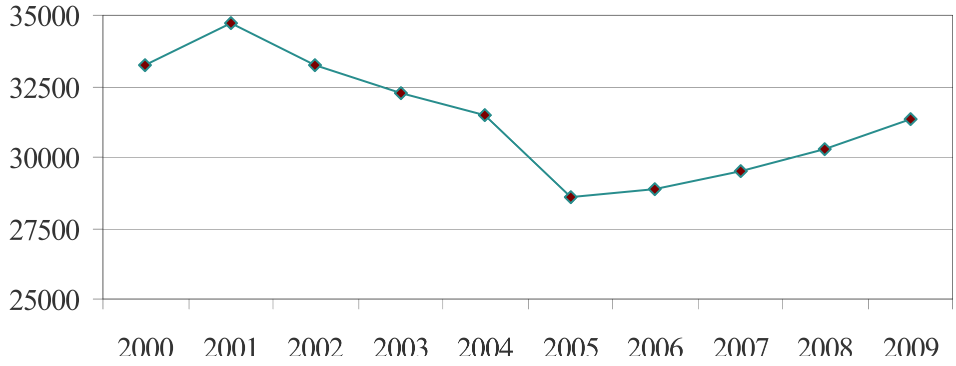
Figure 3.3: Direct employment in the EU space sector, 2009



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):

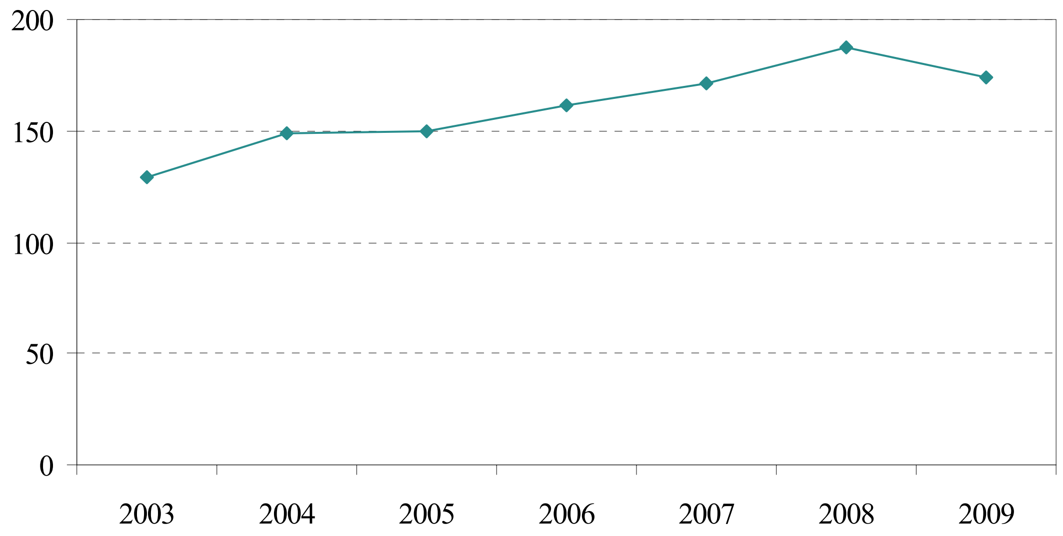
- Turnover in a high-technology sector such as space is higher than in other sectors because the value of inputs is higher. Any comparison across sectors based on turnover per employee is therefore flawed, as is any comparison of segments within the space sector.

- 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.

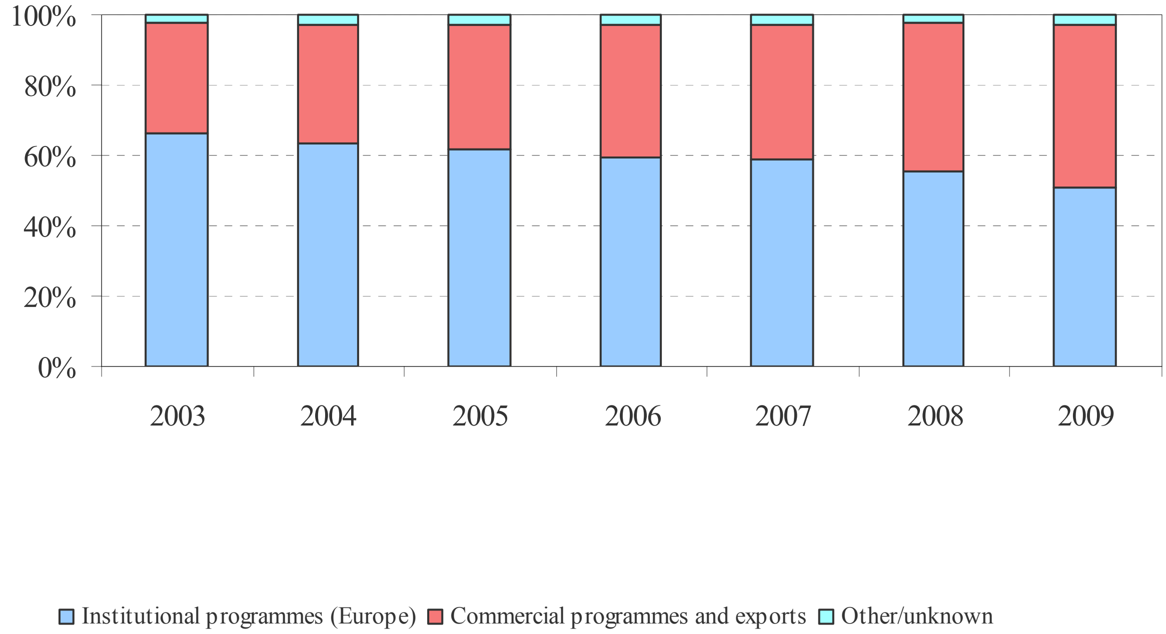
3.4. Results of the analysis

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

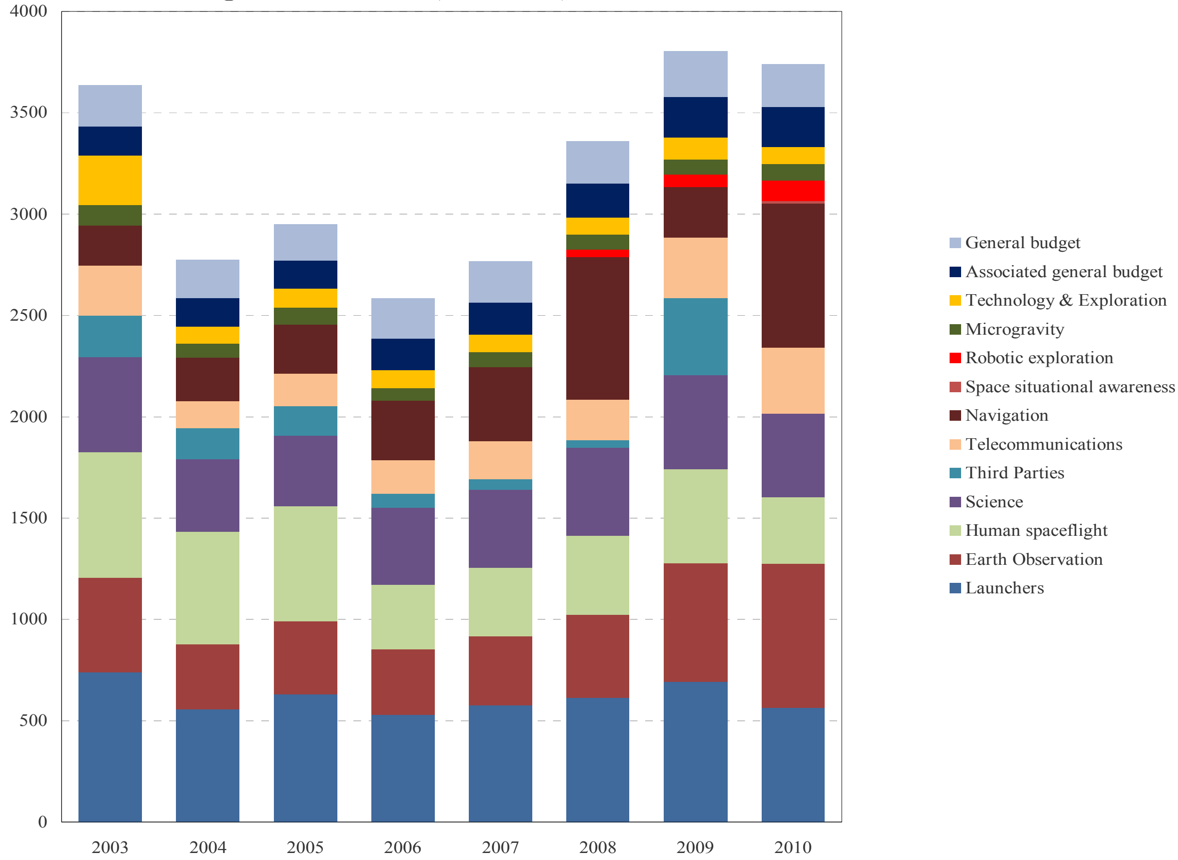
Due to the innovative nature of the sector, research, development and innovation are of crucial importance. Total R&D is estimated to account for 10 per cent of unconsolidated sales turnover of the EU space sector. Internal R&D investments by companies in the sector account for roughly one third of the 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.

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,

[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.

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.

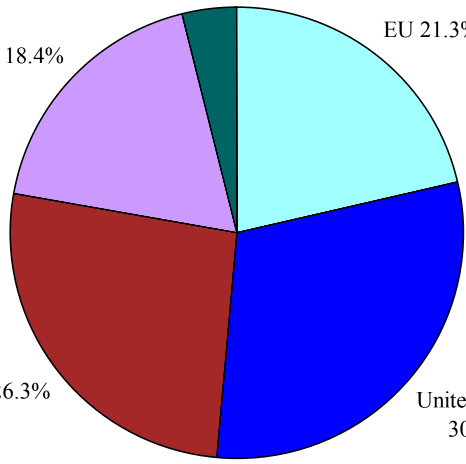
In 2008, the Commission, ESA and the European Defence Agency (EDA) set up a Joint Task Force with the aim of addressing critical space technologies for European strategic non-dependence. The task force drew up a list of priorities for critical space technologies for 2009 and proposed a methodology for 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.

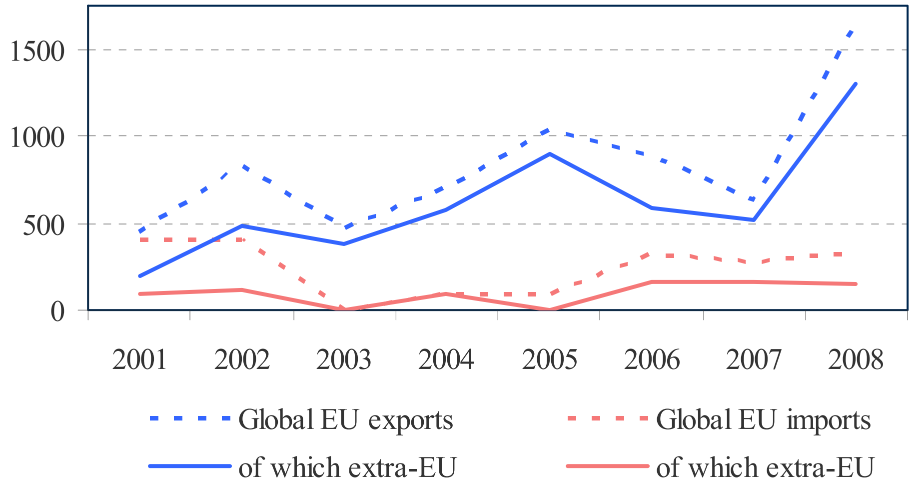
The share of patent applications emanating from EU applicants is surprisingly small, notably in comparison with other high-technology sectors such as nanotechnology, photonics, micro and nanoelectronics, industrial biotechnology, advanced materials, and advanced manufacturing technologies. As reported 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.

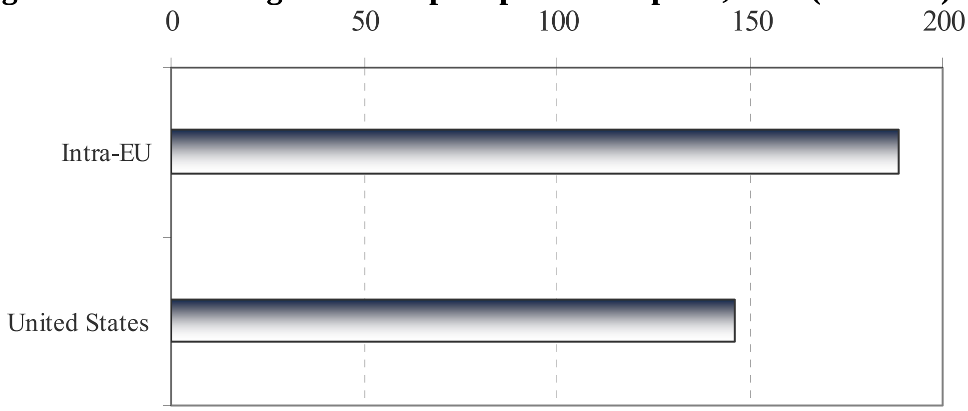
Figure 3.9: Total European exports and imports in value (million €), 2001–2008



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.

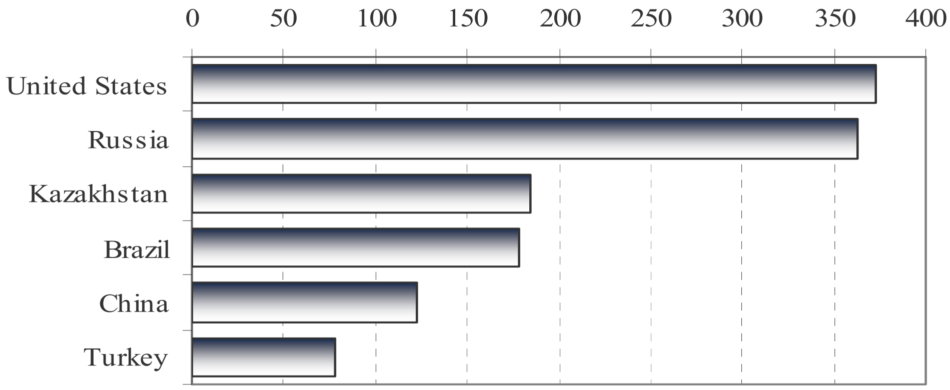
Figure 3.10: Main origins of EU space product imports, 2008 (million €)



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.

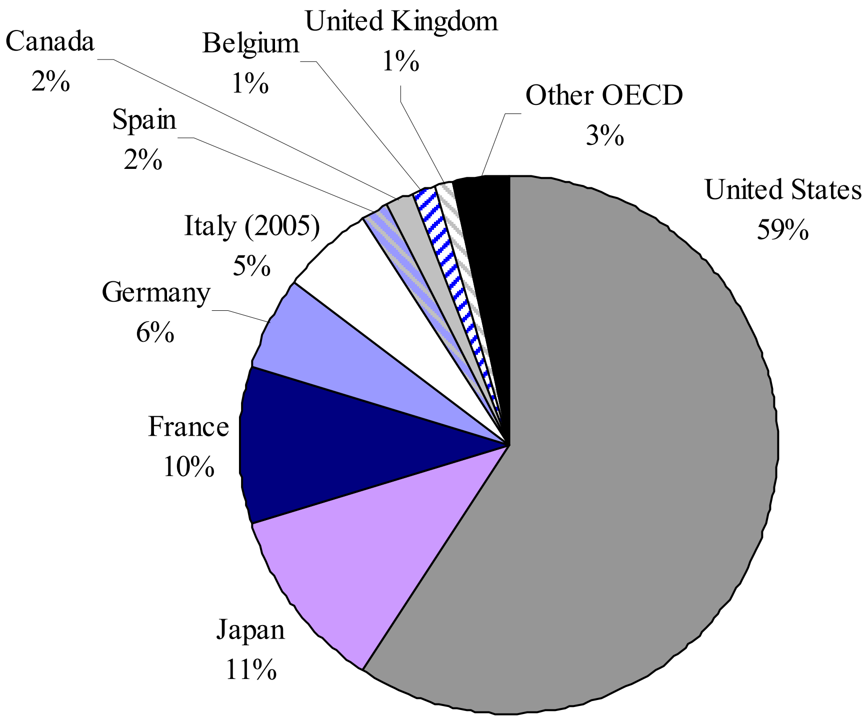
3.4.5. The EU space sector benchmarked against its US competitor

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).

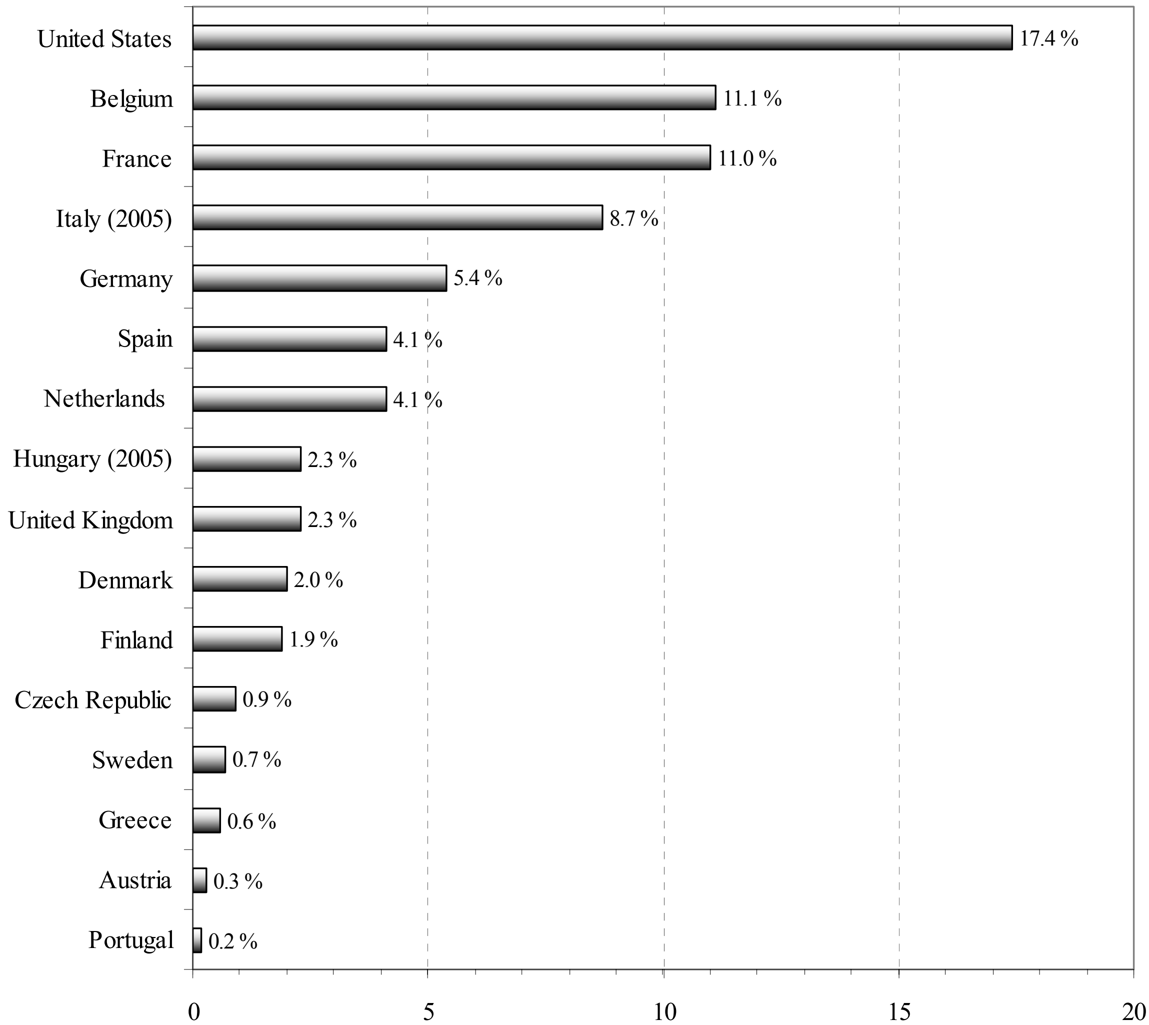
Figure 3.12: Breakdown of total OECD R&D for space, 2004



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.

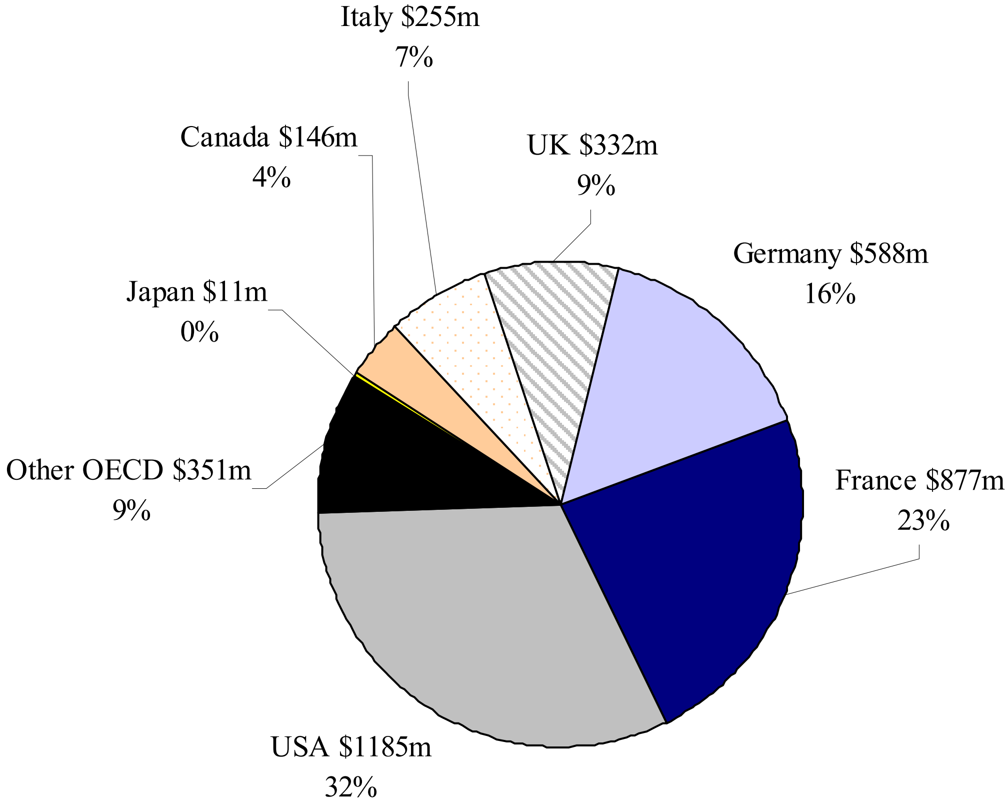
Figure 3.13: Space R&D as a share of government R&D budget in selected OECD countries, 2004



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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4. ACCESS TO NON-ENERGY RAW MATERIALS AND THE COMPETITIVENESS OF EU INDUSTRY

4.1. Introduction

4.1.1. Context of the analysis

The accessibility and affordability of non-energy, non-agricultural raw materials[53] is crucial for ensuring the competitiveness of EU industry.[54] The competitiveness of several European sectors such as electronics, cars, chemicals or construction can be hampered by a limited or more costly supply of certain raw materials. Like the US and Japan, the EU is highly dependent on imports for many of its raw materials for industrial and manufacturing purposes. While the EU has many raw material deposits, their exploration and extraction is hindered by increased competition for land use and the higher costs of safeguarding the environment and human health.

The fast-changing geopolitical and economic context affects the supply and demand of these materials. On the one hand, the industrialisation and urbanisation of emerging economies (e.g. the BRICs) has increased global demand for particular industrial raw materials,[55] as these countries have become more important purchasers of such materials on global markets.[56] Also the fast diffusion of emerging technologies is expected to raise global demand.[57] On the other hand, the mining and production of certain raw materials is concentrated in a few countries, and the free and transparent operation of global markets in these raw materials is not ensured. In many cases, distorting measures such as export taxes, quotas, import subsidies, and restrictive investment rules hamper access for EU industry.

Recent sectoral studies have highlighted a number of problems: i) high volatility of world market prices; ii) increased use of short-term supply contracts (e.g. supply of iron ore); iii) monopolisation of supply for certain ‘high-tech’ materials in certain countries; iv) growing competition and demand from emerging economies and increased concentration of suppliers of raw materials, leading to a more difficult price negotiation position, especially for SMEs.

The European Commission has launched a number of policy initiatives to address the challenges regarding access (conditions) to raw materials. In particular, the Raw Materials Initiative has highlighted the importance of access to non-energy, non-

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53 In the Report, the term of "raw materials" is understood as non-energy, non-agricultural raw materials used for industrial and manufacturing purposes and that are not primarily used to generate energy. For a more detailed definition of raw materials discussed in this chapter, see section 4.1.3.

54 See European Commission (2008a), e.g. Angerer G. et al. (2009), and Öko-Institut e.V., (2009).

55 For example, trade in base metals increased by 21.6 % yearly on the global market over the period 2004-2008.

56 However this should not be taken too far since in 2005 for instance China had import dependency rates ranging from 70-100 % for cobalt, copper, manganese, nickel, and titanium, see Hveem (2010). The European Commission (2009) also pointed out that countries generally considered resource-rich (like China, Canada, Russia, India, or Australia) can be dependent on imports of some raw materials.

57 See for example Fraunhofer ISI, IZT (2009).

agricultural raw materials for the competitiveness of crucial industries in the EU-27 economy.[58] The document set out a three-pillar approach towards an integrated strategy. These pillars are:

1. Fair and sustainable supply of raw materials from global markets;

2. Fostering a sustainable supply of raw materials within the EU;

3. Boosting resource efficiency and promoting recycling.

This was later followed up by the identification of 14 critical raw materials.[59] Their critical nature is based on the fact that they are entirely produced in a limited number of countries outside the EU, and have low substitutability and recycling rates. The Communication of February 2011 on ‘Tackling the challenges in commodity markets and on raw materials’ examined the problems in the wider context of commodity trade and emphasised the role of commodity derivatives and the link between physical and financial markets.[60] The overarching flagship initiative under the Europe 2020 Strategy for a resource-efficient Europe,[61] considers the problem of non-energy industrial raw materials in the wider context of a resource-efficient Europe in a global setting and in relation to related issues such as climate change, biodiversity, land use, deforestation, sustainable consumption and competitiveness. In March 2011 the Council of the European Union endorsed the three-pillar approach and the accompanying actions.[62] The Communication on Trade, Growth and World Affairs (2010) also addressed the strategic importance of access to an undistorted supply of raw materials to ensure the competitiveness of the EU economy[63]. The upcoming Communication on the European Innovation Partnership on Raw Materials will address the role of R&D and innovation in tackling the scarcity of raw materials.

4.1.2. The goal of the analysis

The main objective of this chapter is to analyse the nature and degree of vulnerability of the EU industry in terms of access to raw materials in a systematic and qualitative way. The focus is on the competitiveness effects for certain industries, taking into account the supply constraints on non-energy, non-agricultural raw materials from a sectoral point of view. ‘Access’ to raw materials is understood in a wider sense, meaning also the access conditions.

As part of this overall objective, this chapter looks into:

- Recent trends in global demand, the EU's supply and trade in raw materials, as well as the role of secondary raw materials and recycling in Europe.

- The competitiveness effects of a set of selected sectors for which raw materials are a critical factor in their relative global competitiveness. It examines supply-related issues regarding raw materials, e.g. price volatility, location of crucial materials, changes in contracting terms, etc., and the responses at company level

58 European Commission (2008a).
59 European Commission (2010a and 2010b). These materials are antimony, beryllium, cobalt, fluorspar, gallium, germanium, graphite, indium, magnesium, niobium, platinum, rare earths, tantalum, and tungsten.
60 European Commission (2011a).
61 European Commission (2011b).
62 Council of the European Union (2011).
63 European Commission (2010c).

to these challenges, including improving material efficiency, recycling, use of substitute materials, and organisational strategies.

- The role of the EU extracting and recycling industries in reducing the vulnerability of EU industries with respect to access raw materials.

- Potential public policies concerning access to raw materials, e.g. measures to promote resource efficiency, undistorted access to raw materials in third countries, measures to promote sustainable supply from domestic sources (mining plus recycling), and other aspects such as globalisation and trade in waste streams.

In terms of geographical coverage the focus is on a comparison of the EU as a whole with the rest of the world (e.g. the main emerging international players, such as China).

The analysis is qualitative in nature, comprising an independent and systematic analytical exercise based mainly on interviews with industry stakeholders, and on relevant literature and data.

4.1.3. Defining non-energy, non-agricultural raw materials

Non-energy, non-agricultural raw materials can be defined as raw materials that are mainly used in industrial and manufacturing processes, semi-products, products and applications and 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 (e.g. sand gravel, aggregates) are within the scope, but it also includes materials such as wood and natural rubber. Furthermore, crude oil and gas can be also considered as raw materials for industrial production [64].

This chapter focuses mainly on unprocessed non-energy, non-agricultural raw materials. However, such raw materials are processed into various products and components used by sectors further up the product value chain. These sectors are thus affected indirectly by the same raw materials issues.

4.1.4. Analytical approach: a framework for interpretation

Figure 4.1 depicts the relationship between raw materials and competitiveness, in the context of the supply chain. It will serve as the backbone for the various parts of the analysis.

The top part of the figure indicates four layers of competitiveness that can be distinguished at sectoral level: inputs, structure, processes and outcomes. These are related to the product market, in which both producers and consumers (or businesses in the case of intermediate consumption) operate.

The middle part of the figure shows the raw material flows throughout the production process, going from raw material to waste. An important aspect is the recycling of raw materials, leading to secondary material flows that reduce the import dependency and on top of that are often associated with lower energy processing costs.

The bottom part indicates the related risks. While problems such as increasing material prices and price volatility as well as monopolisation of supply for certain materials and trade restriction measures can be classified as supply risks, the problem

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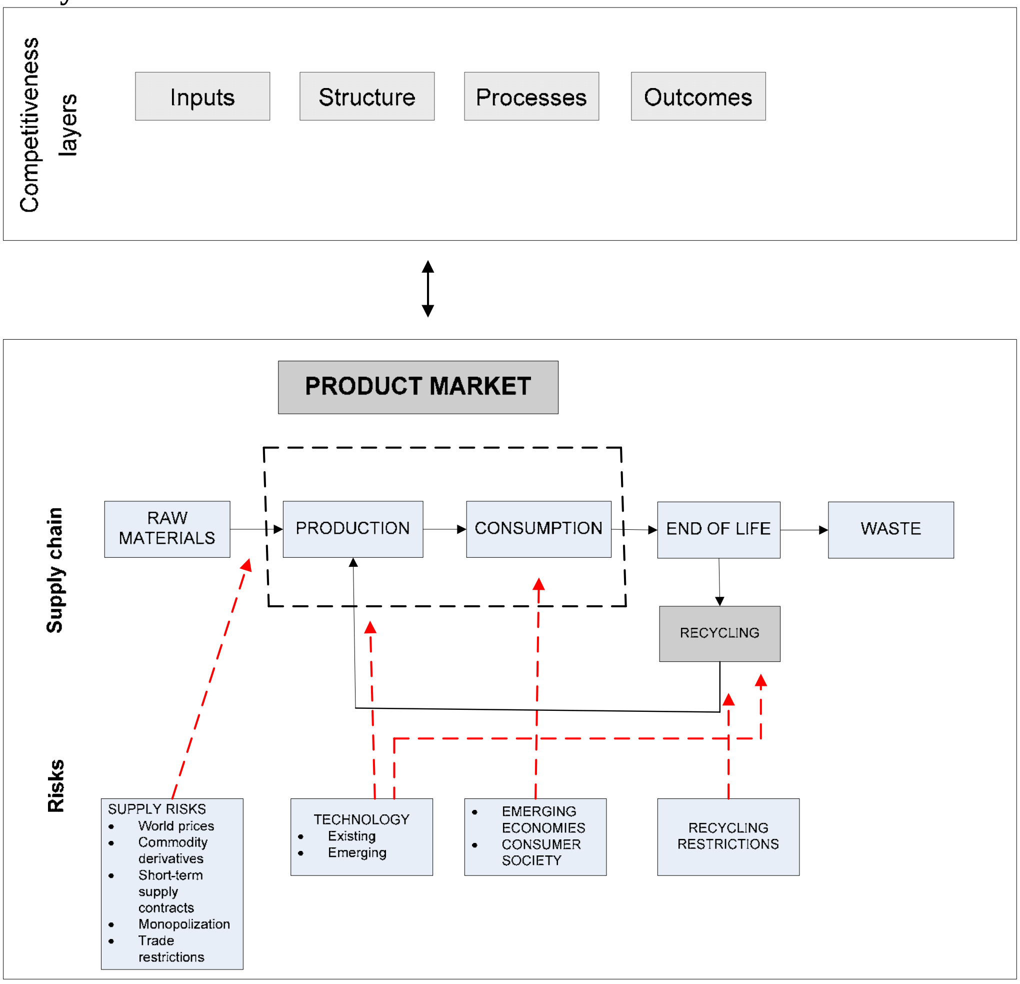
64 Although raw materials are commonly associated with minerals and metals, in particular the list of 14 critical raw materials identified by the Commission, the concept used in this chapter is wider. Although the latter two are typically used for energy production, they are the main raw materials in the chemical industry. Wood is considered as ‘forestry materials’.

of growing competition and consumption in emerging markets concerns the demand side of the product market. Also, risks and (technological) challenges can be identified at the recycling stage can be identified. These risk factors can be further refined, such as increased demand due to the development of emerging technologies, changes in consumer preferences, etc.

Figure 4.1: Raw material use in the production process and the value chain: analytical framework



Source: IDEA Consult.

4.2. Contextual data

This section presents data portraying the EU in its wider global economic context with respect to non-energy, non-agricultural raw materials. The data revolve around five themes:

– Demand: GDP growth of major economic blocks in the world, indicating where increasing demand for raw materials is expected to come.

– Price: changes in the prices of particular raw materials e.g. copper, zinc, aluminium.

– Supply: location of major deposits in the world and the EU's position.

– Trade: major raw material trade flows in terms of value and quantities, indicating that the EU is a major importer.

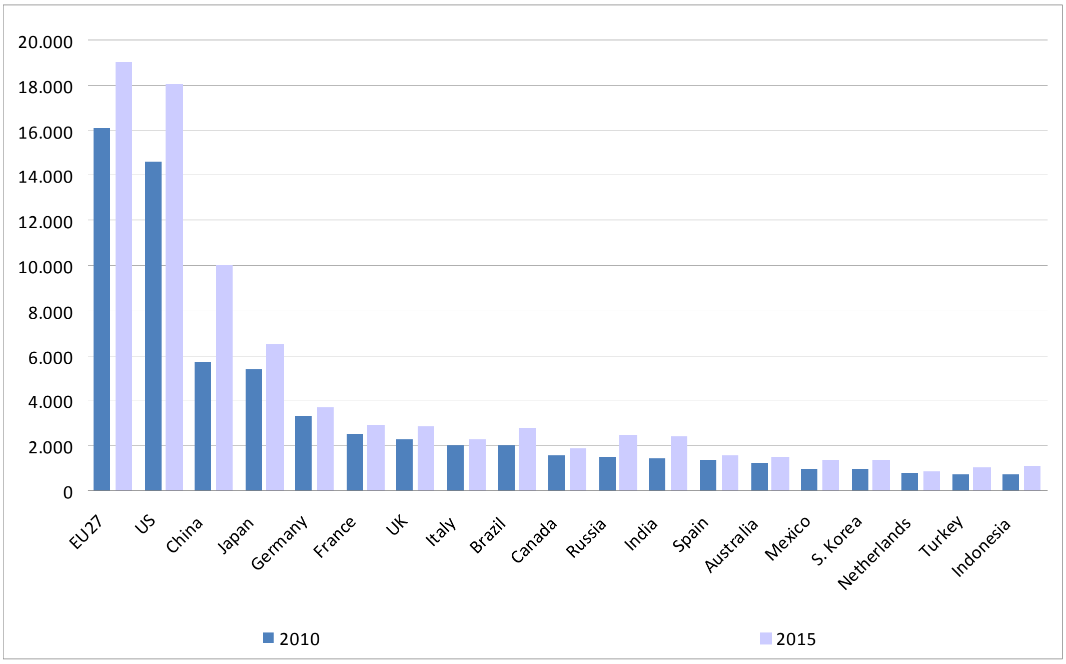
– Secondary raw materials and recycling: estimated waste stream recovery potential.

4.2.1. Global demand and the EU

The key factors driving the demand for raw materials are global economic and population growth and new technological applications. In particular, the growing appetite of the emerging economies for raw materials is seen as major force driving global demand.[65] The influence of China and, increasingly, India is commonly seen as dominant in this context. This is both a reflection of the scale of their economies and their current economic dynamism. Since the 1990s, developing countries have significantly increased their consumption of raw materials to help fuel their economies, and are now among the leading consumers and high long-term demand is expected.[66]

Figure 4.2 shows the GDP of major countries in the world in 2010 and estimates for 2015. The EU-27 and the US are the main economic blocks, both in 2010 and in the near future. Yet for other countries, in particular the BRIC countries, relatively significant changes are anticipated. According to IMF forecasts, India, Russia and Brazil will have economies of similar sizes as those of France, Italy and the UK.

Figure 4.2: GDP and GDP evolution of major world countries



Note: The vertical scale is expressed in billion USD.
Source: IMF.

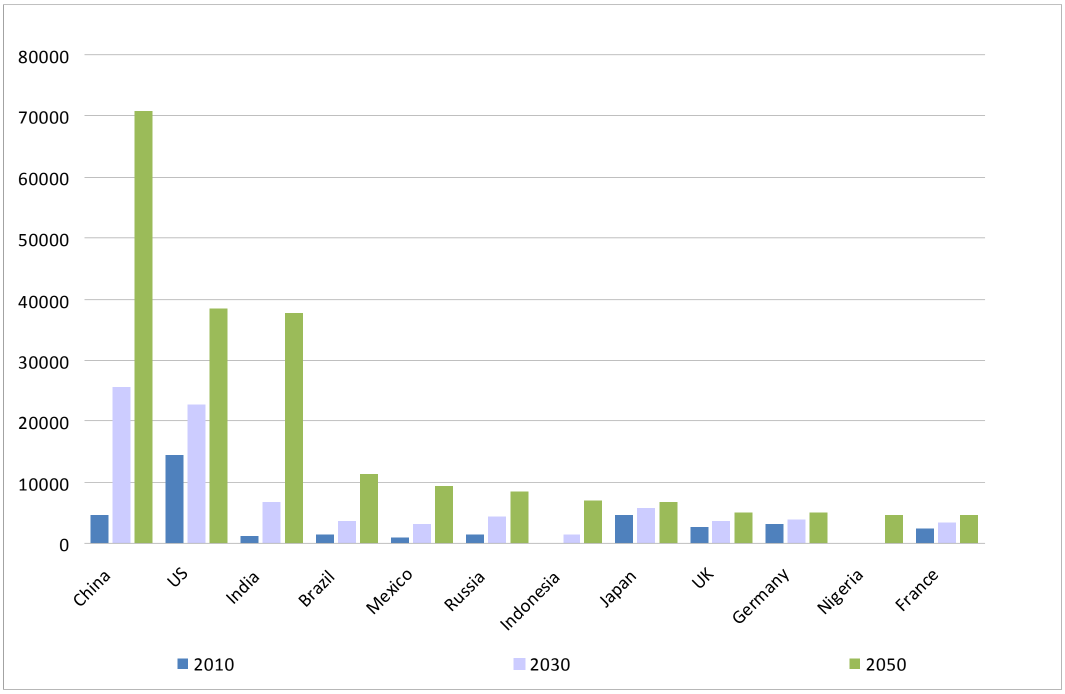
In 2010, China passed Japan as the world's second largest producer of goods and services. Japan is followed by the major European countries Germany, France, the UK and Italy. For the time being, the United States' GDP amounts to two and a half

65 See European Commission (2010a).
66 OECD (2010b).

times the GDP of China. The combined GDP of the EU-27 is about 10% higher than the GDP of the US. According to the IMF's forecasts for the near future, this world order will not change substantially by 2015. However, it is expected that China's GDP will be more than half of US GDP by 2015.

According to other forecasts[67] the economic world order is expected to change substantially by 2030 (see Figure 4.3). China will likely have surpassed the United States to top the GDP rankings, with India third. By 2050, the traditional large economies such as Japan, UK, Germany and France are expected to fall further back in the global GDP rankings. Of course, one has to bear in mind that long-term forecasts are by their nature very speculative. Yet they point to a certain economic growth pattern that will also have an impact on global demand for non-energy, non-agricultural raw materials.

Figure 4.3: Top-10 countries by GDP in 2050



Note: The vertical scale is expressed in billion USD.

Source: Goldman Sachs, Global Economics Paper, n 170, 'The expanding Middle: The Exploding World Middle Class and Falling Global Inequality', July 2008.

4.2.2. Long-term price evolutions

Demand from emerging economies has pushed up prices for important metals and minerals.[68] China's economic dynamism is described as a major factor in commodity market developments. China currently consumes about 30% of the world's base metals, against about 5% in the early 1980s. Increasing demand from emerging economies 'appears to represent a longer-term structural shift in consumption' and not just a 'cyclical movement'[69]. The literature also suggests that global markets for metals and minerals tend to be volatile, partly due to time lags in the response of

[67] See Goldman Sachs (2008).

[68] See for example OECD (2010b), European Commission (2011a).

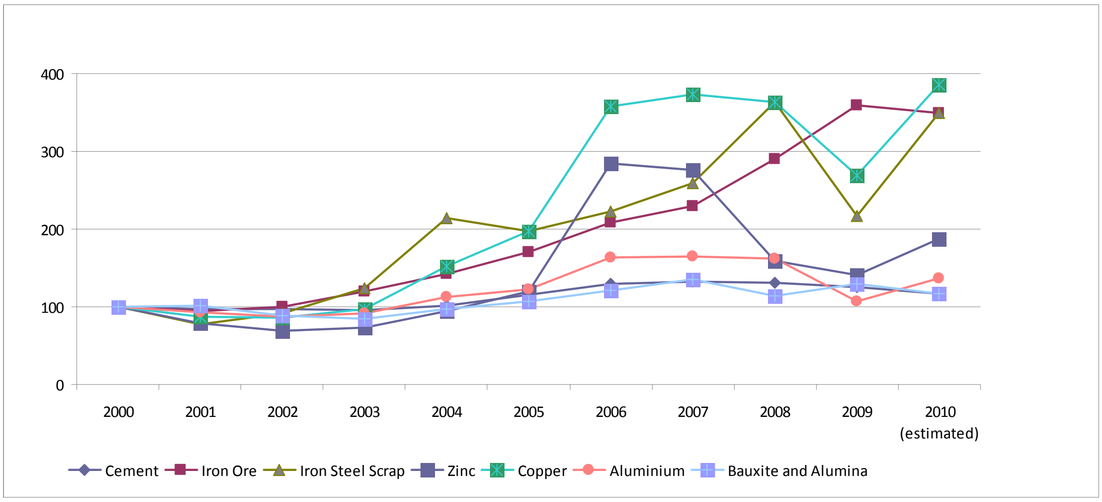
[69] J.P. Morgan (2010).

supply to changes in demand, but technological change in products also often changes the demand for strategic metals and minerals, contributing to high price volatility.[70] Furthermore, the export restriction measures often applied, such as quotas and minimum export prices have also contributed to soaring raw materials prices.

From 1990 onwards, prices had been relatively stable up to the year 2002. From 2003, the prices of the materials considered here generally started to increase, sometimes gradually (aluminium, cement, iron ore) and sometimes sharply (copper, zinc, iron and steel scrap). Much of the increase in prices from 2003 to 2008 can be explained by the strength of the demand and the lagged response of the supplying industry (Humphreys, 2009). In the case of copper, prices stabilised again from 2006 onwards, while in the case of zinc, prices fell sharply again. The prices of iron ore and steel scrap continued to increase vigorously up to 2008.

When prices are measured against their year 2000 levels, one can observe that prices for zinc, bauxite, aluminium and cement rose at a gentle pace, with increases of between 20% and 60% during 2000-2008 (See Figure 4.4). On the other hand, prices for iron ore almost tripled during the same period. Prices for iron and steel scrap and copper more than tripled, with an average yearly increase of 17% during this period. While the economic crisis of 2008/9 had a significant impact on the prices of metals, some metal prices, such as copper and iron ore – have recovered to near pre-crisis levels.

Figure 4.4: Price indexes of selected raw materials (2000=100)



Source: United States Geological Survey (USGS).

4.2.3. The EU's supply from a global perspective

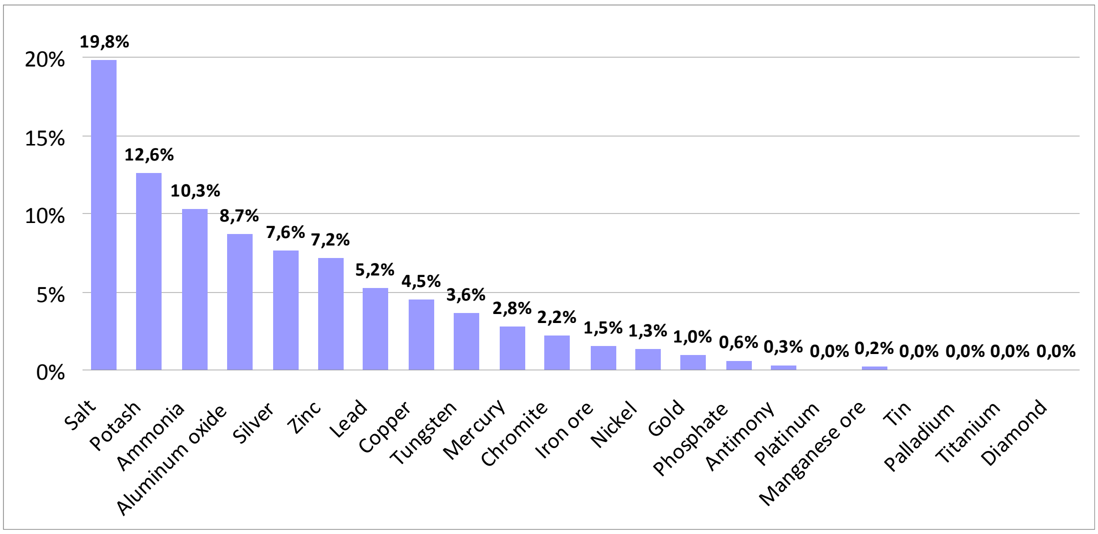
The supply of non-energy, non-agricultural raw materials is described as relatively inelastic in the literature. This is mainly the result of long lead-times in the mining and recycling industry. Investments in the extractive industries are associated with high capital intensity and a long-term payback characteristic, often involving substantial risk.[71] Furthermore, investments are very often influenced by environmental considerations and political decisions. This is one of the reasons why

70 OECD (2010a).

71 UNCTAD (2007), p. 83.

supply does not immediately respond to changes in demand, since weak price signals can leave a 'legacy of underinvestment' reaching years into the future.[72] The resulting lag in the response to growing demand can translate into temporary supply gaps.
The second pillar of the EU's Raw Material Initiative focuses on fostering sustainable supply within the EU. Figure 4.5 indicates the share of the EU-27 in world mining production for a set of minerals and metals.

Figure 4.5: Share of EU-27 in world mining production



Source: IDEA Consult based on USGS.

For most mining materials, the EU-27 only accounts for a small share of world mining production. Only for salt and potash is mining production in EU-27 on a global scale, with shares of 20% and 13% of world production, respectively. For some critical raw materials, EU-27 share is below 5% (tungsten) or even non-existent (antimony, manganese, platinum). Due to price increases, the return on investment of recovery and recycling of certain materials has changed over recent years, especially in Europe and North America.[73]

Within the EU, several countries are quite significant producers, yet in terms of global supply the amounts produced are relatively small. Austria was estimated to have been the fourth biggest tungsten producer in the world in 2009. Portugal is also a significant producer of tungsten. Poland is the EU's biggest producer of silver, and also quite active in producing of copper, zinc and lead. Ireland is the EU's largest producer of zinc. Sweden has a variety of raw materials. It is the leading producer of iron ore in the EU, and also processes lead, gold and zinc, too. Bulgaria and Spain are also quite significant producers of gold. Within the EU, Germany produces most of the potash and the largest amount of ammonia and salt.

4.2.4. Trade flows

The literature on trade and global supply chains highlights the highly uneven distribution of metal and mineral reserves across countries as a key contextual factor (see for example OECD 2010a). Large shares of important raw materials are

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[72] J.P. Morgan (2010).

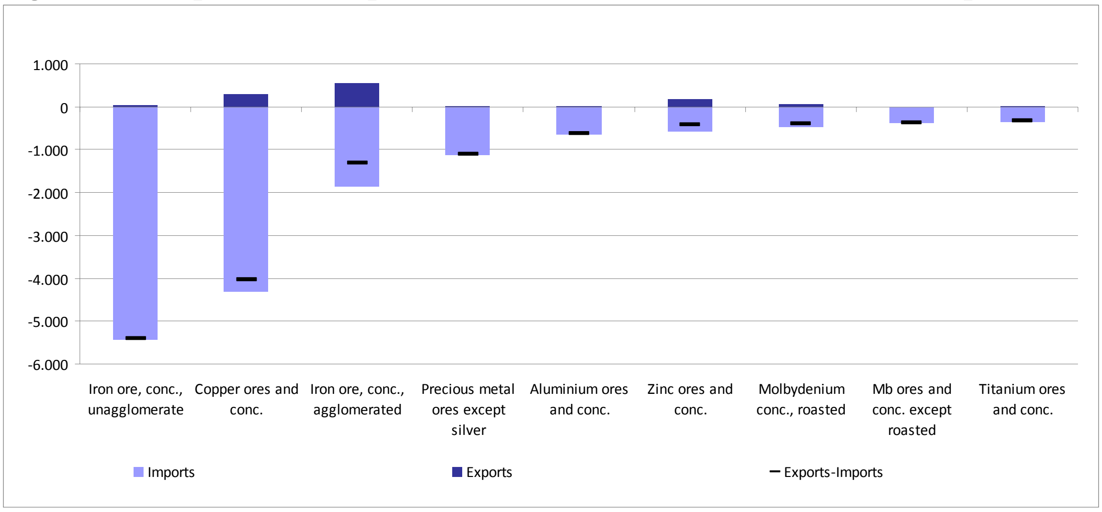
[73] A good example is platinum: global recovery from car catalysts has risen by more than 10 % every year since 2006, with 39 % of this secondary platinum produced in Europe in 2009.

concentrated in a relatively small number of countries and other economies have limited domestic supplies and therefore depend on imports. Some of the major producers and exporters of raw materials are located in developing economies. The global supply chains for essential raw materials have become increasingly complex and interdependent, which leaves supply relatively vulnerable. The vulnerability of industry can be assumed to be greatest in sectors unable to replace scarce and expensive raw materials with more abundant and cheaper materials with similar properties (Angerer et al., 2009). The unequal distribution of raw material reserves is also considered to be an important source of trade friction.

4.2.4.1. Trade data

The trade balance for raw materials in the EU-27 leans strongly to the import side (see Figure 4.6 and 4.7.). For the main raw materials, unagglomerate regards the most important materials, such as unagglomerated iron ore and copper ore, imports surpassed USD 5 billion and USD 4 billion in 2009, respectively. Imports of agglomerated iron ore and precious metals each amounted to more than USD 1 billion in 2009. Other important imports, surpassing USD 300 million in 2009, are ores from aluminium, molybdenum and titanium ores.

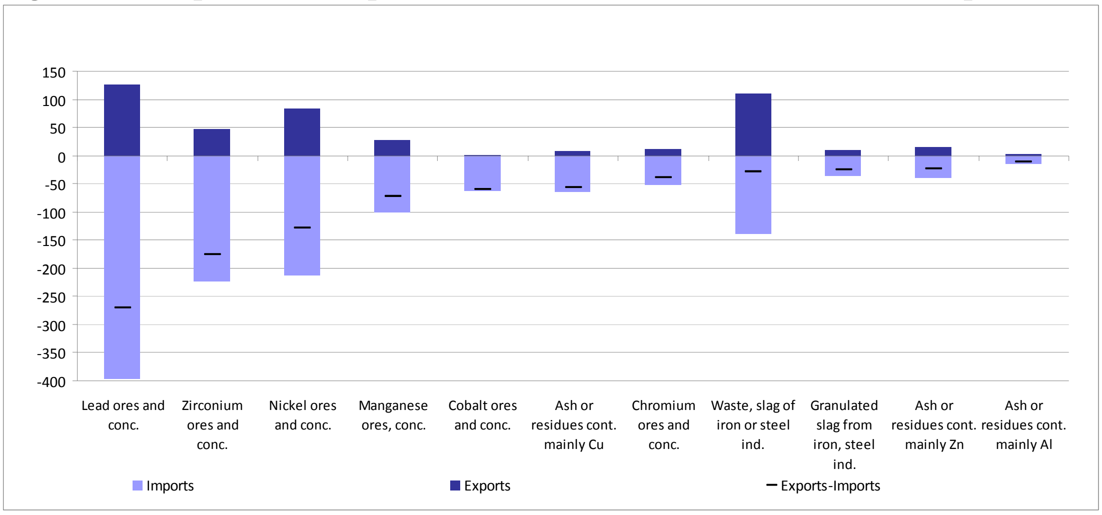
Figure 4.6: Exports and imports of raw materials in the EU-27, 2009 – part 1



Note: values are in million USD.

Source: UN Trade data.

Figure 4.7: Exports and imports of raw materials in the EU-27, 2009 – part 2

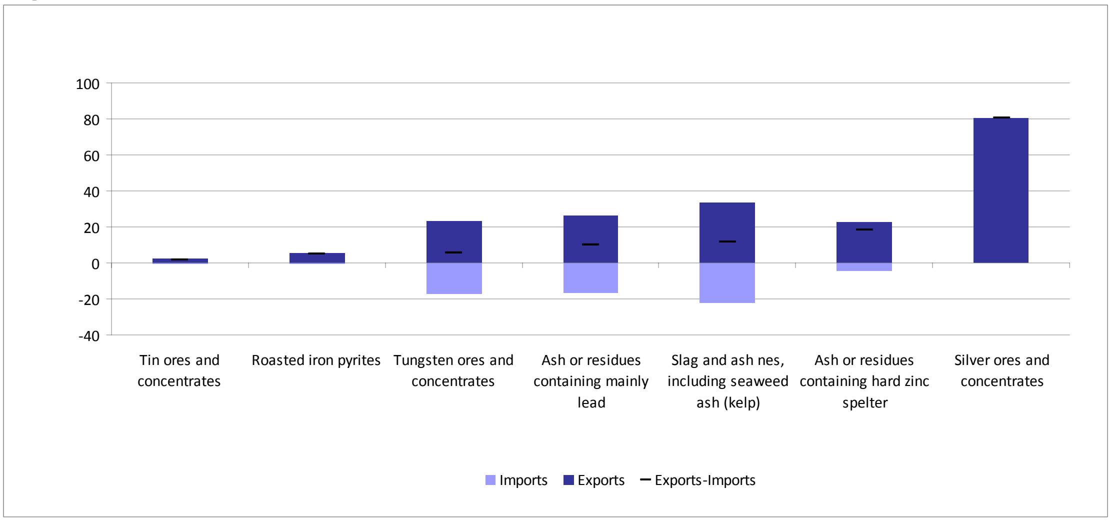


Note: values are in million USD.

Source: UN Trade data.

Within the EU-27 some materials have a positive export balance. However, these balances are much smaller than the positive import balances. Silver has a positive export balance amounting to USD 80 million. Other materials with a positive balance sheet are tungsten and some slag and ash materials (Figure 4.8).

Figure 4.8: Exports and imports of raw materials in the EU-27, 2009 – part 3

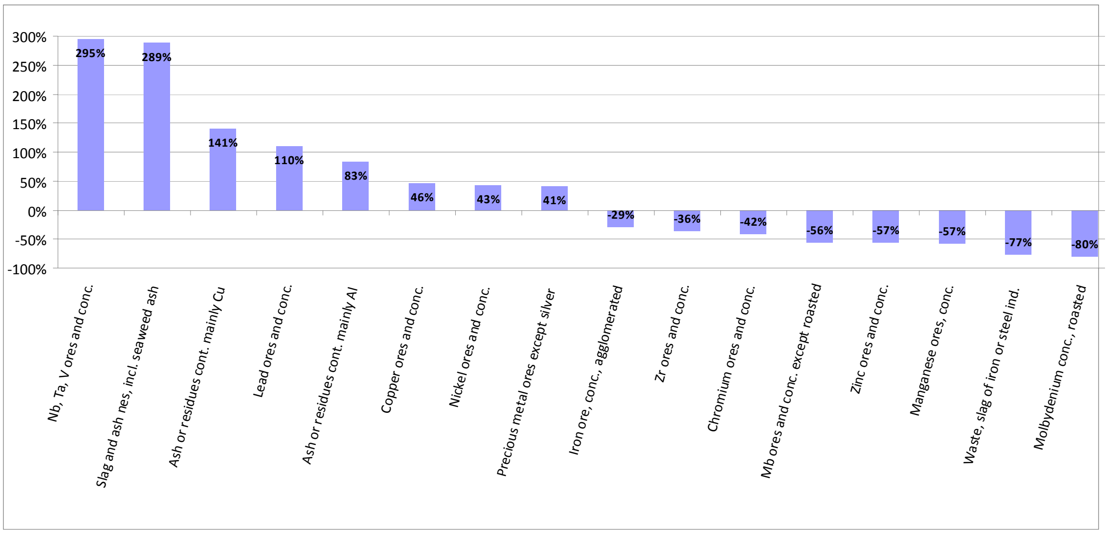


Note: values are in million USD.

Source: UN Trade data.

Over time, it is worth noting that between 2005 and 2009, net imports of some materials into the EU-27 increased strongly (Figure 4.9). This was the case for 'niobium, tantalum and vanadium ores', and for some ash and slag materials. Net imports of lead ores, copper ores and nickel ores also increased. On the other hand, net imports decreased for certain materials - roasted molybdenum concentrates and waste of iron, - and certain ores - zirconium, chromium, zinc and manganese.

Figure 4.9: Relative evolution of imports-exports in the EU-27 between 2005 and 2009

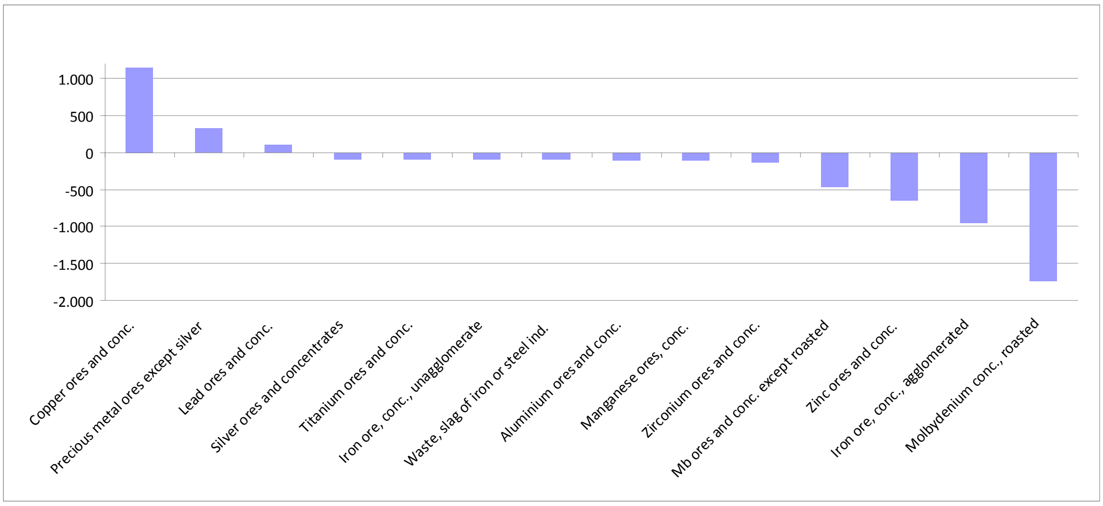


Source: UN Trade data.

Figure 4.10 presents the largest changes in absolute net imports were seen evolution the case of copper with an increase of more than USD 1 billion, and in the case of iron with a decrease of more than USD 1 billion (both agglomerated and unagglomerated) decreased in the same value.[74] Net imports of most materials decreased between 2005 and 2009, by USD 600 million for zinc ores and by USD 500 million for molybdenum ores.

[74] The significant increase in copper imports during this period can be partly explained by the boom in the construction sector, which is the largest user of copper in Europe. The substantial decrease in iron ore imports can be linked to the falling demand for raw materials in the manufacturing industry, especially in the automotive sector, during the crisis.

Figure 4.10: Absolute evolution of imports-exports in the EU-27 between 2005 and 2009



Note: Values are in million USD.

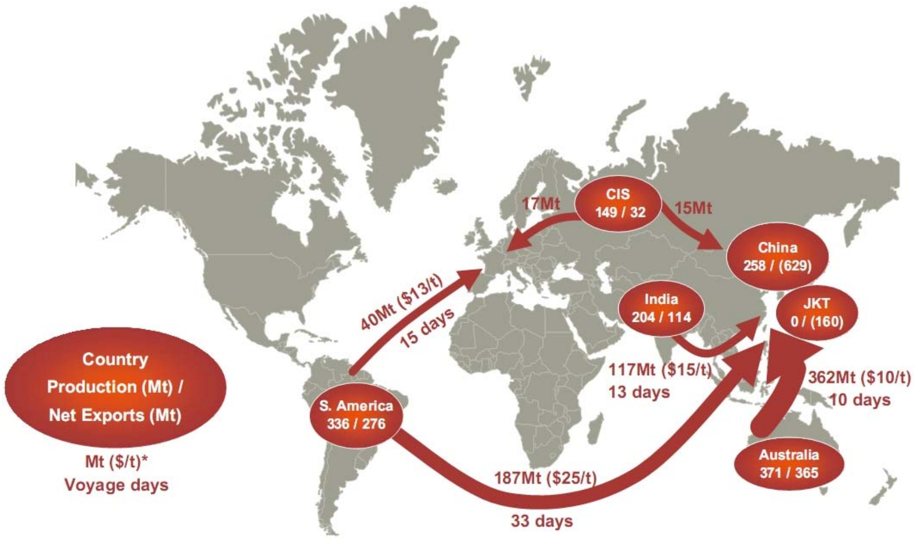
Source: UN Trade data.

4.2.4.2. Trade of iron ore, critical raw materials and rare earths

Iron ore, critical raw materials and rare earths are especially important for the sound functioning of European industry. It is worth taking a closer look at global trade in these materials.

Iron /steel is a very important metal being used widely many sectors. The major flows of iron ore are from the two major production regions (South America, notably Brazil, and Australia) to the major consuming region (Asia, notably China, Japan and Korea) (see Figure 4.11). The two producing regions export a large share of their production. Another important producer, India, only exports half of its iron ore production, being an important consumer too. Europe, with a very low production rate (see Figure 4.4), imports mainly from South America and the Russian Federation. China, as an important producer, has no substantial exports of its iron ores. In fact, China needs to import iron ores from Russia, Australia, India and South America.

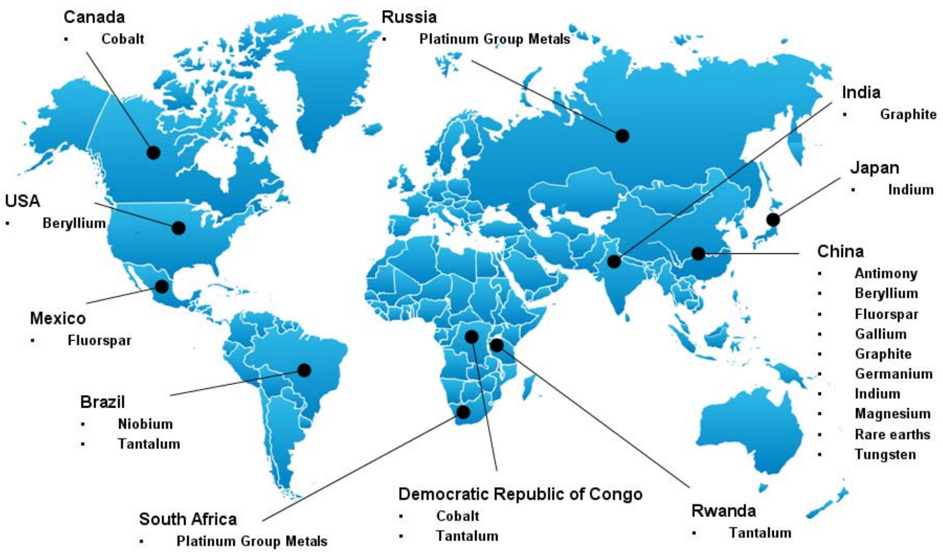
Figure 4.11: Major trade flows of iron ore, 2009



Source: adapted from www.bhpbilliton.com.

The above overview of certain selected critical raw materials (see Figure 4.12) shows the high dependency of European industrial countries on other countries, very often third world countries or emerging economies. By far, the most resource-rich country in this respect is China. This country is the world's top exporter of rare earths, graphite, magnesium, antimony and fluorspar. Moreover, it has the largest reserves of rare earths, tungsten, graphite and antimony. Other important countries for these resources are Russia, DR Congo, South Africa, Brazil and Mexico. European dependency can be observed in the import column: very often, the most industrialised countries (Germany, France, Spain, Italy, UK, the Netherlands, Austria and Belgium) are among the top 15 importers.

Figure 4.12: Production concentration of critical raw mineral materials, 2006

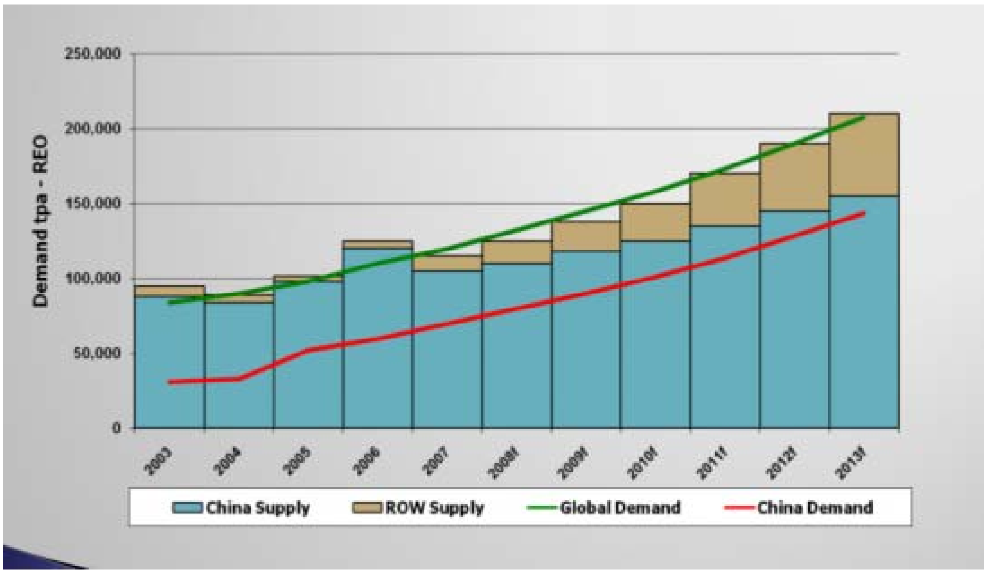


Source: Press release by European Commission MEMO/10/263 on 17/06/2010.

Recent trends often show a similar picture. Following the economic downturn, demand for these critical raw materials fell on a global scale. In 2010, global demand started to increase again, driven by emerging countries, resulting in price increases in general. Combined with the fact that technological evolution is further pushing demand for some of these critical raw materials (graphite, rare earths), prices for 2011 are expected to soar to levels far above those before the economic downturn. Mining projects are (re)starting production and new mining opportunities are being explored worldwide (magnesium, fluorspar, cobalt, antimony). Only in the case of cobalt is production likely to outpace demand, possibly resulting in lower prices.

Rare earth elements[75] are widely used in a variety of applications that are growing on a global scale, such as cell phones, computers, electric and hybrid vehicle motors, wind turbines etc. Rare earth elements are relatively plentiful in the earth's crust;. However, it is difficult to find them in sufficient concentration in places where they can be profitably mined and processed. China, with the most abundant resources in the world, dominates the world market and exports the largest amounts of rare earth compounds and metals, followed by Austria, Japan, Russia and the USA. In recent years, the biggest importers of rare earth have been Japan, USA, Germany, France and Austria. Figure 4.13 shows that global demand for rare earth is expected to outpace Chinese supply if current trends continue. To meet this demand, production and supply by the rest of the world should further increase during the following years.

Figure 4.13: Supply and demand for rare earths, assuming current trends continue



Source: Industrial Minerals Cooperation, http://www.industrialmineralscorp.com.au/ accessed on 2[nd] February 2011.

4.2.5. Import dependency: evidence from material flow data from Germany and the UK

A natural question to ask after having discussed the limited supply of non-energy, non-agricultural raw materials in Europe, its relatively large net import rates, and the EU’s recovery prospects is to what degree can the EU´s material requirements be covered by own supply. It is clear from the analysis in previous sections that the answer in general is relatively little. However, a more precise answer can be given on

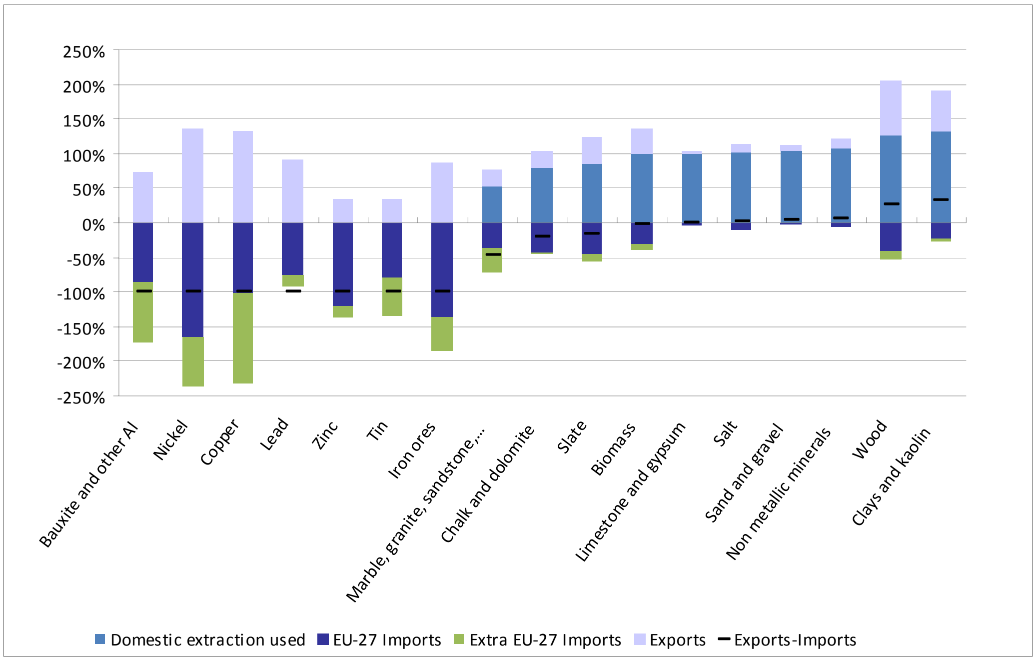
75 Rare earth elements are a collection of 17 chemically similar metallic elements. The term ‘rare earth’ is a misnomer arising from the rarity of the minerals from which they were originally isolated.

the basis of material flow data. These data are shown for two major economies in the EU: Germany and the UK.

Material flow data from Germany and the UK show a 100% import dependency for a range of raw materials, such as bauxite, alumina, nickel, copper, lead, zinc, tin and iron ores, as there is virtually no domestic extraction that can be used in domestic industries. Germany imports substantially higher shares from inside the EU-27 in comparison with the United Kingdom.[76]

For certain materials, domestic extraction has to be supplemented by imports. In Germany, this is the case for marble and granite, chalk and slate. In Germany, domestic extraction fills up the domestic needs for limestone, salt, sand and gravel and certain non-metallic minerals, while there is an extraction overabundance that can be exported for wood and certain clays.

Figure 4.14: Domestic extraction used, exports and imports as a percentage of domestic material input, Germany 2007



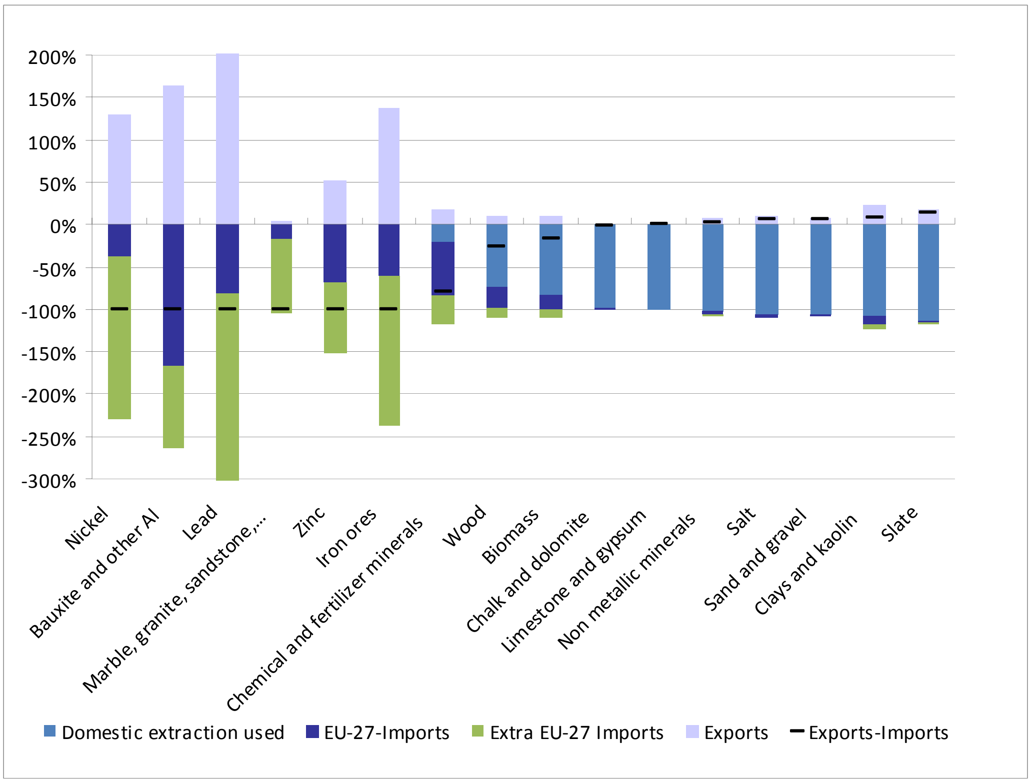
Note: DEU: domestic extraction used which is the total amount of the domestic mining/quarrying extraction used in domestic industries or for export. DMC: domestic material consumption:, which is the total of the domestic extraction used and the difference between imports and exports, which is the total amount used of a certain material in domestic industries.

Source: Eurostat, Material Flow Accounts.

In the UK, however, significant amounts of fertiliser materials, wood and biomass are available from domestic sources, though additional imports are needed. Domestic extraction meets domestic demand for chalk and limestone. Small surpluses can be exported in the cases of salt, sand and gravel, certain clays and slate.

76 However, it should be noted that these intra-EU-27 imports may be re-exports from EU countries. The recorded exports of Germany and the UK of these materials are also re-exports.

Figure 4.15: Domestic extraction used, exports and imports as a percentage of domestic material input, United Kingdom 2007



Source: Eurostat, Material Flow Accounts.

4.2.6. Secondary raw materials and recycling

A substantial increase in world output has boosted the demand for raw materials used for industrial and manufacturing purposes. At the same time, the quantity of waste produced has risen, so the potential to use more secondary raw materials as inputs has also increased. As the previous section reports, although the EU's global position is relatively modest as a supplier of primary raw materials, in terms of secondary raw materials, there is still substantial potential.

Recycling has often been identified as an important component of improved and sustainable resource management. Together with the development of substitute materials, recycling and improved resource management may reduce the current global population's current resource footprint, implying a decoupling of economic growth and environmental impact.

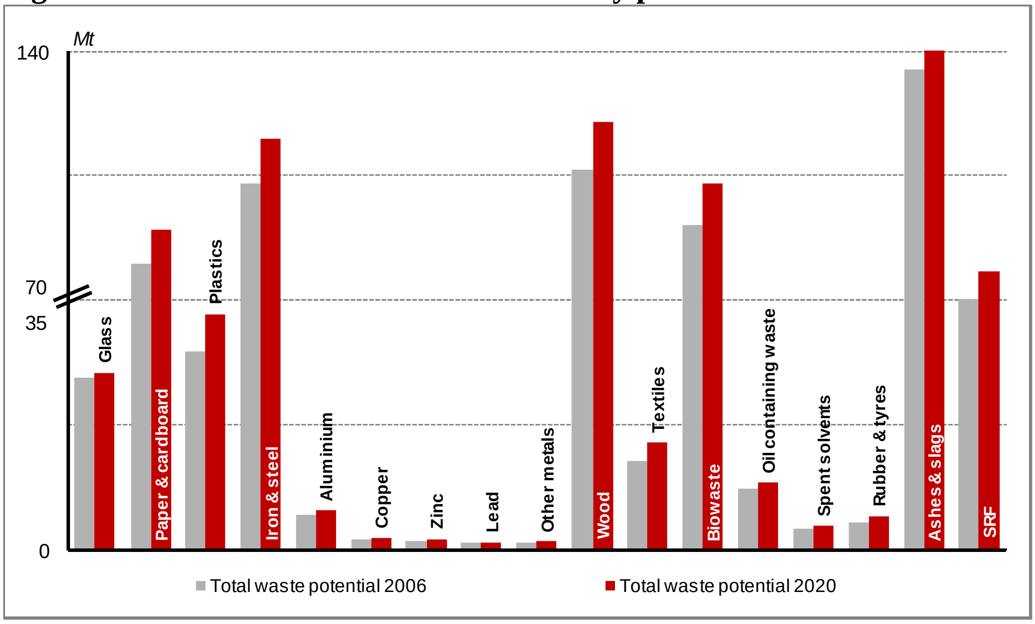
As regards the recovery and reuse of raw materials good waste management is a crucial point. The EU has seen a significant change in waste management in general, driven by EU and national legislation[77] and supported by rising prices for both energy and non-energy raw materials.

Birnstengel and Hoffmeister (2010) estimated that in 2006, 23 % of the EU's total waste stream could be recovered as secondary raw materials, amounting to 675 million tonnes. Somewhat more than half was actually being recovered for energy and

[77] For example: the setting of targets for recycling, landfill taxes and restrictions etc.

material, leaving 45 % of the potential still largely unused, mainly dumped as landfill or incinerated without energy recovery. Figure 4.16 indicates the EU's recycling potential for each of the 17 identified waste streams for 2006 and projections for 2020. It is evident that the potential differs across waste streams. The biggest potential is found for paper, plastics, bio-waste and wood, but also for iron and for ashes and slag.

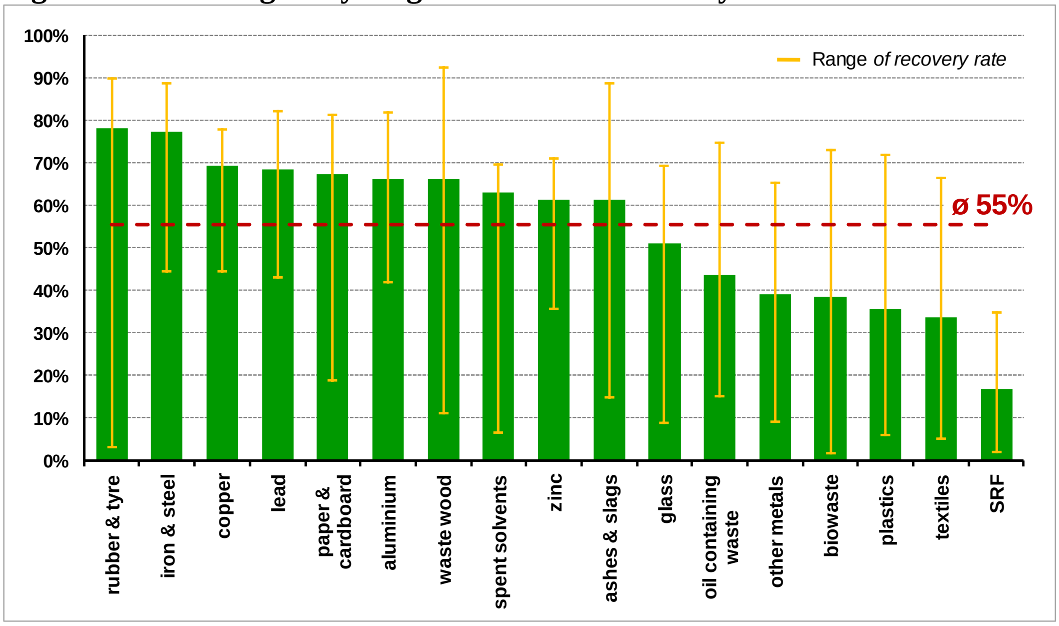
Figure 4.16: Estimated waste stream recovery potential in the EU in 2006 and 2020



Source: Birnstengel and Hoffmeister (2010).

To a certain degree, the potential depends inversely on the actual EU recovery rate. However, the variance across Member States also plays a role. Ceteris paribus, the higher the variance, the higher the potential. Figure 4.17 shows the EU recovery rate per material and the range of recovery rates across Member States. One can observe that for the major raw materials (rubber and tyres, iron and steel, copper, lead, paper and cardboard, aluminium, solvents, zinc, glass and ashes) the recovery rates are more than 60 % for the EU as a whole. For other metals, plastics and textiles, recovery is still on the low side.

Figure 4.17: Average recycling rates for the EU-27 by waste stream in 2006



Note: the yellow whisker plots indicate the ranges over the Member States. The green bars indicate recovery rates for the EU-27 as a whole.

Source: Birnstengel and Hoffmeister (2010), p.4.

One may conclude that for certain metals and minerals there is still substantial untapped potential within the EU as a whole for the recovery of non-energy raw materials.[78] Conversely, for other materials such as copper, aluminium, lead, zinc as well as 'other metals', recovery is gradually reaching its full potential.

4.3. Qualitative analysis results

The following section complements the statistical evidence with qualitative information from expert interviews for a selection of industries. They were selected through an iterative process, starting with a literature review, followed by inquiries among experts for an independent view and subsequently discussions with industry representatives.[79] In this section, the positions of the selected sectors in the value chain are first identified, then the main competitiveness issues with respect to raw materials shortages are discussed. Following this, policies related to each sector and the role and challenges of the European non-energy extractive industry are illustrated, since the industry plays an increasing role in reducing dependency on imports of raw materials.

4.3.1. Interrelation of the selected industries in the value chain

An important aspect is the interrelation of the raw material intensive industries and the way in which raw materials risks and consequences pass through the value chain. To give an example, the Figure 4.18 for Germany presents the share of the selected industries to GDP and their position in the value chain. The latter is calculated as the percentage of output produced for final use.[80]

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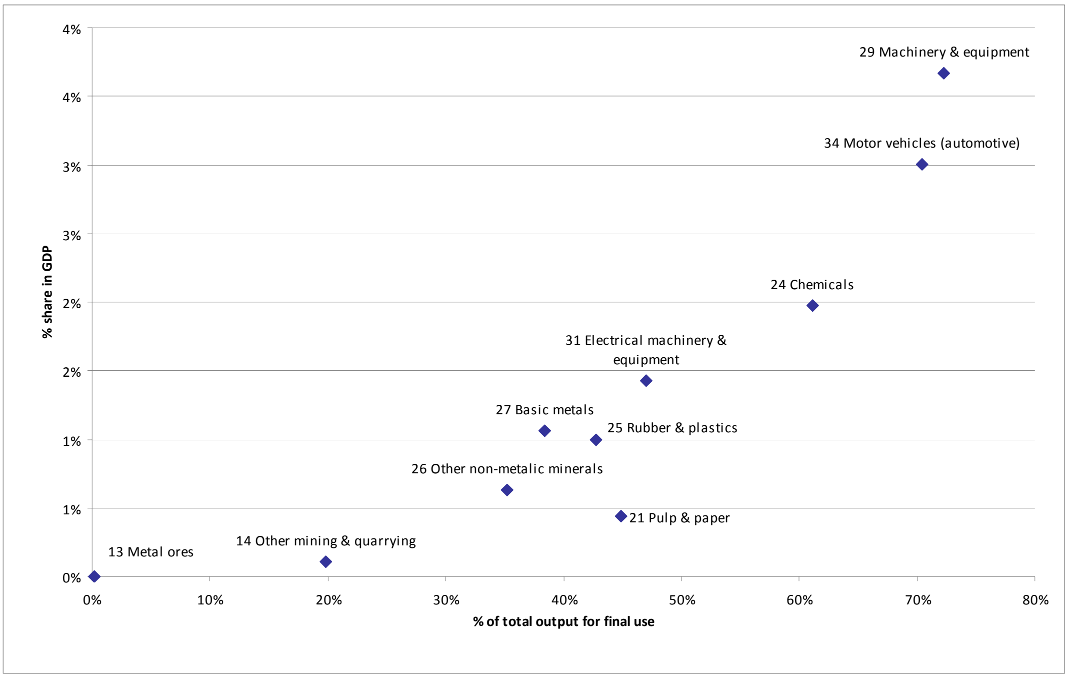
78 For recycling rates for metals, various recycling metrics and current estimates on global end-of-life recycling rates, recycled content, and old scrap ratios, see UNEP (2011).

79 For the list of interviewed persons see References.

80 Since no input-output table is available for the whole of the EU-27 (or even part of it) the results for the largest industrialised economy are presented.

Figure 4.18: Location of the selected industries in the value chain – Germany 2007



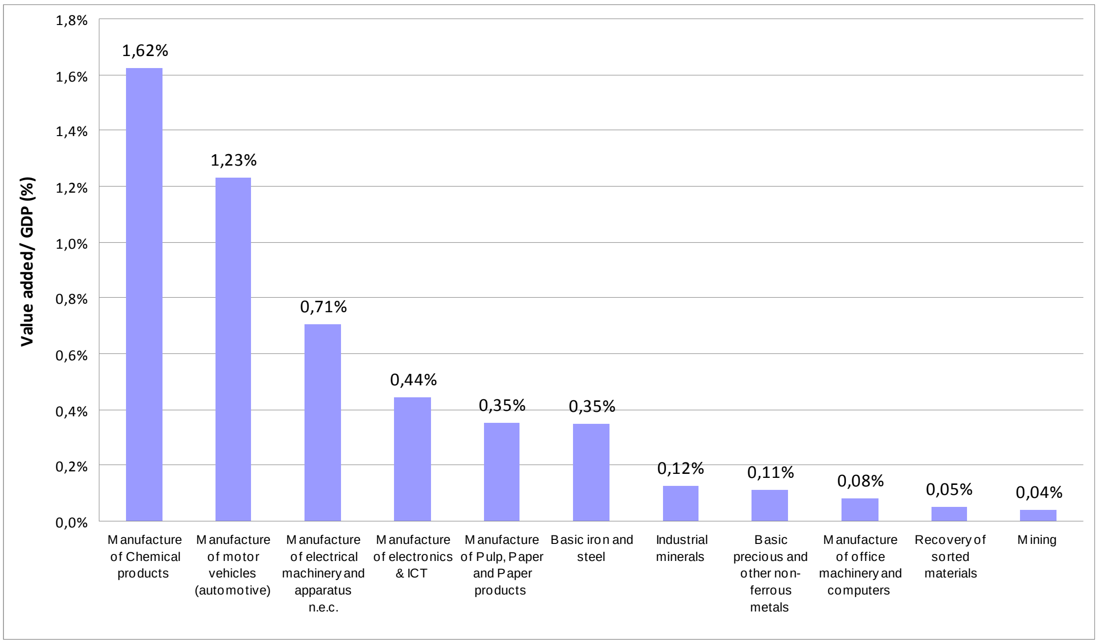
Note: the numbers refer to the NACE classification.

Source: IDEA Consult based on Eurostat: symmetric input-output table for Germany, 2007.

An important observation is that industries higher up in the value chain contribute to a larger degree to the economy's GDP. While in certain EU Member States such as Sweden, metal ores and other mining and quarrying might have bigger weights in the economy, it is characteristic for EU economies that these activities account for relatively small shares in overall GDP.

In order to present a picture closer to the situation of the EU-27 and to the selected sectors discussed later, Figure 4.19 shows the % share in GDP for the EU-27 as a whole. In general, one can observe a similar pattern for the EU-27 as for its largest economy, in terms of relative position. Yet there are a few important differences. The German economy has relatively higher shares for most of the selected sectors. The share of machinery and equipment is much lower for the EU as a whole than for its main economy. Based on the economic importance of the manufacturing sectors and their high raw material intensity, the impacts of shortages of raw materials on the steel, non-ferrous metal, automotive, chemical as well as paper and pulp industries will be investigated in the next section.

Figure 4.19: Share of selected industries in the EU-27 GDP, 2006



Note: 'Basic iron and steel', 'Basic precious and other non-ferrous metals' and 'Recovery of sorted materials', based on data 2008.

Source: Eurostat.

4.3.2. Raw materials insufficiency and related competitiveness issues

The competitiveness effects of non-energy raw materials on the selected European industries are illustrated in this section. Two main competitiveness issues can be identified in terms of raw materials shortages. The first concerns cost competitiveness effects on essential raw material inputs for production, stemming from different sources, such as increasing global demand, trade restrictions, transportation costs etc. The second issue concerns the solutions and strategies that industries tend to adopt to tackle the relative shortage of raw materials, including increasing material efficiency, using recycled and substitute materials, as well as choosing various organisational strategies. Finally, the policy implications relevant to each industry are presented.

4.3.2.1. Cost competitiveness effects

The input effects resulting from shortages of raw materials differ across industries, not only in terms of subject, but also in terms of weight. The price increase in globally-traded raw materials has hit most industries, ranging from steel and non-ferrous metals, to sectors such as car manufacturing. There are several reasons for rising input costs for raw materials. Those most important for the sectors selected will be illustrated here.

First, prices for most raw materials have been escalating over the last decade (see section 4.2.2). Prices of raw materials depend mainly on the time lag with which supply follows demand. Increasing demand from emerging countries has been a major factor accounting for the rise in prices. Clearly, these lagged adjustments have an important effect on price levels and there volatility.

Second, besides supply scarcity and adjustments, supply concentration is also a factor in determining prices. A large share of many raw materials is concentrated in a small number of countries, which often apply export restriction measures.[81] Export restrictions lead to a decrease in export volumes, thus affecting global competition and supply chains. Export restrictions contribute to pushing up international raw material prices due to curbs on supply to the global market, while domestic consumers of raw materials enjoy lower input costs for production. Certain countries often support their domestic industries by offering them lower prices for raw materials (and energy). So the gap between domestic and international prices provides an artificial cost advantage for domestic consumers[82].

Third, Europe faces a competitive disadvantage in terms of transport and trade costs for raw materials whose sources are concentrated in other continents, e.g. in Asia, Africa or South America.

Finally, the oligopolistic nature of production for many raw materials, as well as changing contract terms, also affects prices. Due to the relatively strong bargaining position of suppliers, the duration of contracts has been switched from long-term to short term, and negotiations take place more frequently. This leads to price volatility, and in many cases, price increases.

All of these dimensions may raise production costs directly or indirectly. When this increase is not equalled in other regions of the world, Europe's competitive position deteriorates. The more raw material-intensive an industry is, the stronger the effects on competitiveness are likely to be. The impacts of issues concerning raw materials can differ depending on their place in the value chain. Process industries such as non-ferrous metal industry are directly affected, while industries active further down the value chain, such as the car industry, undergo knock-on effects from the same raw material issues. The market structure and power relations between industries along the value chain determine the extent to which a shortage of raw materials is transmitted to downstream industries and, ultimately, to the final consumer. Below, selected sectors are given as examples to illustrate the related cost competitiveness effects.

- Steel industry

As one of the key sectors in the EU, the steel industry is a good example to illustrate the channels through which prices for the main input material for production have been escalating for the main input material. This puts additional competitive pressure on producers if costs to downstream industries and consumers can not be passed on. Rising costs for raw material in this sector stem from different sources such as the oligopolistic structure of the iron ore market, trade costs and unfair trade conditions.

The steel sector is very dependent on the supply of raw materials. In 2010, costs of raw materials accounted for roughly 70% of total costs, and iron ore[83] for more than 40%. Even though the EU produces iron ore, a significant portion of iron ore needs

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81 According to WTO, export restrictions are "a border measure that takes the form of a government law or regulation which expressly limits the quantity of exports or places explicit conditions on the circumstances under which exports are permitted, or that takes the form of a government-imposed fee or tax on exports of the products calculated to limit the quantity of exports."

82 OECD (2010a).

83 Iron ore is the main input for steel industry. Other important raw materials used in steel production are coal, coke.

(84%) is imported from overseas. Accordingly, costs of raw material have a considerable impact on profitability and strategic investment decisions.

Following a strong increase in market concentration over the last decade, three big suppliers[84] control the market for the supply of iron ore. Over a third of the world supply of iron ore and 67% of world seaborne iron ore are concentrated in the hands of these three major exporters. One of the consequences of this oligopolistic structure is that iron ore prices have outpaced mining costs significantly. Prices for iron ore are now about four times the cost of production (about USD 30.00/tonne) at main mines[85]. Producers' market power has increased significantly, resulting for example in the introduction of short-term contracts which transfer the price hikes, and associated risks, more easily further downstream in the supply chain. Since 2010, after a tradition that lasted 40 years, contract prices are set on a quarterly basis, reflecting a switch of power from the steel industry to the mining industry. As well as higher prices, the steel industry also faces price uncertainty. This affects the its ability companies to hedge against the risk of higher prices in future make forward-looking business plans, more generally.

As prices of iron ore are set globally, increased input prices would not necessarily create an advantage for countries with better access to iron ore. However, producers in regions with abundant reserves usually enjoy a strategic cost advantage over steel producers that need to import iron ore from abroad. The cost of raw materials in production has been highest for Western Europe, while Russia, India, South Africa and Brazil are among the most competitive steel producers in the world, partly due to local access to iron ore resulting in lower raw material costs.[86]

The competitiveness of the European steel industry is also affected by high transport costs for imported iron ore and other raw materials. According to Eurofer[87], transport costs represent up to 15% of the production costs. It is clear that countries with better access to raw materials have a competitive advantage because of lower transport costs.

Export restrictions are partly responsible for the limited supply of iron ore available or for higher prices on the global market. The forms of export restriction most often applied are export taxes and quotas, which have contributed to raising international prices for iron ore and scrap. Export taxes imposed mainly by emerging countries can range from between 5-20% for iron ore and 10-35% for scrap, pushing up international prices significantly. Additionally, emerging countries producing steel are also imposing export restrictions on the export of scrap, giving an unfair cost advantage to the local industry.

The combination of the above factors, basically pushed by the increasing demand from industrialising economies, has resulted in serious price increases for both iron ore and scrap. The cost structure of steel production has gone through a significant change. In 2005, the cost of iron ore in the production process for Western Europe

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84 Rio Tinto, BHP and Vale.

85 Oxford Analytica (2011).

86 Russia has benefited from material cost advantages from all fronts, due to abundance of iron ore, coal/coke, scrap and energy. (SteelConsult International (2005)).

87 European Confederation of Iron and Steel Industries http://www.eurofer.org/index.php/eng/Issues-Positions/Transport, accessed on 14.07.2011.

accounted for slightly above 20% against an estimated 40% in 2010.[88] The extra costs and risks (because of difficult planning and hedging) are also problematic for the steel industry's customers, as costs are passed on down the supply chain as far as possible.

- Non-ferrous metals industry

The non-ferrous metals[89] industry can be characterised by competitiveness issues similar to those the steel industry faces. Trade restrictions and subsidies are often applied by countries producing raw materials. The industry incorporates a range of activities along the value chain, including mining, smelting, recycling and refinery upstream, and second processing and fabrication intermediaries further downstream. The products of the industry, non-ferrous metals, are important inputs for a range of economic activities, such as transport, mechanical engineering, aerospace, construction, packaging, electricity and energy, consumer electronics, medical devices etc.

The inputs needed by the non-ferrous metal sector include virgin metal ores and concentrates and recyclates. The European non-ferrous metal industry is highly dependent on the imports of these metals, including ores, concentrates and refined metals and scrap. Raw material costs can range from 49% to 85% of total production costs in the industry, depending on the subsectors and type of products. The balance of supply and demand determines the price of the metals on the exchanges.

The non-ferrous metal industry, like the steel industry is very often targeted by trade distortion measures, in the form of export restrictions, trade subsidies and state support in non-EU countries.[90] These measures, coupled with increasing global demand, have resulted in prices hikes and volatility on the global market. They result in relatively higher input costs and higher levels of uncertainty for the European non-ferrous metal industry. Several metal-producing countries, such as China, Russia, and Ukraine have applied trade restrictions on exports of many non-ferrous metals and their scrap, such as aluminium, copper, nickel and tungsten[91]. Export quotas and bans reduced export VAT rebates have often been placed on these materials. Export taxes on them typically range between 5 and 30%, depending on the producing country and the type of raw material.

One of the most debated trade restriction issues has recently been the export quotas, export taxes and VAT refund imposed on rare earth exports from China. Rare earths are not non-ferrous metals, though they are sometimes used as inputs for non-ferrous metal production. World prices in these raw materials are currently typically 20-40% higher than Chinese domestic prices.[92]
In addition, indirect or direct subsidies, such as providing access to lower-cost energy for export-oriented smelters, or stimulus packages, ensure competitiveness advantages for the raw material producing countries, notably Russia and China.

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88 AT Kearney (2010).

89 Non-ferrous metals cover common metals (mainly aluminium, copper, zinc, lead, nickel and tin) and precious metals (gold, silver, platinum, and palladium) and minor metals (e.g. tungsten, tantalum, cobalt, and germanium).

90 Ecorys (2011a).

91 European Commission (2008a).

92 OECD (2010d).

- Automotive industry

The automotive industry, as a downstream industry, feels the indirect effects of limited access to raw materials. Due to rising raw material input costs in the steel and non-ferrous metals industry, it faces serious challenges, since cars are complex products consisting largely of steel, non-ferrous metals, as well as polymers, rubber and glass. The industry is also affected by the risk associated with the use of critical raw materials. As a result of the future developments in car-design, the demand for critical raw materials is expected to increase. Environmental standards and requirements and customer convenience play an especially crucial role here. According to the European Automobile Manufacturers Association (2010), the demand for rare earths and lithium will rise, due to more use of advanced electronics, magnetic materials, new surface treatment systems and alternative propulsion technologies.

Rising prices of raw materials may have a significant negative impact on the materials input costs of the sector, so customers are expected to face higher prices for end-products. A study on resource productivity[93] points out that if the prices of more raw materials inputs used in the car production go up, the product price for the final customer would also go up significantly.

- Chemicals industry

The competitiveness of the European chemicals industry is affected by rising prices for raw materials, and the emergence of newcomers better placed to benefit from control of advantaged feedstocks. The European chemicals industry is a significant supplier to other sectors and its competitiveness is highly dependent on imported raw materials, as these costs account for some 34% of manufacturing costs, while energy accounts for 2%. Oil and gas are the main inputs for the industry, so new players from oil-and gas- producing countries and emerging economies, especially China and India create challenges for the European chemical industry. The Middle East increasingly uses its favourable feedstock availability to develop its own integrated chemicals production chain, thereby strengthening its position in a wider range of basic petrochemicals. The European chemicals industry is gearing up to face the emergence of companies in the Middle East and Asia, where proximity of feedstock is considered is an advantage for chemicals producers, while developed countries try to leverage their traditional strength in technology and expertise.[94]

Trade barriers and unfair trade practices imposed by non-EU countries such as export restrictions, export taxes for ethylene feedstock, gas, palm oil, and key minerals (e.g. fluorspar), also create a substantial burden for the European chemicals industry.[95]

- Pulp and paper industry

The pulp and paper industry also faces challenges stemming from a shortage of raw materials, even though wood, the primary raw material for the industry, is widely available in Europe, especially in Finland and Sweden. The competition for raw materials in this sector is not primarily due to non-EU countries protecting their resources nor to the depletion of the materials. For wood, the challenge is due to the bio-energy industry competing for access to the material, facilitated by European

93 European Commission (2007a).

94 KPMG (2011).

95 Cefic (The European Chemical Industry Council) http://www.cefic.org/Policy-Centre/Industry-Policy/Access-to-Raw-Materials/, accessed on 05.07.2011.

environmental regulations, and by the difficult mobilisation of wood due to the small ownership structure of forests, biodiversity protection and varying efficiency levels in Member States' action plans. Furthermore, the rise in exports of recovered paper to non-EU countries creates an additional pressure on the industry. Industry representatives estimate that the supply of wood will not be able to meet demand for both industries (biomass and paper) at current rates.[96]

Raw materials consumption in the last two decades went through a significant change in the European pulp and paper industry. Use of wood pulp decreased more than 10 percentage points during this period, and was practically replaced by the use of recovered paper. In 2009 some 88% of wood came from EU sources (plus Norway and Switzerland), the remainder originating mainly from Russia. CEPI sees a gap of more than 200 million m^3 between supply and demand of wood by 2020 due to an increase both in traditional demand (e.g. paper and construction) and non-traditional demand (bio-energy).

4.3.2.2. Responses to shortages of raw material at industry level

Companies in different sectors have developed various strategies to reduce import dependency and to mitigate the costs and risks related to shortages of raw materials. These include more efficient use of materials, increased use of recovered and recycled raw materials, and use of substitute/alternative materials as well as organisational strategies such as outsourcing or relocation of the production process. From the long-term sustainability point of view, the first group of solutions are beneficial, while the others may have rather negative effects on European's growth and employment.

Resource efficiency, including raw material efficiency, is one of the most important challenges for European industry. Sustainable production has become an integrated part of EU industries' competitiveness strategy, albeit to various degrees, depending on the technological possibilities and the markets in which the industries are operating (see Chapter 5).

Improving material efficiency is a constant objective for companies, since it leads to cost reduction and increased competitiveness. Material efficiency can be improved in the four main steps of product manufacturing, i.e. production of raw materials (e.g. exploration and extraction of raw materials); product manufacturing (streamlining different stages of production, using new production methods); use; and end-of-life[97].

Use of recycled materials can contribute to reducing dependency on primary raw materials, depending on the sector and products. Many raw materials in process industries can be replaced by others. This is especially important for critical raw materials, where abundant materials can be a substitute for potentially scarce and critical ones (e.g. indium for zinc).[98] Minimising losses of raw material, increasing the use of recycled and recovered materials, and substitute/alternative materials are of key importance in reducing primary raw material import dependency, thereby improving the competitiveness of European manufacturing industries. All of these dimensions are supported by the European Commission through initiatives such as the Factories

[96] Mantau U. et al. (2008).
[97] European Commission (2010a) p.52.
[98] European Commission (2010a).

of the Future Research Programme, Sustainable Process Industry Public Private Partnership, and European Green Cars Initiative, etc.

Insufficient supply and rising prices of materials force companies to invest in more efficient modes of production, which can reduce waste. Another increasingly used method, recycling has often been identified as an important component of a better, sustainable resource management. The European recycling industry is the most competitive in international comparison. There is considerable potential to increase the share of recyclates in European manufacturing sectors. However in the sectors selected, the use of secondary raw materials is relatively high compared to third countries. Recycled and recovered material has also been widely used in the EU steel industry, car manufacturing, and pulp and paper. The chemicals industry is different in the sense that the recovered and recycled chemicals and especially polymers (plastics) cannot be used to replace virgin raw materials. Focusing more on R&D efforts, substitute/alternative materials are being increasingly used in some downstream industries.

Various organisational strategies can ensure the supply of sufficient raw materials. These include integration along the value chain, relocation of production or outsourcing. The most common examples will be illustrated in the relevant sectors.

Below, these different responses to shortages of the raw materials are discussed in more detail.

- Steel industry

Resource efficiency and increased use of scrap could be a solution for problems arising from supply of raw materials for the steel industry. Steel is 100% recyclable Due to the long life of steel products, approximately 45% of steel produced in the EU comes from steel scrap. In comparison, Chinese recycled scrap steel accounts for only 8% of total steel production, while for the U.S., the total is 33%.[99]. Increasing use of scrap steel in the sector makes it possible to reduce dependency on imported iron ore and contributes to sustainable production. However, the steel industry has to contend with the increasing export of scrap from the EU-27, while non-EU countries impose export restrictions on it. According to the criteria of the "End of Waste Regulation", scrap metal is treated as a waste product, so there are no export restrictions. EU-27 exports of ferrous waste and scrap more than doubled during the last decade, generating a significant loss of resources for the European steel industry.

There are several initiatives to increase resource efficiency (including material efficiency) in the steel industry. The European Steel Technology Platform (ESTEP), which brings together research and other institutions, the European Commission and Member States, was set up with the aim to give new impetus to European research into materials and processes. One of the aims of the ESTEP Research Agenda is to ensure more sustainable and profitable steel production in Europe through innovation and new technologies.

New production methods with electric arc furnaces (EAF) can use up to 100% scrap as input for steel. However, as scrap is scarce, partly due to European exports, its use

[99] Ecorys (2011b).

is still quite low and the possibility of boosting the amount of steel produced with EAFs is limited. At present, research is being carried out into making use of secondary powder material (resulting from primary steel making) as a raw material alternative in EAF steelmaking. The breakthrough technology project of the steel sector (ULCOS) receives funding from Research Fund for Coal and Steel (RFCS) and the EU 6th framework programme.

Regarding organisational strategies to mitigate the effects of the oligopoly in the iron ore market, vertical integration is a possibility for steel makers to help tackle raw material scarcity. Traditionally, control over mining activities has often been led by smelters, and there appears to be a trend towards higher levels of vertical downstream integration between the mining and refining stages of production.[100] Backward vertical integration, investing in new mines or buying up existing ones, is often observed in the steel industry outside the EU as a strategy to ensure better access to raw materials and lower transaction costs.[101] Chinese steel companies, for instance, have been actively investing abroad in iron ore mining to secure supplies.[102] This international presence is increasingly facilitated by state support. But EU-based producers have also started to take initiatives for vertical integration, e.g. Arcelor-Mittal, the world's leading steel company, has secured in-house supply of almost half the company's iron-ore needs. For the EU steel industry, it is strategically important to ensure future access to raw materials through increasing vertical integration through acquisitions, mergers and joint ventures/partnerships. However, this option is possible only for global players with the financial resources and the geological expertise to make such investments.

- Non-ferrous metal industry

Non-ferrous metals are infinitely recyclable. However, primary resources are essential to cover total demand and produce high-quality products. Recovery and recycling rates within the EU are among the highest in the world. Secondary raw material use in the sector has increased substantially. The two main sources of non-ferrous metal scrap for recycling are industrial waste streams and end-of-life scrap. While industrial waste is used efficiently, as regards the latter there is still much potential to increase use of end-life scrap. Regarding the most important raw materials in this industry, more than 70% of EU refined lead production stems from scrap metal, along with, nearly 60% of aluminium and over 40% of refined copper.

Recycling of scrap metal is essential to maintain the competitiveness of the EU non-ferrous metal industry. However valuable resources have been shipped to developing and emerging countries. This is one of the biggest problems the sector is facing. For example the EU has lost a significant amount of its own copper scrap resources, almost 1.2 million tonnes in 2009, of which nearly 80% has ended up in China. Rising demand for aluminium scrap is even more striking. In 2000, the EU was a small net importer, while in 2009, more than 1.1 million tonnes of aluminium scrap were exported. It is thus important to improve the Waste Shipment Regulation to reduce exports of non-ferrous scrap metal, particularly aluminium and copper.

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[100] UNCTAD (2007).

[101] Ecorys (2008).

[102] According to the National Bureau of Statistics of China, at the end of 2008 Chinese outward FDI in the mining sector (including other than iron ore mining as well) accounted for 12% of its total overseas FDI stock.

R&D and innovation have an important role in improving material efficiency, developing new production processes and substitutions in the non-ferrous metal industry. The industry is constantly looking for cheaper substitutes with the same or better qualities than the originals. The European Aluminium Technology Platform, set up in 2005, is a key tool to ensure cost, eco- and material efficiency to support the competitiveness and sustainability of the largest subsector in the non-ferrous metal industry.

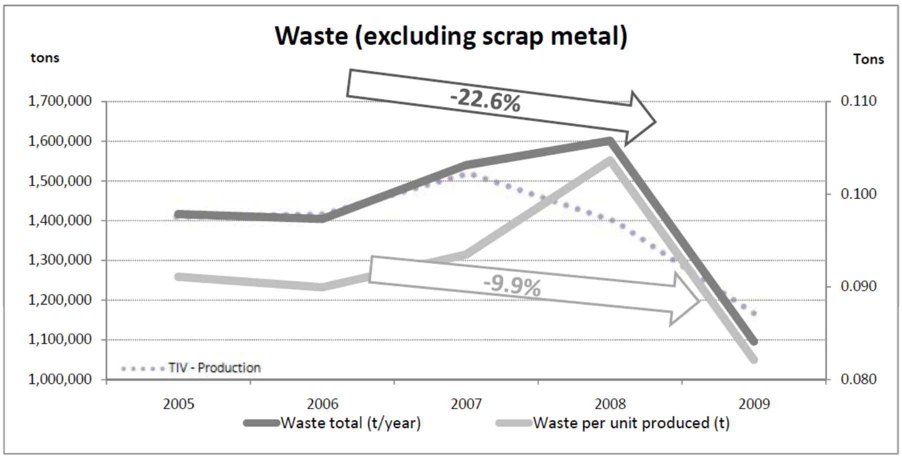
- Automotive industry

Since cars consist of numerous different parts, the automotive industry is one of the best examples to illustrate how soaring prices for raw material, along with lack of supplies and environmental regulations, have led to more efficiency and more use of non-primary raw materials. Resource-efficient technologies and the use of recyclates and substitutes are the two main strategies the automotive industry is deploying to reduce dependency on raw materials.

The industry is one of the most innovative sectors in Europe. According to ACEA, the sector spent more than EUR 26 billion or 5% of their turnover on R&D in 2009 and accounted for more than 50% of the global patent applications in the automotive sector. The industry files around 6,300 new patents each year in the following fields: materials technology, recycling, ICT and telematics, energy and fuels, drive-train development, aerodynamics and ergonomics. German auto manufacturers, a vital part of the European automotive industry, spent almost 10% of their total turnover on innovation purposes in 2009. Most of this was spent on improving product quality and developing new technological solutions. According to statistics, only 6.8% of the expenditures on innovation led to cost reduction[103].

Resource-efficient technologies are increasingly being used in the automotive industry. Thanks to efforts by manufacturers to reduce waste in the period between 2005 and 2009 the total waste per unit produced (excluding scrap metal) went down by 9.9% (see Figure 4.20). The total waste in the sector decreased, by 22.6% over the same period.

Figure 4.20: Waste: excluding scrap metal



Note: Data refer to passenger cars.

103 ZEW (2011a).

Source: ACEA, 2009.

The recycling of scrap cars is of key importance, which is adequately regulated by the End-of-Life Vehicle Directive.[104] The Directive on Reusability, Recyclability and Recoverability of motor vehicles[105]set new requirements for vehicle recycling. In 2008 total reuse, recovery and recycling rates varied between 79.8-92.9% in the Member States, with Germany having the highest rate in Europe.

A technical approach to finding substitutions is at the core of the automobile manufacturing industry's R&D agenda.[106] ACEA estimates that the first significant volumes for recycling of electrical vehicles, which contain rare earths, cobalt and lithium, will come around 2025-2030 at the earliest. Demand for these materials is expected to boom around 2015-2020, so the industry hopes to have a new generation of batteries based on other materials by 2025-2030. To meet environmental, safety and price demands, the use of light, smart and innovative materials, such as composites, and the efficient use of high value-added metals will be inevitable in car manufacturing. Research activity focuses on materials such as carbon fibres, natural/glass fibres, high strength steel/aluminium, magnesium technologies, and hybrid materials.[107]

The European automotive industry is involved in a wide range of collaborative European research and development projects. The European Council for Automotive R&D (EUCAR) plays an important role and provides automotive manufacturers with a platform for identifying common pre-competitive European R&D. Some innovative projects in the field of materials and manufacturing are worth mentioning, see Box 4.1.

Box 4.1: EUCAR Projects in the field of materials and manufacturing

Multi-level protection of materials for vehicles by smart nanocontainers The aim of the project is to develop new active multi-level protective systems for future vehicle materials. A multi-level self-healing approach will combine several damage prevention and reparation mechanisms within one system. These will be activated depending on the type and intensity of the environmental impact.

Multi-functional materials and related production technologies integrated into future industries: This project, which closed last year, aimed to introduce new materials and processes, to reduce cost and development time and increase customisation possibilities. The following achievements have been reported.

- weight reduction of 18% through flange reduction for laser welding of mass flow meter (MFMs)
- single part roof bow by stretch bending to achieve scability and re-use
- 44% increase of MFMs utilisation rate
- 2.7 kg weight reduction with nano-composits for the rear spare wheel well
- 20% increase of frontal passive safety through integration of APM foam into rails

104 ELV Directive 2000/53/EC, for an assessment of the ELV Directive see Chapter 5, Box 4.4.

105 Directive 2005/64/EC on the type-approval of motor vehicles with regard to their reusability, recyclability and recoverability and amending Council Directive 70/156/EEC.

106 The automotive industry is a prime sector in driving new technological developments. Because of its high R&D expenses, this industry is determining the directions of research in several area's', see Fraunhofer ISI (2003).

107 Ecorys (2011b).

MyCar Project enables an ultimate degree of customisation, which could allow every customer to purchase a unique vehicle. The project will further develop and integrate technologies that enable the vehicle assembly process to become self-adaptive to any kind of market variation, capable of producing cars with an extended degree of personalisation. MyCar aspires to integrate the customer into the automotive industry's assembly processes.

Adaptive Control for Metal Cutting project: This project aims to develop a generic modular adaptive control platform that will allow metal cutting processes to respond to changing circumstances. The main goals are:

- Robust production processes by optimizing the performance of machining processes;
- Reconfigurable production enabled at process level;
- Development of Adaptive Machining Systems for difficult metal cutting operations;
- Achievement of an online quality control system for mass customisation and small batch production.

Source: EUCAR, http://www.eucar.be/projects-and-working-groups/projects-and-working-groups, accessed on 06.07.2011.

However, from a general sector perspective, current critical raw materials might be substituted for various raw materials before they can be recycled. Yet the same materials might be in great demand for applications in other industries, which will then definitely require adequate recycling technologies as a valuable option to sustain future access to critical raw materials.

As regards organisational strategies responding to raw material challenges, outsourcing of manufacturing cars or car parts can be seen as an option to secure access to raw materials. This concerns not only rare-earths, but also aluminium where China has recently turned from net exporter to net importer.[108] Setting up part of the production in China and South-East Asia may enable access to raw materials at better prices. The European car manufacturers have increased production capacities in these emerging countries, which could enable access to input materials at a lower cost by avoiding export restrictions.

- Chemicals industry

Decreasing availability of raw material and increasing prices require raw materials efficiency in the chemical industry too. From economic and sustainability reasons, a decrease in raw material intensity is unavoidable.[109] R&D and innovation play a significant role. In general, the chemical sector is the most innovative industry. Its share of all EU manufacturing patent applications was 16% in 2007.

The industry is largely based on oil and natural gas, but due to material and cost efficiency concerns, the share of renewable raw materials[110] used in the manufacturing process has increased substantially. A broader use of renewable raw materials also contributes to reduce environmental impacts of the use of fossil fuels. However, using renewable raw materials means a challenge as regards competition

108 McKinsey&Company (2004).

109 In Germany, for example, raw material intensity in the chemical industry decreased by 26% between 1994 and 2007, and a target was set to reduce it by a further 32% by 2020.

110 Plant, animal and microbial biomass which are based on the photosynthetic primary production and are used by man outside the food and feed area for material or energy consumption. These include materials such as plant oils, animal fats, sugar, cellulose fibres, wood etc. (ETC/SCP 2010).

for land use, due to increasing demand worldwide for biomass, food, fodder and bioenergy.[111] The chemical industry was estimated to account for around 8% of total feedstock use in the industry. There is still significant potential to increase the share of renewable raw materials in the medium and long term. Nonetheless, this process is dependent on developments regarding the overall availability of these renewable raw materials and the degree of economic viability of new production technologies. New processes in the industry, such as chemical leasing (see Chapter 5) or other new materials, such as CO_2 and other unconventional carbon sources open up new possibilities for the sustainable production of fine chemicals.[112] Furthermore, the European Technology Platform for Sustainable Chemistry supports chemistry biotechnology and chemical engineering R&D and innovation in Europe.

As regards organisational strategies the chemical industry can provide interesting examples. Resource-seeking FDI, securing raw material inputs at lower costs (though often coupled with other investment motives) is often applied by raw material intensive industries. Constraints for the further development of the chemical industry in Europe include existing trade barriers and unfair trade practices. These barriers may in certain cases prompt the relocation of activities from Europe to other parts of the world. This strategy provides access to materials under similar economic conditions to those enjoyed by he main global competitors.[113] Obviously relocation can be profitable for companies, yet is sub-optimal from a European growth and job perspective.

- Pulp and paper industry

Raw materials efficiency is one of the key drivers for the competitiveness of the EU paper and pulp industry. The European paper industry is the leader in collection, sorting and recycling of paper. The industry's recycling was 68.9% in 2010[114] and has risen substantially over the last 15 years. Recycling is thus relatively high in Europe compared to third countries (see Figure 4.21). Today, recovered paper accounts for 44% of total raw materials used in papermaking. This means a rise of over 16 percentage points, as compared to 2000. However, as is the case for scrap metal, paper recovered in Europe is increasingly exported, notably to China, where demand for pulp and recovered paper has been growing and the industry is subsidised. About 20% of the recovered papers go outside Europe per year, creating a significant loss for the European industry. The industry plans to increase the use of the recycled inputs within Europe instead of exporting these for use in the rest of the world.

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111 ETC/SCP (2010).

112 For instance, the FP7 NMP Work programme 2012 provides sources for research on production of fine chemicals from CO_2 directly or indirectly.

113 For instance, due to current high import duties on bio-ethanol, the chemical industry finds it less expensive to produce bio-ethanol based chemical products outside Europe (e.g. Brazil) and export them to Europe with lower import duties due to the tariff harmonization agreement concluded in the Uruguay Round, even though bio-ethanol is the most important production cost factor.

114 Recovered Paper Council (2011).

Figure 4.21: European paper recycling

Source: Adapted from European Recovered Paper Council, Monitoring Report 2010, accessed on 29.06.2011.

Further improvement is now sought in the eco-design of end products to improve the efficiency of the recycling process. The Forest Based Sector Technology Platform was set up to assist the forest-based sector, including the pulp and paper industry and its shareholders in fulfilling their future research, development and innovation needs. For example, new technologies are being developed to improve the material and energy efficiency of recycling operations.

4.3.2.3. Policy implications at industry level

The selected European industries are facing serious competitiveness challenges due to raw materials scarcity. They are affected by the distorted global raw materials market and/or by EU legislation and policy.

As regards the steel industry, challenges for European policy in the near future are to make the structure of iron ore supply more competitive, eliminate trade distortions in the supply of raw materials, and create breakthrough technologies towards low-carbon production. It is important that competition policy, including merger control, continue to be enforced in the iron ore supply market where the degree of concentration is already high. Continuing negotiations with resource-rich countries in FTA and WTO may lead to a more balanced trade situation. Furthermore, the EU should continue to promote recycling and to address obstacles to the development of recycling industries. Finally, it is advisable to continue and strengthen the support for investments in research through e.g. RFCS, Research Framework Programme or other funding instruments.

One of the two main issues considered as important for the non-ferrous metal sector is the quality of recycling, in terms of the processes to ensure optimum output. Despite increased recycling, another issue for the sector is access to primary materials (ores and concentrates) so that can respond to increasing demand and provide the required quality. For recycling, turnover time plays an important role. Policies that promote the collection and treatment of scrap and end-of-life goods are welcomed in this respect.

In a complex industry such as car manufacturing, the competitiveness issues are driven by a number of different factors. In the short term a greater and more immediate effect can be achieved by policies to stimulate, increased resource efficiency by improving production organisation and by promoting equal opportunity access to critical raw materials on international markets. Depending on the effectiveness of negotiations, trade policy can bear fruit as well in the relatively short term. In the long term the competitive position of European car manufacturing can best be promoted by supporting research and development efforts to achieve more extensive and more effective use of substitutes for critical raw materials and a greater general material efficiency in general. Policies promoting the recycling of critical raw materials can achieve a positive impact not only in terms of import substitution but also in terms of improving energy efficiency and limiting the environmental impact of the industry.

The EU chemical industry would benefit from further global tariffs dismantling and continued support and promotion of general WTO rules to address trade problems related to the discriminatory supply of raw materials. At bilateral level, the EU should continue to address the issues of unfair trade practices that cause imbalances in access to raw materials and world markets. It is desirable to continue to support the R&D, innovation and the further expansion of infrastructure in order to maintain and promote the technological advantage of the European chemicals industry. In particular support should go in particular towards increasing energy and resource efficiency, reducing CO_2 emissions and expanding the use of renewables. Although it is too early to envisage considerable substitution of fossil-based feedstock by renewables, it is desirable to support market developments towards renewable raw materials with the focus on the sustainability of the markets for both inputs and outputs. Steps should be taken to define standards and criteria for products, including sustainability criteria.

Given the competing use of wood and land by other industries and for other purposes, it is advisable to stimulate integrated and prioritised land use policies at Member States level. At EU level, a balanced approach embracing different policy themes (waste, recycling, competitiveness and trade, raw materials and management of natural resources) should be considered in order to prioritise on objectives where overlaps occur and to clarify this towards all actors involved, e.g. by defining a cascading order of use. The European Commission has launched initiatives on these matters in the recent past. With respect to exports of recovered paper, waste paper should be recycled close to the place of consumption, keeping secondary materials within European borders.

4.3.3. The role of the non-energy extractive industry

The main company strategies and possible policy responses to tackle the scarcity of raw materials have been discussed in the previous section. Besides these, as the second pillar of the Raw Materials Initiative points out, the non-energy extractive industry has great potential to mitigate import dependency on several raw materials. It is therefore it is worth mentioning its role and the challenges it is faces in more detail. The non-energy extractive industry can be divided into three main sub-sectors, according to the different physical and chemical characteristics of the minerals produced and on the downstream industries they supply:[115]

[115] See e.g.: http://ec.europa.eu/enterprise/sectors/metals-minerals/non-energy-extractive-industries/index_en.htm.

- construction minerals and aggregates
- industrial minerals, and
- metallic minerals

4.3.3.1. Challenges in the non-energy extractive industry

The micro-economic analysis[116] revealed that the current EU non-energy extractive industry is in a relatively good competitive position in comparison to the rest of the world. Overall its apparent productivity is higher and in contrast to most of the other industries, its profitability is comparable. This suggests that the EU companies in this sector provide a viable basis for further development and as such an avenue for alleviating some of the raw materials pressure for the downstream industries.

It is estimated that Europe still has significant extracting potential for non-energy raw materials.[117] In the past, given the low prices of raw materials, it was sometimes more profitable to import these than to extract them. That is why there are still several large deposits, and there is potential to benefit from these. However, the EU cannot expect to be self-sufficient in providing for its material resource needs.

A number of concerns regarding the competitiveness of the non-energy extractive industry are emphasised by the industry and the European Commission.[118] These issues include the need for a more detailed and systematic monitoring of raw materials in Europe. Geological surveys are carried out at Member State level, yet mutual consistency, as well as the introduction of advanced techniques at EU level, such as GMES,[119] are essential for prioritising and defining further actions and would facilitate a co-ordinated joint knowledge base. Another challenge is the competing land use, mostly related to stringent environmental regulations, such as Natura 2000. Start-up costs are relatively higher compared to non-EU countries, due to relatively higher insurance requirements, more administrative regulations, and administrative fragmentation. The industry indicated that the EU financial sector is less inclined to invest in mining projects than counterparts in e.g. the U.S., Australia and Canada, where more financial expertise and capital is available.

4.3.3.2. The role of innovation in the future of the non-energy extractive industry

The non-energy extractive industry has viewed innovation in resource-efficient and sustainable production technologies as an important driver for its future competitiveness in Europe. There have already been important policy initiatives have already been taken such as the European Technology Platform on Sustainable Mineral Resources, which aims to modernise and reshape the European mineral industry to secure the future supply of/access to raw materials. It plans to do this by supporting the revival of exploration of Europe's mineral potential; developing innovative and sustainable production technologies; implementing best practices; reuse, recovery and

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[116] IDEA Consult (2011): Background report on the "Access to non-energy raw materials and the competitiveness of EU industry".

[117] European Commission (2010a).

[118] European Commission (2007b).

[119] GMES: Global Monitoring for Environment and Security, the EU's earth observation programme.

recycling as well as new product applications; and creating European added value through RTD-based technology leadership, education and training.

New technology innovations help to overcome environmental and social objections to non-energy materials extraction in the EU. For example, through subsea mining exploitation of raw materials located deep offshore would contribute to solving the complex worldwide equation linking security of supply, sustainable development and industrial competitiveness. Intelligent Deep Mine provides eco-innovative and intelligent exploration and extraction. Optimising extraction and processing of resources throughout their lifecycle or using mines for geothermal energy production at the end of their life are all expected to contribute to sustainable raw materials extraction.

4.3.3.3. Policy implications

One of the major policy issues is working towards an integrated policy vision on developing of the EU non-energy extracting industry, to make it consistent with land use and environmental policies. The industry would expect this to improve the investment climate, especially since investments are typically long-term.

Much of the authority on mining and land use lies with the Member States. This is a barrier to the creation of a common policy on these matters. A clear European vision could steer Member States in their own policy choices in a coherent manner. That is why the European Commission sees its current role as a facilitator for the exchange of best practices.[120] A European Commission report entitled, ‘Exchange of best practices in land use planning and permitting’ (2010) presented best practices in the field of land use planning policies for minerals, the geological knowledge base and networking, and integrating subsurface information in GMES. In this respect, three practices are considered important in promoting investment in extractive industries:

– Defining a national minerals policy, to ensure that mineral resources are exploited in an economically viable way, harmonised with other national policies, based on sustainable development principles and accompanied by a commitment to provide an appropriate legal and information framework;

– Setting up a land use planning policy for minerals comprising a digital geological knowledge base, a transparent methodology for identifying mineral resources, long term estimates for regional and local demand and identifying and safeguarding of mineral resources (taking into account other land uses), including their protection from the effects of natural disasters;

– Putting in place a process to authorise mineral exploration and extraction which is clear and understandable, provides certainty and helps to streamline the administrative process (e.g. the introduction of lead times, permit applications in parallel, and one-stop-shops).

On the operational side of mining, the "time to permit" is a hindering factor. Continued dialogue between Member States to align the permitting process according to best practices in other countries is necessary. The system of one-stop shop system, for example, could be elaborated in all Member States.[121]

[120] European Commission (2011).
[121] University of Leoben (2004).

Insurance requirements are another concern. Aligning these with the actual size of the mine or quarry, rather than the eventual full size, to be reached only in the future, would considerably reduce capital requirements upon start-up.
Finally, promoting for R&D and innovation for sustainable extraction is crucial for this industry's (future) competitiveness.

4.4. Conclusions and policy discussion

The goal of this chapter was to gain a better insight into five aspects of access to non-energy, non-agricultural raw materials and the challenges involved:

1. global demand and supply
2. the competitiveness effects in the selected industries
3. the responses given at industry level to raw materials challenges (including the role of recycling, R&D and organisational strategies)
4. the EU policies that can be developed
5. the role of the EU non-energy extracting industry in alleviating the EU industry's raw materials vulnerability.

The approach in the original research was mainly qualitative in nature, drawing on existing literature and data, and using inquiries among representatives of a selected set of EU sectors for which competitiveness effects were identified. The selection of the sectors was based on insights from the literature review, experts in the field and from the overarching EU association Business Europe. In contrast with existing studies, the specific focus of the present study was on the sectoral and competitiveness angle.

4.4.1. Competitiveness effects

The analysis made clear that the prices of raw materials have been increasing significantly over the long term with a dip during the financial crisis. For the industries surveyed, the share of virgin raw materials was significant ranging from one third in the steel sector to more than two thirds in the paper and pulp industry, chemicals and car manufacturing. Here, non-energy raw materials include not only metals and minerals, but also crude oil, gas and wood.

In comparison with the rest of the world, the micro-economic analysis[122] indicated that steel, non-ferrous metals and chemicals in the EU typically have higher productivity levels, yet end up with lower profitability rates. The trends along the (global) business cycle were usually similar. This suggests that EU companies on average face with relatively higher costs, which makes the issue of increased raw materials prices particularly sensitive. For other sectors such as the EU paper and pulp industry and EU car manufacturing, the profitability, patterns were more complex. In both sectors, a positive productivity gap with the rest of the world could be observed. Yet the EU paper and pulp industry showed a gradual decline in profitability while the EU car industry improved its profitability over time, unlike the companies in the rest of the world. In the car industry, raw materials issue has a different impact than in the paper and pulp industry. A potential explanation might be that there is more scope for the EU car industry to invest in R&D and innovation in trying to find substitutes for expensive raw material inputs. Moreover, the competitive use of wood by less regulated sectors (e.g. waste incineration) and the 'export leakage' of recovered paper

[122] IDEA Consult (2011).

due to high demand in the BRIC countries indirectly add to the costs of the paper and pulp industry.

Sector interviews confirmed that market concentration on the supply side contributed significantly to the price increase in raw materials, especially in the case of commodities such as iron ore, copper, zinc and lead. In the case of iron ore, one can observe an increased market power of the global mining companies. This is reflected in their imposition of short-term supply contracts on the steel mills, which in turn try to pass the resulting risks and price increases through to their customers, some of which are large players, such as car manufacturers, though the others are mostly small players, such as the metal working industry. The effects of market concentration can nonetheless be bypassed through company strategies such as vertical integration. Yet such a strategy that is not feasible for all companies in the EU, and certainly not for most SMEs.

An important aspect for the competitiveness for all selected sectors is the absence of a global level playing field in trade. Virtually all manufacturing sectors surveyed depend to a large extent on imported raw materials. Export restrictions on certain materials in BRIC countries, implicit subsidies, and soft loans place EU companies at a relative cost disadvantage. However, a switch to EU raw materials is often not possible, even though the EU is a global leader in the production of certain minerals. This is because the materials are not available in the EU or not in the specific grades required for product quality process efficiency.

4.4.2. The potential of recycling and innovation

In the investigated industrial sectors two main drivers for reducing dependence on primary raw materials can be identified. The first driver is purely economical, related to economic gains from material efficiency, reuse of recycled materials (such as in the steel, non-ferrous metals, pulp and paper and the car manufacturing industries) and use of cheaper substitute materials. The second driver originates in requirements imposed by safety and environmental regulations, which primarily stimulate recycling activities and resource efficiency, particularly in the chemicals and in the automotive industries.

When the industries described in this report are considered in terms of their relative performance in recycling, the steel, non-ferrous metals and paper and pulp industries are clear leaders. This is mainly due to two facts. First, metals and paper are highly recyclable products, where the quality and utility of the recycled material is almost the same as that of the virgin raw materials. Second, one should note the relative upstream position of these industries in the whole production value chain. There are a number of other downstream industrial sectors (such as car manufacturing, electronics, printing and publishing, etc.) whose end products are subsequently recycled. In the automobile industry, for example, the high degree of reuse and recycling is mainly driven by the high recycling capabilities of the upstream steel and non-ferrous metals industries.[123]

[123] However, not all upstream industries have a high recycling potential. The mining and extraction industry is situated at the very top of the value chain, which is precisely why the concept of recycling does not really apply in these industries. Recycling requires the presence of certain processing capabilities, which the extraction industry does not have.

A more complicated situation with recycling is observed in the chemical industry. It possesses quite substantial chemical processing capabilities, which should allow it to perform many of the operations required for the recycling of chemicals. Nonetheless, the intensity of recycling in this industry is primarily driven by safety and environmental regulations, rather than by reuse and cost-saving factors.

What is the potential of the EU recycling industry in alleviating EU industry's raw materials vulnerability? Looking at the current situation with recycling in the EU, economic gains from raw materials recycling are relatively high in most of the industries considered. The additional efforts currently undertaken in Europe to expand the recycling activities are primarily driven by the environmental and safety concerns. Additional stimuli for recycling are created by regulations to reduce the CO2 and improve efficiency.

The untapped potential seems to lie more in improving framework conditions, which are linked with policy, and in applying the latest methods and techniques to increase resource efficiency. Examples are materials recovery from municipal solid waste, self-disassembling joints, and specialised plants for complex recycling. Also, promoting the use of product-service systems improves material efficiency and recycling performance as well as reuse. Another interesting avenue for achieving sustainable production is the organisation of local production activities within a setting of industrial symbiosis.

Regarding the potential of the EU recycling industry to reduce vulnerability with respect to raw materials likely promising developments may come from adjusting production technologies to ensure greater reuse and recyclability of raw materials, especially rare earths and energy-intensive materials. It is also worth stressing once again the importance of R&D and innovation, which play an important role in the future development of efficient production processes, recycling processes and substitute materials. Substitute materials are increasingly used in many sectors, such as the chemicals and car industries, and further development is expected, partly due to various research programmes.

One observation is the apparent dichotomy between the solutions presented in the, mostly academic, literature about sustainable production and the implementation and perceptions of industry. Close interaction between industry and research laboratories is therefore very important. However, case studies can be found on successful pilot projects for sustainable raw material use, there is still a wide gap between research findings and concepts and profitable implementation in a market economy/business context.

4.4.3. Policy discussion

Access to non-energy, non-agricultural raw materials can be facilitated by different policy tools. Based on the analysis and EU policy documents on the topic, some important policy conclusions can be identified.

Firstly, the internal consistency of existing regulations and directives at EU level should be ensured. This would promote better operational and regulatory environment for industries affected by the scarcity of non-energy raw materials. Otherwise pursuing one policy goal might hinder reaching another one. Internal consistency should be in line with sustainability objectives and policies, e.g. competing uses of materials or waste incineration versus recycling.

Secondly, in line with the first pillar of the Raw Materials Initiative, fostering a global level playing field in trade and investment is essential in order to ensure the fair and sustainable supply of raw materials from international markets through strategic partnerships and policy dialogues. Developing strategic partnerships, such as the Africa-EU Joint Strategy Union, can contribute to the sustainable supply of raw materials from third countries while at the same time assisting these countries in reaching development goals. The EU can play a crucial role in creating win-win situations where both developing and developed economies benefit from the sustainable supply of raw materials. Alongside the European Commission, the European Investment Bank and other European development financing institutions will continue to support creating better conditions (e.g. infrastructure).

Pursuing policy dialogues as well as strengthening ongoing debates in pluri – and multilateral fora (e.g. G20, UNCTAD, WTO, OECD) is of key importance in order to tackle existing trade barriers. It is crucial to include raw materials issues, such as export restrictions and investments aspects, in ongoing and future trade negotiations. Speeding up the establishment of a mechanism for monitoring export restrictions and raw materials strategies in other countries outside the EU is essential. In particular, increased state intervention in former centrally planned economies, most notably China and Russia, is a concern. Here, industry interests are pursued at the level of diplomacy, rather than at company level on the market. European industry representatives therefore often call for a 'raw materials diplomacy' at the level of the EU, or the Member States. On the other hand however, fears are also expressed about overregulation and the side effects of policy intervention on the internal EU market.

Thirdly, regarding the second pillar of the Raw Materials Initiative, intelligent development of the further exploration and exploitation of European raw material resources can play an important role in obtaining certain materials for production. In this connection, building an innovative knowledge base of European resources and standardising geological data are of key importance. In the short term, it is feasible to increase synergies between national geological surveys. In the medium term, such synergies will help improve the European raw materials knowledge base. Furthermore, basing national mineral policies, based on sustainable development principles and an appropriate legal framework will facilitate access to European reserves. The exchange of best practices in land use planning policy, national mineral policy and mineral exploration and extraction authorisation processes is expected to contribute to the sustainable supply of raw materials within the EU.

Regarding the third pillar of the Raw Materials Initiative, encouraging and supporting R&D and innovation for substitutes, better recycling techniques and sustainable production (material efficiency) is of key importance in tackling the lack of raw materials for EU manufacturing in the longer term. Here the upcoming European Innovation Partnership on Raw Materials will play a crucial role. Developing new innovative materials can help reduce the use of critical, scarce or hazardous raw materials. Improved conditions for recycling and better recycling techniques, can reduce the cost of recycling, leading to the more efficient reuse of recyclable and renewable materials. Higher recycling rates will reduce the pressure on demand for primary raw materials. To achieve all this, better implementation and enforcement of existing EU waste legislation is crucial. Furthermore, strengthening the Waste Shipment Regulation is essential in order to prevent the illegal dumping of waste products, and reduce the transport of important secondary raw materials to developing countries, in particular.

From the competitiveness point of view, it is important to strengthen the industrial base in Europe. Specific skills development, R&D and innovation play a central role along the entire value chain, including extraction, sustainable processing, eco-design, substitute and new materials, recycling, resource efficiency and land use planning, in addressing the challenges posed by the lack of raw materials.

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Mr Bernard Lombard – CEPI – Confederation of European Paper Industries – Brussels.

Mr Klaus Nottinger – APAG - European Oleochemicals and Allied Products - Neuss, Germany.

Mr Lionel Platteuw – EUCETSA – European Committee of Environmental Technology Suppliers Association – Brussels.

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Mr Marc Vermeulen – CEFIC - European Chemical Industry Council – Brussels.

Dr Michelle Wyart-Remy – IMA-Europe – Industrial Minerals Association – Europe.

Annex

Table 4.1: Crosscutting sectoral competitiveness issues related to non-energy raw materials

	Extractive industries		Steel	Non-ferrous metals	Paper and pulp	Chemicals	Car manufacturing
	Mining & quarrying	Industrial minerals					
Competitiveness layers							
Market structure / price setting	Mix of small, medium and large enterprises according to their role in the exploration, development and operation process; Global price setting	Large number of SMEs but also international leaders present in the sector Price negotiated between buyer and seller High transportation costs	Oligopolistic structure of the supply of iron ore Price setting of iron ore by 3 main suppliers Price of steel directly dependent on price of iron ore	Heterogeneity in terms of size of companies and vertical or horizontal integration of their production activities Price taking: companies cannot negotiate prices The industry operates in a totally international market	Small ownership structure; Global price setting	Prices for outputs in their majority are competitive. For many raw materials prices are distorted.	Prices for outputs and most of the inputs are competitive.
Position in the supply chain	High upstream position; Supplier to all industries and products	Supplier to a variety of industries and sectors	Important supplier to other industries (construction, packaging)	Supplier to a large variety of industries and sectors	Close to the end market; Integration of activities such as recycling	Important supplier to other industries.	Can be considered a real downstream producer.
Share of NEIRM in cost structure	NERMs are output of this industry	NERMs are output of this industry	Very important: iron ore 34% on average ; scrap metal 10% on average	Energy-intensive and raw-material intensive industry	Very important: 63,8% of operational cash	The price of raw materials can comprise a substantial share of the end product's price (up to 60%)	The share of NEIRM is substantial: more than 80%.
Framework conditions and policies							
Administrative barriers	Long and sometimes complex authorization process for extractive activities; Compliance with environmental regulations and assessments needed	Legislation controlling exploration/extraction activities is often different depending on private- or state-ownership Large differences in land use policies and practices among MS	Sometimes difficult to distinguish good from bad quality on imported scrap metal; quality standards		Regulations (IPPC, REACH)	Mostly trade policy related restrictions: import and export duties, and quotas.	
Financial barriers	High capital requirements for insurance at		Few players on the steel market are big enough to raise the funding				

	authorization; EU financial organisations are less geared towards investments in the mining sector, because of the inherent long-term risks (Euromines)		needed for vertical integration (investments in iron ore mines)				
Trade	High import dependency for metallic minerals, also net importer for industrial minerals and aggregates Export of minerals with specific characteristics	The EU is the world's largest producer of a number of industrial minerals and the second or third largest producer of a number of others For some Industrial Minerals, two other dominant producers are China and the USA	Export restrictions of raw materials (iron ore and scrap) by several emerging economies Free flow of good quality scrap metal from EU to emerging economies	Subsidies of third-country companies distort competition Illegal shipments (dubious export) should be systematically handled	Export of end products of high quality Net importer of pulp (raw material) Increased imports in China of raw materials (wood, pulp, recovered paper) EU trade hindered by costs of compliance with environmental regulation (CEPI)	The EU has an overall trade deficit for chemicals. CAP induced import rights for bio-ethanol 30-65% of its price	Export dependability; export duties and quotas
National policies	Integrated and prioritized land use policies needed at MS level Competing land use with more progress in environmental regulations			Differences in environmental-related and other regulation among also EU MSs	Integrated and prioritized land use policies needed at MS level	Import duties for bio-based raw materials for industrial use in the chemicals industry should be comparable to those for the fossil-based feedstock	
EU policies	Balanced policies needed; Sensitize MS on land use for extractives activities		Prevent further horizontal integration of the iron ore market Research through Research Fund for Coal and Steel (RFCS)		Balanced policies needed; Sensitize MS on land use and mobilization of wood	The EU industry should be prepared for the emergence of the Middle East as a very important player in the petrochemicals market	
Risks							
Supply risks	Certain raw materials are critical due to the combination of lack of resources within EU, increased use in developing economies and their strategic importance for products like future	The fact that an Industrial Mineral is extracted in the EU does not necessarily mean serving that market too due to the natural variability in the quality and characteristics of a particular mineral found	Risk of limited access to most important raw materials (iron ore and scrap) because of protectionist measures of emerging economies	With respect to raw materials the EU industry is highly dependent on third countries for imports	Competing use of the raw material wood by less regulated industries; Export of and global price setting for recovered paper	Losing in the race with China in terms of demand for raw materials.	Higher dependency on foreign rare earth as electrical vehicles become more wide spread

	environmental technologies; The NEEI has a potential to alleviate the pressure on imported NERMs, but EU mining does/cannot always produce what EU industry needs.	in different parts of the EU and the location of different markets Often very few suppliers					
Trade practices			Export restrictions reduce the supply on the world market and aggravate increases in iron ore spot price Export of valuable scrap as waste	Hidden subsidies in some exporting countries distort the competition in these markets creating unfair competition among EU companies and foreign states		Cost disadvantage for imports of industrial bio-ethanol	
Emerging Technologies						Intensified R&D effort towards development of more efficient production processes for renewable feedstock	Research towards niche support for 'domestic mining' industry mostly for the rare earths
Solutions							
Trade (Pillar 1)	Reduction of import dependency especially for metallic minerals	Dependency especially on China and the US for some materials should be reduced.		Application/optimization of waste framework directive Improved market access for the EU non-ferrous metals industry exports world-wide Level playing field access to raw materials	Costs of compliance with environmental regulation (CEPI) are hindering EU trade	Trade deficit for chemicals is a point of attention.	Export dependability to be reduced
R&D, innovation (Pillar 2)	Research for modern technologies to overcome public and local resistance to extractive activities, to comply with higher safety and environmental standards and to reach 'difficult' deposits more efficiently e.g. ETP SMR		Most R&D concentrates on CO2-reduction (e.g. efficient use of coal), not on recycling or efficiency of other resources.	The location where raw materials are found is important especially if resulting in the relocation of R&D activities impacting the R&D that takes places in EU vs. non-EU countries.	Eco-design for efficient recycling	Breakthrough technologies needed towards more efficient production	R&D for substitutes should be supported

Recycling (Pillar 3)		Not recyclable; highly recoverable	Scrap steel widely used and amounts to 10% of total costs in steel sector Use of scrap steel widely suboptimal because of lack of availability. Steel making procedures with electric arc furnaces (EAF) can use 100% scrap as raw material.	Unique recycling properties Substitution is very important for this industry: improper dismantling (recycling all special metals in the product) should be handled	High recycling rate in EU	Chemicals are needed in order to recycle chemicals. Recycled chemicals not always substitute the raw materials used in production. Recycling of chemicals can have negative environmental impact. It is not always an evident positive strategy.	Steps should be taken to provide for recyclability already during production process.
Resource-efficiency potential (Pillar 3)	Efficient processes of extraction Efficient approach of deposits that are more difficult to reach	The full life-cycle of the end-applications from cradle to grave should be considered: a holistic approach in the implementation of resource efficiency is required rather than fragmented approaches focusing only on parts of the process.	Research is carried out in order to make use of secondary powder material (resulting from primary steel making) as a raw material alternative in electric arc furnaces (EAF) steelmaking.	Location matters: besides recycling, access to primary raw materials is crucial as demand is increasing.	Limited growth potential of recycling rate, but more efficient recycling process; Intention of increased use of recycled products within EU instead of export	Positive effects can be obtained from greater energy efficiency and greater use of bio-feedstock.	Focus should be put on material substitution
Policy and further research	Integration of policy on environment, safety, raw materials and management of natural resources, land use To prioritize on the competing use of land	Industrial mineral may be critical locally but not globally: in terms of data availability for policy monitoring, the geographical factor should be taken into account at the level of countries and even regions Data on the differences of criticality among the different grades of the same raw material also needed.	Policy may pursue a higher use of scrap metal in steel making, as technologies are able to use more in practice More funding will be needed (e.g. in RFCS) to obtain fundamental breakthroughs, together with better cooperation between public and private research institutions	A capital-intensive industry where investments have a long-term nature: it is important for investment decisions that there is a relative 'stability' in the regulatory framework so that planning (especially of innovation activities) becomes viable.	Integration of policy on waste, recycling, competitiveness and trade, raw materials and management of natural resources To prioritize on the competing use of raw materials, the competing use of land and the export of recycled materials	Integration of policy on fossil and renewable feedstock materials. Special attention towards ensuring equal competitive access to raw materials in international markets	Market efficiency is the solution to reach resource efficiency targets, as opposed to regulatory incentives

Note: CAP: Common Agricultural Policy; ETP-SMR: European Technology Platform on Sustainable Mineral Resources, IPPC: Industrial Pollution Prevention Control, MS: Member States, NEEI: Non-energy extractive industry, NERM: Non-energy raw materials, RFCS: Research Fund Coal Steel.

5. EU INDUSTRY IN A SUSTAINABLE GROWTH CONTEXT

5.1. Introduction

The eco-performance of the EU economy is increasingly at the forefront of policy discussion. On the one hand, this reflects the impact of economic activities on the environment (e.g. climate change, environmental degradation, etc.). On the other, it mirrors deep concerns about resource scarcity, coupled with the EU's reliance on external supplies of energy and of raw and critical materials. In this context, policy-makers – along with industry and citizens – face the dual challenge of delivering economic growth and ever mounting demands to improve energy and resource-utilisation efficiency within the economy, on both the production and consumption sides.

This chapter examines the progress made on moving EU industry towards a more sustainable growth path by analysing economic and environment performance trends in industry over the last 10 to 20 years. Particular attention is paid to developments in resource efficiency and in carbon and energy intensity over recent years at country and sector level, to the extent to which economic growth is being decoupled from resources used and environmental impacts and to the potential of the different public policy instruments and industry initiatives to facilitate sustainable growth and promote a strong industrial base in Europe.

This chapter is organised as follows: section 2 provides a brief overview of the policy context and the economic performance of EU industry in the last 10 to 15 years. Against this general background, section 3 presents a general assessment of the advances made in the eco-performance of European industry relative to the trends and developments in its economic performance. This empirical analysis is illustrated by selected case studies, with the aim of obtaining a more detailed understanding of the motives, drivers and effects of particular policy initiatives. Section 4 examines evidence of the levels of investment made in environmental protection and eco-innovation as an indicator of mitigation efforts by industry and future decoupling. A few examples of new 'green business' models are highlighted. Finally, the conclusions are presented in section 5, focusing on the relative strengths and weaknesses of the policy instruments available and the general lessons learned about the optimal design of sustainable growth policies.

5.2. Policy and economic context

5.2.1. EU policy context

The European policy debate has evolved over the last ten years. Initially, the 2000 Lisbon Strategy (relabelled in 2005 as the Growth and Jobs Strategy) and the 2001 Gothenburg Strategy (relabelled in 2005 as the EU Sustainable Development Strategy) continued to move along parallel tracks. Although both these EU policy frameworks aimed to be all-embracing and comprehensive, they allowed some room for interpretation in the balance between economic and environmental performance.

Since 2007, increasing attention has been paid to further development of EU *energy policies* with the aim of reducing dependence on external fossil fuel resources and promoting energy efficiency and renewables. The cornerstone of this policy is the Industrial Emissions (Integrated Pollution Prevention and Control – IPPC – recast) Directive (EC, 2010) and the EU Emission Trading System (EU ETS) (EC, 2003). Recent amendments to the EU ETS (EC, 2009a) and Directives on carbon capture and storage (CCS) (EC, 2009b) and on renewable energy sources (EC, 2009c) are all part of a wider package of reforms directed towards meeting the EU's target of reducing its overall emissions to 20% below 1990 levels by 2020 and increasing the share of renewable energy to 20%. Other important initiatives in the energy domain are the National Energy Efficiency and Renewable Energy Action Plans (NEEAPs and REAPs), which Member States are required to submit under EU directives.

At EU-level, progress has been partial in a broad range of areas. The Progress Report on the EU Sustainable Development Strategy pointed to limited improvements in the area of sustainable transport – at least in the years 2000-2007. Beyond that, a lack of direction was seen in the area of sustainable consumption and production (European Commission, 2007, p.32).

In 2008, the Communication from the Commission on the Sustainable Consumption and Production and Sustainable Industrial Policy Action (European Commission, 2008) was published. It provided a framework for improving the energy and environmental performance of products and fostering their take-up by consumers. The Communication highlighted the challenge of improving the overall environmental performance of products throughout their life-cycle, of stimulating demand for better products and production technologies and of helping consumers to make better choices with the aid of labelling (specific examples of regulatory-driven and voluntary eco-labelling schemes are presented in Boxes 5.2 and 5.6, respectively). Further action was launched to promote cleaner and leaner production and to address international aspects of the production process. The 2008 Sustainable Consumption Action Plan on Green Public Procurement includes references to various regulatory initiatives, such as extension of the Energy Labelling Directive, the Eco-design Directive and the Eco-label Regulation – the later of these being voluntary. Other green public procurement (GPP) measures were also voluntary, as were aspects of the Open Method of Coordination such as cooperation between Member States on common GPP criteria for products and services and on preparation of national action plans. A separate Communication on green public procurement gave fuller details of these measures.

The Europe 2020 Strategy presents a new all-embracing policy framework promoting a strategy for smart, sustainable and inclusive growth. Sustainable growth is understood to mean '*building a resource-efficient, sustainable and competitive economy, exploiting Europe's leadership in the race to develop new processes and technologies, including green technologies, accelerating the roll-out of smart grids using ICT, exploiting EU-scale networks and reinforcing the competitive advantages of our businesses, particularly in manufacturing and within our SMEs as well as through assisting consumers to value resource efficiency*' (European Commission, 2010a, p.14).

This concept of sustainable growth has been further translated into a number of 'flagship initiatives'. The most relevant are found under the heading 'Sustainable Growth'. They include the Sustainable Industrial Competitiveness and the Resource Efficiency flagships. The Sustainable Industrial Competitiveness flagship addresses issues such as industrial innovation, access to raw materials and critical products or resource, energy and carbon efficiency (European Commission, 2010b). The flagship initiative on the Innovation Union is also aligned with these goals: it states that stricter environmental targets and standards establish challenging objectives but ensure long-term predictability, thus providing a boost to eco-innovation (European Commission, 2010c).

Even more recently, the flagship initiative on a Resource-Efficient Europe aims to create a framework for policies to support the shift towards a resource-efficient and low-carbon economy which will help to 'boost economic performance while reducing resource use;

identify and create new opportunities for economic growth and greater innovation and boost the EU's competitiveness; ensure security of supply of essential resources; and fight against climate change and limit the environmental impacts of resource use' (European Commission, 2011, p.3). This flagship initiative aims to make use of *regulatory, voluntary, communication and information instruments.* It also takes account of *public investment*, by aligning this initiative with the proposed reforms on the future of the EU's own major spending programmes, including the Common Agricultural Policy, the Common Fisheries Policy, Cohesion Policy, energy grids and trans-European electricity transport networks.

In conclusion, building on the earlier partial success of previous policy frameworks, EU-wide policies relevant to economic and environmental performance can be seen to have evolved in at least three directions over the last ten years. EU-level policies:

- tend increasingly to treat ***economic and environmental performance*** as dual objectives (intrinsically linked through e.g. 'green growth', 'green' skills and jobs, eco-innovation); the latest Europe 2020 framework appears to have provided greater clarity, reducing the degree of room for interpretation in the balance between economic and environmental objectives, that emerged over time during implementation of the Lisbon and Gothenburg Strategies;

- make use of an increasing ***array of policy instruments**,* recognising that a policy mix of all instruments available is needed in order to achieve the objectives set. This includes not only regulatory, voluntary, communication and information but also public investment instruments. This is a clear evolution from the earlier Lisbon and Gothenburg Strategies, with the Community policy pillar and country surveillance of the Europe 2020 Strategy clearly more based on quantitative objectives and having more binding elements;

- recognise increasingly the role of ***other governance layers*** and players, notably Member States, but also regional and local authorities, businesses, social partners and civil society, plus the global level (e.g. via the WTO and G20). This is particularly important as such a 'multi-governance' approach allows alignment of goals at all levels and mobilisation of all policy instruments and resources – thus adding to the effectiveness of policies. Another reason why this approach is important is that policies promoting economic and environmental performance are not always clearly aligned between governance layers.

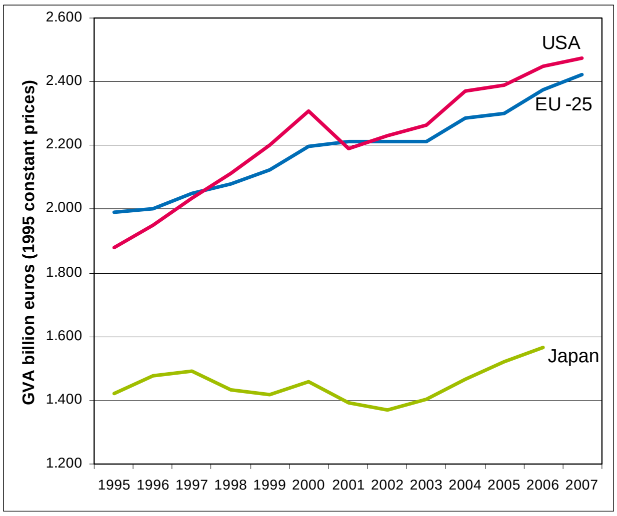
Finally, building upon the points set out above, before shifting attention to the Member State level, it is important to recognise the difference between the level at which policy decisions are taken and the level where they are implemented. As will be seen later, a growing range of policy measures – though implemented at Member State or sub-national level - are directly or indirectly induced by the above- mentioned EU policy frameworks and action plans.

5.2.2. Economic context: industry gross value added (GVA) and employment

The overall economic trend over the last 10 to 20 years, until the recent financial crisis, had been one of steady and continuous growth. Overall, industrial GVA was increasing in every country, although at a slower rate than GVA for the whole economy, reflecting a decline in the relative importance of industry (for the purposes of this chapter, defined, wherever possible, as sectors A to F under NACE revision 1.1, see Annex I).

Figure 5.1 depicts industrial GVA trends at constant prices for the EU, the USA and Japan from 1995 to 2007. Industrial GVA in the EU-25 increased by 22.1% over this period, ahead of the 10.2% increase in Japan in the same period, but behind the 31.6% increase in the US.

Figure 5.1: Industrial GVA in the EU-25[124], USA and Japan, 1995-2007 (indexed at 1995 prices[125])



Source: Ecorys analysis of EU KLEMS datasets.

Figure 5.2 shows contrasting industrial GVA trends across different Member States over the years 1995-2000, 2000-2007 and 2007-2009. In the period 1995-2000, Ireland recorded total growth of over 50%, supported to a large extent by attracting industrial FDI.

In the period 2000-2007, only Portugal and Malta suffered a decline in industrial GVA: in the case of Portugal this was due mainly to a significant (-15.3%) decline in construction. The Baltic states, together with Slovakia, reported the highest growth in this period, each with total growth over 60%. Other Central and Eastern European Member States also recorded faster and above-average industrial growth, seizing the opportunities brought by EU membership and access to the single market.

Many EU-15 Member States – including the ones with the largest industrial GVA, i.e. Germany, France, Italy and the UK – achieved relatively modest total growth over the full period. Notable exceptions were Finland and Sweden where industrial GVA grew by over 20% in both periods (i.e. 1995-2000 and 2000-2007). The expansion of the telecoms sector and the innovative success of these two economies played a leading role in this (the GVA data show increases in the electrical and optical sectors [NACE rev.1.1 – codes 30-33] of over 750% in both countries over the whole period).

The recent recession following the financial crisis has had a significant impact on EU industry. However, the EU KLEMS datasets are only partially available at the moment, which could only be partially redeemed for some countries for the years 2008 and 2009 with data from the OECD STAN database. Figure 5.2 shows that every country for which data are available suffered a decline in industrial GVA. In total, these 12 Member States reported an 11.5% decline in industrial GVA in this period, with the situation contrasting from one Member State to another. Slovakia, Slovenia and Greece saw the smallest declines, of less than 5%, whereas the biggest, of more than 10%, were in Finland, Sweden, Austria, Germany and Italy (see Box 5.1).

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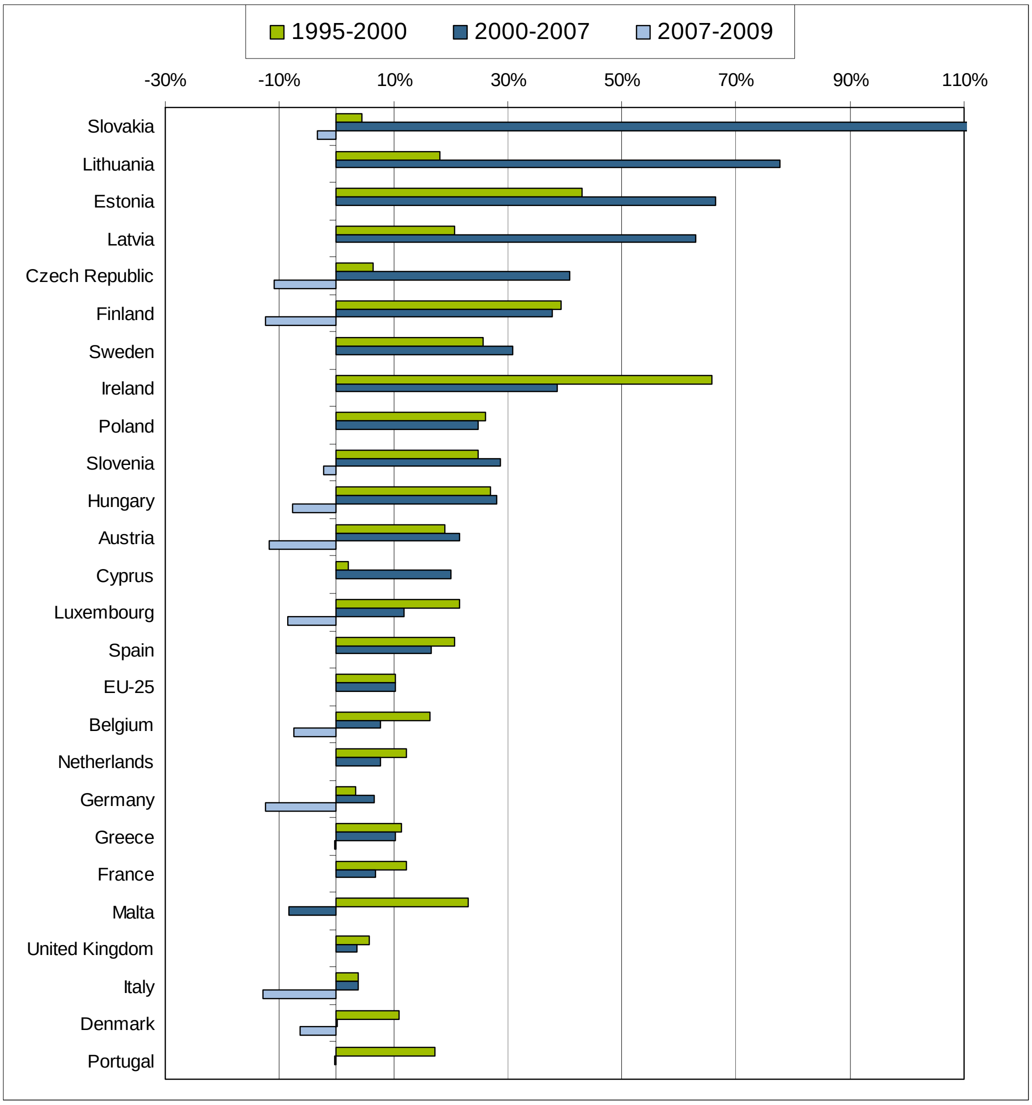
124 EU-27 less Bulgaria and Romania, as EU KLEMS data were unfortunately unavailable for these countries – the use of EU-25 from this point forward refers to this definition.

125 GVA has been indexed to 1995 constant prices using industry and member state specific price deflators, also contained in the EU KLEMS dataset – this process has been used for all GVA and intensity calculations to present the real economic changes as far as possible.

Figure 5.2: Total % changes in industrial GVA EU-25, 1995-2009



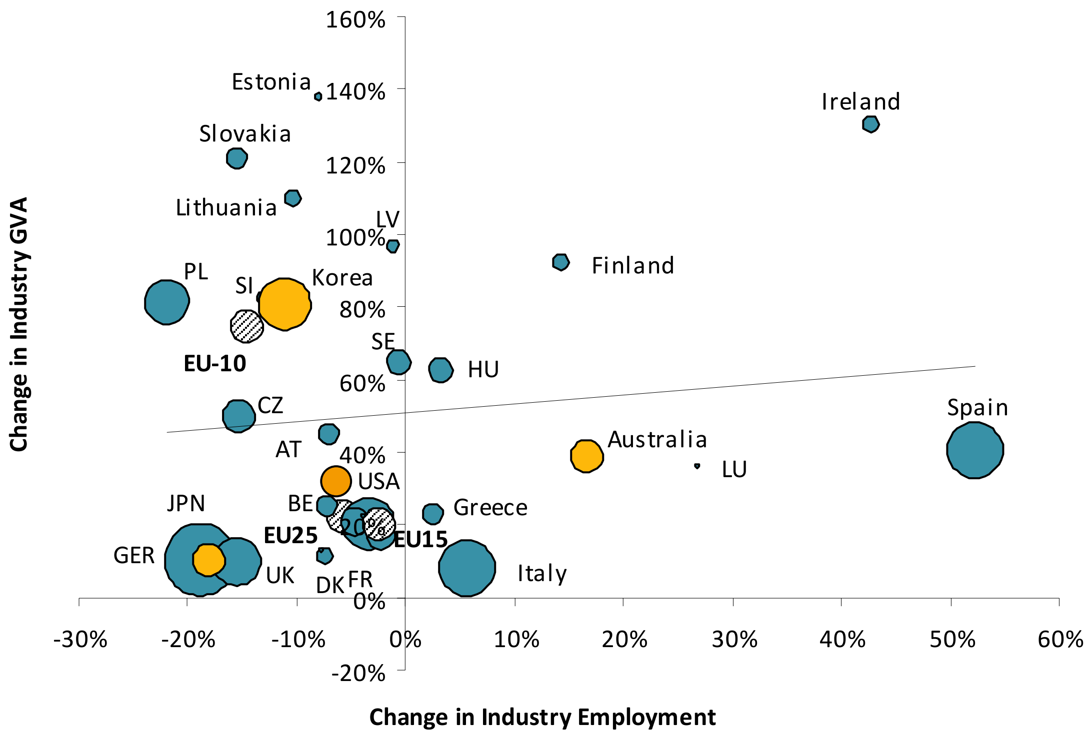
Note: *2007-2009* data available for only 12 Member States (data missing from LT, EE, LV, SE, IE, PL, CY, ES, NL, FR, MT, UK and PT) and produced from a different dataset than data up to 2007, which could account for some of the differences.

Source: Ecorys based on EU KLEMS, OECD STAN.

The decline in the relative importance of industry was matched by a decline in industrial employment across the developed world, both in total employment in industry and also as a proportion of total employment.

Figure 5.3 relates changes in industrial GVA to changes in industrial employment in the period 1995-2007. Industrial employment increased in this period in only eight of the countries selected. Ireland and Spain recorded the biggest expansion in employment, driven primarily by rapid expansion of the construction sector. Finland and, to a lesser extent, Sweden saw strong GVA and employment growth fuelled by expansion of their electrical and optical sectors. Germany, Japan and the UK all suffered a significant decline in industrial employment and among the lowest rates of GVA growth. In Germany this was caused by a decline in mining, textiles and construction. In the UK it was attributable to a general decline in manufacturing and a particularly severe contraction in the textiles industry. In Poland, Slovakia and the Czech Republic, although GVA growth was much more vigorous, there was also a significant decline in industrial employment, mostly concentrated in agriculture and the mining and extractive industries but also including manufacturing.

Figure 5.3: Change in industrial employment and industrial GVA, 1995-2007



Notes: Bubble size represents relative total industrial employment in 2007 for each Member State – except for the EU-10, EU-15 and EU-25 aggregates or the USA or Japan, where for visual reasons these have been set to a uniform size.

Data points are unlabelled where visually it was not possible to name all the Member States. Unlabelled points include NL, PT, CY and MT (they cluster with EU15).

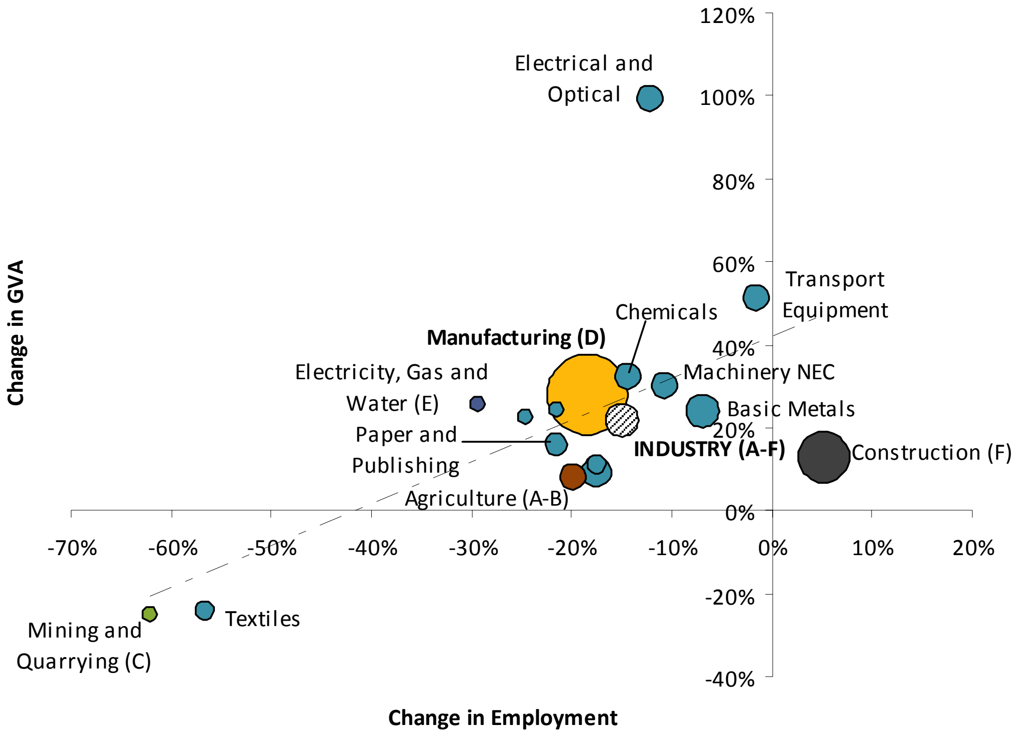
Source: Ecorys based on EU KLEMS database, release November 2009.

Within the EU as a whole a decline in industrial employment of 5.7% was seen, at the same time as industrial GVA grew by 22.1%. Similar proportions were reported by the USA and Japan, but Korea was able to secure greater industrial GVA growth, despite a higher decline in employment (-11.1%), while Australia saw a significant expansion in industrial employment (+16.6%), concentrated, as with growth, in construction and mining.

The EU-15 recorded a lower decline in employment (-2.4%) than the EU-25 but also lower GVA growth, related to relatively mature industrial sectors and labour market differences (e.g. stronger employment protection overall). On the other hand, the EU-10 (EU-12 minus Bulgaria and Romania) reported a sharper decline in employment (-14.1%) but a much higher increase in industrial GVA (+74.6%).

Changes in GVA and employment also varied significantly across sectors. Figure 5.4 presents the changes for the EU-25 sector by sector. The biggest GVA growth was achieved in the electrical and optical sector, almost doubling over the period. Transport equipment also recorded significant growth. The figure shows that, among the sectors where employment declined, textiles and mining and quarrying saw the biggest falls, losing over 40% of employment between 1995 and 2007. Falls of approximately 13 to 14% were recorded in agriculture, pulp and paper, electricity gas and water and other non-metallic minerals. In other sectors employment declined by between 3 and 10%. The construction sector, due to its labour-intensive nature, made by far the biggest contribution to employment growth and remained much closer to a one-to-one relationship between employment and GVA growth.

Figure 5.4: Change in industrial employment and GVA per sector in the EU-25, 1995-2007



Notes: Bubble size represents relative total employment per sector in 2007.
Data points are unlabelled for the other NACE rev. 1.1 manufacturing sectors, where visually it was not possible to name them all – including wood and wood products, food, beverages and tobacco, other non-metallic minerals and manufacturing not elsewhere classified and recycling.
Source: Ecorys based on EU KLEMS database, release November 2009.

Significant increases in productivity per worker have been achieved for the generality of countries and sectors (as reflected by the decline in employment and GVA growth). They are the result of factors such as the technological progress in interaction with the increased globalisation, associated market developments, increasing specialisation by EU industry in high-value products and value-chain segments, increasing levels of innovation, production automation and technological intensity, etc.

At the same time as productivity and specialisation has increased, increases in industrial GVA are being achieved in tandem with proportionally higher increases in the consumption of intermediate inputs. This is particularly evident in the manufacture of transport equipment. This point to lower marginal added value per unit of output, reflecting longer and more complex value chains often involving greater global competition and a complex blend of inputs needed to meet consumer demands. Only two sectors -electrical and optical equipment and agriculture- run counter this trend, and then by only a small amount.

The structural change taking place in traditional industry is particularly noticeable in terms of employment, with an average of almost 250 000 jobs per year being lost. At the same time, eco-innovation efforts and the transition to a more sustainable economy and industry can offset part of the general industrial relative decline. The potential for sustainable growth and direct and indirect job creation can be particularly significant in specific sectors and areas. The EU is a market leader in the so-called 'eco-industries', a set of eco-related sectors and activities that have been expanding rapidly in the recent years, growing to become a sector equivalent (in terms of employment) to chemicals or electrical and optical equipment in the EU. Annual employment growth in 'eco-industries' averaged approximately 179 000 jobs per year between 1999 and 2008, equal to over 7% annual growth. In 2008 'eco-industries' employed an estimated 3.4 million people across the EU (Ecorys et al., 2009, see also GHK et al. 2007). However, sustainable growth is not the exclusive domain of certain sectors. Rather, it has the potential to create new jobs and increase efficiency and productivity in every firm and sector across the whole economy.

Box 5.1: The impact of the recent financial and economic crisis

The latest recession was unusually severe, provoking dramatic falls in industrial production and employment. Industries producing durable consumer goods were hit harder: capital goods and intermediate goods suffered most with production losses of around 26% relative to EU pre-recession peaks (European Union Industrial Structure 2011). The sharp fall in industrial activity has led to deep job cuts. The reduction in GVA and employment has been particularly evident in the two biggest industrial sectors -manufacturing and construction. For example, manufacturing registered a drop of 15% in GVA and 4% in employment over the period 2007-2009 (for a set of 11 EU Member States for which figures are available, accounting for around half of total industrial employment in the EU-25). Patterns of employment decline appear consistent across sectors but are uneven between countries. Member States affected by housing bubbles or other macroeconomic imbalances suffered most in terms of output and, in particular, job losses (see chapter 1 of this report).

The incomplete data currently available show that declines in industrial GVA began to be felt in 2008 in most sectors, though growth was still seen in manufacturing of electrical and optical equipment, chemicals, rubber and plastics and machinery not elsewhere classified (NEC). In 2009 the impact of the crisis on industry was more significant, with declines gaining pace in most sectors. They were particularly sharp in industrial GVA in the electrical and optical equipment, basic and fabricated metals, machinery NEC, transport equipment and other non-metallic mineral sectors. These changes are evidence of both consumer and business purchases of equipment being postponed (electrical and optical, machinery NEC and transport sectors) and of the drying-up of demand from industry as a whole and the construction sector (basic and fabricated metals and non-metallic minerals). In the case of the transport sector, the reaction is instructive as in many Member States there was a strong focus on scrapping and other schemes to support vehicle purchases.

In addition, many governments, both European and non-European, have emphasised the importance of a '*green* recovery' by investing in, for example, renewables and energy efficiency in their recovery packages (OECD, 2009). The total '*green*' part has been estimated to represent 10% of the EU's economic recovery plans (HSBC, 2010, see table 7 in annex for an overview of the stimulus plans adopted in the EU, USA, Japan, South Korea and China, their estimated 'green component' and thematic focus). However, this percentage is highly sensitive to how '*green* investments' in, for example, infrastructure, are defined and is difficult to interpret in terms of environmental impact (European Commission, 2009a). The aggregate spending on and stage of implementation of the 'green' elements in European Recovery Packages are currently under review by the European Commission. However, some examples of mid-term evaluations exist. Car scrapping schemes, for example, were carried out in 13 Member States to boost car sales and take fuel-inefficient vehicles off the roads. The total injection of capital adds up to 7.9 billion Euros and significant environmental benefits are expected, e.g. removing 1.06 million tones of CO_2 and pulling down average emissions from the whole market to 145 g/km (IHS Global Insight, 2010).

5.3. Eco-performance of the EU Industry

This section analyses the main summaries of eco-performance and tries to draw the main findings together to form a coherent picture of EU industry's move to sustainability. Eco-performance and sustainability are assessed on the basis of the evidence available in the key areas of energy, greenhouse gas emissions, other emissions, resource use and water (see Annex I for the full list and a description of the indicators used). Sustainability is most closely associated with decoupling of production (and to a lesser extent consumption) from environmental impact. Two forms of decoupling, as levels of eco-performance, can be identified:

– Relative decoupling of resource utilisation (or production of harmful outputs) from economic activity: while overall utilisation of resources may increase, the intensity of use falls relative to the quantity of output produced.

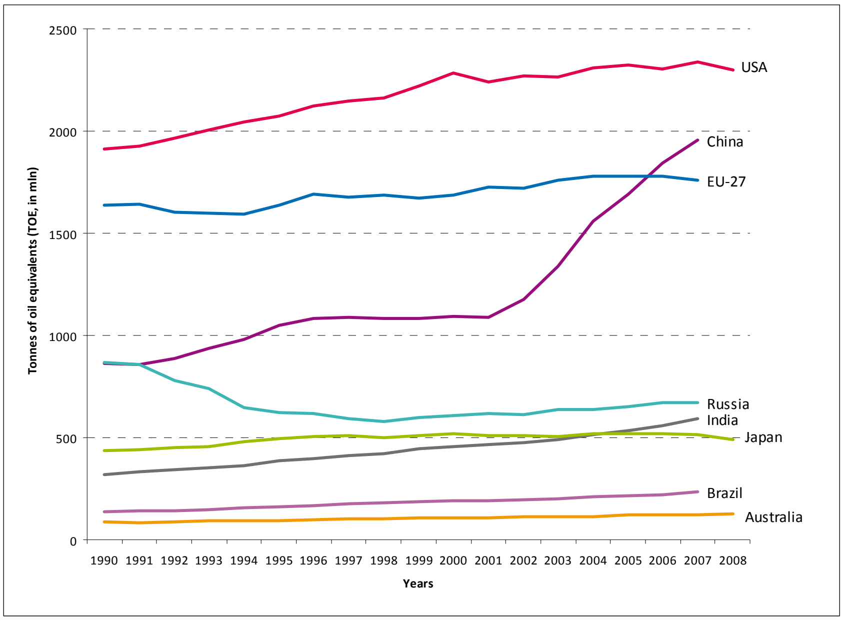
– Absolute decoupling of resource utilisation (or production of harmful outputs) from economic activity: the intensity of use of resources falls relative to output along with a reduction in the overall quantity of resources used.

5.3.1. Energy consumption and intensity

Whole economy

Figure 5.5 displays the overall final energy consumption for the major international economies. As can be seen, since 1990 there has been huge growth in energy consumption in China, particularly since 2001. The USA and India have also exhibited strong growth, whereas in the EU-27 energy consumption has grown slowly over the same period. Analysis shows that the main source of growth in energy use in the EU-27 over this period has been in the transport sector, with overall energy consumption in industry decreasing.

Figure 5.5 Change in final energy consumption in million toe from 1990 to 2008



Source: OECD Factbook 2010, toe = tonnes of oil equivalent.

Energy intensity trends (final energy consumption in toe relative to GDP at constant prices, see Annex I) show that in recent years the EU-27 has closed the gap with Japan, the leading (i.e. least energy-intensive) major economy. The USA and other countries such as Australia have been able to narrow the gap on the EU-27, but remain significantly more energy-intensive. In particular, looking at the relative improvement in percentage terms, the EU-27 outperforms these countries.

Industry

Energy is a critical input for industry. Changes in energy consumption, both headline and relative to output, are therefore important measures of eco-performance. The industrial energy intensity data presented in figure 5.6[126] show that *final energy consumption* (FEC) by industry in the EU-23[127] as a whole increased by 2.1%, while industrial GVA increased by 24.4%. The increase in FEC was higher in the EU-15, for a lower increase in GVA. An overall decline in FEC was recorded in the EU-12(-4)[128], whereas industrial GVA increased by 95%. This reflects a 'catch-up process', specifically the shift to more energy-efficient processes and less energy-intensive sectors in these countries.

Large differences in performance were observed between Member States, with Poland, for example, achieving 88% growth in industrial GVA and a 22% reduction in FEC, but Ireland recorded 157% growth in GVA and a 37% increase in FEC. In countries such as Ireland and Spain, the large increase in final energy consumption is mostly due to the rapid growth of energy-intensive industries, across manufacturing and including construction. The Baltic region – plus Slovakia – achieved the largest increase in GVA without substantially increasing final energy consumption and, in the case of Estonia, even decreasing it.

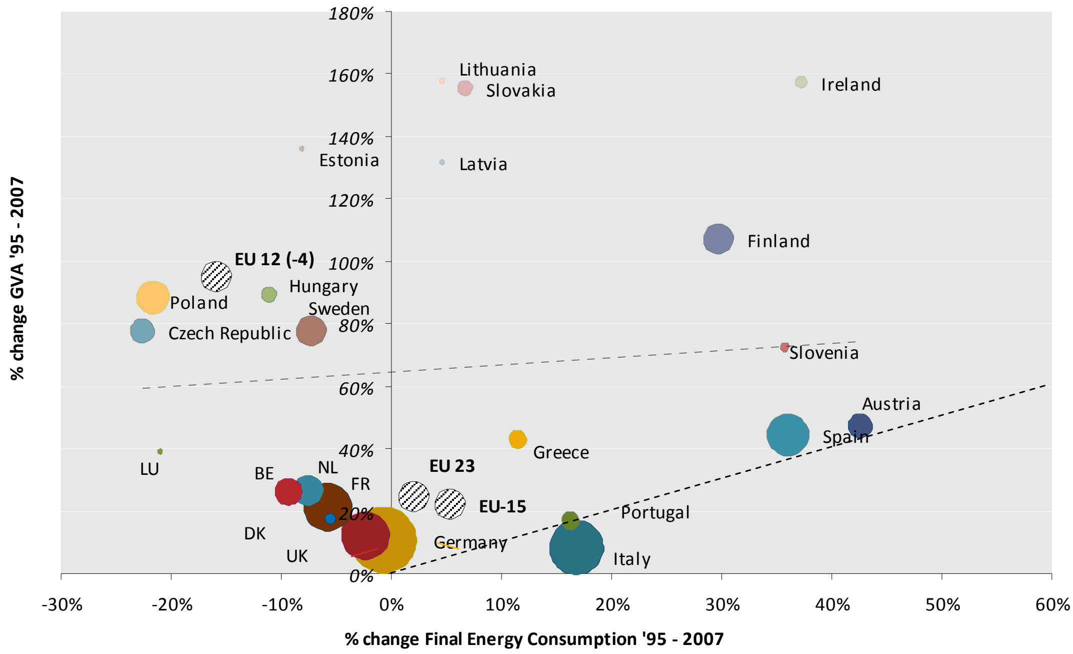
The data at Member State level point to a decoupling of energy use by industry from GVA growth in every Member State except Italy. In ten Member States (AT, ES, IE, FI, SI, LT, SK, LV, EL and PT) this decoupling was relative, with GVA increasing faster than FEC. In the remaining twelve (DE, UK, NL, FR, BE, DK, LU, CZ, PL, HU, SE and EE) an absolute decoupling of FEC from GVA growth was evident.

126 This figure should be interpreted as follows: a high GVA growth in combination with low or negative growth in energy use can be considered efficient. Hence, further to the left along the horizontal axis and further up along the vertical axis is better in various terms. The 45 degree line marks the no change in energy intensity locus. The vertical distance from a given point to the 45 degree line gives an approximation to the percentage change in energy intensity (the exact percentage change is equal to this distance/ (1 + % change in GVA)).

127 EU-27 – minus BG, RO, CY and MT, due to incomplete datasets.

128 EU-12 – minus BG, RO, CY and MT, due to incomplete datasets.

Figure 5.6: Energy intensity of EU industry (manufacturing and construction, % change in final energy consumption versus % change in GVA), 1995 and 2007

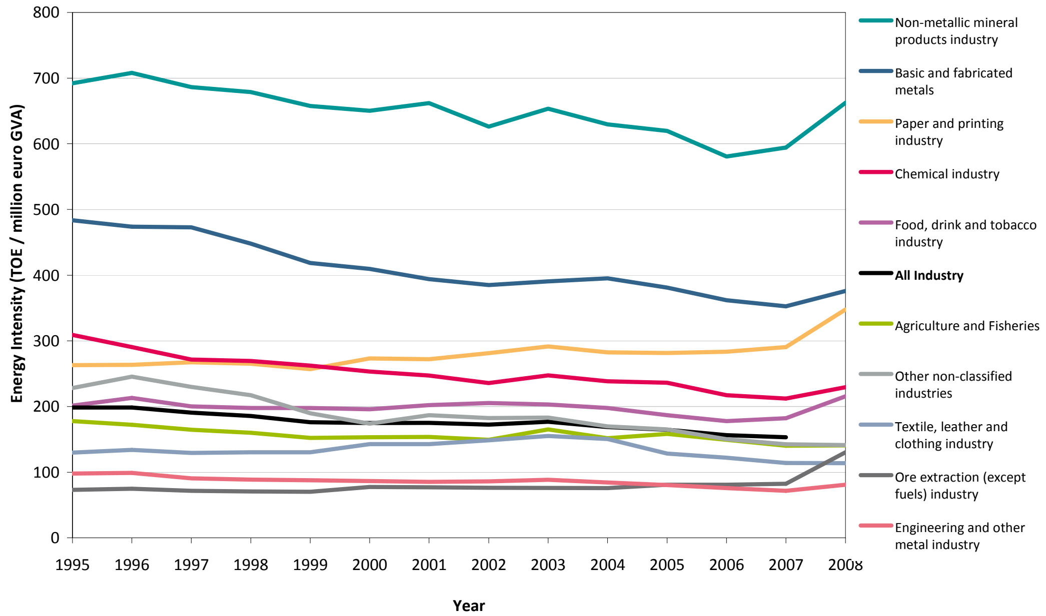


Notes: Bubble size represents relative industrial FEC in 2007. Dashed lines represent the trend of all data points and the 45 degree line one-to-one changes. Bulgaria and Romania are missing (because the latest EU KLEMS database release has no GVA data for these two countries). For Portugal, Poland and Slovenia the EU KLEMS database has GVA data until 2006 only. Therefore, for these three Member States the % change has been calculated over 1995-2006. EU-23=EU-27 – minus BG, RO, CY and MT; EU-12(-4)=EU12 – minus BG, RO, CY and MT.

Source: Eurostat (final energy consumption) and EU KLEMS database (GVA).

Energy intensity improved within most of the individual industrial sectors (see figure 5.7). Overall, the picture was favourable and some of the sectors with the highest initial energy intensity achieved some of the largest improvements. The basic and fabricated metals sector (i.e. the iron and steel and non-ferrous metals industries) saw an improvement of 22.2% from 1990 to 2008, with the downward trend continuing until 2007-2008 when a significant fall in GVA led to an increase in energy intensity. The chemical industry recorded a 25.7% improvement over the whole period, which has levelled off somewhat in recent years. The biggest improvement over the period, (38%), was achieved by the 'other non-classified industries' (i.e. electrical and optical equipment and wood products), again a product of rapid increases in GVA. GVA stands out as the dominant variable in intensity trends, with the increases in intensity recorded in 2007-2008 a result of falls in GVA greater than the decline in energy consumption.

Figure 5.7: Energy intensity sector by sector (final energy consumption (in toe)/GVA in million euros (1995 constant prices)), 1995-2008

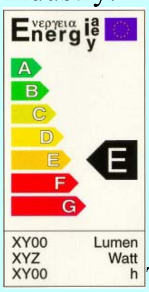


Source: Eurostat and EU KLEMS data (Ecorys calculations)

Changes in energy use and efficiency across sectors and their impact are affected by the fuel or energy mix used, choices of fuels and, within any given energy mix, by many factors, including local resource availability, energy prices and public policies. Public policies can promote energy efficiency and sustainable growth by means of a broad range of instruments (such as energy taxes and subsidies, regulations and standards, eco-designs, eco-labels, see section 5.5). Box 5.2 describes the specific case of mandatory energy labels for light bulbs in the EU which has produced significant economic and environmental benefits.

Box 5.2: Energy labelling for light bulbs: linking sustainable consumption, production and eco-innovation

Energy labelling is a mandatory requirement for light bulbs, cars, and most electronic appliances in the EU. These EU initiatives illustrate how consumer-oriented approaches to improve sustainable consumption and production can have far-reaching implications for the economic and eco-performance of industry. The regulatory energy-efficiency labelling scheme for light bulbs is an example of a labelling scheme with clear positive effects on both eco-performance (energy-efficiency improvements) and economic performance (higher value-added products and stimulating innovation). The labelling scheme has been primarily a regulatory initiative with the aim of informing consumers and supported and anticipated by industry.



The mandatory energy labelling scheme for light bulbs (under Energy Labelling Directive 92/75/EEC and Implementing Directive 98/11/EC on household lamps) is an example of a compulsory method for informing consumers and setting minimum thresholds the level of eco-performance of consumer products. Since December 2008, minimum energy-efficiency requirements for light bulbs are in force with the goal of phasing out incandescent bulbs by 2012. The energy label for light bulbs shows their energy efficiency level on a scale from G to A+++ plus the number of lumen and watts used, indicating the power of the light and the energy consumption per second. Compared with incandescent bulbs (levels E to G), compact fluorescent lamps (CFLs) (level A) can save up to 80% of energy for the same light output and have a service life six to fifteen times longer.

The development and market penetration of compact fluorescent lamps (CFLs) – the main sustainable alternative to incandescent light bulbs – has kept partly ahead of regulation. Sales of CFLs increased by 340% from 2003 to 2007 (Bertoldi and Atanasiu, 2009). Industry has taken on a proactive role in developing and marketing more sustainable lighting alternatives. Nonetheless, there seems to be consensus among policy makers, industry and consumer organisations that similar levels of energy efficiency would not have been achieved without these regulatory schemes, e.g. if the scheme had been voluntary[129]. This is mainly because consumers are concerned foremost about the quality (colour) of the light and price of the bulb and do not believe that they can make a bigger impact by buying energy-efficient appliances.

In general, awareness and willingness to act as a 'sustainable consumer' are increasing in the EU; more than 80% of Europeans believe that a product's environmental impact in general is a significant factor when deciding which product to buy (Eurobarometer, European Commission 2009b). However, when making a purchasing decision, a large majority of consumers consider quality and price more important than environmental impact. EU consumers see minimising waste and recycling as the ways in which they can have most influence on solving environmental problems, more so than by purchasing energy-efficient appliances or products that were produced using environmentally sustainable methods. Differences in consumer attitudes exist between Member States; for example, eco-labels play a larger role in purchasing decisions by consumers in Malta, Austria, Portugal and Italy than in the Czech Republic, Hungary, Estonia, Slovakia and Bulgaria.

Even though the general level of consumer recognition of the A-G energy label is high across Europe, ranging from 81% in Poland to 95% in the Netherlands, France and Denmark (Ipsos MORI, 2008), this can mainly be explained by the mandatory nature of the scheme. Consumer awareness of 'cost of ownership' arguments – i.e. that over the entire lifetime of the light bulb, energy saving costs can outweigh the initial higher purchasing price – is still assessed relatively low.

Energy prices and policies or market conditions affecting their level or volatility, (such as taxes, subsidies, liberalised markets and competition) can also induce significant changes in industrial energy use and efficiency. For example, the relatively higher increase in gas prices against electricity prices over the last decade has been reflected by a shift in the relative industrial energy mix, from gas to electricity, in the majority of Member States.

The way changes in energy use make an environmental impact is also affected by the energy mix in the country or industry concerned. Low-carbon (i.e. nuclear and renewable) energy sources play a leading role in this, as do factors such as fuel switching. The proportion of renewable energy in the energy mix in the EU increased from 13.8% in 2000 to 15.6% in 2008 (EEA, 2010, page 36) with improvements evident across almost every Member State, in line with policy goals on climate change. The EU as a whole remains ahead of Japan, the USA and many other countries on the use of renewable energy but countries such as China are also rapidly developing their technology and capacity.

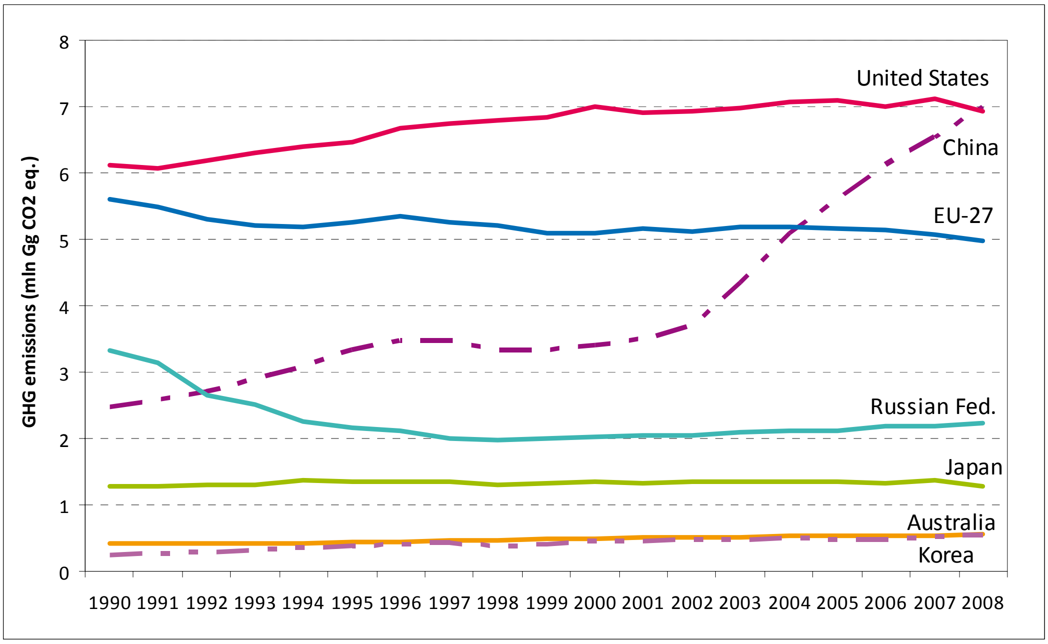
[129] See references for the list of interviews conducted.

5.3.2. Greenhouse gas (GHG) emissions and intensity

Whole economy

The environmental impact of changes in the energy mix is better reflected by changes in emissions. Mirroring changes in energy consumption, the biggest mover in global GHG emissions since 1990 has been China (see figure 5.8) which has surpassed the EU-27, and now also by most estimates the USA too, to become the world's biggest emitter. For both the EU and USA, the trends in total GHG emissions differ from final energy consumption, with the EU-27 recording a decrease in emissions while FEC was increasing and the USA also recording lower increases in emissions than FEC. This is a result of measures in these economies to promote use of renewable energy sources and energy efficient processes and to switch the fuel mix away from coal, the most carbon-intensive energy source.

Figure 5.8: Total GHG emissions in million Gg of CO2 equivalent, 1990-2008



Note: Data for China and Korea are based on CO_2 emissions data only, as CO_2 equivalent data are not reported to the UNFCCC by these two countries. Estimates suggest that CO_2 equivalent data would increase their emissions by approximately 8%, based on the proportions of the other countries.
Source: UNFCCC.

Analysing overall GHG trends within the EU-27, a marked difference emerges over time. In the early part of the period 1995-2000, significant reductions in GHG emissions were reported across the EU-12 countries, again tied to economic transition. The picture in the EU-15 at the same time was more mixed, with most countries decreasing emissions as more renewables came online and fuel mixes switched from coal to gas, but rapid economic expansion meaning that in countries such as Ireland, Portugal, Spain and Greece, GHG emissions also increased rapidly in this period. From 2001 on, this situation was reversed, with most of the EU-15 countries reducing emissions. At the same time, rapid economic growth in the EU-12 Member States increased their total emissions by 1.2% from 2001 to 2008. This increase was not universal, with Hungary, the Czech Republic and Slovakia managing to continue reducing their emissions.

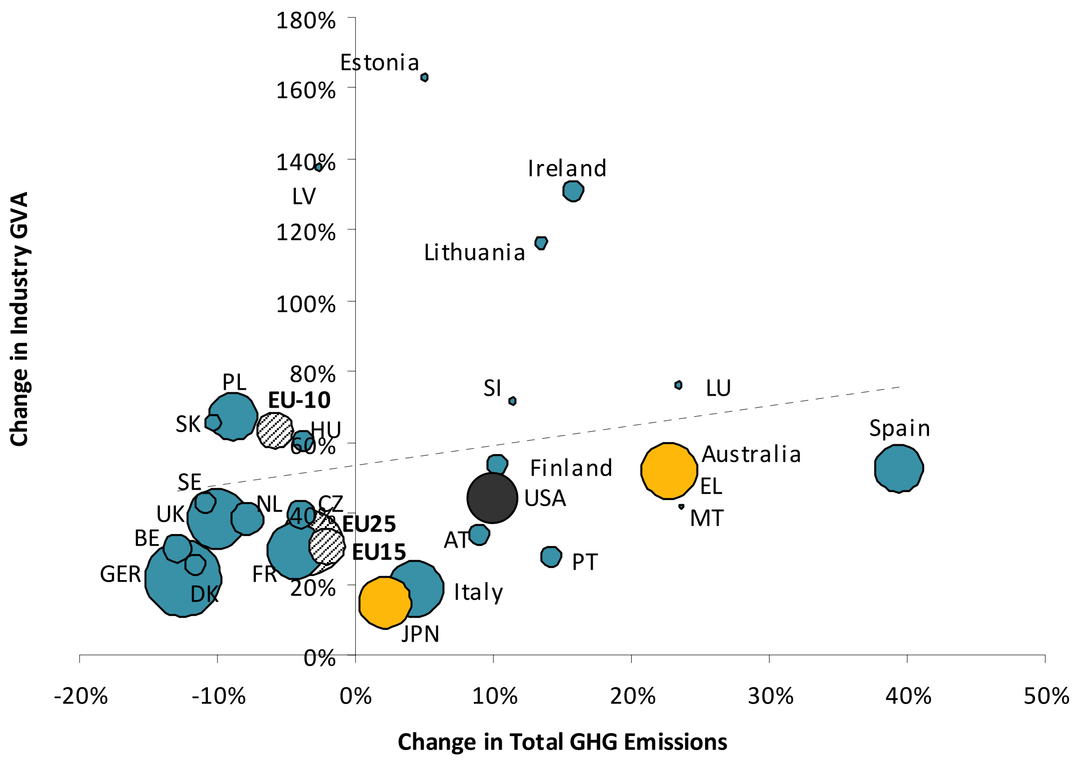
Figure 5.9 presents GHG emissions at whole economy level against GVA changes in the same period. It reveals a variety of interesting findings: firstly, that the variation from the average trend is significant, demonstrating that there appears to be no strong correlation between changes in emissions and changes in GVA. While changes in GVA are likely to be a factor in emissions, the energy mix and transport both play a significant role at whole economy level.

Secondly, 12 EU economies achieved an absolute decoupling of GHG emissions from GVA growth during this period. This is interesting, as it includes both EU-15 and EU-10 Member States, showing that EU-10 Member States are capable of a more sustainable economic transition in terms of emissions.

Thirdly, every country in the analysis achieved at least relative decoupling of economic growth from GHG emissions growth over the period. Various factors lie behind this, including improved efficiency, cleaner power generation and more renewables in the energy mix. A further factor is the exporting or 'offshoring' of emissions: as heavy manufacturing is relocated outside these countries, domestic emissions decline, but the products, despite being produced offshore in places such as the BRIC (Brazil, Russia, India and China) countries, are still consumed in the EU and the developed world.

Finally, related to this, an international comparison of GHG emission intensity shows that the EU achieved the biggest proportional reductions and, similarly to energy intensity, is closing the gap on Japan. The USA and Australia lag behind in comparison. Since 1995 the EU has gained on Japan, while the USA and Australia have also closed on the EU.

Figure 5.9: Change in EU GHG emissions and GVA – Whole economy, i.e. all NACE rev. 1.1 sectors (GHG emissions (Gg CO2 equivalent)/GVA (in million EUR at 1995 constant prices), 1995-2007



Note: Bubble size relative to 2007 emissions, except for EU aggregates, US and Japan, which are set to uniform size for visual reasons.
Source: Ecorys based on UNFCCC and EU KLEMS data.

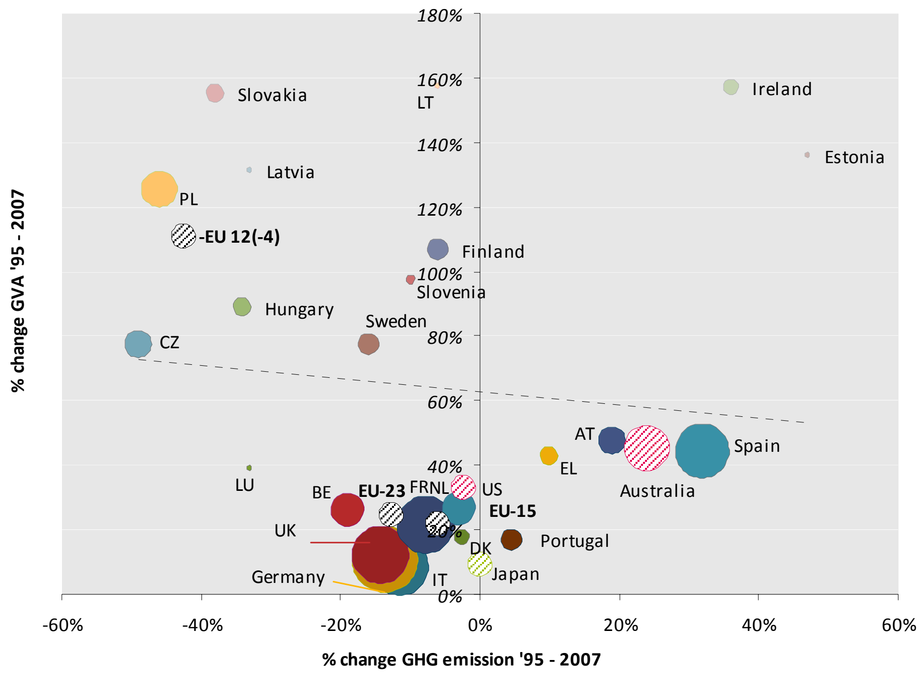
Industrial emissions

Focusing solely on the role of industry is difficult, as the emissions data reported to the UNFCCC are not directly aligned with the standard NACE industrial classifications and, consequently, GVA. This study matched the closest sectoral definition for industry in the emissions data – Manufacturing and construction emissions – to the appropriate economic sectors to form an analysis, but the match between the data sources is not perfect.

Figure 5.10 presents the trends in industrial GHG emissions for individual Member States against changes in GVA. This shows little clear correlation between changes in GVA and emissions from manufacturing and construction. GVA growth over the period was positive in every Member State, with 17 of the 23 for which data is available, achieving absolute decoupling of emissions from GVA. At the same time, six Member States – Spain, Ireland, Austria, Greece, Estonia and Portugal - saw emissions increase in this period. One conclusion is that the construction bubble in some of these six countries contributed disproportionately to emission increases per percentage point of growth. However, looking at GVA growth in just the construction sector, Lithuania (+146.1%), Slovakia (+99.2%) and Latvia (+293.9%) show growth rates at least as high as in these six countries and Portugal recorded only 6.5% growth in construction in this period. The construction sector is, therefore, unlikely to be the only explanatory factor.

The figure also gives an indication of the relative trends in emission intensity internationally. These show that over the full period the average EU emission reductions exceed those achieved in all non-EU countries. The USA has achieved absolute decoupling of emissions, but not to the same extent as in the EU. This reflects a long-term trend over the period for the USA to close the gap on the EU, although this is more a result of faster increases in industrial GVA than of emission reductions.

Figure 5.10: Change in GHG emissions from manufacturing and construction (UNFCCC) and GVA in the EU-23 (NACE rev. 1.1 D + F), 1995-2007



Note: Bubble size is relative to GHG emissions in 2007, except for EU aggregates, USA and Japan, which are set to uniform size for visual reasons.
GVA is measured in constant 1995 euros, using EU KLEMS industry-specific price deflators.
Countries omitted from the analysis due to missing data are: CY and MT (no GHG data) and BG and RO (no GVA data).

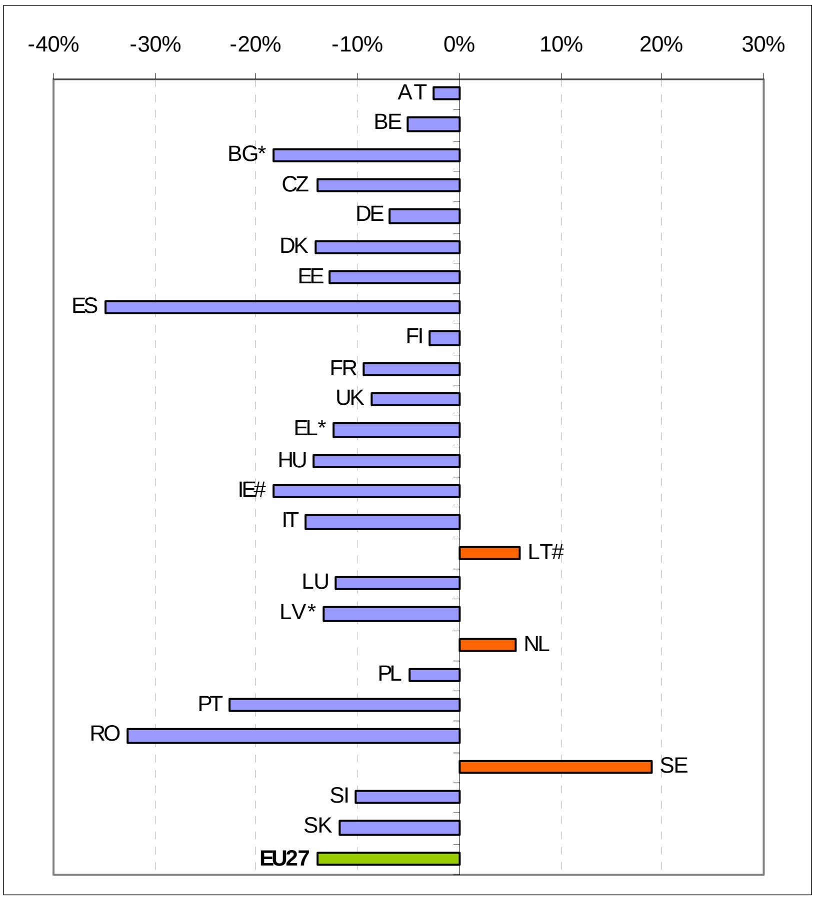
Source: Ecorys based on UNFCCC and EU KLEMS data.

Box 5.3: Setoral emissions in the EU based on the CITL database

It is possible to form a more nuanced view of sectoral emissions in the EU by drawing on data from the CITL database, compiled as part of the EU emission trading scheme (ETS). This records and verifies emissions from the largest energy-generating and industrial installations

across the EU, which generate around 40% of total EU-27 emissions. Data are available from 2005 to 2010, with 2009 and 2010 data still showing some variability in the quality in the data for specific sectors. Generally, the CITL data show a decline in emissions of 1% across all installations covered by the EU ETS between 2005 and 2008. At the same time, a 3.6% decline in overall EU-25 emissions was reported to the UNFCCC.
Going beyond 2007, the data from the CITL show that between 2007 and 2010 emissions declined by around 14% across the EU (see Figure 5.11), with particularly significant declines in Spain, Portugal and Romania. This is consistent with expectations, based on the impact of the financial crisis and contraction in economic activity in 2008 and 2009 in most Member States. Yet the decline was not felt everywhere, with three Member States – Sweden, the Netherlands and Lithuania – seeing emissions increase in this period. In Sweden the increase was tied to problems in the energy sector, with the shutdown of nuclear reactors increasing the demand for energy from gas-fuelled plants, combined with increased emissions from large chemical facilities and metal smelters. In Lithuania and the Netherlands the increases are a result of increased emissions from existing and new chemical installations and fuel refineries.

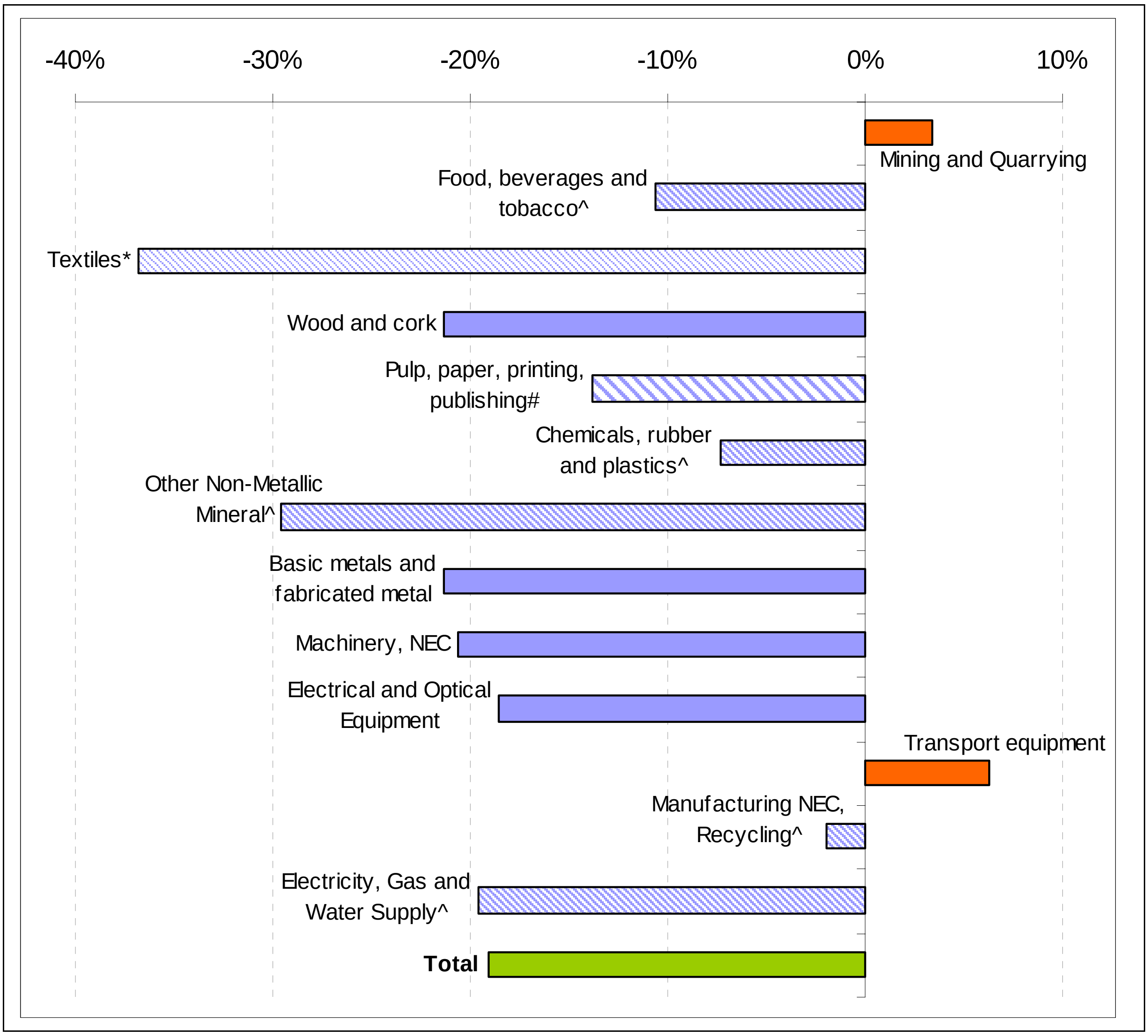
Figure 5.11 Change in EU-25 Member States' industrial GHG emissions, 2007-2010



* - 2007-2009 data only – due to reporting gaps in 2010 data.
\# - Dataset for 2007-2010, but some concerns over completeness, with – estimates pointing to 5 to 10% potential additional emissions. This is based on an estimate of the emissions from installations that have not yet reported data or for which the data are still provisional, for 2008-2010. An assessment of potential additional emissions still to be reported has been made for all Member States in every year, based on emissions in the latest year from each installation. Only in Ireland and Lithuania does this estimate exceed 5% of total emissions in one or more year. In most Member States and years the proportion is less than 1% of the total.
Countries missing due to no or incomplete datasets: CY and MT.
Source: Ecorys based on CITL data (2009 and 2010 data provisional).

The CITL data also allow a more comprehensive examination of sectoral emissions over the same period, as shown in figure 5.12. This shows that EU industry under the ETS was able to achieve a 19% total reduction in emissions between 2007 and 2010, although a significant portion of this is likely to be related to the fall in economic activity. The biggest emitter by far is the electricity, gas and water supply sector, accounting for around 65% of all emissions under the EU ETS. The 19.6% decline in emissions from this sector is therefore a major contributor to the overall decline in emissions. The move to partial auctioning of EU ETS permits for the energy sector and continuing expansion of renewable energy are among the factors at work. Two sectors saw emissions increase in this period: mining and quarrying (+3.4%) and manufacture of transport equipment (+6.3%). Together these account for only 1.9% of total emissions. Increases in emissions are centred on the oil and gas extraction industries and a significant increase from a major German vehicle manufacturer.

Figure 5.12: Change in industrial GHG emissions in the EU-25, 2007-2010



* - Significant data concerns (estimated >5% of installations/emissions non-reported) in all years.
# - Data concerns in 2009 and 2010.
^ - Data concerns in 2010 figures.

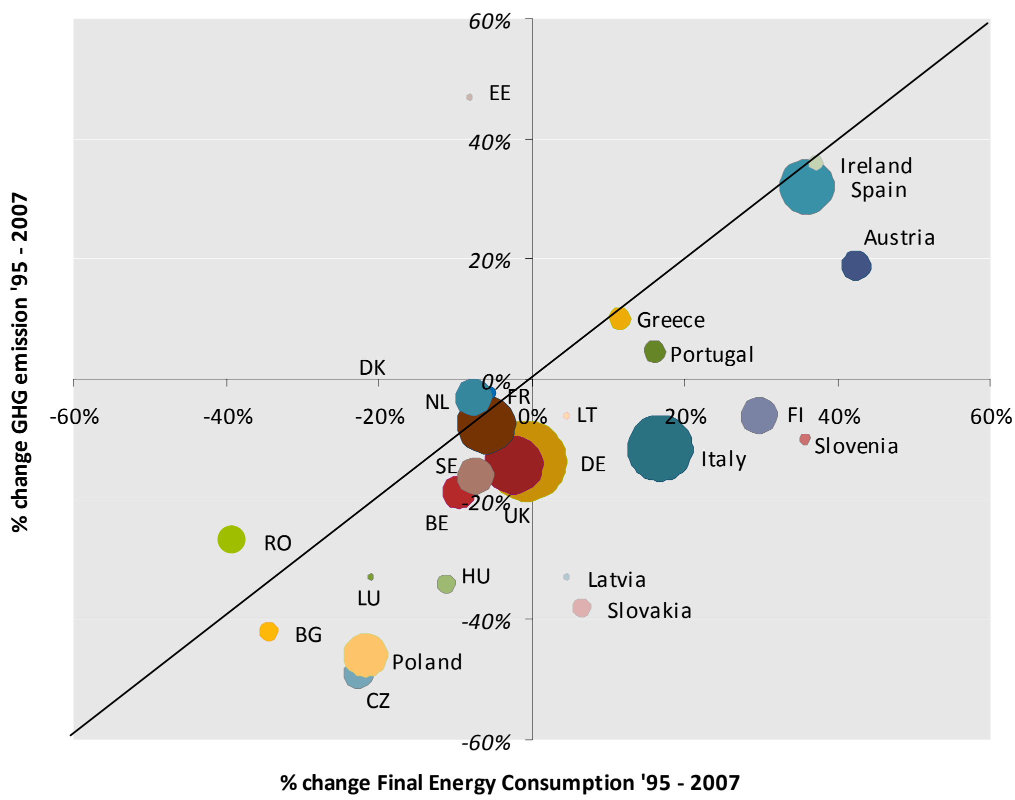
Note: In 2007, approximately 98.7% of total emissions were allocated to a specific sector: in 2010 92.9% were allocated.

Source: Ecorys based on CITL data, unless stated, all data estimated to be within 5% margin of error.

The role of the energy generation mix in determining emission levels and changes in emissions was mentioned earlier. Figure 5.13 presents the change in GHG emissions from industry against the changes in final energy consumption (FEC) by industry for the period 1995-2007. This demonstrates that in the EU-25 (EU-27 excluding CY, MT) FEC by industry remained largely unchanged, whereas emissions declined by 14%. This indicates an overall decarbonisation of the energy consumed by industry.

All but four Member States – indicates – are below the 45 degree line, indicating that most Member States were able to decouple industrial energy consumption from industrial emissions. In these four Member States, the recent changes suggest that the energy mix has become higher carbon, due to retirement of low-emission nuclear capacity and expansion of coal -or gas- fired plants. Equally, the nature of the data and the potential for differences in classifications[130] between the two indicators means the comparison might not be exact. Differences due to this could change the position as regards decoupling in these four countries. Five countries achieved only relative decoupling of industrial energy consumption from industrial emissions: Ireland, Spain, Portugal, Greece and Austria.

Figure 5.13: Change in industrial GHG emissions (manufacturing and construction) and final energy consumption by industry in the EU-25, 1995-2007



Note: Countries missing due to no or incomplete datasets: CY and MT (no industry-level GHG data). **Bubble size represents scale of FEC.**

Source: Ecorys based on UNFCCC and Eurostat data.

In summary, by most measures of performance with regard to emissions the EU outperforms the USA and is closing the gap on Japan. Emissions show a marked trend towards decoupling

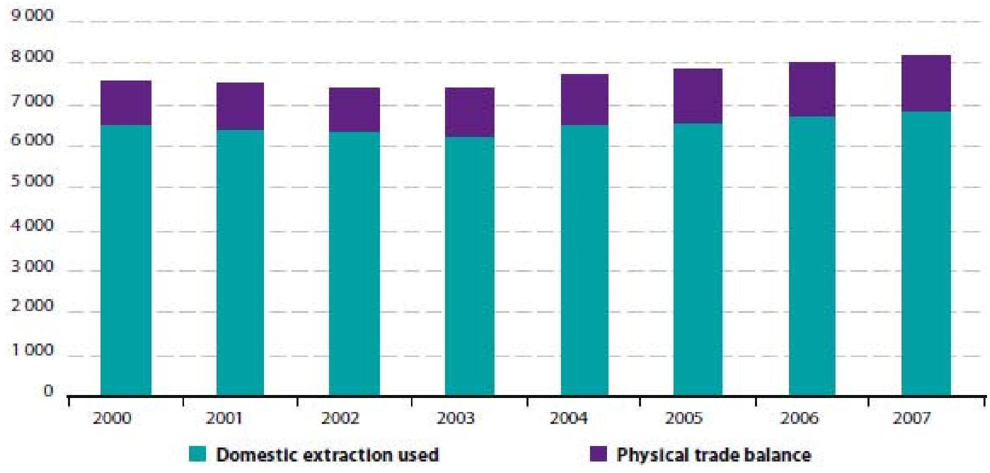
130 The NACE rev 1.1. sector scope of both GHG emissions and FEC is not clearly defined, particularly in respect of FEC-related construction emissions.

from GVA growth. In around half of the countries this trend is heading towards absolute decoupling. This trend is evident for emissions for the whole economy but also holds when the best available evidence for emissions from industry, manufacturing and construction, is considered. The best performers come from across the EU, with EU-12 Member States performing particularly well. Indeed, the weakest performers are found in the EU-15. The other EU-15 Member States generally report emission reductions of up to 20% combined with GVA growth rates of up to 40%.

5.3.3. Material flows and resource efficiency

The way in which industries use and dispose of raw materials is a critical component of their environmental impact and performance. . It is important to consider the impact of material flows in all lifecycle stages, namely: how raw materials are extracted (as this places environmental pressure on the locations from which they are sourced); how they are used (resource efficiency); how resources or materials are finally disposed of or reused.
Domestic material consumption (DMC) is a measure of the volume (in tonnes) of materials directly consumed in an economy. It is the sum of all materials extracted domestically plus the materials in physical imports, minus the materials in physical exports. As a volume measure, DMC does not differentiate between the type of material consumed, although it is important to note the differences between, for example, consuming one tonne of wood versus one tonne of mercury, as they obviously differ in mass density and the potential environmental implications of the latter are far more serious. Figure 5.14 shows that within the EU-27, DMC increased by 7.9% between 2000 and 2007.

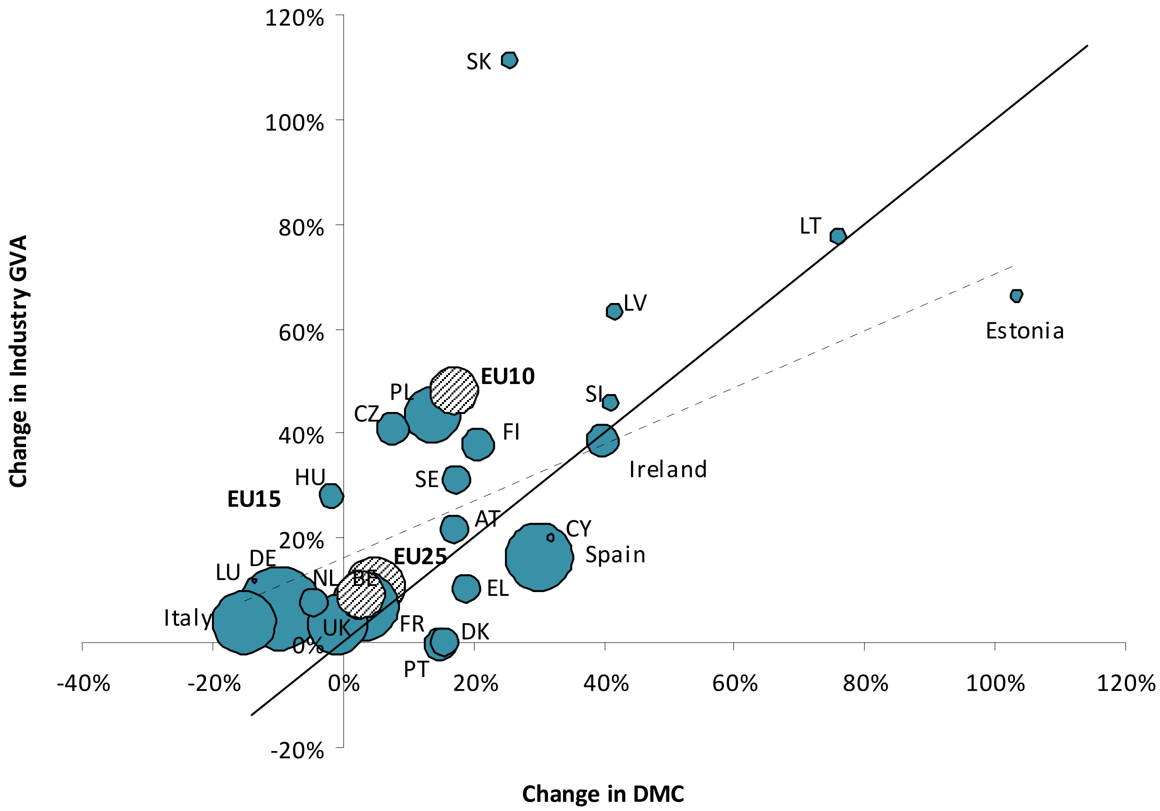
Figure 5.14: Domestic material consumption (DMC) in the EU-27 by components (in million tonnes)



Source: Eurostat (env_ac_mfa)

Figure 5.15 presents an analysis of the change in DMC against the change in industrial GVA over the same period, though due to data limitations DMC is for the whole economy and not just industry. The figure shows, how in terms of material consumption, six economies - Italy, Germany, the UK, the Netherlands, Luxembourg and Hungary - all achieved what may be regarded, to some extent, as absolute decoupling, by reducing material consumption while increasing industrial GVA. Eleven other – France, Poland, Czech Republic, Sweden, Austria, Belgium, Slovakia, Finland, Lithuania, Latvia, Slovenia –demonstrated what could be regarded as relative decoupling, with industrial GVA increasing faster than DMC in this period. In the other Member States below the 45 degree line – Spain, Greece, Denmark, Ireland, Estonia, Cyprus, Portugal and Malta – DMC grew faster than GVA, pointing to a reliance on resource use to fuel economic growth. In Spain and Ireland this is understood to be consistent with expansion in the construction sector with its high material needs (see figure 5.18).

Figure 5.15: Change in DMC and industrial GVA by Member State, 2000-2007

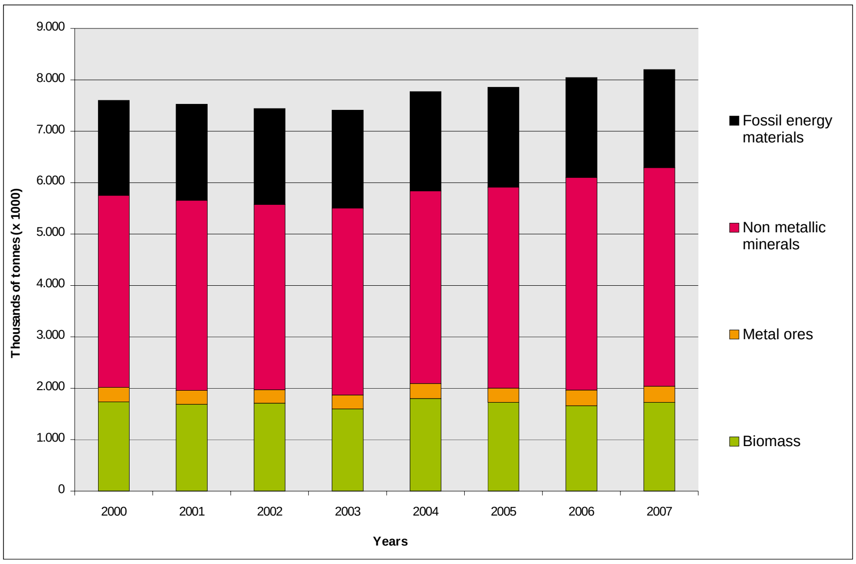


Note: Bubble size is relative to 2007 DMC, except for EU aggregates.

Source: Ecorys from Eurostat and EU KLEMS data.

Figure 5.16 presents DMC over the four main categories of material: fossil energy (carrier) materials, biomass, non-metallic minerals and metal ores. It shows that consumption of biomass declined by 0.4%, but metal ore consumption increased by over 10% and non-metallic mineral consumption by 13.9%. Fossil fuel consumption grew by 3.2%, in keeping with overall growth in FEC in the EU-27 over this period.

Figure 5.16: Domestic material consumption in the EU-27 by main material categories, 2000-2007



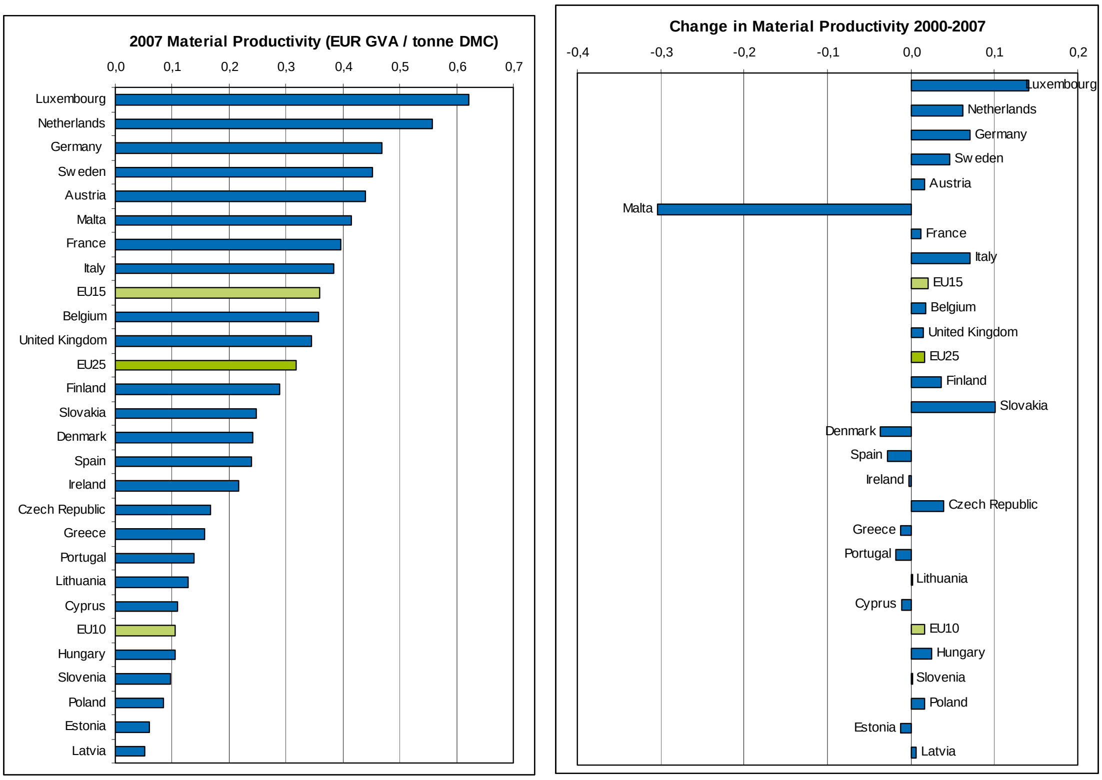
Source: Eurostat.

Developing this further, figure 5.17 presents the material productivity for each Member State in 2007 as a factor of euros of GVA from industry, at 1995 constant prices, per tonne of DMC for the whole economy. Material productivity for the EU-25 was 0.32 euros of industrial GVA per tonne of DMC and improved by EUR 0.02 or 5.2% from 2000 to 2007. This small improvement provides evidence of a limited relative decoupling of industrial GVA from material use.

A distinct difference is evident between the EU-15 and EU-10 economies, with material productivity more than three times higher in the EU-15 (0.36) than in the EU-10 (0.10). The countries with the highest material productivity levels are Luxembourg, the Netherlands and Germany, broadly consistent with the data on DMC. Spain and Ireland rank among the countries with the lowest levels, again reflecting the role of the relatively high material consumption of the construction sector.

Eight Member States recorded a decline in material productivity – Malta, Denmark, Spain, Ireland, Greece, Portugal, Cyprus and Estonia – mainly a trend in the Member States with strong expansion in the construction sector, rather than a divide along EU-15 and EU-10 lines, as was evident in the changes in figure 5.15. The change in the EU-10 marked a relatively bigger increase in material productivity than that achieved in the EU-15. The biggest absolute increase in material productivity came in Luxembourg, the Netherlands, Germany, Italy, Sweden and Slovakia, each recording increases of 0.05 EUR or more over the period. The biggest relative increases in material productivity (greater than 20% over the period), came in Luxembourg, Italy, Slovakia, Czech Republic, Hungary and Poland, illustrating the catching up process in some of the EU10 countries.

Figure 5.17: Material productivity in the EU-25 in 2007 – Industrial GVA in EUR (1995 constant prices) per tonne of DMC in 2007 and change in material productivity, 2000-2007



Source: Ecorys based on Eurostat (DMC) and EU KLEMS (GVA) data.

5.3.4. *Waste generation and treatment*

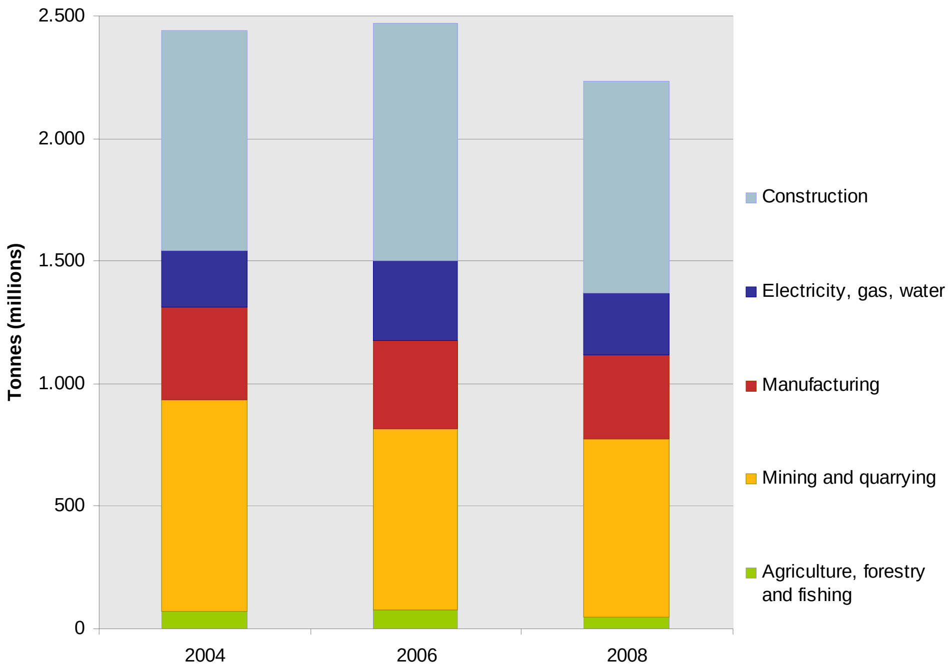
The production process in industry creates waste at various stages. Examining trends in the volume of waste generated by industry provides insights into changes in the absolute and, by relating back to GVA, the relative impact of industry. The coverage and quality of waste data restrict the extent to which analysis is possible, as so far data have been collected for only 2004, 2006 and 2008 and are not directly comparable between industries.[131]

Total waste generation data for industry[132] in the EU-27 are presented in figure 5.18. This shows clearly that the two sectors that appear to generate the largest amount of waste are construction and mining and quarrying. The overall trend is interesting, with a 4.8% rise in the total from 2004 to 2006, fuelled by an increase in waste generation from the electricity, gas and water sector (+42.7%) and construction (+7.9%). Over the same period there were decreases in the volume of waste generated from mining and quarrying (-14.1%) and manufacturing (-5.2%). According to the same data source, from 2006 to 2008 there was a significant decline (-11%) in the volume of waste generated, with the biggest arising in agriculture (-41.4%) and electricity, gas and water (-20.8%).

131 The data are compiled on a NACE rev. 2 sectoral basis, which is not directly comparable with other data, such as GVA data from EU KLEMS, compiled on a NACE rev. 1.1 basis.

132 This is for NACE rev.2 categories A to F. While the category headers are similar to NACE rev.1.1, there are differences in their composition. Focusing solely on industrial sectors A to F covers 93 to 94% of waste generated across all NACE categories and 83.8% to 86.3% of all NACE category and household waste generated in this period across the whole EU27.

Figure 5.18: Total waste generation by industry in the EU-27 (NACE rev.2 A-F), 2004-2008



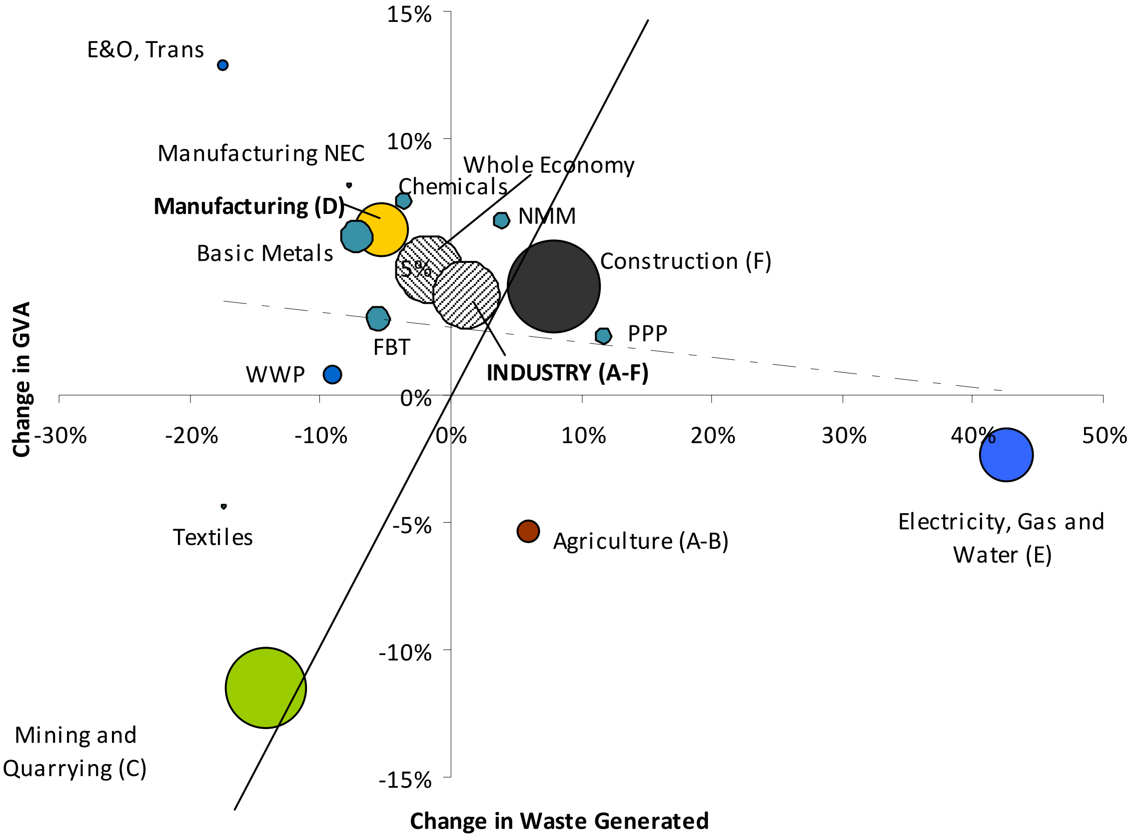
Source: Ecorys based on Eurostat data.

Figure 5.19 presents the change in waste generation by sector, against the change in GVA over the period 2004-2006.[133] This demonstrates an absolute decoupling of waste generation from GVA growth in this period for all sectors in the upper left quadrant, including manufacturing as a whole and electrical, optical and transport equipment, basic and fabricated metals, food, beverages and tobacco (FBT), chemicals and wood and wood products (WWP).

Relative decoupling, with generation of waste increasing at a slower rate than GVA, is evident in all but four of the other sectors. The four sectors that counter the trend are construction, agriculture, electricity, gas and water and paper and publishing. In each case the change in GVA was exceeded by the change in waste generated, apparently pointing to negative trends in eco-performance in these sectors. There is no clear explanation for the increase in waste generation in these sectors is not clear. Box 5.4 presents a brief assessment of the impact of the End-of-Life Vehicles Directive (which imposed binding targets for reuse, recovery and recycling) on the eco-performance of the automobile industry in the EU.

133 GVA data are not yet available for 2008.

Figure 5.19: Change in total waste generation by industry (NACE rev. 2 A-F) and GVA in the EU-27, 2004-2006



Notes: Bubble size represents relative waste generated in the sector, except for whole economy and industry (A-F). E&O, Trans represents the combined totals for the electrical and optical and transport sectors.

Source: Ecorys based on Eurostat data.

Box 5.4: Measures to support sustainable performance in the EU automobile industry: an assessment of the ELV Directive

The End-of-Life Vehicles (ELV) Directive (EC, 2000a) was introduced in 2000 in order to achieve a number of environmental benefits (and is thus based on Article 192 of the Lisbon Treaty). It covers the **whole lifecycle of a vehicle**, including the design, re-use and recycling stages. Above all, it regulates a major sector of European industry that is facing considerable competition from around the world. This is perhaps why the Directive has attracted considerable attention, and at times criticism, from the different industries involved in the product chain.

The headline provisions of the Directive are its binding targets for re-use, recovery and recycling of ELVs. By 2006, 85% of the weight of each vehicle had to be either reused or recovered (e.g. bumpers, tyres, etc.) and 80% had to be reused or recycled. Moreover, these targets will rise to 95% and 85% respectively by 2015. Before the ELV Directive some countries had already managed to achieve high levels of reuse, recovery and recycling thanks to effective voluntary agreements with industry (for example, in Sweden and the Netherlands). However, this was not the case throughout the EU, which was one of the reasons for introducing the Directive.

The 2006 targets have been reached in nineteen Member States, though reporting has been problematic because of the different methods employed by the national authorities (EP, 2010). There is, however, some concern that the 2015 targets cannot be achieved because of the extra proportion that needs to be recovered or recycled, as every additional percentage point becomes more difficult. A large proportion of each ELV has significant value, which is why dismantling cars has long been a profitable business all over Europe. However, the parts of an ELV with less value make reuse and recycling less commercially attractive. By way of illustration, the average value of the ferrous metals in an ELV (steel and iron) is €128, whereas the plastic is worth only €1 (ARN Recycling).

The different industries in the automobile supply chain have been forced to make considerable changes in order to meet the requirements of the Directive. Significantly, the principle of *extended producer responsibility* has been introduced whereby manufacturers assume responsibility for the final use of their products, which had previously not been considered part of an industry's core business (Gerrard and Kandlikar, 2007). Some of the specific challenges which the EU industry has had to face are described below:

- Vehicles now need to be designed for recycling in addition to normal commercial considerations. Use of plastics is problematic, because of their low value and mixture of types, which makes them difficult, and therefore more expensive, to recycle. However, changing the design of a vehicle for recycling purposes can increase its weight which has a negative impact on energy efficiency and emission reduction efforts. In this regard the increasing use of aluminium is encouraging, since it is a light material with a high end value. Although it is expensive, use of aluminium could help to reinforce Europe's tradition of making quality cars. Even closer coordination between suppliers and manufacturers and the recycling industry is needed to make sure that the whole life cycle of the vehicle is taken into account. Some interesting and useful research was conducted with these different partners in the EU-funded LIRECAR ('Light and recyclable cars') project just after the Directive was introduced. More investment in similar research is needed to ensure that vehicles are designed for both the environment and recycling, while remaining competitive on price.

- Manufacturers and, consequently, their suppliers have also had to stop using four heavy metals (lead, cadmium, mercury and hexavalent chromium) which are damaging the environment. The industry has largely achieved this (ÖKO Institut, 2010) but at a considerable financial cost. These heavy metals were being gradually phased out by industry but future vehicles such as battery-powered or hydrogen cars will need other raw materials (European Commission, 2010e). To remain competitive, more resources have to be invested in **research for the future** (e.g. into long-term substitutes that do not rely on access to critical raw materials; see the previous chapter of this report), which should be given equal priority to regulation of cars designed today.

- The recycling industry has had to **innovate** in order to meet the targets set by the Directive, notably in use of post shredding technology (PST) that separates materials even further so that they can then be recycled or used for energy production. ARN Recycling recently completed a large plant in Tiel (Netherlands) with support from the automobile industry and new facilities have also been opened in Austria and Germany. Volkswagen, in partnership with the recycling company Sicon, has produced the first car that meets the recycling targets set in the Directive, mainly by means of investment in PST.

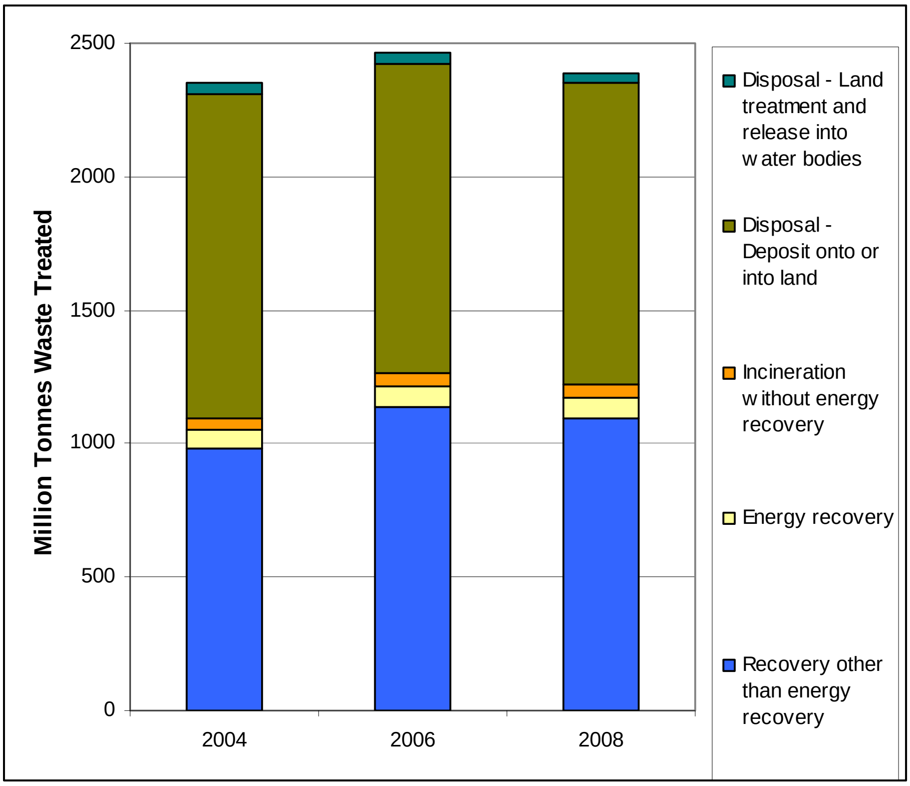
However, overall, industry has been expressing some concerns about whether imposing headline targets is the best strategy to create sustainable growth. This is illustrated by its much larger investment in R&D on emission reduction, fuel efficiency and energy consumption technologies (Gerrard and Kandlikar, 2007). The environmental benefits of the Directive have to be weighed against the costs and the need to concentrate on the future of a rapidly changing industry. Greater understanding of the **different stages of the supply chain** helps to ensure that the **whole lifecycle of the product** is taken into account. Legislation certainly has a role to play in this, but so do research and intra-industry cooperation. Consequently, the right combination and the establishment of well functioning markets for recycled materials are needed in order to create the conditions for sustainable growth.

Waste can have a significant environmental impact, particularly if it is hazardous or otherwise contaminated, but even simple biological waste can also be a significant source of GHG when disposed of in landfills. It is becoming increasingly important to view waste as a potential resource stream, rather than a problem that needs to be disposed of in the cheapest way possible.

Figure 5.20 illustrates the most recent trends in waste treatment across the EU-27, giving details of the process used to dispose of the waste. In keeping with the waste hierarchy of reduce, re-use, recycle, recover or dispose (in that order of preference), the waste treatment methods span the last three stages. Recovery other than energy recovery means recycling or other more environmentally friendly treatment of waste. Energy recovery means using waste to produce energy, typically by means of incineration, but also via other processes. The three other categories cover forms of disposal, from incineration without energy recovery to disposal of waste on land (landfill) or into water.

The total quantity of waste treated increased from 2004 to 2006 before falling from 2006 to 2008. Overall, from 2004 to 2008 the total volume of waste sent for treatment increased by 1.6% from 2 353 million tonnes to 2 391 million tonnes. Changes between the main treatment and disposal methods over the period were limited primarily to a move towards greater recycling in the 'recovery other than energy recovery' category, which increased its share of waste treatment from 41.7% to 45.7% between 2004 and 2008. At the same time, disposal of waste via landfill or 'deposit onto or into land' decreased from 51.9% to 47.3%. An increase in energy recovery from 3.1% to 3.4% was also recorded (see also chapter 4 of this report on waste stream recovery and recycling of non-energy materials).

Figure 5.20: Total waste treatment in the EU-27, 2004-2008



Source: Eurostat.

The waste treatment data do not allow sectoral analysis. Nevertheless, it is clear that the way in which waste can eventually be treated is a factor in how industrial processes enable or restrict the options by which products can be recycled or disposed of safely. If targets are to be met and the environmental impact reduced, it is important for industry to design products with cradle-to-cradle life-cycle processes in mind. Although not evident at macro level, several initiatives have been launched to increase resource efficiency, but they are still not widespread among all industry. Collection systems' bottlenecks and the lack of incentives to use recycled material are major barriers to enhancing the waste recycling markets.

The overall eco-performance of industry in terms of material and resource use is more mixed than for other environmental variables. With material consumption increasing as a whole, but at a slower rate than GVA growth, there is evidence of relative decoupling of the impact for the EU as a whole. At Member State level the picture is more mixed with only a few countries providing strong evidence of absolute decoupling of economic growth from material and resource use - Germany, Italy, the Netherlands and, to a lesser extent, the UK, Hungary and Luxembourg. A more worrying trend is that nine Member States (Spain, Greece, Denmark, Ireland, Slovenia, Estonia, Cyprus, Portugal and Malta) exhibit no decoupling of resource consumption from GVA growth, demonstrating that, in some Member States at least, efficient and sustainable resource use is some distance away.

Within industry there were more positive trends in most sectors, with waste generation being decoupled from GVA growth to some extent in all but three. Manufacturing as a whole and many of its sub-sectors exhibit absolute decoupling. Notably, there was relative decoupling in the construction sector, the biggest waste generator. The second biggest waste-generating sector, mining and quarrying, was among the poorest relative performers.

Positive eco-performance trends were exhibited in waste treatment in general, with energy recovery and recycling slowly displacing disposal to landfill. The role of policy in initiating this change should not be underestimated.

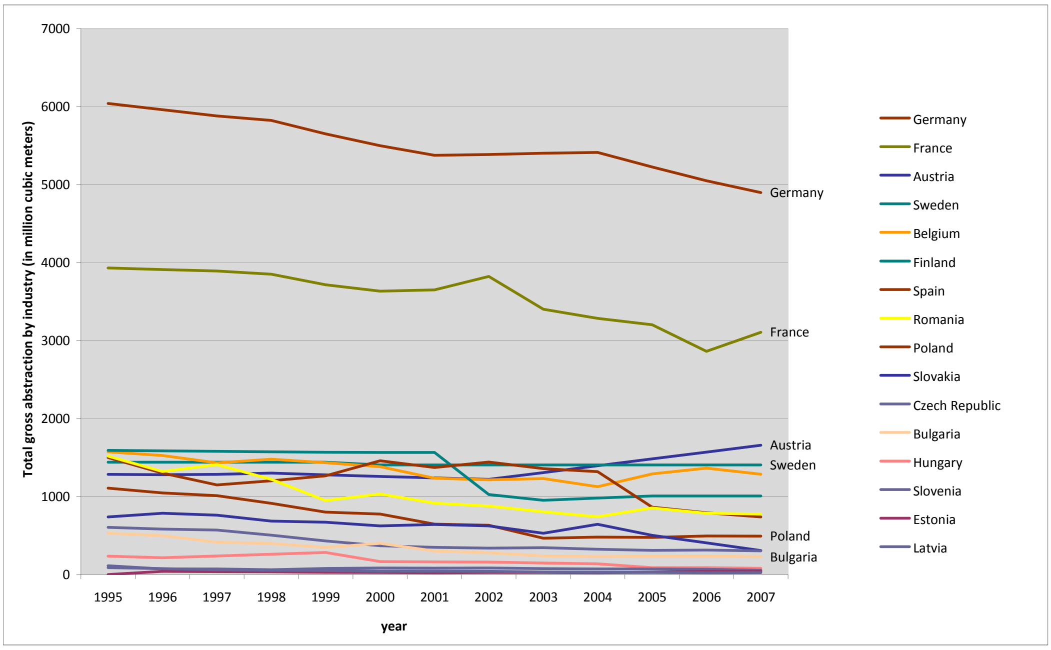
5.3.5. Water

Europe has abundant water resources, but they are not distributed evenly. In some regions water is becoming an increasingly precious and scarce resource. Therefore, efficient use and management of (waste)-water resources is important to prevent and/or adapt to water scarcity. The Water Framework Directive was designed to safeguard a sufficient supply of good-quality fresh surface water and groundwater within a sustainable, balanced and equitable water use scheme in each Member State (EC, 2000b).

The efficiency with which industry uses water is important, although agriculture and residential users are the largest sources of demand. Water is crucial to many industrial processes. It is therefore important to balance industrial needs against agricultural and domestic requirements, knowing that losses of water in the supply network are often substantial, particularly in Member States with severe water scarcity, as in southern Europe. Water has a number of other environmental impacts, including indirectly via the energy used in processing, supplying and treating it.

It is hard to draw robust conclusions on the eco-performance of industry in terms of water use (both as input and as destination for its emissions) as the data are weak and incomplete on a yearly and Member State basis. Comparing total water abstraction with abstraction for industry, the latter has fallen faster than total abstraction over the same period. Figure 5.21 provides some evidence of an absolute decoupling of industrial water abstraction from industrial GVA growth. A particular improvement is evident in Germany over the whole period. The one exception according to the available data is Austria, where water abstraction increased over the period. As regards water as destination for industrial emissions, see Box 5.5.

Figure 5.21: Water abstraction by EU manufacturing industry by Member State, 1995-2007

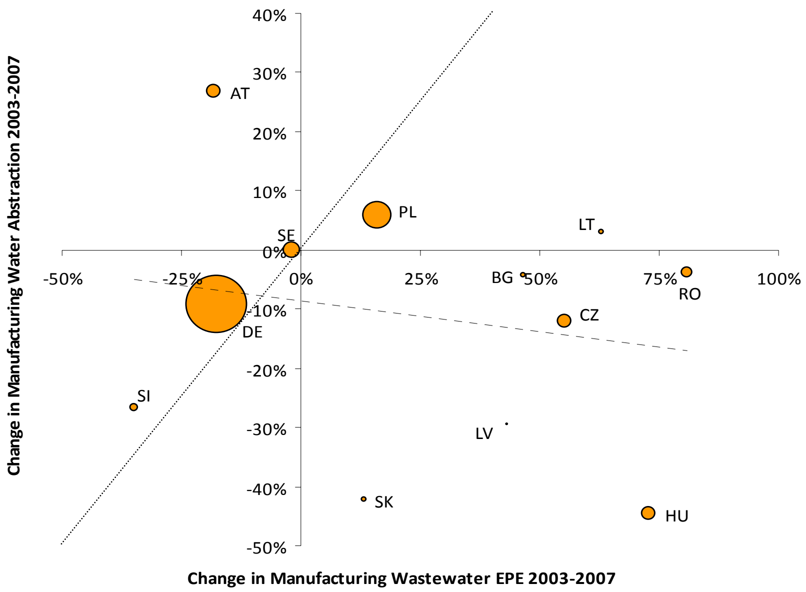


Note: Countries missing due to no or incomplete data: UK, MT, IE, LU, PT, FI, IT, NL, LT, DK and EL.
Source: Eurostat.

Box 5.5: Eco-expenditures on waste-water management

Wastewater management is a major item in industrial environmental protection expenditures (EPE), which is presented in section 5.4.2. In 2006, wastewater management accounted for 17% of public EPE. Figure 5.22 presents an analysis of the extent to which increased EPE on wastewater by manufacturing industry could lead to decreases in industrial water abstraction. It demonstrates that the correlation between the two variables could be weak: in general, EPE on wastewater has been increasing faster than water abstraction. In addition, aside from Poland and Lithuania, the five other Member States where EPE on wastewater by manufacturing industry increased, also saw their water abstraction for manufacturing decline. Austria saw the biggest increase in water abstraction. As mentioned previously, this was due to above-average growth in water intensive manufacturing sectors such as food, drink and tobacco and chemicals.

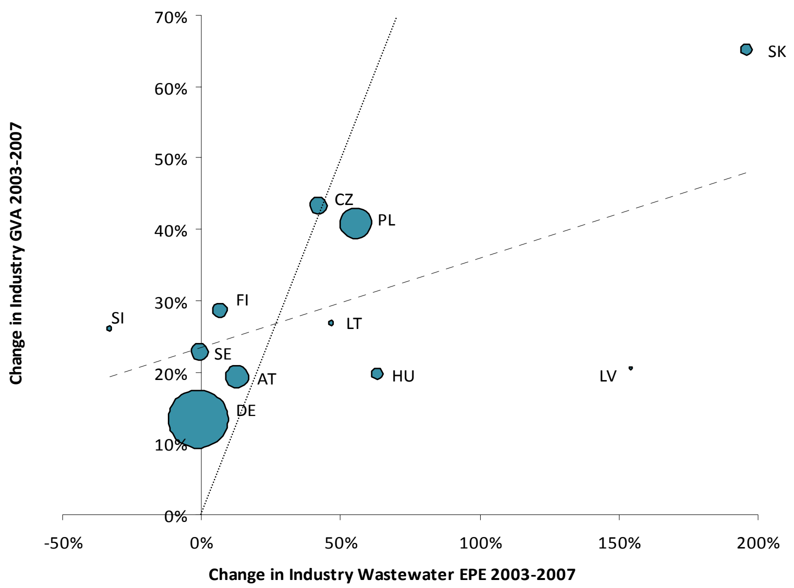
Figure 5.22: Change in EPE on wastewater and in water abstraction by manufacturing industry in selected Member States, 2003-2007



Note: Bubble size represents relative industrial EPE on wastewater in 2007. Member States missing due to incomplete data: BE, DK, IE, EE, EL, ES, FR, IT, CY, LU, MT, NL, FI, PT and UK.
Source: Eurostat data – Ecorys analysis.

As shown by figure 5.23 in general there appears to be a correlation between increased industrial GVA and increased industrial EPE on wastewater. This is strongest in newer Member States in Central and Eastern Europe, as a result of lower relative starting points than in Member States such as Germany and Sweden

Figure 5.23: Change in EPE on wastewater and GVA in industry in selected Member States, 2003-2007



Note: Bubble size represents relative industrial wastewater EPE in 2007. Member States missing due to incomplete data: BE, BG, DK, IE, EL, IT, EE, ES, FR, CY, LU, MT, NL, PT, RO and UK.

Source: Eurostat data – Ecorys analysis.

There are various other aspects affecting the sustainability of industry including its impact on land use, biodiversity and air pollution (see also subsection 5.4.3 and Box 5.8 below on environmental protection expenditures). Measures of these are of mixed quality. For air pollution there has been a significant improvement in industrial emissions in the last 10-20 years, closely following the trends in energy and GHG emissions as the emission source points are often the same. Since 1995 there have been falls of around 50% in particulates (PM10), which are responsible for human respiratory problems, and over 50% falls in nitrogen oxide (NOx), ammonia (NH4) and Sulphur dioxide (SO2), the main pollutants responsible for acid rain (Ecorys et al. 2011). Reductions in these emissions are continuing, although they have slowed since the early impetus given by EU air pollution legislation (see also Commission 2002).

5.3.6. Summary and tentative discussion on the impact of the recent crisis

The overall picture emerging of the eco-performance of EU industry is one of significant progress towards decoupling economic growth from environmental impact over the last two decades. The specific role played by industry within this setting is not always clear from the data, as it is not always possible to separate out which part of the changes is the result of growing efficiency in industry and which is due to other improvements. A case in point is that many of the most positive aspects of industry's eco-performance stem from improvements in emissions from the energy sector. However, the evidence points to these improvements being based on wider policy intervention in the energy generation sector, rather than on action taken by industry. While not all the improvement could be claimed by industry for these reasons, the evidence does support the view that on the whole industry has improved its eco-performance over the period covered and that these trends are continuing in most sectors and Member States. Policy has played a prominent role in many of these developments, particularly in improvements in emissions to air and in waste and resource efficiency.

Overall, there remains strong evidence of, at least, relative decoupling of GVA from environmental impact across the majority of industry, particularly in respect the cases of energy, GHG or other emissions and water use. Relative decoupling is also apparent in material consumption, but not to the same extent as in the other aspects. The evidence suggests that absolute decoupling is also taking place, with eco-performance improving in absolute terms, not just proportionally, while economic performance is also improving. This is most visible in the cases of energy use and emissions, but, as noted above, any absolute decoupling is the product of a variety of factors to which actions by industry alone makes only a small contribution.

Throughout the text references are made to the recent economic crisis. Unfortunately, however, 2007 is the latest year for which most indicators of industrial eco-performance are available. Nevertheless, whenever more recent observations are available, a steep decline in the eco-indicators over the last two years tends to be observed. These drops are likely to have been influenced by the dramatic fall in economic activity. The crisis is also the probable reason for the reductions in emissions and resource use in the short-term (European Commission, 2010f). Early estimates from the EEA (EEA, 2010) point to a:

- 5.5% drop in fossil fuel consumption (oil, coal and natural gas);
- 6.8% drop in GHG emissions compared with 2008, which implies a 17.3% reduction from 1990s levels;
- 12.7% drop in coal use;
- 8.3% increase in use of renewables;
- 11.6% reduction in emissions from sectors covered by the EU ETS.

On a global scale, however, the drop in GHG emissions was limited to 1.3%, which is significantly less than predicted at the dawn of the crisis (Friedlingstein et al., 2010).

There is a growing body of evidence showing a short-term (beneficial) impact on some of the indicators for sustainable growth. The medium and long-term impact is more difficult to estimate. As economies rebound emissions are expected to increase. Friedlingstein et al. (2010) suggests that if global GDP increases by 4.8% (as projected by the IMF in 2010) then carbon emissions would follow with a 3% increase, assuming that improvement trends for carbon intensity remain stable. With the recovery of the European economy (which experienced an uneven and fragile economic growth of 1.8% in 2010 and is projected to maintain the same growth rate in 2011, EC, 2011a), GHG emissions from the power sector and industry appear to have increased by 3.5% in 2010, as indicated by preliminary figures (DG CLIMA, 2011).

The scattered evidence and data presented in the previous paragraphs can provide a starting point for analysing the effects of the economic crisis on sustainable growth. Comprehensive analysis will, however, have to wait until data are published for 2008-2010 and the effects of the economic rebound are better known.

5.4. Eco-expenditure and eco-innovation

This section analyses the evidence on the levels of investment made in environmental protection and eco-innovation as a marker of mitigation efforts by industry and future decoupling. New "green" business models are also briefly discussed.

5.4.1. Eco-innovation

Eco-innovation is often regarded as pivotal for achieving sustainable growth (see, for example, Aghion et al. 2009a). According to the Eco-Innovation Observatory (EIO, 2010), '*eco-innovation is the introduction of any new or significantly improved product (good or service), process, organisational change or marketing solution that reduces the use of natural resources (including materials, energy, water and land) and decreases the release of harmful substances across the whole lifecycle'*.

Data on eco-innovation are relatively poor and researchers rely heavily on patent statistics (see e.g. Oltra et al., 2008, Dechezleprêtre et al., 2011, Johnstone et al., 2010), single case studies (Technopolis Group, 2008) or scattered surveys (Kemp, 2008). Using survey, patent and venture capital data, Aghion et al., (2009b) argue that the speed of eco-innovation in technologies is slow compared with other emerging technologies. The authors see some momentum but claim that support from tax rates on energy, the ETS and public spending on R&D is still too low and/or fragmented. Patent data are also used in case studies on the state of eco-innovation in particular countries. Dechezlêprete and Martin (2010), for example, look at how the UK performs in terms of eco-innovation by identifying 19 technologies they claim are 'clean'. The study singles out certain technologies (such as marine technologies) where the UK holds a comparative advantage.

This section examines the environmental benefits of innovation using micro-level and firm data from the Community Innovation Survey (CIS 2008) and a Eurobarometer study based on a survey of managers of European SMEs ('Attitude of European entrepreneurs towards eco-innovation', Flash Eurobarometer 315). CIS 2008 provides some insight into whether innovation generally leads to environmental benefits for firms, in addition to the perceived economic benefits.

Table 1 presents an overview of the environmental benefits reported by firms with innovation activities in CIS 2008. There are marked differences between countries but, overall, lower energy use is the most commonly reported benefit. This might be related to the fact that it is a general target relevant to every enterprise in every sector. Other prominent environmental benefits include 'Recycled waste, water or materials' and 'Reduced material use per unit of output'.

There clearly appear to be big differences between some countries. The countries with the highest percentage of innovating companies reporting environmental benefits are Ireland, Germany and Portugal. Environmental benefits are clearly less present in Bulgaria, Cyprus and Czech Republic. Up to two thirds of the Irish innovating companies report recycled waste, water or materials, whereas only 15% of the Bulgarian innovating companies report reduced energy use per unit of output in the form of production of goods or services. One notable finding is that the three best and three worst performing countries are each spread across the innovation typology groupings (innovation "leaders", "followers", "moderate innovators" and "catching-up countries", see the Innovation Union Scoreboard 2010). This provides some evidence that typologies for overall innovation may not be as appropriate for the analysis in terms of environmental benefits of innovation. Looking at the underlying data, generally speaking, industry reports more environmental benefits than services.

Table 5.1: Percentage of enterprises with innovation activity reporting an environmental benefit, 2008 – Industry (without construction)

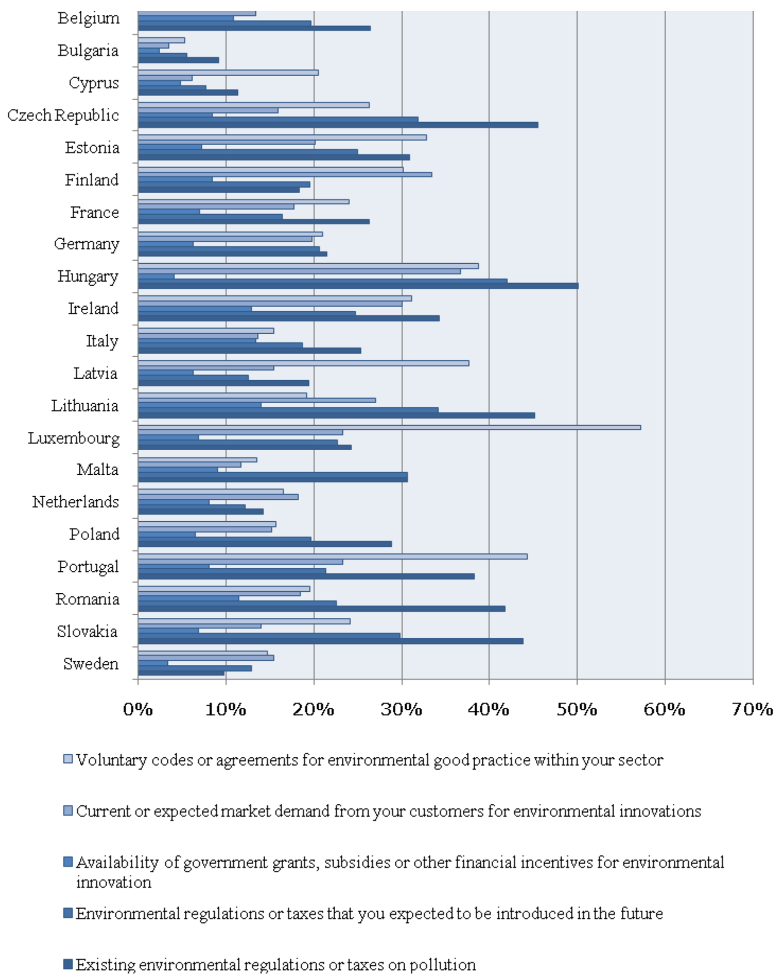
	Environmental benefits from production of goods or services within enterprise						Environmental benefits from after-sale use of goods or services by the end-user		
	Reduced material use per unit of output	Reduced energy use per unit of output	Reduced CO_2 'footprint' (total CO_2 production) by your enterprise	Replaced materials with less polluting or hazardous substitutes	Reduced soil, water, noise or air pollution	Recycled waste, water or materials	End-user benefits, reduced energy use	End-user benefits, reduced air, water, soil or noise pollution	End-user benefits, improved recycling of product after use
Austria	37%	39%	29%	34%	39%	32%	34%	26%	22%
Belgium	33%	40%	31%	30%	37%	44%	28%	23%	26%
Bulgaria	13%	15%	6%	10%	12%	9%	8%	8%	6%
Cyprus	16%	21%	13%	12%	21%	19%	8%	9%	8%
Czech Republic	37%	41%	20%	24%	32%	45%	34%	31%	30%
Estonia	26%	9%	14%	22%	9%	13%	18%	14%	13%
Finland	41%	38%	28%	29%	28%	40%	34%	23%	25%
France	30%	28%	18%	33%	29%	43%	23%	19%	23%
Germany	46%	54%	39%	31%	47%	48%	47%	37%	34%
Hungary	39%	44%	20%	37%	36%	29%	21%	20%	14%
Ireland	37%	43%	39%	40%	38%	66%	38%	29%	42%
Italy	16%	19%	15%	16%	28%	28%	24%	25%	24%
Latvia	21%	27%	10%	25%	36%	17%	24%	34%	11%
Lithuania	40%	42%	25%	33%	29%	26%	27%	21%	21%
Luxembourg	35%	39%	38%	38%	41%	61%	29%	29%	33%
Malta	32%	33%	14%	26%	22%	31%	18%	5%	14%
Netherlands	25%	29%	18%	30%	27%	31%	25%	20%	18%
Poland	31%	33%	19%	30%	35%	28%	28%	30%	19%
Portugal	42%	46%	33%	46%	54%	64%	40%	43%	45%
Romania	40%	41%	26%	26%	37%	37%	33%	33%	22%
Slovakia	27%	34%	12%	24%	29%	33%	31%	26%	25%
Sweden	32%	35%	24%	29%	27%	27%	30%	24%	20%

Source: CIS 2008 (IDEA Consult).

These findings are consistent with the analysis of eco-innovation in *Flash Eurobarometer 315*. According to *Eurobarometer*, about 42% of the enterprises that had introduced at least one type of eco-innovation in the last two years said that such innovations had led to a reduction in material use. Furthermore, comparing CIS data with *Flash Eurobarometer 315*, no direct correlation can be established between eco-innovation and reporting an environmental benefit, as the countries reporting the highest environmental benefits are not especially the ones reporting high investment in eco-innovation investments. According to *Flash Eurobarometer 315*, '*there are only six countries where more than 20% of respondents estimated that 30% of their innovation investments were eco-related (Sweden, Greece, Austria, Cyprus, Luxembourg and Poland')*. This list of countries clearly does not coincide with the countries reporting high percentages of environmental benefits (mainly Ireland, Germany and Portugal).

Figure 5.24 presents the CIS results on the motives for eco-innovation. These are instructive, as they show that firms' expenditure on environmental protection is primarily driven by compliance and regulation and that in every case grants, subsidies and financial incentives were the weakest motivation for environmental innovation.

Figure 5.24: Motives for environmental innovation (percentage of enterprises with innovation activity), 2008 - Industry (without construction)



Source: CIS 2008 (IDEA Consult).

Some reasons can be put forward to explain why government grants play a rather limited role in triggering environmental innovation: firstly, that the available grants do not provide a big enough incentive for European companies to invest in eco-innovation or, secondly, that companies are unable to gain easy access to these grants. The Eurobarometer survey found some evidence to support this latter point, stating that *'barriers related to financing and funds were very or somewhat serious barriers to an accelerated development and uptake of eco-innovation. For example, insufficient access to existing subsidies and fiscal incentives was considered a barrier by 6 in 10 respondents.'*

Figure 5.24 also reveals that in Belgium, Finland, Luxembourg and Portugal, companies tend to be relatively more proactive, introducing environmental innovations in response to current or expected market demand and because of voluntary agreements within their sector. This contrasts with other Member States (such as the Czech Republic, Lithuania, Malta, Romania and Slovakia) where firms report they mainly react to regulation (existing or expected). This may still reflect the implementation of the acquis as a driving force for innovation. The remaining countries have mixed profiles, with no clear dominant motive for environmental innovation. The Eurobarometer survey also corroborates these findings for SMEs. About two thirds of managers said that uncertain market demand was a barrier to faster take-up of eco-innovation in their company. This uncertainty would definitely play a role in defensive behaviour in eco-innovation, with firms unwilling to take a lead in market demand and voluntary agreements.

A detailed sectoral analysis reveals that firms in some sectors tend to be more responsive to one or even all the motives suggested for introducing an eco-innovation (such as electricity, gas, steam, air conditioning, water supply or waste management), but that, overall, existing regulation is the preponderant factor. See boxes 5.6 and 5.7 for two sectoral case studies.

Box 5.6: Industrial initiatives: the Marine Stewardship Council sustainable fishing labelling scheme

One example of a voluntary labelling scheme is the Marine Stewardship Council (MSC) sustainable fishing labelling scheme, which certifies and promotes well-managed marine wild-capture fisheries. MSC certification is based on third-party assessment of sustainable use of resources and the environmental effects of the activities from capture up until delivery on land. To date, 105 fisheries around the world have been MSC-certified, of which 39 are in Europe.

Since the MSC label was introduced in 2004, take-up has been strong. The total number of MSC-labelled seafood products available increased from an estimated 1 000 in January 2008 to 7 362 in September 2010 and approximately 8 200 in January 2011. The largest range of MSC-labelled fish products available is in Germany (2 018 products), the UK (791) and the Netherlands (727). In the Netherlands for example, MSC-labelled products are estimated to have a share of 19% of total wild-caught seafood products now available at retailers. In this case, consumers also consider various other factors (freshness, health benefits and price) to be more important than environmental impact (World Business Council for Sustainable Development, 2008 and Seafood Choices Alliance, 2007). Nonetheless, consumer willingness to buy sustainable products seems to be slightly higher for food and fish than for other products.

Consumers have, however, not been the main drivers of take-up of the MSC label. Looking at the fisheries value chain, industry, civil society and retailers all play a central part. In 1997, the MSC was set up by a joint engagement of a food brand (Unilever) and a civil society organisation (WWF), in response to concerns about depletion of fish stocks (whether for reasons of environmental protection or as a company response to input supply insecurity). Retailers, although not the primary initiators, have been fast to take it up. Operating in a responsive, fast-moving segment in close interaction with consumers, retailers play a central role in the MSC scheme. Along the **value chain** of the fisheries, there has been more resistance to the MSC labelling scheme. For the fisheries economic considerations are the dominant driving factor and the label has been perceived by some as an additional cost burden (on top of fishery policies like quotas that influence this part of the value chain more directly) – even though, for some fisheries, more sustainable fishing methods have given rise to cost savings and economic benefits. For example, in a small fishery in the Netherlands, a switch to sustainable practices led to a saving of up to 70% in fuel expenses while catching higher quality fish and reducing the by-catch and debris. Nonetheless, in general, fisheries' move to MSC certification has been pushed primarily by the **next links along the value chain**, where brands have created demand for certified fish from the fisheries. More recently, fisheries that claimed to have been using sustainable practices before they receive certification have been using the MSC label as a way to increase their exposure to the markets and legitimise their good-quality practices (Potts, T. et al., 2011).

In short, both voluntary and mandatory (see Box 5.2) labelling schemes can be seen as successful examples of enhancing economic and environmental performance. In general, consumer awareness and responsiveness to eco-labels is increasing in the EU (see Box 5.2), even though price and quality remain the main factors in consumers' purchasing decisions. Consumers tend to associate fish products (food) more closely with sustainability than light bulbs (consumer electronics), possibly as a result of their more direct perception of scarcity and of the finite nature of natural resources. The voluntary MSC label has attained a high take-up rate, especially in some perceptive countries. The main drivers behind the high take-up rates for MSC have been food processors and food brands, along with retailers. Industry plays a crucial role as a driver for successful labelling and sustainable consumption and production. From the specific cases analysed, consumers seem to accept rather than drive more sustainable consumption and production.

Box 5.7: Industrial initiatives and new more sustainable business models: chemical leasing

This case study takes the perspective of the chemicals industry in the search for sustainable business models – models that can simultaneously have a positive impact on the competitive position of a sector or company (e.g. by means of 'green' brand positioning and /or cost reductions) and on the use of natural resources.

The considerable move by EU industry towards more sustainable chemistry over recent years has been mostly from within the chemical industry, driven by considerations such as resource efficiency, costs and the availability of raw materials. A strong focus has been placed on a *substitution approach*, i.e. replacing substances by other less hazardous substances that achieve the same or better results and/or diminish resource input requirements. In addition to this trend of substitution and resource efficiency, a second (partly overlapping) line can be observed with a stronger focus on processes, i.e. a stronger *(risk) management approach* to chemicals, taking a more service-oriented approach to management of chemicals all along value chains and focusing on process optimisation. Chemicals suppliers have been induced to do so partly by regulatory requirements (such as REACH), partly by the need to regain market power on what have become buyers' markets. Users of chemicals are motivated by the increase in regulatory requirements, no longer fully matched by in house expertise, seeking to improve the performance of their production processes by having chemicals inputs more finely tuned to their technical requirements. This service-oriented approach, often encountered, either implicitly or under the name of outsourcing, is a new more sustainable way of manufacturing together with offering service packages for regular clients, application of lifecycle and supply chain assessments, resource efficiency, reduced waste, etc.

Chemical leasing (CL) is one clear example of such a service-oriented risk management approach. Broadly, CL is a concept in which a firm (the customer) that uses chemicals in its production process no longer purchases the chemicals, including taking responsibility for how they are handled, but purchases from the ‘chemical operator’ a service limited to the functions (performed by the chemicals) that are needed for the customer’s production process. The ownership and associated responsibilities during the life cycle of the chemical remain with the chemical operator, i.e. the leasing company. This model shifts the producer’s previous focus on increasing sales volume to increasing value-added and the per-unit performance of the chemical (see the following schematic representation of the incentives under CL).

Incentives under chemical leasing

CL is mainly a B2B (business to business) model suitable for specific applications. Typical applications in which this model is applied include: powder coating, solvents for cleaning, galvanisation, food processing, pest control, anti-fouling services, detergents for water purification and electroplating or lubricants for sugar production. Some of the ideas underlying the concept of CL have been applied for longer, or implicitly, for example in paint applications for the automobile industry. In the 1980s, General Motors (GM) was one of the first companies to recognise the opportunities offered by forming partnerships with chemicals suppliers. By transferring overall management of the chemicals to the supplier, GM cut its costs by 30% (Stoughton, M. and Votta, T., 2002). Since 2004, CL has been actively promoted, mainly by UNIDO, which established a definition of CL and a set of quality criteria.

In instances where CL is suitable, the improvements in economic and environmental performance can be considerable. Several applications suggest that the model can in some cases reduce the total chemicals input by 40 to 80% (Safechem, 2005). The optimisation of production and reduction of ‘spoilage’ may considerably reduce not only the environmental impact but also costs. The CL model ‘divides’ these gains between the players primarily involved: the chemical service supplier and the (business) customer. For example, a customer that ‘outsources’ high-performance cleaning for medical devices now pays per unit cleaned instead of for the chemicals and equipment to clean them. The total cost of cleaning the same number of devices for the customer becomes lower while, due to the more efficient resource input, the supplier now also obtains a higher price per unit of chemicals used. In practice, the value added by unit of chemicals used for cleaning has increased and this benefit is shared. Often, the equipment is also provided and managed by the lessor (chemical operator), thereby transferring the associated investment costs and financial risks for the customer and including them in the overall service.

The main drivers behind sustainable chemistry and the trend to make chemical-related business processes more sustainable, including CL, are reduction of use of resources and the associated costs and input supply risks. However, the CL model has been limited to specific sectors and applications. Some companies have mentioned that issues regarding information transfer have complicated application (trust is an essential part of the CL model as the purchaser of the services needs to transfer information to the supplier so that the service can be performed). Its impact on the chemical industry as a whole is therefore (as yet) small. The model should nonetheless be seen as one positive example within a much broader range heading towards sustainable chemistry that illustrate industry’s search for substitution and/or risk management models that fit companies striving to move to more sustainable business practices.

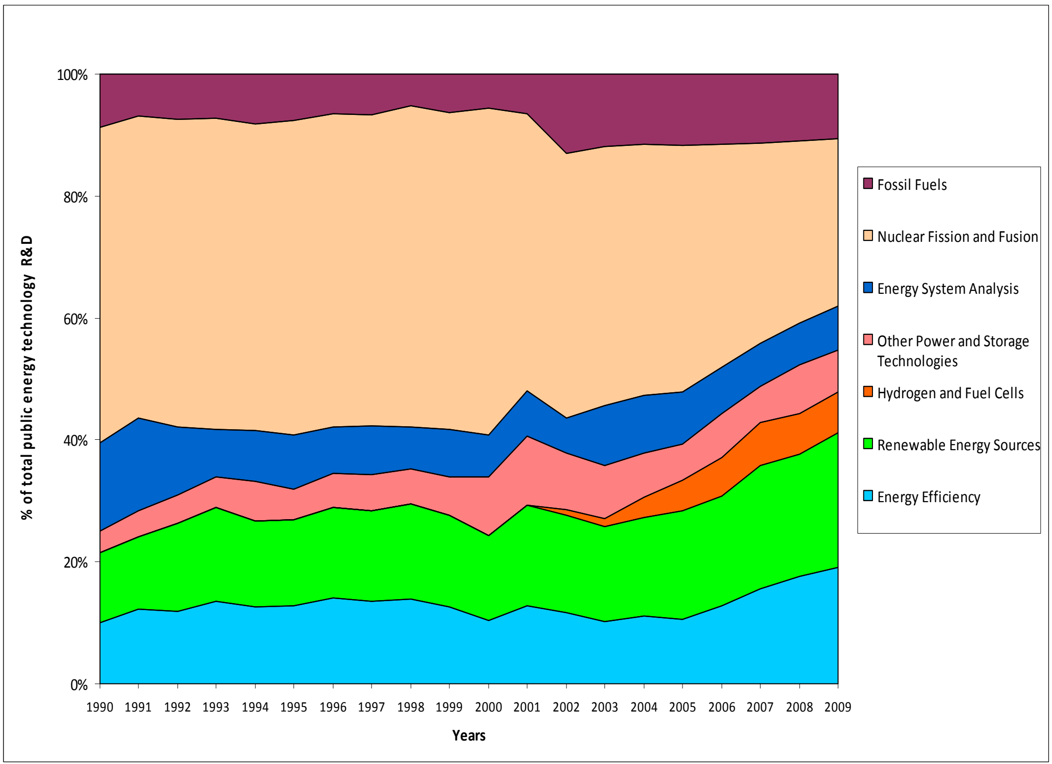
The drivers behind and barriers standing in the way of eco-innovation and specific policy measures to promote it have been analysed and proposed in the literature (see, for example, EIO, 2010). Aghion et al. (2009b) suggested combining a carbon price with high initial subsidies for R&D into clean-innovation. In a modelling exercise, Conte et al. (2010) addressed the market failure of low carbon prices to act as an incentive for eco-innovation, investigating different policy mixes and the design of policies which reallocate revenue from the carbon market to target "green" R&D in the short run and labour market support.

5.4.2. *Eco-innovation and R&D on energy*

Policy measures in the field of eco-innovation consist not only of regulating or encouraging adoption of existing technologies, as regards e.g. increasing energy efficiency or waste reduction. Discovery and development of new technologies are the cornerstone of sustained "*green" growth,* including future improvement of eco-performance in industry. Innovative technologies are costly in terms of investment, and often create new markets for their products, with all the uncertainties attached. Public support is therefore essential both for development of existing "*green"* technologies such as renewable energy technologies and to support new-born cutting-edge technologies such as hydrogen and fuel cells. The EU is a market leader in the development of many of these technologies (e.g. renewable energy generation, see for instance Box 3.2 in European Commission 2010f). This report does not focus on the economic case for financing these R&D projects. Studies analysing this problem are available (Conte et al., 2010).

Limited data are available on total "*green" R&D* expenditure. However, the International Energy Agency (IEA) provides data on public support to all types of energy-related R&D for a number of countries including the EU-15 and Hungary. Figure 5.25 clearly shows the increase in the relative share of public support allocated to "*green" R&D* into energy technology: from 22% in 1990 up to 48% in 2009. This was manly at the expense of nuclear fission and fusion R&D. It should be taken into account that, according to the IEA definitions, research into fossil fuels covers all research conducted in the domain of CO_2 capture and storage which, since 2003, accounts for about 10% of total fossil fuels research. Another notable feature is the higher share of public funding that hydrogen and fuel cells have secured since the European Initiatives for Growth were adopted in 2003 and the Fuel Cells and Hydrogen Joint Technology Initiative in 2008, both by the European Commission as part of the 7th Framework Programme (EC, 2008b).

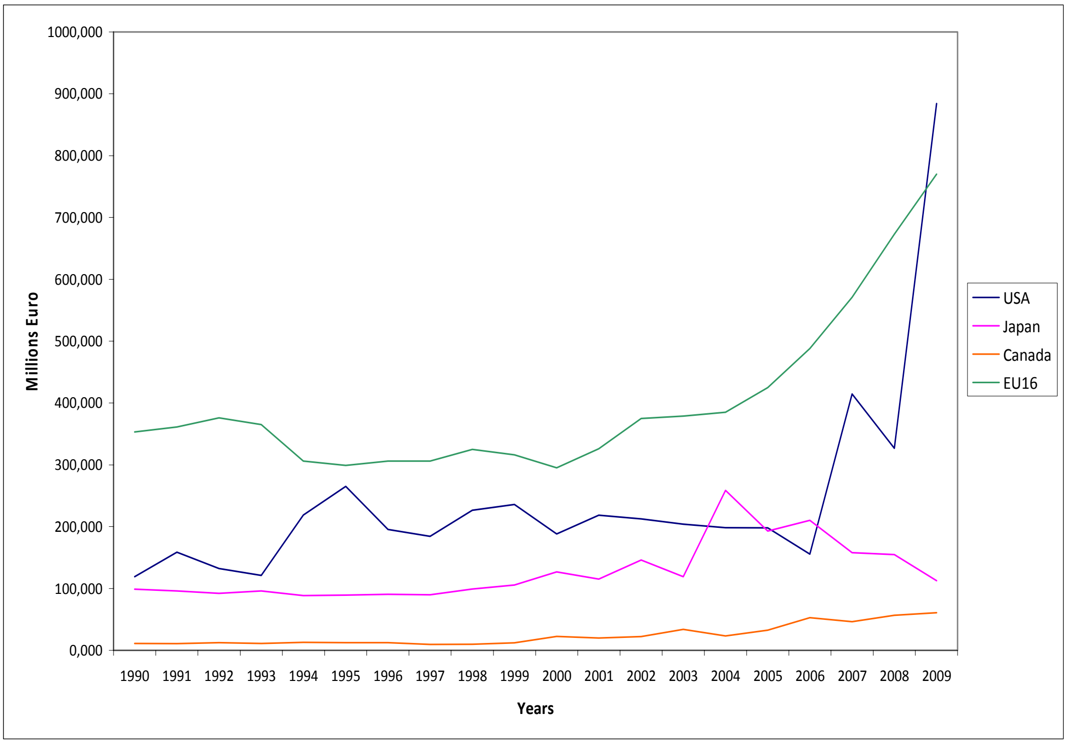
Figure 5.25: Relative share of public support to sub-fields of energy R&D in the EU-16



Source: own calculations based on IEA data. EU-16 is AT, BE, DK, FI, FR, DE, EL, HU, IE, IT, LU, the NL, PT, ES, SE and the UK. The original IEA data also include Switzerland, Turkey and Norway.

A comparison at international level can be made with other major players on the "*green" R&D* scene. The EU has always played a leading role in public funding of renewable energy research: in order to meet the 2020 targets for the shares of renewable energy in final energy consumption, substantial resources have been invested in further developing existing technologies. Looking at figure 5.26 public support for renewable energy R&D increased more than twofold between 2000 and 2009. However, the data do not include EU FP7 related spending, nor the part of the Emission Trading System allowances allocated to innovative renewables The USA doubled its funding in only one year, under the 2009 American Recovery and Reinvestment Act. It is not yet clear whether this increase is sustained by a long-term commitment, as it evidently appears to be in the case of the EU.

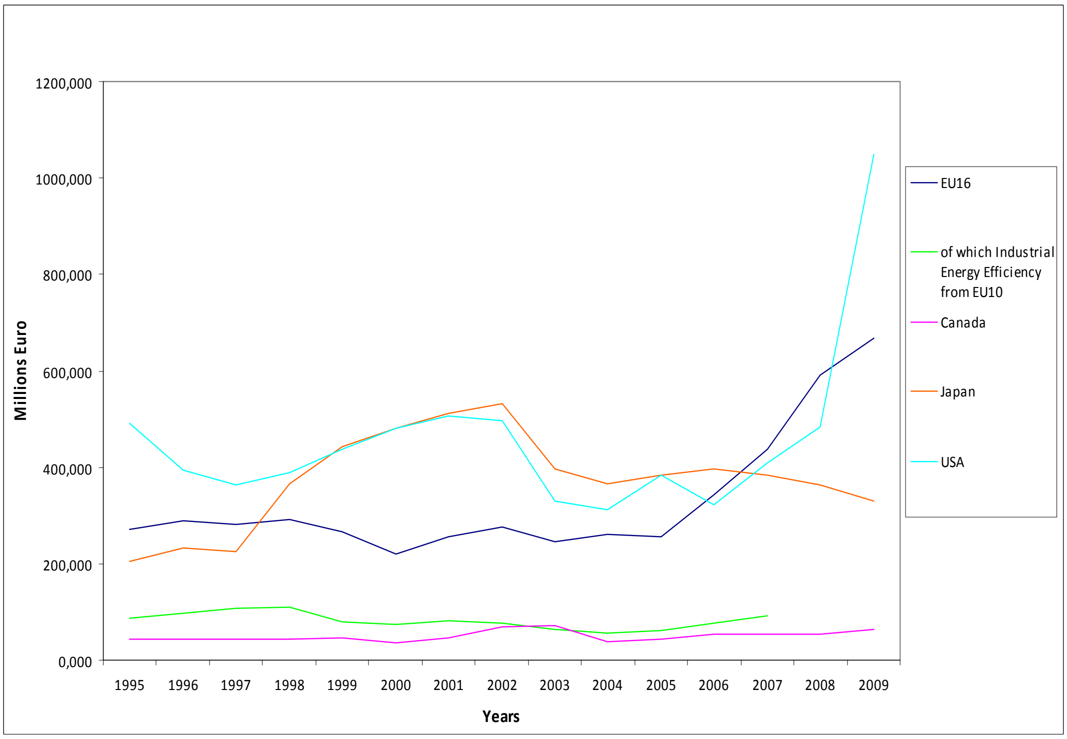
Figure 5.26: Public support for R&D into renewable energy resources, international comparison (2009 prices and exchange rates)



Source: own calculations based on IEA data. EU16 is AT, BE, DK, FI, FR, DE, EL, HU, IE, IT, LU, the NL, PT, ES, SE and the UK. The original IEA data also include Switzerland, Turkey and Norway.

Major eco-innovation can be achieved not only by conducting research into technologies based on renewable sources, but also by increasing the energy efficiency and environmental impact of existing technologies, production processes and techniques. Figure 5.27 shows that R&D on energy efficiency is also heavily funded in the EU, with a more than twofold increase between 2005 and 2009 (not counting FP7 related spending). Again, in the USA the Recovery Act was the single cause for the doubling of funds. With respect to industrial energy efficiency, disaggregated data are available for only a subset of countries (labelled as EU-10), which account for 70% of public funding of total R&D on energy efficiency.

Figure 5.27: Public support of energy efficiency (not only industrial) R&D (2009 prices and exchange rates)



Source: own calculations based on IEA data. EU16 is AT, BE, DK, FI, FR, DE, EL, HU, IE, IT, LU, the NL, PT, ES, SE and the UK. For industrial energy efficiency, EU10 is EU16 minus BE, EL, HU, IE, LU and the UK. The original IEA data also include Switzerland, Turkey and Norway.

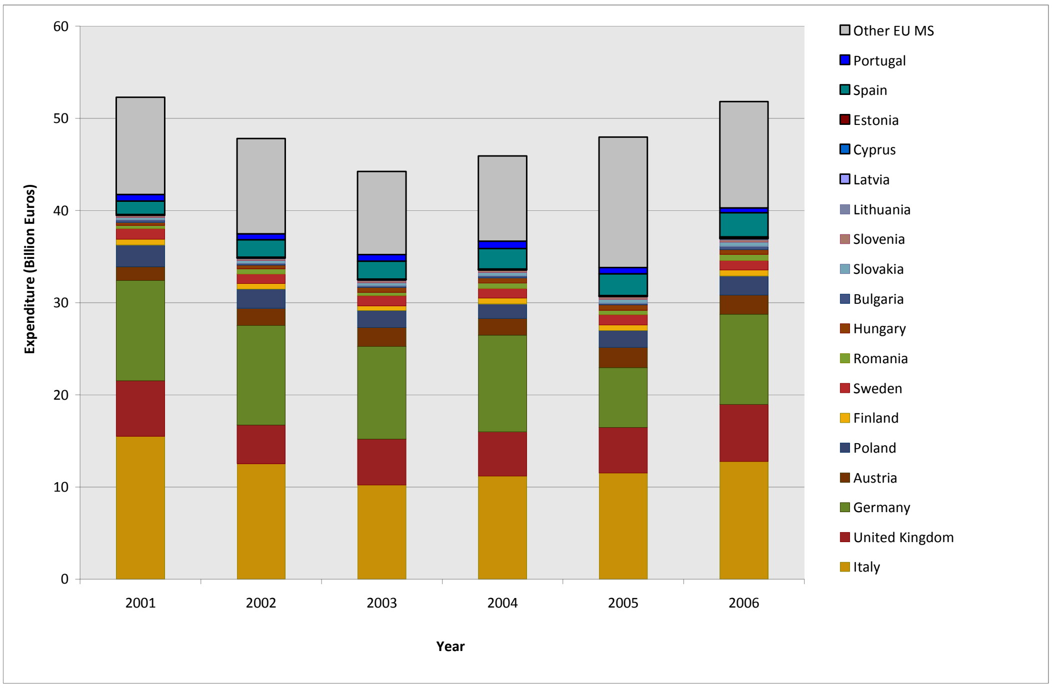
Box 5.1 above mentioned the importance that many governments put in "green" growth as a way out of the economic crisis. Figures 5.26 and 5.27 give a clear hint (for two sub-fields of research) of the considerable effort put in by the US in green recovery, leading to a noticeable change of pace concerning public support to green R&D; all of this as a part of a wider stimulus plan. However, it is not a coincidence that also many other major economies had stimuli plan that included a considerable "green" components (see Table 5.7 in annex for an overview of the stimulus measures adopted in the EU, USA, Japan, South Korea and China).

5.4.3. Environmental protection expenditures

Another key indicator of current endeavours to reduce the long-term environmental impact is environmental protection expenditures (EPE) by industries, which is the sum of investment and current expenditure on prevention, reduction and elimination of pollution resulting from production processes. Expenditure on environmental protection by industry within a Member State can give some insight into the level of consideration given to eco-performance (although, strictly speaking, not on the relative efficiency of these expenditures). As a proxy for sustainability, it encapsulates all industry's efforts to protect the environment, including pollution prevention, sustainable supply chains and biodiversity protection. In 2006, the combined EPE of all industries in the EU-25 added up to 50 billion euros, a 1% decrease compared with 2001, with a trough of 8 billion euros in between. However, as a percentage of GVA, industrial EPE fell from 2.8% in 2001 to less than 2.5% in 2006 (Eurostat, 2010).
Data fragmentation issues similar as those mentioned for water abstraction also arise with EPE, which limits the ability to draw robust conclusions on eco-performance. Figure 5.28 shows positive trends in EPE at EU-27 level in the most recent years for which data are available, particularly in EU-12 states. The decoupling trends seen in many EU-12 states could potentially be related to increased EPE, though the actual links to EPE are unclear. One

final conclusion to be drawn from the data is that EPE expenditure by industry is highly variable, changing significantly from one year to the next.

Figure 5.28: Total environmental protection expenditure by industry (NACE A-E, excluding construction) in selected Member States, 2001-2006



Note: Countries included under 'Other EU MS' due to no or incomplete data: BE, DK, IE, EL, LU, MT and FR.

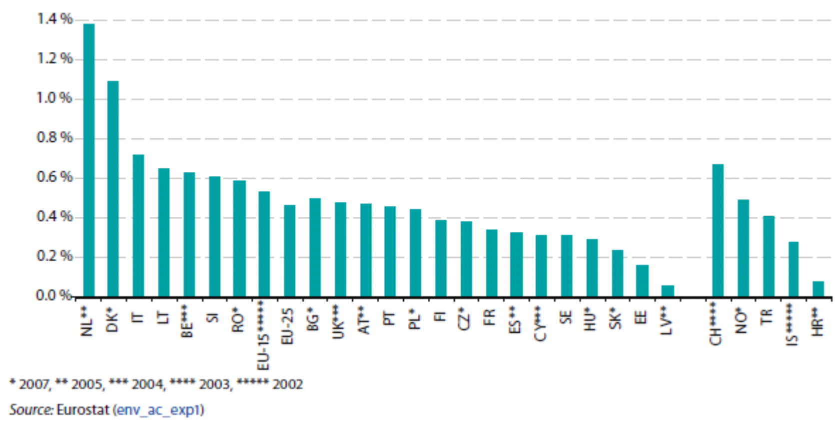
Source: Eurostat data – Ecorys analysis.

Box 5.8: Public-sector environmental protection expenditure

One proxy for identifying the amount of public investment in the environment is the 'public environmental protection expenditure' figure collected by Eurostat. In 2006 such investments – including current account expenses – broke down as follows: 40% to waste, 17% to waste water, 1% to air and 42% to other domains.

In the EU-25, most of this expenditure in 2006 went towards providing waste management services or to activities related to soil, biodiversity and landscape protection, protection against radiation and research and development. Spending was mostly related to current costs, rather than investments or subsidies/transfers.

Figure 5.29: Public-sector EPE investment and current expenditure by Member State (% of GDP, 2008 unless otherwise indicated)



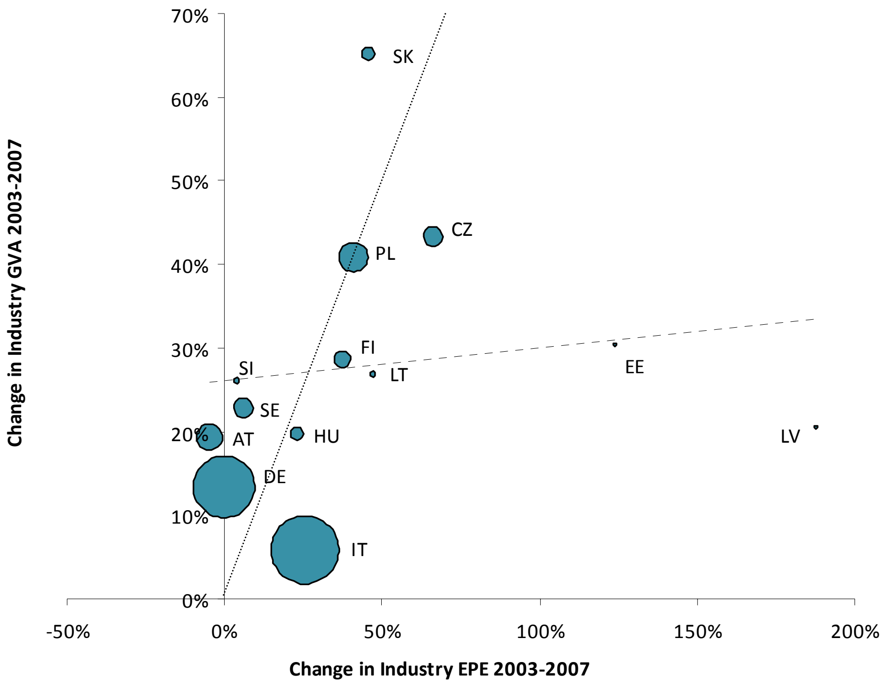
Source: Eurostat 2010: Environmental statistics and account handbook.

In most European countries, in 2006 the public sector spent between 0.2 and 0.6 % of GDP on environmental protection investments and current expenditure. In 2005, the Netherlands earmarked almost 1.4% of its GDP for this, but Latvia only 0.06 %.

By restricting the Member States taken into consideration to those that reported in both 2003 and 2007,[134] it is possible to draw a more detailed picture of the changes that have taken place in industrial EPE and to relate them back to changes in GVA. Figure 5.30 presents these changes for the Member States for which data are available. It shows a weak overall trend to increase industrial EPE as GVA increases, lending some support to the idea of a Kuznets curve for industrial EPE. The biggest increases in EPE were found in Member States in the Baltic region and Central Europe (CZ, SK and PL). Relative to GVA seven Member States (IT, HU, LT, FI, CZ, EE, and LV) increased their EPE by more than their industrial GVA increased. Member States known for having strong EPE records (DE, AT and SE) saw their EPE remain largely stable over the period.

These relationships hold broadly across the main industrial sectors (NACE rev. 1.1 A to E), with the exception of agriculture, forestry and fishing, where there appears to be no clear correlation between EPE and GVA, though this is likely to be a result of incomplete data.

Figure 5.30: Change in industrial EPE and industrial GVA (NACE A-E, excluding construction) in selected Member States, 2003-2007



Note: Bubble size represents relative industrial EPE expenditure in 2007.
Member States missing due to incomplete data: BE, BG, DK, IE, EL, ES, FR, CY, LU, MT, NL, PT, RO and UK.
Source: Eurostat data – Ecorys analysis.

134 These years were selected as they were the years when most Member States reported EPE data. They were chosen to maximise coverage and relevance.

5.5. Conclusions and policy implications

The analysis of major trends and developments has shown significant improvements in the eco-performance of European industry. However, there are also signs that efficiency increases slow down, as the higher the initial efficiency levels already are the more difficult it becomes to achieve further improvements. Adopting the right mix of policies, including the right measures and conditions to foster *green* R&D, eco-technologies and eco-innovation, is of paramount importance in this regard. Eco-performance improvements will be more easily sustained, environmental problems dealt with more efficiently and European firms may fully and more easily exploit new business opportunities and improve their competitiveness. This section discusses briefly the available mix of policy instruments in the light of their economic rationale and past experience.

5.5.1. Policy instruments for sustainable growth

Looking at the public policy instruments[135] currently in use to raise eco-performance and, at the same time, facilitate industry's transformation towards more sustainable methods of production and greater competitiveness shows that, at EU level, policy has, in the last decade or more, been focused on energy and on controlling GHG emissions. The findings in section 3 illustrate that these policies have contributed to an increase in energy efficiency and a significant reduction of both GHG and other emissions from energy generation.

To date there has been less focus on policies with an impact on resource efficiency and use of natural resources such as water and land. This has been changing in recent years, with an increase in the number of policy initiatives in this area and attention shifting towards sustainable consumption and production, "green" public procurement and, more recently, resource efficiency. The overall policy framework is currently weaker than for energy and related emissions and the performance on resource use appears to be much more mixed. The efforts to develop a stronger policy framework in this area should draw on the lessons learned from the implemented in the area of energy and emissions and their performance against expectations and theory.

The policy instruments available differ by government level: at EU level regulatory instruments are widespread and powerful; fiscal instruments are strongest at Member State level while subsidies are widespread at both Member State and subnational (regional and local) level. Each instrument has its advantages and disadvantages in relation to sustainable industrial growth and eco-performance.

Regulation

Overall, EU industry has shown that it tends to respond well to regulatory policy measures, when these are carefully designed and take a long-term perspective. Regulation tends to work well when it comes to performance targets, once these are anticipated and gradually introduced. The introduction of regulations on energy-efficient and incandescent light bulbs is one example of successful regulation of this type. However, standards which are over-ambitious and/or introduced too early run the risk of being counterproductive, as they sometimes induce disruptions. Furthermore, implementation can be unequal across the EU-27, thus affecting industry in one part of the EU more or earlier than in other locations.

Regulation is one of the primary drivers of eco-innovation activities in firms. In certain cases regulation can be the most cost-effective solution, particularly when carefully designed and enforced, allowing e.g. for a suitable level of freedom for business to innovate and in finding the best way to achieve given targets. Most EU firms, particularly SMEs, remain compliance driven rather than pro-active in pursuing eco-innovation.

135 For a more detailed account of these policy instruments see the background report to this study (ECORYS, 2011a).

However, direct regulation can be considered to be often less cost-effective than market-based instruments, as it tends to impose uniform rules, targets or constraints that do not necessarily take full account of the settings and competitive environment of industry. This has been a key factor in the growing use of market based instruments.

Market-based instruments

While there are concerns about the cost-effectiveness and competitiveness effects of regulatory measures there is also mixed evidence about the effectiveness of market-based instruments in the context of sustainable growth and eco-performance. Here a distinction can be made between *subsidies, tenders* and *grants* ('bonus incentives') on the one hand and *taxes, penalties* and *trading schemes* ('malus incentives'*)* on the other hand.

'Bonus incentives' such as subsidies, tenders and grants may be necessary to induce industry learning curves, albeit they typically entail heavy budgetary costs. However, practical experience has been mixed. As regards subsidies supporting innovation the evidence suggests that grants and subsidies were among the least powerful motivators for adopting environmental innovations. At the same time, subsidy systems based on feed-in tariffs have proved very successful for deployment of onshore wind energy and photovoltaic energy, yet they are typically also expensive. Many feed-in tariff schemes have been scaled down in the light of the financial crisis and resulting pressures on public finances and the costs imposed on firms and households.

In principle, subsidies should be time-limited, addressing temporary rather than structural market failures. This time-horizon issue is also important for EU industry and long-term planning. EU industry urgent needs a stable long-term policy framework, to provide greater certainty for firms considering expensive long-term capital investment in technology. The time horizon of many public policy initiatives - especially subsidies and grants - is often too short and prone to fluctuations in terms of continuity, eligibility or funding. Investments in eco-innovation and clean energy technologies require longer time spans, in order to recoup such investments over periods of 10 to 20 years.

'Malus incentives' like taxes, penalties and trading schemes offer an alternative to 'bonus incentives'. They send a direct signal that works through prices to influence market conditions and bring about the desired changes. By working through prices, tax instruments have an impact on both supply and demand, which can be an advantage over regulation. Taxes can have negative implications for competitiveness, but consumers and firms retain the flexibility on how to respond to increased prices and costs. Hence, from a welfare and environmental perspective, if targeted correctly, taxes can work in accordance with the polluter pays principle and to the overall benefit of society. Judging the level at which to set a tax is a complex matter and must take into account relative tax systems in other economies.

Sometimes an argument is raised that tax or tariff mechanisms are needed for imports produced in economies with weaker eco-performance. It is argued that it would have an effect equivalent to internalising the negative environmental externalities of these imports, thus levelling the playing field for EU-27 producers in their domestic markets, by imposing equivalent costs on all producers. Such a tariff would need to be graduated, depending on the eco-performance of industries or firms in the country of production. However, the practical and political feasibility of such a scheme is debatable, as is its compatibility with international trade agreements. Without a clear evidence base, it could open the door to unwarranted protectionism in international trade. It cannot be excluded as part of a wider package in case substantial 'leakage' effects from EU environmental policies are to be expected. 'Softer' alternatives to this involve international negotiations and persuasion and pressure to align environmental policies of the EU and other countries in view of adopting and implementing more sustainable production behaviour.

Permit trading schemes are favoured in some situations as the most economically efficient way of achieving eco-performance gains and for making the total environmental benefits known in advance, as caps are chosen by policy-makers. They can maximise the competitive benefits to firms that invest most heavily in sustainable practices, providing clear and continuing incentives to improve performance over time. Permit trading schemes are most effective for sustainability when the environmental impact can be easily monitored and verified, when firms can adequately bear the transaction costs, when a viable market can be created and when a move is made towards full auctioning of permits. Where this is not the case, taxation and regulation may be better alternatives to permits.[136]

Voluntary agreements and information

Voluntary agreements (i.e. self-regulation) can be effective for both industry and policymakers. By anticipating changes in consumer demand industry can stay at the cutting edge and also mitigate the need for policy action and the associated costs and burdens. Experience from the MSC scheme suggests that such schemes tend to be used more widely when larger companies are involved, but can be more difficult to implement when many SMEs are concerned. Furthermore, they appear to be more effective for final product groups, where the interface with consumers is strong. One drawback of voluntary approaches is that their effectiveness in addressing environmental concerns will depend on the perceived benefits to the companies concerned. They could also reduce competition. Its effectiveness can also suffer from information asymmetries between governments and firms. Voluntary schemes can therefore be an effective instrument in certain circumstances where policy has been unable to act effectively and/or provides a framework for industry to go beyond compliance.

Information and communication can be useful in situations where information problems exist (e.g. in household energy consumption) or where enforcement costs are disproportionately high (e.g. small-scale emissions creating air pollution). This area is particularly important for consumer demand and consumer action to support improvements in eco-performance. The evidence clearly shows that price and performance (quality) remain the primary demands of consumers. Products offering higher eco-performance need to compete on these two fronts too and to offer something more.

As regards influencing consumer behaviour, it is important for the choice of instrument to take account of their understanding of the environmental benefit in question. Voluntary schemes relying on consumer action appear less effective when the environmental benefits are more abstract, as in the case of energy and emission reductions. However, the successful take-up of the MSC scheme and improvements in recycling efforts are examples where the physical link to the environment is clear for consumers and of how this has supported success in these areas. In these cases it is important that other instruments, such as regulation or taxes, are also employed.

5.5.2. Policy design and implementation

As regards policy design and implementation, a number of important factors must be considered and the findings of this work have significant implications. Whilst developing

[136] The EU ETS is the prime example of this type of instrument in the EU. The performance of the ETS has been mixed and has illustrated both the pros and cons of a trading permit scheme. It has been successful in bringing the largest emitters of GHG into a compliance and reduction scheme, creating a viable market for permits and contributing to overall emission reductions. Yet the costs to firms of participating, i.e. the transaction costs, have been high, as they have learned to adapt to the market. This is a big barrier to introducing permit trading schemes that will have an impact on SMEs and large numbers of operators. There has also been contention about the over-allocation and free allocation of permits, creating both a weak cap and a weak market price and handing free income to polluters, a perverse incentive. To reap the full efficiency benefits of a permit trading system, it is essential to move towards a larger share of permits auctioned. With the ETS phase 2 and plans for phase 3 moving in this direction, this should become less of an issue.

such policies, there is a need for comprehensive and robust impact assessments, covering both economic and environmental aspects as well as administrative costs and burdens.

The EU's growing practice of impact assessment could be echoed more clearly in policy development at the level of Member States, regions and local authorities. This is particularly important for the competitiveness of EU industry, to ensure long-term predictability and that policy action remains proportionate to the environmental benefits that result. Absolute bans and limits can place significant burdens on producers, occasionally with high marginal costs for only small environmental gains, after most reductions have already been achieved. Duplication is also an issue: if industry is hit by multiple regulations on a single product or input material, this adds to the complexity and burdens of compliance, particularly for SMEs (Calogirou et al. 2010). Consideration must be given to how a particular policy fits into the wider framework and how compliance procedures could be integrated more effectively.

Ex-post evaluation and monitoring of policies and measures that promote economic and environmental performance are vital in order to learn lessons that can lead to design improvements during the policy lifetime and can also inform further developments. Particular attention needs to be paid to the mechanisms by which such policies influence EU industry and whether such policies are effectively doing what they intend to.

Complementarity and enforcement

Similar trends to those in EU policy are also found at Member State level in terms of the issues addressed, with over half of all the major policy initiatives identified at Member State level focusing on energy efficiency and climate change. The policy instruments used by Member States tend to include market-based instruments (taxes and subsidies) along with public investment and regulation and self-regulation. Analysis of the cross-section of policies at EU and other levels clearly showed that there are often tight links and complementarities between the policies on various levels both within the EU and also across Member States'. Care needs to be taken to ensure that policy measures are not duplicated, that overlaps and uneven implementation are minimised and that the scope for learning and sharing of best practice are exploited wherever possible to reduce the compliance burdens on EU industry.

The effectiveness of policy implementation is closely related to enforcement. Implementation of regulations matters for containing the general administrative burden. Evidence from the case studies found that lax enforcement can have a negative economic impact on companies that have complied with the regulation, creating undue competitive advantages for non-compliant firms, either from within or outside the EU.

Policy as a supporting framework

As a final point, policy should provide a predictable enabling framework for industry itself, creating the conditions for and supporting moves by industry towards eco-performance benefits. The examples of voluntary labelling schemes and chemical leasing (Boxes 5.6 and 5.7) show how industry initiatives can create significant incentives for resource-efficient behaviour, improving eco-performance. They illustrate the link between economic competitiveness and eco-performance. The current limited scope of these types of arrangements points to wider potential to deliver benefits in this way.

Establishing this link between economic benefits and eco-performance is difficult, as the impact of policy is uneven across industry. For the industry directly affected, policy-imposed changes are initially felt to be negative. However, in many cases regulatory approaches can help creating a market for new eco-friendly products. The light bulbs (Box 5.2) is such an example, illustrating the engagement in the development of products with significant environmental benefits, whose purchase by consumers was facilitated by the energy labelling scheme. Overall, the case studies demonstrated that considering the effects on industry along the entire value chain is vital to securing competitive and sustainable industries.

Table 5.2: NACE rev. 1.1 classifications used in this report

Category	Sub-category
A and B – Agriculture, hunting, forestry and fishing	
C – Mining and quarrying	
D – Manufacturing	15-16 – Food, beverages and tobacco
	17-19 – Textiles, leather and footwear
	20 – Wood and products of wood and cork
	21-22 – Pulp, paper, printing and publishing
	23-25 – Chemicals, rubber, plastics and fuel
	26 – Other non-metallic minerals
	27-28 – Basic metals and other fabrication of metal
	29 – Machinery not elsewhere classified
	30-33 – Electrical and optical equipment
	34-35 – Transport equipment
	36-37 – Manufacturing not elsewhere classified and recycling
E – Electricity, gas and water	
F – Construction	

Indicators of eco-performance

– Energy consumption is one of the key areas for measuring the environmental impact of industry, though the impact itself is often indirect and based on the emissions into the air and water by energy generators. Energy efficiency is an important policy goal and route to decoupling. Final energy consumption and energy intensity indicators are reviewed to provide both a nominal and marginal view on eco-performance in this area.

– Greenhouse gas (GHG) emissions are the primary climate change impact associated with industry. They are closely related to energy use. Decoupling emissions from economic growth is among the most pressing drivers of sustainable production. The cumulative and global nature of emissions makes the total level of emissions important, but as it is not always clear if emissions have simply 'leaked' outside the EU it is important to consider emission intensity too.

– Other emissions into the air and water from industry can also have a significant environmental impact. This study considers the performance in terms of acidification potential – as a contributor to acid rain – and also of particulate emissions to the air (PM10) which can damage human health.

– Material flows and resource efficiency are essential components of environmental impact, both in the extractive (or harvesting) process and when it comes to their eventual disposal as waste. Indicators of these are vital to understand how process and product efficiency has changed and are especially important to the issue of decoupling. Various indicators relating to material consumption, use of inputs, productivity and waste treatment are reviewed.

– Water use is also considered as water is a key resource used during industrial production processes (e.g. as cooling water) and is also coming under increasing scrutiny as pressures on it mount from population growth and expected reductions in supply from rainfall due to climate change. Indicators on water abstraction are presented.

- Environmental protection expenditure (EPE) gives an indication of investment and expenditure on resource, energy and carbon efficiency and, as such, is a useful indicator to measure eco-performance.

- Eco-innovation provides insight into investments and "green" R&D with the objective of improving eco-performance. This is important as an indicator of industrial investment in current, but also towards future, eco-performance. It is a new and complex area to define and the relevant section reviews the major discussions around such an indicator before presenting findings. Each of the indicators listed above has been analysed on three different levels, determined by the data available. This approach has been used to capture the relevant effects at each level to help explain the changes observed. The first level taken into account is the international and EU-27 level, since an understanding of overall economic performance and eco-performance is needed in order to comment on the relative position and developments of the EU-27 against its international trade partners, between the Member States themselves and also intra-industry - between sectors.

Table 5.3: Entergy intensity of manufacturing plus construction (NACE rev. 1.1 D+F) by Member State in selected years Industrial energy use in thousand toe per million EUR industrial GVA at 1995 prices

	1995			2000			2005			2008		
	GVA	**FEC**	**EI**	**GVA**	**FEC**	**EI**	**GVA**	**FEC**	**EI**	**GVA**	**FEC**	**EI**
Austria	42 923	6 199	0.14	51 528	7 019	0.14	55 256	8 367	0.15	62 674	8 831	0.14
Belgium	47 368	13 612	0.29	54 395	15 762	0.29	55 959	13 555	0.24	59 341	12 036	0.20
Czech Republic	15 637	12 450	0.80	18 026	10 077	0.56	22 245	9 762	0.44	27 338	9 112	0.33
Denmark	25 801	3 040	0.12	28 031	2 938	0.10	27 212	2 867	0.11	30 125	2 765	0.09
Estonia	674	836	1.24	905	571	0.63	1 316	718	0.55	1 863	770	0.41
Finland	24 877	9 989	0.40	36 451	12 046	0.33	43 040	12 082	0.28	54 716	12 451	0.23
France	238 838	37 119	0.16	269 989	36 887	0.14	284 386	35 728	0.13	288 256	36 334	0.13
Germany	491 439	62 002	0.13	504 593	57 896	0.11	504 527	57 436	0.11	553 485	60 436	0.11
Greece	14 323	4 114	0.29	16 606	4 445	0.27	17 957	4 143	0.23	19 696	4 238	0.22
Hungary	4 862	3 797	0.78	6 759	3 446	0.51	8 339	3 422	0.41	9 217	3 358	0.36
Ireland*	16 929	1 853	0.11	30 852	2 339	0.08	38 969	2 595	0.07	43 550	2 544	0.06
Italy	235 029	36 091	0.15	243 321	39 775	0.16	243 363	41 855	0.17	249 078	36 551	0.15
Latvia*	827	692	0.84	1 094	571	0.52	1 645	705	0.43	1 915	724	0.38
Lithuania*	1 822	1 017	0.56	2 312	780	0.34	3 843	994	0.26	4 694	1 064	0.23
Luxembourg	2 756	1 214	0.44	3 389	957	0.28	3 798	940	0.25	3 778	876	0.23
Netherlands	63 055	14 092	0.22	73 543	14 895	0.20	74 702	14 925	0.20	80 671	13 081	0.16
Poland	19 931	22 790	1.14	28 111	18 882	0.67	32 436	16 413	0.51	48 615	16 560	0.34
Portugal*	18 591	4 974	0.27	22 547	6 244	0.28	21 770	5 689	0.26	21 740	5 782	0.27
Slovakia	5 546	4 120	0.74	6 208	3 826	0.62	10 519	4 499	0.43	16 733	4 316	0.26
Slovenia	2 712	1 178	0.43	3 544	1 421	0.40	4 304	1 653	0.38	5 416	1 480	0.27
Spain	114 414	20 507	0.18	137 995	25 527	0.18	155 750	31 097	0.20	159 863	26 773	0.17
Sweden	40 685	13 820	0.34	53 792	14 290	0.27	65 677	12 628	0.19	75 257	12 292	0.16
UK	187 742	35 146	0.19	197 453	38 574	0.20	203 479	36 019	0.18	208 100	32 775	0.16
EU-23*	1 616 781	310 652	0.19	1 791 446	319 168	0.18	1 880 492	318 092	0.17	2 011 750	317 157	0.16
EU-15*	1 564 771	263 772	0.17	1 724 486	279 594	0.16	1 795 845	279 926	0.16	1 910 188	277 722	0.15
EU-12 - 4*	52 010	46 880	0.90	66 960	39 574	0.59	84 647	38 166	0.45	101 562	39435	0.39

* Figures for 2007. EU-23 is EU-27 minus Bulgaria, Cyprus, Malta and Romania. EU-12 - 4 is EU-12 minus Bulgaria, Cyprus, Malta and Romania.
FEC = final energy consumption. EI = energy intensity, i.e. FEC/GVA.
Source: EU KLEMS, OECD STAN and Eurostat.

Table 5.4: Energy intensity of industries, for EU-25, in selected sectors and selected years Energy use in thousand toe per million EUR GVA at 1995 constant prices

		1995			2000			2005			2008		
		GVA	**FEC**	**EI**	**GVA**	**FEC**	**EI**	**GVA**	**FEC**	**EI**	**GVA**	**FEC**	**EI**
A-B	Agriculture and fisheries	177 698	31 568	0.18	195 196	29 898	0.15	195 703	30 954	0.16	186 725	26 312	0.14
15-16	Food, drink and tobacco	150 772	30 383	0.20	156 421	30 622	0.20	162 818	30 400	0.19	135 024	29 103	0.22
17-19	Textiles, leather and clothing	81 044	10 522	0.13	75 604	10 780	0.14	61 877	7 951	0.13	55 258	6 276	0.11
21-22	Paper and printing	115 503	30 361	0.26	129 027	35 260	0.27	126 625	35 629	0.28	104 438	36 317	0.35
23-25	Chemicals	204 649	63 248	0.31	232 630	58 917	0.25	258 946	61 200	0.24	240 093	55 097	0.23
26	Non-metallic mineral products	60 965	42 195	0.69	67 081	43 638	0.65	70 480	43 664	0.62	64 801	42 944	0.66
27-28	Iron and steel and non-ferrous metals	171 166	82 756	0.48	190 610	78 088	0.41	196 602	74 911	0.38	189 365	71 191	0.38
20, 30-33	Other non-classified	170 907	39 000	0.23	236 040	41 044	0.17	276 612	45 642	0.17	316 928	44 838	0.14
29, 34-37	Engineering and other metals	299 723	29 318	0.10	339 082	29 293	0.09	366 824	29 522	0.08	356 581	28 918	0.08
C	Ore extraction (except fuels)	53 202	3 889	0.07	48 313	3 745	0.08	41 042	3 326	0.08	23 436	3 053	0.13

EU-25 is EU-27 minus Bulgaria and Romania.
Source: EU KLEMS, OECD STAN, Eurostat

Table 5.5: GHG emission intensity of manufacturing plus construction (NACE rev. 1.1 D+F) by Member State plus USA and Japan in Gg CO_2 eq. per million EUR GVA at 1995 constant prices

	1995			2000			2005			2008		
	GVA	GHG	Intensity	GVA	GHG	Intensity	GVA	GHG	Intensity	GVA	GHG	Intensity
Austria	42 923	13 593	0.32	51 528	13 864	0.27	55 256	16 143	0.29	62 674	16 161	0.26
Belgium	47 368	32 495	0.69	54 395	32 923	0.61	55 959	27 930	0.50	59 341	26 669	0.45
Czech Republic	15 637	32 964	2.11	18 026	28 364	1.57	22 245	19 093	0.86	27 338	16 097	0.59
Denmark	25 801	6 042	0.23	28 031	6 213	0.22	27 212	5 807	0.21	30 125	5 393	0.18
Estonia	674	794	1.18	905	569	0.63	1 316	707	0.54	1 863	985	0.53
Finland	24 877	12 138	0.49	36 451	11 937	0.33	43 040	11 331	0.26	54 716	10 783	0.20
France	238 838	83 843	0.35	269 989	83 371	0.31	284 386	80 714	0.28	288 256	75 660	0.26
Germany	491 439	119 473	0.24	504 593	106 797	0.21	504 527	100 793	0.20	553 485	102 505	0.19
Greece	14 323	9 274	0.65	16 606	9 785	0.59	17 957	10 227	0.57	19 696	9 303	0.47
Hungary	4 862	10 996	2.26	6 759	8 486	1.26	8 339	8 748	1.05	9 217	7 034	0.76
Ireland	16 929	4 318	0.26	30 852	5 588	0.18	38 969	5 743	0.15	5 652	5 548	0.98
Italy	235 029	87 637	0.37	243 321	85 323	0.35	243 363	82 174	0.34	249 078	74 372	0.30
Latvia*	827	1 899	2.30	1 094	1 199	1.10	1 645	1 174	0.71	1 915	1 268	0.66
Lithuania*	1 822	1 532	0.84	2 312	997	0.43	3 843	1 272	0.33	4 694	1 445	0.31
Luxembourg	2 756	2 726	0.99	3 389	1 755	0.52	3 798	1 718	0.45	3 778	1 630	0.43
Netherlands	63 055	28 728	0.46	73 543	27 142	0.37	74 702	27 374	0.37	80 671	27 586	0.34
Poland	19 931	63 286	3.18	28 111	47 968	1.71	32 436	32 469	1.00	48 615	32 624	0.67
Portugal*	18 591	10 292	0.55	22 547	12 030	0.53	21 770	10 973	0.50	21 740	10 769	0.50
Slovakia	5 546	12 354	2.23	6 208	8 525	1.37	10 519	7 367	0.70	16 733	7 869	0.47
Slovenia	2 712	2 615	0.96	3 544	2 269	0.64	4 304	2 486	0.58	5 416	2 305	0.43
Spain	114 414	53 350	0.47	137 995	58 480	0.42	155 750	72 355	0.46	159 863	67 722	0.42
Sweden	40 685	13 892	0.34	53 792	12 881	0.24	65 677	11 789	0.18	75 257	10 695	0.14
UK	187 742	94 035	0.50	197 453	93 581	0.47	203 479	84 354	0.41	208 100	76 891	0.37
EU-23*	1 616 781	698 276	0.43	1 791 446	660 049	0.37	1 880 492	622 741	0.33	2 019 808	609 758	0.30
EU-15	1 564 771	571 835	0.37	1 724 486	561 672	0.33	1 795 845	549 427	0.31	1 872 434	521 689	0.28
EU-12 - 4*	52 010	126 441	2.43	66 960	98 377	1.47	84 647	73 314	0.87	109 619	72 586	0.66
United States	1 539 230	868 908	0.56	1 925 722	858 514	0.45	1 977 696	831 850	0.42	1 453 932	825 210	0.57
Japan**	1 190 365	372 521	0.31	1 208 958	379 005	0.31	1 257 005	373 523	0.30	1 302 371	375 632	0.29

* Figures for 2007. ** Figures for 2006. EU-23 is EU-27 minus Bulgaria, Cyprus, Malta and Romania. EU-12 - 4 is EU-12 minus Bulgaria, Cyprus, Malta and Romania.

Source: UNFCCC, EU KLEMS, OECD STAN.

Table 5.6: Materials productivity by Member State per million EUR of industrial GVA (NACE rev. 1.1 A-F) at 1995 constant prices, per tonne

of DMC for the whole economy in selected years

	2000			2003			2005			2006			2007	
	GVA	DMC	Productivity	GVA	DMC	Productivity	GVA	DMC	Productivity	GVA	DMC	Productivity	GVA	DMC
Belgium	64 911	190 785	0.34	63 519	183 609	0.35	65 344	190 137	0.34	68 100	195 814	0.35	69 956	195 684
Czech Rep.	23 384	182 901	0.13	23 523	178 430	0.13	28 169	187 906	0.15	30 783	193 804	0.16	32 946	196 649
Denmark	37 511	134 757	0.28	36 071	129 539	0.28	36 373	151 203	0.24	37 851	158 447	0.24	37 572	155 530
Germany	577 525	1 453 485	0.40	559 178	1 318 590	0.42	583 085	1 294 062	0.45	606 845	1 324 307	0.46	615 456	1 314 169
Estonia	1 351	18 766	0.07	1 637	30 030	0.05	1 892	28 267	0.07	2 072	31 538	0.07	2 247	38 170
Ireland	35 950	164 032	0.22	43 156	183 357	0.24	44 982	201 058	0.22	45 113	217 816	0.21	49 886	229 539
Greece	26 525	156 648	0.17	28 724	188 009	0.15	27 606	186 343	0.15	29 355	185 778	0.16	29 255	186 334
Spain	179 830	674 684	0.27	193 448	810 698	0.24	198 486	848 078	0.23	203 687	897 400	0.23	209 488	877 810
France	336 466	876 917	0.38	341 485	799 263	0.43	354 756	852 238	0.42	356 490	871 816	0.41	359 825	907 955
Italy	297 512	947494	0.31	292 394	749 037	0.39	297 947	831 976	0.36	305 197	835 104	0.37	309 028	804 257
Cyprus	1 833	15 189	0.12	1 870	16 129	0.12	1 967	18 999	0.10	2 164	18 590	0.12	2 200	20 020
Latvia	1 557	34 293	0.05	1 930	35 672	0.05	2 231	43 046	0.05	2 395	45 506	0.05	2 539	48 594
Lithuania	3 493	27 638	0.13	4 629	40 536	0.11	5 333	41 181	0.13	5 702	41 351	0.14	6 207	48 613
Luxembourg	3 785	7 886	0.48	4 028	7 896	0.51	4 247	7 860	0.54	4 116	9 085	0.45	4 233	6 821
Hungary	8 963	111 703	0.08	9 802	125 713	0.08	11 277	165 919	0.07	11 604	138 310	0.08	11 472	109 684
Malta	1 008	1 405	0.72	911	1 511	0.60	886	1 836	0.48	917	2 108	0.44	925	2 233
Netherlands	95 397	192 689	0.50	94 190	174 735	0.54	98 078	182 109	0.54	99 725	178 117	0.56	102 727	184 299
Austria	62 158	147 165	0.42	64 594	155 671	0.41	67 513	171 951	0.39	70 793	175 304	0.40	75 593	172 154
Poland	38 994	564 980	0.07	39 890	515 314	0.08	44 225	558 071	0.08	48 678	572 096	0.09	55 919	642 107
Portugal	29 846	189 630	0.16	29 344	171 606	0.17	29 285	186 390	0.16	29 724	213 377	0.14	29 724	218 109
Slovenia	4 217	44 252	0.10	4 694	46 570	0.10	5 047	47 877	0.11	5 427	55 792	0.10	6 158	62 372
Slovakia	7 942	54 003	0.15	10 141	57 702	0.18	12 692	71 300	0.18	14 533	67 943	0.21	16 792	67 800
Finland	43 335	171 681	0.25	46 921	184 649	0.25	50 460	186 777	0.27	55 103	199 349	0.28	59 750	207 033
Sweden	63 292	156 165	0.41	67 679	155 072	0.44	75 936	181 040	0.42	80 975	163 726	0.49	82 901	183 453
UK	249 454	757 830	0.33	247 716	746 898	0.33	253 268	751 135	0.34	256 074	751 228	0.34	258 511	750 744
EU-27	2 196 241	7 597 803	0.29	2 211 476	7 406 528	0.30	2 301 088	7 848 070	0.29	2 373 423	8 041 963	0.30	2 431 309	8 200 293
EU-15	2 103 499	6 221 848	0.34	2 112 448	5 958 629	0.35	2 187 367	6 222 357	0.35	2 249 148	6 376 668	0.35	2 293 905	6 393 891
EU-10	92 742	1 055 130	0.09	99 028	1 047 607	0.09	113 720	1 164 402	0.10	124 276	1 167 038	0.11	137 404	1 236 242

Source: Eurostat, EU KLEMS. DMC = Domestic material consumption. Productivity is GVA/DMC.

Table 5.7 – Green components in economic stimulus packages, 2009

Country	Stimulus package	Total amount package, (period)	Amount green component, (%)	Focus themes
USA	American Recovery and Reinvestment Act, 2008; Emergency Economic Stabilization Act 2008; Green allocation in US Budget 2010.	USD 787 bln (10 years); USD 185 bln (10 years);	USD 94.1 bln (12%); USD 18.2 bln (10%); USD 4.9 bln	Renewables; Building energy efficiency
China	NDRC stimulus package 2008; Budget 2009.	USD 586 bln (2009-2010); USD 61.4 bln (2009);	USD 201 bln (34%); USD 15.6 bln (25%)	Energy efficiency (rail, grid); Waste & water
Japan	Measures to Support People's Daily Lives 2008; second stimulus plan 2009.	USD 486 bln (2009 onwards); USD 154 bln (2009 onwards).	USD 12.4 bln (3%); USD 23.6 bln (15%)	Building energy efficiency
South Korea	Green New Deal 2009 and subsequent Five Year Plan for Green Growth 2009	USD 76 bln bln (2009-2013);	USD 60 bln (79%);	Water & waste; Building energy efficiency
EU	Sum of stimulus packages from EU Member States and direct EU contribution.	USD 537 bln (mostly 2009-2010, some packages beyond)	USD 53.4 bln (10%)	Energy efficiency (building, rail, grid); Low carbon power (CCS)

Source: HSBC (2009), A Climate for Recovery – the colour of stimulus goes green, Feb 2009; and HSBC (2009), Building green recovery – governments allocate USD470bln – and counting…, May 2009 and HSBC (2010), Overview of global green stimulus spending, Feb 2010.

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ACEA, Association of European Car Manufacturers (Director of Environmental Policy).

Robert Bosch (Head of European Government and Political Relations).

Ford (Sustainability Manager).

EFR, Association of European Shredders (Environmental and Technical Officer).

European Commission, DG Environment (Unit C2).

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Marine Stewardship Council (MSC), Deputy Director for Europe.

Dutch Retail Association, Director of Consumer Affairs and Quality.

IGLO (formerly part of Unilever and co-founder of MSC), Director of Sustainability and External Affairs.

OSRAM, Spokesperson on Trade Media.

European Consumers' Organisation (BEUC), Eco-Design Project Coordinator.

Philips, Vice-President — Sustainability, Government and Industry Affairs, Philips Lighting.

EkoFish B.V., General Manager.

Interviews – Chemical industry case study

CEFIC, Head of Trade Policy and Executive Director for the Programme Product Stewardship.

Dow Chemicals/SAFECHEM, Business Manager.

Umweltbundesamt (UBA), German Federal Environment Agency, International Chemicals Management, Sustainable Chemistry Officer.

UNIDO, Chemical Leasing Coordinator.

VCI, Director of Product Safety.

6. EU INDUSTRIAL POLICY AND GLOBAL COMPETITION: RECENT LESSONS AND WAY FORWARD

6.1. Introduction

The EU economy faces long-term structural challenges that necessitate a strategic response in order to meet the targets set out in the Europe 2020 strategy. Improving the performance of the EU economy, in particular maintaining and reinforcing the competitiveness of European industry (competitiveness is defined in Chapter 1, Box 1.1), forms an indispensible part of this response and requires close integration of all relevant policies. This applies first and foremost to the core EU policies that shape industrial competitiveness and their respective toolkits.

Nearly a decade ago, a European Commission report pointed to 'new challenges that emerge at an accelerating rate: new markets, new ways of doing business, new drivers of growth and of dynamic competition.'[137] Since then, the speed at which these challenges have materialised and their extent have exceeded all expectations. In essence, the macroeconomic trends reshaping the global economy have forced the EU to move away from an inward-looking focus on the Single Market to a broader and more global, resource-oriented perspective. The old order, in which the EU determined the pace and pattern of global growth and trade together with the US and Japan, has been irreversibly overturned by the emergence of an as yet unfinished power patchwork involving ever more players.

In addition, the economic and financial crisis has triggered a debate about the strength and sustainability of the institutional pillars on which the Western socioeconomic model rests. While it is by now clear that this crisis has only temporarily exacerbated weaknesses that already existed in the real economy, recent positive economic signals are no reason to return to business as usual. On the contrary, identifying these weaknesses and proposing practical solutions embedded within the EU's competitiveness policies is essential in order to ensure long-term industrial competitiveness.

In this context, not only industrial and competition policies but also trade, Single Market and other policies are indispensible. In fact, in parallel to the shift in focus towards external developments, the EU has undergone its biggest enlargement ever, resulting in an internal market of 500 million citizens. As a consequence, the Lisbon Treaty, which entered into force in December 2009, was designed to provide the enlarged EU-27 with a workable governance structure. It also reinforced the role of industrial policy at European level and prompted, in the context of the Europe 2020 strategy, a new industrial policy for the globalisation era (cf. section 6.3.2). These changes are of particular importance for the EU's competitiveness.

This chapter assesses the synergies between industrial policy and other competitiveness policies, in particular competition policy, building on an earlier analysis in 2002.[138] As such, the chapter is intended to contribute to the debate on the way ahead for the Europe 2020 strategy. In order to remain concrete and concise, it largely focuses on manufacturing industry.

Section 6.2 revisits the major developments over the last decade and explains the main challenges for the EU. Section 6.3 summarises the institutional and policy toolkit so far available to address these challenges. Section 6.4 then explores how the identified challenges result in practical problems for European industry at different stages of their production value chain. Section 6.5 suggests relevant solutions in the context of EU policy making, based on

137 European Commission (2002), *2002 European Competitiveness Report,* Commission Staff Working Paper, SEC(2002) 528, p. 93.

138 Cf. European Commission (2002), *2002 European Competitiveness Report,* Commission Staff Working Paper, SEC(2002) 528.

the existing legal framework and a reassessment of how it relates to the issues raised. Some concluding remarks in section 6.6 highlight the merits of a more integrated policy approach and complete the chapter.

6.2. Key challenges for the competitiveness of the EU economy

Three major developments have marked the last decade, each resulting in specific challenges for EU industry: enlargement to form the EU-27, globalisation with the resulting relative rise in importance of some EU trade partners, and the recent economic and financial crisis. Overall, their effects overlap and create a dynamically changing economic environment that forms the background for this chapter.

6.2.1. Exploiting the full potential of the enlarged internal market

The historically unprecedented enlargement from the EU-15 to first the EU-25 in 2004 and then the EU-27 in 2007 has triggered the most fundamental and visible change in the EU since the start of the millennium. It has enabled the new Member States to complete the adjustments they had already starting making to their political and economic systems and has resulted in a massive extension of the EU internal market. The EU now embraces about 500 million citizens and forms one of the most powerful economic blocs in the world.

The resulting dynamics have created new business opportunities and growth potential that is far from fully exploited. The old Member States have benefited from increased trade with and investment in the new Member States.[139] In turn, the new Member States have experienced significant growth financed by private investment and access to EU cohesion funds. Overall, trade integration has triggered a more efficient allocation of productive resources, had a positive effect on employment in the EU-27 and significantly improved the global competitiveness of European companies.

The relationship between the enlarged internal market and European industry is a mutually beneficial one. This was recently highlighted when the Commission presented its new industrial policy in 2010:

'Now more than ever, Europe needs industry and industry needs Europe. The Single Market, with 500 million consumers, 220 million workers and 20 million entrepreneurs, is a key instrument in achieving a competitive industrial Europe'. [140]

In the past, the internal market has been the main driving force behind European economic growth, based on the freedom of movement of goods, persons, services and capital. Little by little, economic integration has provided companies in Europe with a domestic market that goes beyond national boundaries and a stimulating and competitive environment conducive to innovation and increased productivity.

However, despite all past successes, the shortcomings within the internal market and its unexploited opportunities remain major challenges holding back the EU's competitiveness. The smooth continuation of the integration process cannot be taken for granted and remains a formidable task, the more so in the face of future enlargements. It is a task that has not been made easier by the emergence of external challenges, in particular the recent economic and financial crisis and the pressures of globalisation, both of which will be discussed further below.

In order to exploit the full potential of the internal market, the Commission adopted on 13 April 2011 the Single Market Act. This proposes 12 levers to strengthen confidence, each featuring one key priority action and a number of additional actions to be implemented by the

139 European Commission (2009), *Five years of an enlarged EU – Economic achievements and challenges,* Communication from the Commission, COM(2009) 79, p. 2.

140 European Commission (2010), *An Integrated Industrial Policy for the Globalisation Era Putting Competitiveness and Sustainability at Centre Stage*, Communication from the Commission, COM(2010) 614.

end of 2012, in time for the 20th anniversary of the Single Market. Actions include tasks particularly important from an industrial competitiveness perspective, such as ensuring access to finance for SMEs, improving the framework governing Intellectual Property Rights (IPRs), reforming standardisation policy, extending high-performance European infrastructure networks and modernising the rules governing public procurement.

Moreover, the challenge ahead is not limited to consolidating and deepening the integration of the internal market. While this is a prerequisite for improving competitiveness, addressing global challenges cannot be achieved by merely extrapolating intra-EU policies beyond Europe. Instead, all EU policies — and notably any attempt to preserve and enhance competitiveness — need to take into account that not all trade partners are market economies. Only a policy approach that takes into account the economic realities faced by European companies outside the EU can establish a powerful link between the Single Market and the rest of the world.

6.2.2. Creating a global level playing field with non-EU competitors

'Europe is the right level for thinking and action in terms of globalisation. Markets are global: Europe must defend its interests and values with greater confidence, in a spirit of reciprocity and mutual benefit. European policies must aim to ensure the greater convergence of rules and standards at international level.'[141]

Progressing at an accelerating speed over the last decade, globalisation has been reshaping the world economy. Newly emerging economies, spearheaded by the BRICs,[142] have established themselves as major economic powers. The main drivers behind this process include economic liberalisation inside these countries, the dismantling of regulatory and tariff barriers to trade between countries, and falling transport and communication costs resulting from better logistics and use of ICT.

The emerging countries have significantly increased their share of output, raw material consumption, trade and capital stocks. The share in world GDP held by China, India and the ASEAN countries, for example, has risen by more than 60 % over the last decade. Their share in world trade has increased by more than 50 % and in world foreign direct investment (FDI) stocks by more than 15 %.[143] China overtook Japan as the world's second largest economy in 2010, and is expected by many observers to become the largest economy within the next 20 years.[144]

Globalisation and the economic rise of Asia have led to important changes to the business context in which European companies operate, notably in the manufacturing sector:

- The newly emerging economies present ever more important markets for European products and thereby new business opportunities. European imports from and exports to newly emerging economies in Asia have doubled since 2000.

- Access to these markets, including access to public procurement, is crucial for the current and future world market position and profitability of European companies, including

141 European Commission (2010), *Towards a Single Market Act, For a highly competitive social market economy, 50 proposals for improving our work, business and exchanges with one another*, Communication from the Commission, COM(2010) 608.

142 Brazil, Russia, India and China.

143 All data are from UNCTADstat. The period is 2000 to 2009; the GDP share in constant prices/exchange rates (2000). The term 'world trade' combines imports and exports.

144 The BRIC countries are expected to account for 60 % of world GDP by 2030 (EIM study on internationalisation of SMEs).

SMEs,[145] but remains difficult and often subject to restrictions unacceptable in and for market economies.

- The structure of European industry has changed profoundly. Competition especially from Asian companies has put intense pressure on European companies to move up the quality and innovation ladder.[146] Some EU industries have retrenched to niches of their former markets, while others have outsourced much of their production outside the EU. Examples include the textile/clothing industry, shipbuilding, and consumer electronics, joined over the last decade by the clean technology and semi-conductor industries.

- European companies face increasing competition for energy resources and non-energy raw materials (cf. Chapter 4.). China's imports of fuels and non-fuel commodities have both increased by 500 % over the last decade.[147] Prices of most raw materials have risen significantly, e.g. the UNCTAD composite price index for minerals, ores and metals has more than doubled since 2000. Key sectors in high technology are dependent on relatively rare raw materials (e.g. lithium for batteries or neodymium for wind turbines and electric cars) only mined outside the EU.[148]

One of the most important consequences of these developments has been a trend towards internationally ever more specialised and fragmented value chains.[149] In the last decade, imports of intermediate goods in the EU (as a proxy for value chain fragmentation) have increased by more than 80%[150] and now amount to about 40% of world trade in manufactured non-fuel products.[151] Formerly vertically integrated companies are concentrating on specific steps of the value chain and are outsourcing many other activities. Making use of efficiency gains stemming from specialisation along value chains is an important factor for the competitiveness of European businesses but can create significant risks as well, linked to security of supplies.

The last decade also saw increasing FDI between the EU and the emerging countries. While European FDI in the developing world has continued to grow, there is a recent trend for increased FDI to flow in the other direction. This is partly the result of the revenues from the huge trade surpluses built up over the last years by certain countries, most importantly China. Furthermore, some companies from these countries have emerged as globally active multi-nationals and have started to acquire assets all over the world, including European companies.

Looking ahead, it seems fair to state that improving the ability of European enterprises to fully capitalise on the business opportunities offered by globalisation is one of the most fundamental challenges ahead, if not the most important. As the EU has recognised the need

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145 European Commission (2011), *Review of the 'Small Business Act' for Europe,* Communication from the Commission, COM(2011) 78.

146 Notably China has recently moved into the manufacturing of high-tech goods as well. India is particular strong in services such as IT or customer care.

147 UNCTADstat.

148 European Commission (2011), *Tackling the Challenges in Commodity Markets and on Raw Materials*, Communication from the Commission, COM(2011) 25.

149 Cf. European Commission (2010), *An Integrated Industrial Policy for the Globalisation Era Putting Competitiveness and Sustainability at Centre Stage*, Communication from the Commission, COM(2010) 614; and European Commission (2010), European Competitiveness Report 2010, Commission Staff Working Document SEC(2010) 1276, Accompanying Document to the Communication from the Commission, *An Integrated Industrial Policy for the Globalisation Era Putting Competitiveness and Sustainability at Centre Stage*, COM(2010) 614.

150 European Commission (2010), *European Competitiveness Report 2010,* Commission Staff Working Document SEC(2010) 1276*,* Accompanying Document to the Communication from the Commission, *An Integrated Industrial Policy for the Globalisation Era Putting Competitiveness and Sustainability at Centre Stage*, COM(2010) 614, p. 81; data are available for the period 1999 to 2008.

151 Figure for 2008; source: WTO International Trade Statistics 2009.

to maintain a strong, diversified and competitive industrial base,[152] it must ensure that its enterprises maintain and reinforce their international competitiveness. A particularly important element for achieving this objective is the creation of a global level playing field,[153] on which companies from around the world are able to compete on their respective commercial merits. This includes all dimensions of economic activity, be it access to inputs and markets, IPR protection, availability of business services or choice of an optimal distribution network.

A continuing challenge to the creation of such a global level playing field results from the fact that some of the new economic powers are emerging from a planned economy model and have started liberalising their internal and external economic activities rather recently. The role of the state in these countries differs substantially from the role of the state in Europe and other mature economies. This may bring about distortions due to strategic macro-economic policy choices, such as fixed exchange rates, or interventionist economic policy strategies. Moreover, distortions other than classical tariffs or straightforward subsidies have risen to the forefront over the last decade.[154]

Box 6.1: Offsets and forced technology transfers

Offsets, notably in the form of forced technology transfers, are a particular interesting example of a non-classical distortion of the global level playing field. Offsets are a price a company is requested to pay to enter a foreign market or obtain a lucrative contract. The price can consist for example in the transfer of technology to a local partner. It can also be more indirect, such as an obligation to use a specific percentage of local inputs or to help local companies in selling a predetermined amount of goods within a specific timeframe. Designed to make up an economic shortfall for local firms and compensate for the backwardness of a developing country, they form part of firms' bids, and their impact on the competitiveness of the European firms concerned can but need not always be negative.

However, such offsets can present a policy dilemma. While the individual company may be willing to pay the price, a negative externality can arise for the sector as a whole, and there may be negative repercussions for policy objectives based on the European interest. The increased use of offsets in an ever greater number of different sectors could call for assessment of the need for a legal framework to govern them.

In this context, and in order to guide the subsequent discussion in this chapter of the more detailed issues involved, a number of fundamental observations apply:

First, creating a level playing field implies a realistic assessment and monitoring of distortions. It can also require bilateral or multilateral negotiations with economic policy makers in the countries concerned. Further, case-by-case interventions may be required to

152 European Commission (2010), *An Integrated Industrial Policy for the Globalisation Era Putting Competitiveness and Sustainability at Centre Stage*, Communication from the Commission, COM(2010) 614.

153 European Commission (2010), EUROPE 2020, *A strategy for smart, sustainable and inclusive growth,* Communication from the Commission, COM(2010) 2020 p. 21; European Commission (2011), *Review of the 'Small Business Act' for Europe,* Communication from the Commission, COM(2011) 78, p. 14.

154 European Commission (2011), Trade and Investment Barriers Report 2011, *Engaging our strategic economic partners on improved market access: Priorities for action on breaking down barriers to trade*, Communication from the Commission, COM(2011) 114.

help European businesses as much as possible to overcome specific distortions.[155] This applies to the activities of EU companies abroad but also to the activities of non-EU companies within Europe.

Second, creating a global level playing field implies neither 'tit for tat' acts of protectionism nor subsidy races between countries. Consumers and tax payers would immediately lose from such an approach, and any short-term benefits for enterprises would be rapidly cancelled out by the longer-term loss of growth opportunities. A global level playing field can therefore only be built on the principle that distortions are minimised.

Third, creating a global level playing field also does not imply a lowering of safety, labour or environmental standards. Societal demand for such standards rises with income, and differences in current levels are primarily a function of different income levels, not of differing preferences. The economic growth observed in significant parts of the developing world therefore goes hand in hand with rising environmental, safety and labour standards. Efforts to create a global level playing field are facilitated by this trend. This is compatible with competition between regulatory regimes in terms of cost-effectiveness (and not lowest standards).

Finally, the role of EU policy makers is enhanced in this global environment. Creating a regulatory framework, in the EU and globally, to address the changed reality of a globalised economy requires significant resources and resourcefulness on the part of policy makers. Rules must fit the needs of globally active businesses and their stakeholders, and also take into account the ever increasing interdependence of companies working in global value chains. Policy makers can also have an important role in facilitating adaptation by enterprises and societies to the substantial economic realignments caused by globalisation.

6.2.3. Boosting the real economy in times of financial trouble and fiscal constraints

The recent economic and financial crisis was the most severe macroeconomic shock since the Great Depression in the 1930s and has had a significant long-term impact on the competitiveness of EU industry.

In the face of the economic crisis originating in the United States, the EU took timely and coordinated policy action to maintain the stability of financial markets in Europe and to avoid a credit crunch by ensuring continued access to finance for the real economy. A Temporary Framework for State Aid was adopted in October 2008 (Box 6.2). The Commission subsequently adopted the European Economic Recovery Plan in November 2008 to coordinate a pan-European fiscal stimulus of about 2 % of EU GDP in order to boost demand and structural change towards sustainable growth.

Box 6.2: State aid during the crisis

The Commission approved specific crisis-related national state aid measures under exceptional temporary rules adopted in October 2008 in accordance with Article 107(3)(b) TFEU, with a view to remedying a 'serious disturbance in the economy of a Member State'.

1) Support for financial institutions

Between 1 October 2008 and 1 October 2010, the Commission adopted approximately 200 decisions on state aid measures for the financial sector, authorising, amending or prolonging 41 schemes and addressing with individual decisions the situation in more than 40 financial institutions, affecting 22 Member States.

In 2009, total state aid granted to the financial sector represented € 351.7 billion, or 2.98 % of EU27 GDP. However, not all of the approved aid has been used by the Member States concerned.

2) Support for the real economy

155 The EU maintains for example 30 'Market Access Teams' in its key export markets and also provides help for European companies that face IPR problems in China.

Between 17 December 2008 and 1 October 2010 the Commission approved 73 schemes under the Temporary Framework and 4 ad hoc aid measures, amounting to a total of € 82.5 billion (0.7 % of EU-27 GDP). The schemes comprised aid of up to € 500 000 per company, subsidised guarantee measures, schemes for subsidised loan interest, schemes offering reduced-interest loans to businesses investing in the production of green products, risk capital schemes and export credit schemes.

In 2009, the Commission approved measures under the Temporary Framework amounting to approximately € 81.3 billion, including aid estimated at € 2.2 billion, which represents 0.018 % of EU27 GDP.

Source: State Aid Scoreboard — Report on State aid granted by the EU Member States- Autumn 2010 Update — 01.12.2010.

Due to the heavy reliance of European enterprises on bank credit and bank intermediation of savings, instability and lack of trust in the banking sector had an immediate impact on the financing of the real economy and on the level of consumption.[156] Credit restraints and reduced business and household demand had a particularly negative impact on those sectors already in need of structural adjustments, as for them access to finance had already been a bottleneck before the crisis.

By the end of 2008, production, demand, investment and trade inside the EU had decreased drastically, with manufacturing output falling by some 20 %. EU real GDP shrank by 4.2 % in 2009, the sharpest contraction in its history.[157] The crisis also had an immediate impact on the level of employment and bankruptcies, with social difficulties aggravating the economic downturn and negatively affecting private domestic demand. Since mid-2009, the EU economy has started to emerge from the recession.[158] Short-term economic data show a strong recovery in Europe, especially for industrial output. However, output remains below its former peak. Employment has also fallen significantly and manufacturing employment is on average some 10 % below its peak (see Figure 6.1).

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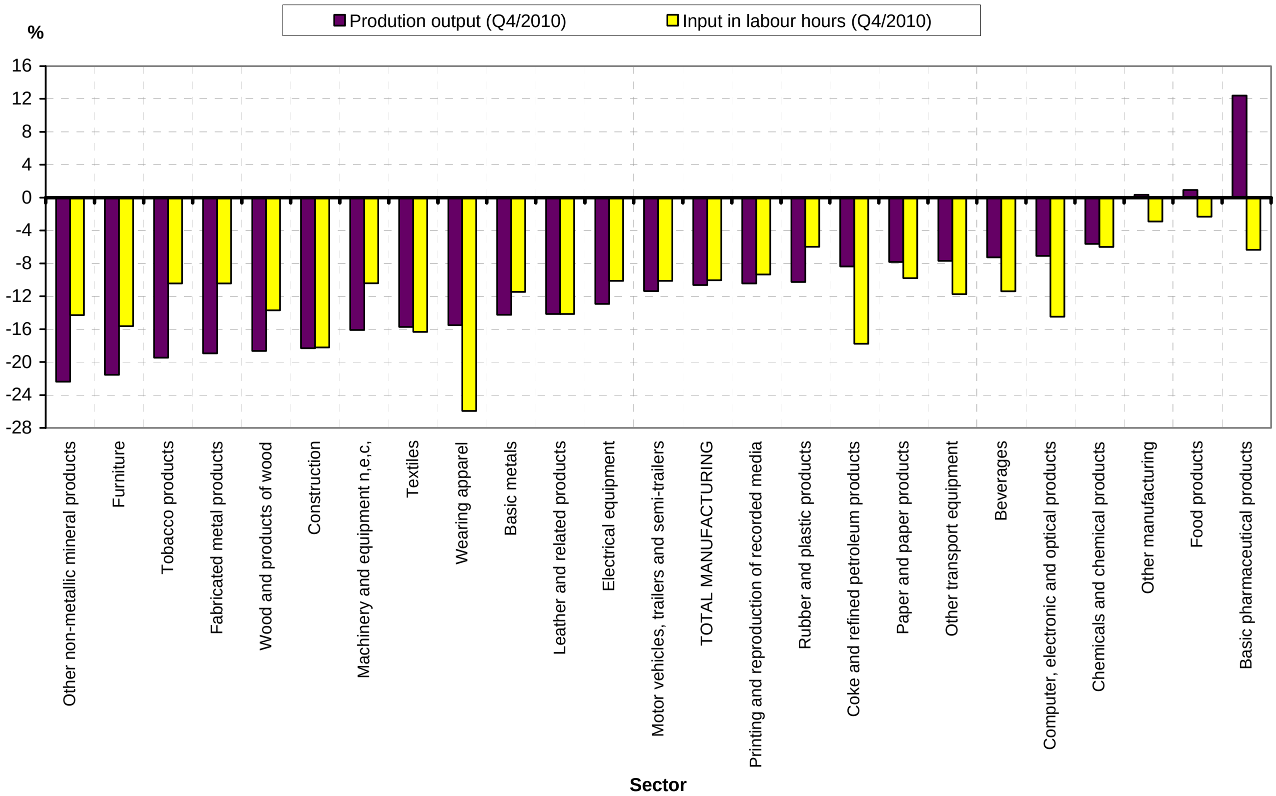
156 Posen, A., Véron, N., (2009), *A Solution for Europe's Banking Problem*, Bruegel Policy Brief 2009/03. It also had an indirect impact on the valuation of the European corporate landscape, with banks representing 24 % of the aggregate market value of European listed companies among the world's 500 largest in mid-2007 and only 12 % in March 2009.

157 European Commission (2009), *Economic Crisis in Europe: Causes, Consequences and Responses*, European Economy 2009-7, DG Economic and Financial Affairs.

158 European Commission (2010) Monthly Note on Economic Recovery in Manufacturing, Construction and Services Industries, March 2010, DG Enterprise & Industry.

Figure 6.1: Sectoral manufacturing output and employment developments

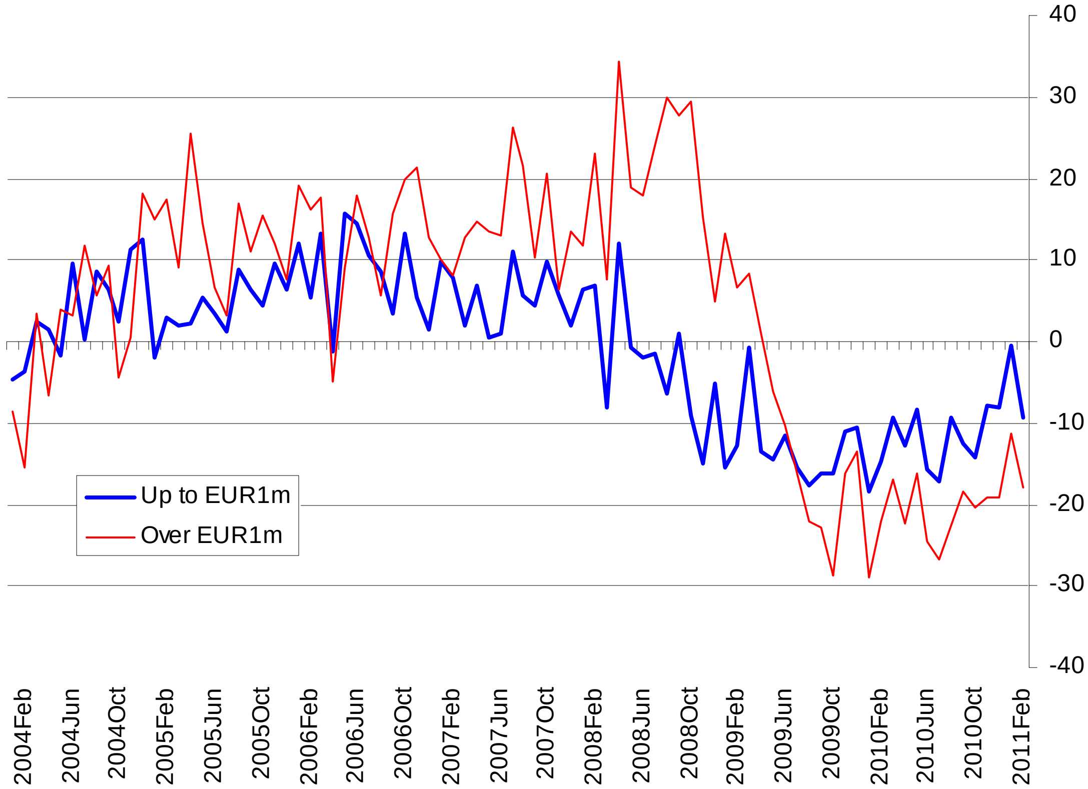


Note: Percentage change, latest data compared to the cyclical peak (Q1/2008), seasonally adjusted
Source: Eurostat

While the current economic outlook for production and growth is now positive, the real economy remains exposed to structural problems with access to finance, which has not returned to normal. The continued high risk aversion of financial institutions, the current uncertainties on the financial markets, the embryonic European venture capital market and ever tighter fiscal constraints together constitute a potentially lasting damaging consequence of the crisis on the EU's economic performance. Credit supply is in fact expected to be further affected by the introduction of the CRD IV guidelines.

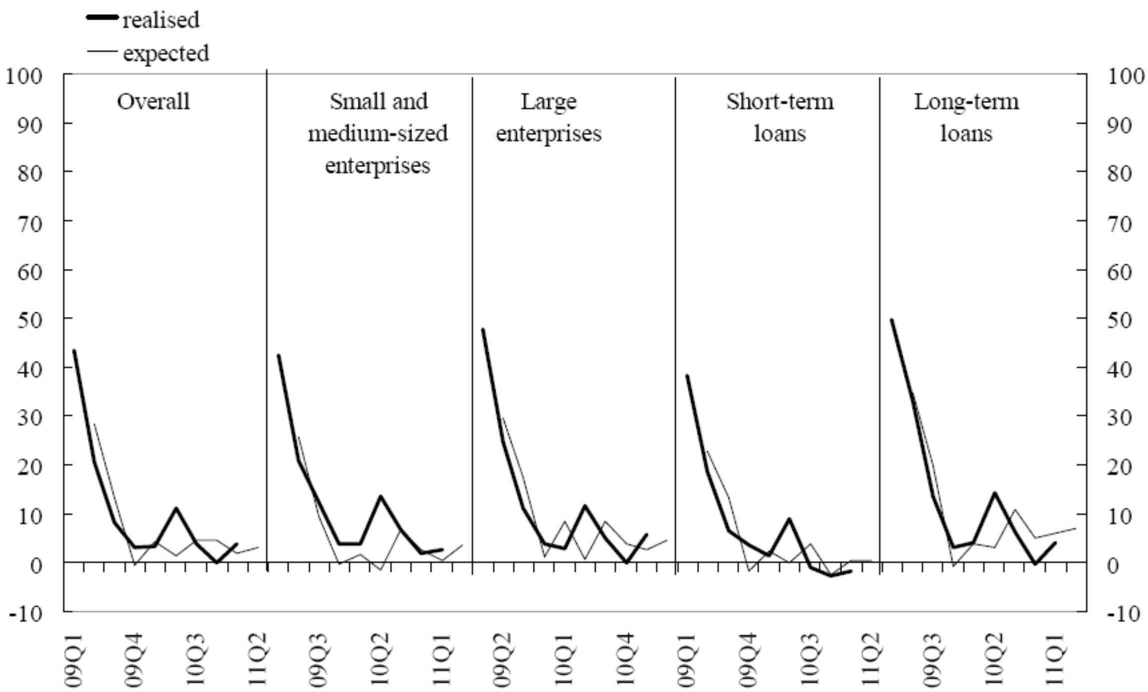
The crisis has in particular revealed the need for further restructuring and better supervision of the banking sector. The increasingly narrower scope for financial state intervention due to fiscal constraints adds to the problem. As a result, many companies in the real economy have been weakened by the crisis — not because they were uncompetitive, but because of the failure of financial service providers to play their supportive role. Some companies have thus reduced or delayed necessary investment or R&D&I expenditure, while others are barely able to survive due to lack of financing, making them vulnerable to any further cyclical change or take-overs. This will have a negative effect on both competition and the strength of Europe's industrial fabric. In particular, non-financial corporations, especially SMEs, are still facing difficulties. New loans to enterprises in the euro zone have continued to fall over the past months, and euro zone banks are still reporting a tightening of their credit standards for loans to enterprises (cf. Figure 6.2 and Figure 6.3).

Figure 6.2: Change in new loans below and above EUR 1 m — year-on-year change



Source: ECB

Figure 6.3: Changes in credit standards applied to the approval of loans or credit lines to enterprises (net percentage of banks reporting tightening credit standards)



Source: ECB Bank Lending Survey, April 2011

Overall, exposure of the European economy to lasting problems of access to finance forms one of the main challenges in the post-crisis context. The key task ahead is thus to restore trust and stability in the financial sector. A move towards more stability and responsibility in the financial system is already ongoing, through a series of important European initiatives to reform financial markets (e.g. corporate governance crisis resolution system, supervision of institutions, strengthening of capital requirements). These are indispensible for improving the system as a whole, as is the balanced restructuring of distressed banks.

A stable and business-oriented financing market is essential not only for daily operations but also for the longer-term investment needed for 'modernising Europe's industrial base and the infrastructure on which it relies'. This also implies 'more private capital for productive investments, in particular through venture capital markets' and, more generally, 'more resilient and efficient financial markets ensuring that they have the right incentives to finance the real economy and investment.'[159]

It is moreover essential to continue structural reforms in Member States, e.g. adjusting labour or pension systems, and to create 'incentive mechanisms encouraging all forms of sustainable investment or investment supporting a long-term strategy.'[160] Facing these short- to medium-term challenges will require innovative approaches, especially to address the fiscal situation of many Member States, characterised by large structural deficits and high levels of public debt. The search for better efficiency in all policies will thus need to be placed high on the agenda.

6.3. Fostering strategic European interests

The challenges identified above have important implications for the EU policy framework. This is reflected in the modernisation of the EU's industrial policy with the specific objective of gaining leverage for global competition. The following section discusses the institutional framework where relevant from a competitiveness perspective.

6.3.1. The Lisbon Treaty and competitiveness

The enlargement of the EU required a new treaty to render governance of the EU-27 more operational. Decision-taking would otherwise have become increasingly difficult. In order to achieve better coordination, a clearer institutional structure and more effective governance, the Lisbon Treaty was signed on 13 December 2007 and entered into force on 1 December 2009 (Box 6.3).[161]

Box 6.3: The Lisbon Treaty

The Treaty of Lisbon amended the EU's two core treaties, the Treaty on European Union (i.e. the 'Maastricht Treaty') and the Treaty establishing the European Community (i.e. the 'Treaty of Rome'). The latter was renamed the Treaty on the Functioning of the European Union (TFEU). In addition, several Protocols and Declarations were attached to the Treaty.

All legal provisions relevant for competitiveness policies are contained in the TFEU. Industrial policy is a field where action at EU level serves to support, coordinate or supplement Member State actions, whereas establishing the competition rules necessary for the functioning of the internal market is an exclusive competence of the EU. Although there are three short references elsewhere in the TFEU,[162] the issue of competitiveness is essentially

159 European Commission (2010), *An Integrated Industrial Policy for the Globalisation Era Putting Competitiveness and Sustainability at Centre Stage*, Communication from the Commission, COM(2010) 614, point 3.2.

160 European Commission (2010), *Towards a Single Market Act, For a highly competitive social market economy, 50 proposals for improving our work, business and exchanges with one another*, Communication from the Commission, COM(2010) 608, point 1.4.

161 Treaty of Lisbon amending the Treaty on European Union and the Treaty establishing the European Community, signed at Lisbon, 13 December 2007, Official Journal C 306 of 17 December 2007.

162 Article 151 TFEU on social policy, Article 189 TFEU on space policy and Article 195 TFEU on tourism, cf. the consolidated versions of the Treaty on European Union and the Treaty on the Functioning of the European Union, Official Journal C 83 of 30.03.2010.

covered by Article 173 TFEU on industry, which establishes industrial policy as the main pillar of the EU's competitiveness policy.

Article 173 keeps the main elements of its predecessor, Article 157 EC.[163] In particular, it maintains the overall objective that

'[t]he Union and the Member States shall ensure that the conditions necessary for the competitiveness of the Union's industry exist.'

The article then lists more detailed industrial policy objectives, such as

- speeding up the adjustment of industry to structural changes;
- creating a favourable business environment, particularly for SMEs; and
- fostering better exploitation of the 'industrial potential of policies of innovation, research and technological development'.

Any action by the EU and the Member States must be in accordance with a system of open and competitive markets. Moreover, Article 173 emphasises that industrial competitiveness has various dimensions. This has broad implications for the positioning of industrial policy in conjunction with other policies, such as R&D, innovation, competition and trade. It also implies that industrial policy is multifaceted, so that a single indicator will not suffice to measure competitiveness in a comprehensive and operational manner.[164]

In addition, Article 173 TFEU includes novel aspects that strengthen its relevance compared with Article 157 EC. Most importantly, Article 173(2) gives the Commission more scope to coordinate between EU level and Member States, for example by establishing guidelines and indicators, exchanging best practice or performing periodic monitoring and evaluation.[165] The conclusions adopted by the Competitiveness Council on 1 March 2010 reconfirm this widened room for manoeuvre.[166] Much of the subsequent discussion in this chapter serves to explain in greater detail how this opportunity can be grasped in practical terms.

With a view to other policies, Article 3(c) TFEU refers to competition policy as one of the EU's exclusive competences, to the extent necessary for the functioning of the internal market. Competition policy thus remains a vital element of any competitiveness policy strategy. As regards trade policy, the Lisbon Treaty introduced two major changes: a clarification of the EU's exclusive competence on all key aspects of trade policy and an increase in the European Parliament's powers vis-à-vis the Council. Concerning the EU's exclusive powers, the Lisbon Treaty explicitly refers not only to trade in goods but also to trade in services, trade-related IPRs and FDI.[167] By extending the competence for FDI without explicitly mentioning investment liberalisation or protection, the Lisbon Treaty has granted the EU an exclusive competence for investment protection. Any new policy is therefore not confined to granting access to trade partners and ensuring access for European companies to the markets of third countries, but can also ensure that these investments are duly protected. Multilateral fora and bilateral trade agreements could serve to advance this approach further.

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163 Cf. also European Commission (2002), *2002 European Competitiveness Report,* Commission Staff Working Paper, SEC(2002) 528, p. 82.

164 European Commission (2010), *Member States competitiveness performance and policies,* Commission Staff Working Document SEC(2010) 1272*,* Accompanying Document to the Communication from the Commission, *An Integrated Industrial Policy for the Globalisation Era Putting Competitiveness and Sustainability at Centre Stage*, COM(2010) 614.

165 Priollaud, F-X., Siritzky, D., (2010) *Le Traité de Lisbonne: commentaire, article par article, des nouveaux traits européens (TUE-TFUE)*, Paris, Documentation française, p. 284.

166 Council of the European Union (2010), *Council conclusions on the need for a new industrial policy,* 2999th Competitiveness Council meeting, Brussels, 1 March 2010, point 9.

167 De Gucht, K., *The implications of the Lisbon Treaty for EU Trade policy,* S&D seminar on EU Trade Policy, Oporto, 8 October 2010.

6.3.2. A new industrial policy for the globalisation era

In the wake of the 1992 Single Market Programme, the EU pursued a horizontal[168] industrial policy aimed at improving the framework conditions necessary to ensure the flourishing of the newly constructed internal market. Strong competition policy was used to break down remaining barriers. Interventionist economic policies were explicitly avoided as likely to be incompatible with the internal market.

As the Single Market has become an established reality, the importance of manufacturing industry in the EU economy has been increasingly recognised. In 2002, with a view to the upcoming enlargement, the Commission published a Communication on Industrial Policy in an Enlarged Europe,[169] which examined the future of EU industrial policy. It underlined the role of a competitive industry and emphasised three key factors influencing industrial competitiveness: knowledge, innovation and entrepreneurship. Two further Communications followed in 2003 and 2004.[170] [171]

In the context of the revised Lisbon Strategy,[172] the Communication on industrial policy in 2005 confirmed industrial policy as a key policy at EU level. The document set out an integrated approach to industrial policy, maintaining a horizontal non-interventionist approach to industrial policy that took full account of sectoral specificities. A detailed set of horizontal and sectoral policies were set out based upon a systematic screening of the opportunities and challenges facing 27 individual sectors of EU manufacturing industry. Key initiatives included a legislative simplification initiative, work on energy and environmental issues, international market access, and intellectual property enforcement, together with a series of High Level Groups, including CARS21 and LeaderSHIP, to review the future of certain sectors. A mid-term review in 2007 further extended and elaborated this policy approach, including working more closely with Member States. Overall, the new policy framework has served the EU well.

When the global business environment changed radically, as described above, the Commission designated industrial policy as one of the key flagship initiatives under the Europe 2020 Strategy, and adopted on 28 October 2010 a new Communication on 'An Integrated Industrial Policy for the Globalisation Era — Putting Competitiveness and Sustainability at the Centre Stage' (Box 6.4). Taking into account in particular the lessons learnt from the crisis, the Commission agreed on a fresh approach to industrial policy, which is to put EU economy on a dynamic growth path by strengthening EU competitiveness, providing growth and jobs, and enabling the transition to a low-carbon and resource-efficient economy. Most importantly, the Communication recognised the need for an outward-looking global perspective with competitiveness as the central element to help ensure consistency between all other policies targeting enterprises.

While it is built on past experience and continues some existing initiatives, this new industrial policy contains some novel elements that strengthen the Commission's role as the coordinator of national policies. On substance, emphasis is placed on the whole value chain, from access to raw materials to after-sales service, in recognition that any focus on solely one part of this chain is detrimental to enhancing the competitiveness of not only firms but the EU economy

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168 As opposed to vertical policies that target specific sectors.

169 European Commission (2002), *Industrial Policy in an Enlarged Europe*, Communication from the Commission, COM(2002) 714.

170 European Commission (2003), *Some Key Issues in Europe's Competitiveness — Towards an Integrated Approach*, Communication from the Commission, COM(2003) 704.

171 European Commission (2004), *Fostering structural change: an industrial policy for an enlarged Europe,* Communication from the Commission, COM(2004) 274.

172 European Commission (2005), *Common Actions for Growth and Employment: The Community Lisbon Programme*, Communication from the Commission, COM(2005) 330.

as a whole. At the same time, the EU has set itself a new strategic objective: maintaining a strong, competitive and diversified industrial base in Europe. In particular, it aims to provide ‘a strategic framework for a new integrated industrial policy that will stimulate economic recovery and jobs by ensuring a thriving world-class industrial base in the EU’.[173]

In order to promote a successful industrial policy, the new strategy requires that industrial policy is understood in a wider sense, focusing on all policies that have an impact on the cost, price and innovative competitiveness of industry and individual sectors, such as standardisation, innovation policies or policies targeting e.g. the innovation performance of individual sectors. It also entails consideration of the competitiveness effects of all other policy initiatives.

The key challenge ahead is to create a framework that accompanies firms through all phases of their life cycle and all stages of their activity. The framework is also intended to provide the right incentives for them to increase their competitiveness (this notion is further discussed in section 6.4). The primary responsibility for doing this rests on industry itself. Nonetheless, a modern industrial policy offers a toolbox that combines the rigour and consistency of horizontal principles with the flexibility of priority setting according to the specific needs of sectors.

In addition to these priorities, the Commission has started reporting on EU and Member State competitiveness, industrial policies and performance on an annual basis as part of the new TFEU provision for it to coordinate competitiveness policies.[174]

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173 European Commission (2010), *An Integrated Industrial Policy for the Globalisation Era Putting Competitiveness and Sustainability at Centre Stage*, Communication from the Commission, COM(2010) 614.

174 European Commission (2010), *Member States competitiveness performance and policies — 2010 edition*, Commission Staff Working Document, SEC(2010) 1272.

Box 6.4: The five key priorities of the October 2010 Industrial Policy Communication

Firstly, the Communication emphasises the need to deliver the right framework conditions for industry and ensure that EU policies all work together in the same direction. To achieve this, all important policy proposals impacting on industry — for example, new regulations for financial markets, environmental standards or new Single Market and competition legislation — should undergo a detailed assessment of their overall impact on industrial and sectoral competitiveness before implementation. This should guarantee a genuinely integrated industrial policy approach at EU level.

Secondly, the Communication stresses the role that the Single Market plays in fostering industry's competitiveness and the need to address its shortcomings. For example, the efficiency of the Single Market crucially depends on the quality and efficiency of the energy, transport and communications infrastructure. The related policies should therefore be considered integral parts of an integrated industrial policy approach. Also, the provision of business services is becoming ever more crucial for modern industry, and the Single Market needs to be modernised in this area.

Thirdly, as Europe needs to improve its ability to turn ideas into marketable goods and services, the Communication puts forward a new industrial innovation policy, to ensure that EU firms are first onto the market. In particular, it emphasises the role that Key Enabling Technologies (KETs) can play in ensuring continuing technological leadership by EU industry in both mature and emerging markets.

Fourthly, the Communication insists that European industry must take advantage of the new markets opened up by globalisation, and that it will only be able to do so if put on an equal footing with its global competitors. This requires greater efforts to identify and combat trade and investment barriers[175] and also beyond-the-border practices, such as subsidies in specific sectors. As access to raw materials is an increasingly strategic issue for Europe, the Communication announced a comprehensive strategy, subsequently presented by the Commission,[176] with a strong external dimension to ensure, in particular, that access is genuinely market-driven and that restrictions and constraints in third countries are removed.

Finally, industry must be accompanied in its transition to a low carbon resource efficient economy. Indeed, combating climate change and increasing resource efficiency should not be seen exclusively as a burden on companies, but also as an opportunity for sustainable growth and gaining competitive advantage. This implies in particular initiatives targeting energy-intensive industries – such as metals, chemicals, and paper and pulp – so that new low-carbon technologies can be developed and disseminated.

6.3.3. *A European policy approach to serve strategic European interests*

In line with the principle of subsidiarity, the appropriate level to design policy is the lowest that can effectively provide a solution for the problem at hand. Action at EU level is thus only justified where the target of such action comprises a significant part of the EU and where a response only at a lower level would create risks of fragmentation, underperformance or inconsistency.

These conditions are met for a policy response towards the challenges discussed above:

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175 European Commission (2011), *Trade and Investment Barriers Report 2011*, Report from the Commission to the European Council, COM(2011) 114.

176 European Commission (2011), *Tackling the challenges in commodities markets and on raw materials,* Communication from the Commission, COM(2011) 25.

- Globalisation affects all Member States, and the strategic response to it is a task with clear economies of scale. In the face of non-EU competitors with swiftly expanding home markets of a potential size much larger than that of any EU Member State, political and economic leverage can be higher at European level.

- There is a strong need to maintain the Single Market across an enlarged EU-27, a much less homogenous economic bloc than the earlier, smaller EU. In a number of sectors, manufacturing is concentrated in a minority of Member States, whereas resources, suppliers and markets encompass all of them. Maintaining and extending the Single Market benefits all businesses and consumers.

- Limited state finances in the wake of the economic and financial crisis call for pan-European solutions, including new ways of financing large-scale demonstration projects (as exemplified by Carbon Capture and Storage or KETs) and supporting infrastructure.

The Europe 2020 strategy provides the basis to implement such a European approach. As discussed in section 6.3.1, the TFEU provides new tools for the 'integrated industrial policy for the globalisation era' flagship to enhance competitiveness, for instance by strengthening the Commission's role as coordinator of national efforts. In this context, it is important as a starting point to clarify some concepts, notably 'European interest', 'strategic' at European level, and 'European company', to the extent relevant for an industrial policy context.

6.3.3.1. European interest

The notion of European interest figures in the TFEU only once, in Article 107(3)(b) on state aid. Financial support measures by Member States 'may be considered to be compatible with the internal market' if they constitute

'aid to promote the execution of an important project of common European interest or to remedy a serious disturbance in the economy of a Member State'.

However, the related term 'common interest' appears ten times. In particular, two subsequent provisions on state aid, Articles 107(3)(c) and (d), state that other forms of aid must not distort trade (and competition) to an extent 'contrary to the common interest'. A common European interest is thus recognised in the TFEU itself.

Beyond these references, the European interest also figures in secondary law:

- In the competition context, the conditions for considering '[a]id for R&D&I to promote the execution of an important project of common European interest' as compatible with the internal market are laid down in the 2006 R&D&I state aid framework.

- In another field, the notion already exists as well. In trade policy,[177] the 'Community interest' is defined on the basis of various interests taken as a whole, including the interests of domestic industry, users and consumers. It thus serves to combine diverse — and sometimes opposed — specific interests to arrive at the common good.

- The notion of European interest is used in EU transport or energy policy for establishing the right framework conditions and financial means to ensure the building or operating of efficient trans-border infrastructures. It can be extended to large research infrastructure projects, e.g. the ITER fusion energy demonstration project in Cadarache.

From the perspective of industrial competitiveness policy, a legitimate European interest could be assumed to exist where an action would benefit industrial competitiveness across

[177] Council Regulation (EC) No 597/2009, of 11 June 2009 on protection against subsidised imports from countries not members of the European Community.

national borders without its benefits being either limited to one Member State or the Member States implementing it or confined to the industry directly concerned, or where the implementation of a project or policy at Member State level would result in wasteful duplication of efforts (i.e. inefficient use of resources), would act against similar efforts in other Member States, or would not happen at all. Reasons for the latter include costs that exceed benefits at national level due to externalities, too large a project size or myopic behaviour, all of which is aggravated in the face of tighter fiscal constraints.

Factual developments underpin the need to rapidly fill the notion of European interest in the competitiveness context with content. The evolution of cross-border industry value chains is one of them. This was prominently highlighted in the 2010 Industrial Policy Communication:

'Delivering the new industrial policy calls for more effective European governance. The concepts of national sectors and national industries with little interaction with other sectors or the rest of the world are becoming less relevant. It is now increasingly important to identify strategic European industrial interests, and uncoordinated national policy responses must give way to coordinated, European policy responses.'[178]

The ongoing changes in the global configuration of industries and countries add a new dimension to the notion of European interest in the field of competitiveness policy. In some areas where the level playing field for all companies is distorted, and where Europe 2020 aims to 'maintain a strong, competitive and diversified industrial base', defining the European interest with regard to non-European trade partners could be done in a more pro-active way.

6.3.3.2. Strategic nature of such interests

The paragraphs above, including the quotation, refer to the concept of 'strategic' interests. Of course, a sector, company or activity is never strategic *per se* but can only be so in specific circumstances. Such circumstances can change over time. This explains why lists of strategic actors or activities differ, depending on their origin. Furthermore, many EU Member States have defined strategic sectors at national level, e.g. relating to national security, which have then received specific support. This need not be in contradiction with EU law, notably on the free movement of capital.[179] However, such definitions can differ profoundly across the EU.

However, a European interest deemed to be strategic must be so at European and not national or sectoral level. The focus should be on criteria that are objective while flexible enough to cope with the relative nature of what is strategic at a given moment in a given context. Accordingly, two such criteria can be singled out: public policy relevance and indispensability for specific economic activities.

1. An activity and its driver — in many cases firms — are the more strategic the more they are indispensible to achieve an acknowledged public policy objective. An example is road safety. If the objective is to reduce the number of fatal accidents in passenger transport, on-board safety systems are essential. If it turns out that the number of producers of state-of-the-art technologies is very limited, any of them is strategically important — not per se, but in this specific context.

2. Many economic activities rely on specific inputs produced by innovative firms with cutting-edge technology and/or on time by highly specialised producers. Indispensible inputs, such as certain raw materials found in few countries, are another example. The less they can be substituted and the more disruptive for global, fine-tuned value chains their temporary non-availability would be, the more they are

[178] European Commission (2010), *An Integrated Industrial Policy for the Globalisation Era Putting Competitiveness and Sustainability at Centre Stage*, Communication from the Commission, COM(2010) 614.

[179] Cf. Bertoncini and de Beaufort (2009).

strategic. Examples here include lightweight, high-resistance materials or electric batteries in road transport or energy-saving propulsion systems in maritime transport.

When one considers these examples in greater detail, similarities become visible. Much of this looks unspectacular, and the companies concerned may in fact be small — and few. They can be prone to weaknesses, including the financial issues that SMEs often face, and can therefore be vulnerable to takeovers. Nevertheless, their strategic value far exceeds their absolute size because of their bottleneck function, not only for production as such but for public policy needs that depend on such production.

If the European interest is to enhance competitiveness, as outlined above, a systemic analysis of how to achieve this must continue to focus on the most strategic elements within the industrial fabric, including both large and small enterprises, whose removal from the market-driven economic system the EU promotes would have an appreciable effect on competitiveness across national borders.[180] This is the notion of 'strategic' pursued in the following sections.

6.3.3.3. European companies

These considerations lead to the third element of the EU competitiveness paradigm: European companies. While references to European companies abound and are pertinent in many industrial contexts, notably strategic contexts at national level (for instance in defence), a clear definition proves particularly difficult. Similar exercises in other countries, such as the US two decades ago, have proven equally difficult, but have ultimately contributed to a better understanding of how companies, regardless of their origin, can help to add value to specific regions of the world. The exercise here has to be understood in a similar vein as a starting point for discussion.

Box 6.5: European companies

Many attempts to define a European enterprise have been made, leading so far to inconclusive results. It has sometimes been defined as a transnational group, in contrast with national companies from Member States or in contrast with third countries. The criteria used to define a European enterprise in economic terms have also been widely discussed: European shareholding, dominant market in Europe, added value created in Europe, headquarters, main production sites, R&D or jobs located in Europe. Some criteria used are identified in sociological terms, such as methods of governance, relations between shareholders and management, importance of employee participation in management, closeness to legal and institutional framework, etc. Debates are still ongoing but seem to add little value to the discussion in this chapter.

Despite these definitional ambiguities a more pragmatic approach would be to say that a company founded in Europe that has its R&D department, production sites and headquarters in Europe is obviously European, whereas a company where none of this applies equally clearly is not. The usual market reality lies in between and need not be further described in many (if not most) cases. For example, whether a producer of final products in a homogenous global market with low transport costs and no capacity constraints is European or not is at best of academic but not practical relevance.

At the same time, this would be an example of a firm that neither merits nor deserves public policy attention. The market reality is usually different. The more a company adds value to the European economy, the more it is entwined with European policies and the more it can become a vehicle for such policies. This is obvious in some contexts, such as employment. In fact, a widely recognised definition of 'competitiveness' includes jobs[181] and thus stresses this particular dimension of economic activity.

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180 As such, the concept obviously includes not only existing and fully active firms but new entrants.

181 See Box 1 in Chapter 1 of this report.

Even if one were to challenge the significance job creation might have for core competitiveness, companies that are strongly rooted in the European economy may produce a series of other beneficial effects in Europe. They often form part of innovation systems within Europe, in which proximity and local or regional spillovers are crucial and where distance matters when it comes to the success or not of such systems. Furthermore, they may be more familiar with the legal and socioeconomic system and the culture in Europe, which may reduce frictions and make it simpler for them to operate and for others to deal with them. Again, this is a success factor not to be underestimated, and is one which is too often absent in investors purely operating from outside the EU.

The objective of any definition of European companies is recognition of the simple fact that the policy of any jurisdiction is primarily targeted at the economic subjects living and operating in it. At the same time, there is a European interest in maintaining a strong presence of companies with strong roots in the European economy in a variety of strategic contexts, as industries or companies that exit the European market cannot return at short notice and without significant cost. In fact, both the time and cost are often prohibitive, and exacerbated by the loss of knowledge and support factors within the system.

6.4. Industrial competitiveness throughout the production value chain

The challenges defined in section 6.2 necessitate the design of a European response that takes into account the institutional framework and the policy principles presented in section 6.3. It is of paramount importance to base this response on the EU's strategic interests. As noted above, these strategic interests depend on the context. In what follows, in order to place the discussion within a more practical context, such interests are exemplified for different stages of the production value chain: access to resources, innovation, access to markets, and restructuring. Each stage is affected differently by the challenges, and each requires a different form of response. Overall, however, all these responses need to be coherent to optimise policy leverage at European level.

6.4.1. Access to resources

European companies can only thrive on the global market if they have reliable access to essential inputs. This particularly applies to raw materials, some of which are subject to trade restrictions, concentrated in few non-EU countries and prone to becoming the subject of strategic leveraging. As the 2010 Industrial Policy Communication put it, 'secure, affordable, reliable and undistorted access to raw materials is essential for industrial competitiveness, innovation, and jobs.' However, fluctuations in both quantities and prices render such access difficult. Increased prices for raw materials in principle reflect increased demand and signal relative scarcity. This is a normal and useful incentive in a market environment to search for alternatives and to increase efficiency (See Chapter 4.). At the same time, such price increases can be partly due to government intervention for strategic reasons, e.g. to give preference to domestic producers.

The response to this is threefold, as identified in the recent Raw Materials Communication:[182]

First, the availability of intra-EU resources should be stepped up. This starts with better knowledge and identification of the EU's indigenous resources, the development of technologies for intelligent mining, and the increased exchange of best practices between Member States in the area of land use planning and permitting of exploration and extraction.

Second, respect for multilateral rules should be enhanced through increased cooperation in global fora, such as the WTO, to address external supply problems, tackling trade barriers through dialogue but also through judicial action, where appropriate. Action at multilateral or

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182 European Commission (2011), *Tackling the Challenges in Commodity Markets and on Raw Materials*, Communication from the Commission, COM(2011) 25.

bilateral level can also be taken in the development field in order to diversify access to raw materials by creating win-win situations.

Third, recycling (e.g. through 'urban mining') and technological substitution can reduce the pressure on access to a certain extent. In both cases, the concept of the sustainable use of natural resources is the driver of EU action.

Box 6.6 Critical raw materials

In order to develop priority actions, the Commission has identified a list of critical raw materials, based on the risk of a supply shortage in the next ten years and the importance for the whole value chain. In all, 14 such critical raw materials figure on this list: antimony, beryllium, cobalt, fluorspar, gallium, germanium, graphite, indium, magnesium, niobium, platinum group metals, rare earths, tantalum and tungsten. These critical raw materials have or should become a core strategic dimension of industrial, trade, research and competition policies.

Strategies at firm level can complement these efforts. Long-term contracts are a particularly useful tool to steady prices and hedge risks. In specific circumstances, such contracts can become anti-competitive, for instance if resources are obtained from a dominant player on the basis of exclusive contracts that result in only minor quantities being available on the market each year, or in general if the long-term contracts lead to market foreclosure. The specific circumstances are now well-established in antitrust case law. In general, however, long-term contracts are often pro-competitive and work even better if their pricing is constrained by spot markets that cater to supplementary short-term needs.

Second, firms can reduce scope for strategic leverage by relying on several suppliers. This proves difficult at times, as bottlenecks emerge in complex supply chains. Moreover, many suppliers are small and prone to risks inherent in cyclical businesses. The financial crisis has exposed such problems and weakened parts of industrial supply chains, which has prompted responses that have not always been pro-competitive, e.g. takeovers that have privatised assets that had formerly been accessible to all buyers.

Recent events, such as the global repercussions of the Japan earthquake and tsunami, have added to these concerns and made supply chain management a number one priority for many global businesses. In fact, the old wisdom of the undisputedly beneficial effects of an enhanced global division of labour cannot be maintained any longer. Greater strategic state intervention, supply chain interruptions for an increasing number of reasons (e.g. natural disasters, piracy), and increasing market concentration are strong disruptive factors. Proximity starts to matter more, not only for innovation — where this principle has been long established — but also for access to resources as such.

6.4.2. Innovation

Maintaining and strengthening a competitive, low-carbon and resource-efficient industrial base in Europe depends upon an appropriately designed research and innovation policy. In particular, a pro-active industrial innovation policy is a key driver for efficiency gains in production processes and services, improved performance of products and the creation of new markets.[183]

Such a policy should take into account the specific research and innovation profile of each Member State and focus on their respective weaknesses. This would also promote convergence between the innovation performances of Member States. All new Member States are currently below the average EU innovation performance.[184] The difficulty of this situation

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[183] European Commission (2010), *An Integrated Industrial Policy for the Globalisation Era Putting Competitiveness and Sustainability at Centre Stage*, Communication from the Commission, COM(2010) 614.

[184] Innovation Union Scoreboard 2010: The Innovation Union's performance scoreboard for Research and Innovation (2011), ProInno Europe Report.

has been compounded by the crisis, which has had a 'disproportionate impact on some less performing regions. Europe must avoid an "innovation divide" between the strongest innovating regions and the others'.[185] More efficient use of the Structural Funds and a more targeted approach, focused on the relative strengths of each region (the so-called 'smart specialisation approach'), together with cluster initiatives, could contribute to this objective.

More generally, the crisis has imposed tight fiscal constraints on national budgets, including those supporting research and innovation. This problem calls for a much better aligned effort from Member States and the Commission to pool resources and coordinate actions in order to optimise efficiency. Such a coordination or pooling strategy would also contribute to addressing the recent changes in global conditions and the competition from non-EU competitors, which are following a similar innovation path and which in many instances have already implemented a coherent research and innovation strategy.

In this context, a fundamental challenge for Europe is fragmentation. Research and innovation capacities in EU firms are numerous and of a high quality, but often small in size and fragmented along national and regional lines. This leads to duplication and overlap. Focusing on the European dimension and going beyond mere national initiatives is necessary, not only to overcome the scarcity of public resources, but also to acquire a recognised weight at global level. This necessitates the pooling of EU efforts, for example by increasing contributions to cross-European initiatives, such as European platforms, the Lead Market Initiative, public-private partnerships, innovation partnerships, Framework Programme support for collective projects of firms from several Member States, or other policy measures. Such policies all encourage cross-border convergence and synergies. They indeed serve to make strategic European interests a priority.

Within such a framework, it is of the utmost importance to help EU firms to become or remain innovation leaders. This includes efforts to ensure their goods or services are low-carbon and resource-efficient. Targeted efforts are for example needed to support the early uptake of KETs[186] (such as industrial biotechnology, advanced materials, nanotechnology, micro- and nano-electronics, photonics, and advanced manufacturing systems) to unleash their full beneficial impact in other industrial sectors. New initiatives to address societal challenges also need to be strongly encouraged, in the field of technology as well as in the field of services.

6.4.3. Access to markets

Access to resources and a strong innovation performance fail to deliver optimal results if access to markets, particularly outside the EU, is a problem. In fact, both the recovery from the crisis and some tendencies in the context of globalisation, where newly emerging competitors might bring forward infant industry arguments or implement other policies that favour their native companies, result in a significant risk of protectionism. European businesses are largely dependent on non-EU markets and integrated global value chains. In the future, the main growth potential for European businesses is expected to come from non-EU markets. European companies can furthermore profit from geographical diversification to hedge against crises that are geographically limited or affect different world regions at different times. All of this means that the need to ensure fair access to markets worldwide is a key ingredient for EU policy in a globalised economy, the more so when Europe faces ever more competitive trading partners.

Access to the Single Market 'home base'

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185 European Commission (2010), *Europe 2020 Flagship Initiative Innovation Union,* Communication from the Commission, COM(2010) 546.

186 Reference to 2009 COM.

Deepening the Single Market plays an essential part in building and strengthening European companies' competitiveness and giving them a 'home base' to compete globally.[187] In the era of globalisation, however, deepening the Single Market goes hand in hand with opening it to the outside world. This opening to imports and investments from trading partners is crucial for economic growth within Europe. Competitive pressure on EU firms from non-EU businesses provides important incentives for them to remain innovative and rapidly adapt to global evolutions.

Access for European companies to foreign markets

The successful removal of tariff barriers to trade, achieved under multilateral and bilateral agreements, has significantly increased global trade. It has benefited EU businesses, helping them to recover from the crisis. While it is necessary to pursue these efforts, the focus has shifted to non-tariff and other 'behind the border' barriers[188] (offsets, burdensome customs procedures, discriminatory technical regulations, etc.). These obstacles are more difficult to identify and to remove. Furthermore, the crisis has unsurprisingly turned out to be a period of increased protectionism, precisely in the form of hidden or 'low intensity' barriers. Access to the Single Market, with its 500 million consumers, remains very attractive to foreign firms, so reciprocity is a highly efficient instrument for reducing non-tariff trade barriers.[189] The economic weight of the Single Market grants the EU considerable influence on regulatory issues in such a context. It also allows it to achieve leadership in standardisation and other policy fields where regulatory competition will increase.

Furthermore, European companies investing abroad need a secure legal framework for doing so. Their capital investments and also their technical know-how (especially in the form of IPR) need to be protected against arbitrary interventions by the government or lack of effective access to the courts or dispute settlement mechanisms. This is especially so for small and medium-sized enterprises, which find it particularly challenging to be active abroad.

Finally, distortions in international trade and investment can result from strategic macro-economic policy choices, such as fixed exchange rates. Exchange rates significantly influence the relative competitiveness of industries and enterprises from different countries. Solutions that aim to create a global level playing field must therefore address all aspects of the existing imbalances if they are to be effective.

6.4.4. Restructuring

The structural weaknesses of the EU economy exposed by the crisis cannot be ignored if the objective is to achieve medium- and long-term growth and secure jobs. Changes should aim, on the one hand, to ensure a transition to more sustainable and innovative production and/or new business models. On the other hand, they may be conceived to manage structural excess capacities or to accompany changes at firm level, ranging from 'engaging in new business models and products to definite market exit'.[190]

Although, in order to successfully compete, any firm and any sector must be ready to adjust, some sectors are more concerned by the need to find new business models or markets than others. These include, for instance, the automotive sector, the basic metals industries, mechanical and electrical engineering, shipbuilding or the printing industry.

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187 European Commission (2010), *Towards a Single Market Act, For a highly competitive social market economy, 50 proposals for improving our work, business and exchanges with one another*, Communication from the Commission, COM(2010) 608.

188 European Commission (2007), *Global Europe, A stronger Partnership to Deliver Market Access for European Exporters*, Communication from the Commission, COM(2007) 183.

189 Accordingly, the Agreement on Government Procurement (GPA), for instance, contains specific reciprocity clauses. http://www.wto.org/english/docs_e/legal_e/gpr-94_e.pdf.

190 'An integrated Industrial Policy for the globalisation era putting competitiveness and sustainability at Centre Stage'.

First, it is essential to consider that restructuring processes constitute an inherent element of the life-cycle of each enterprise. Companies must constantly adjust their strategies to the changing environment and to their internal evolution. This being said, many firms have come into difficulties almost exclusively because of the crisis and the lingering difficult access to finance. For these firms, when facing adjustment needs the issue of access to finance becomes existential.

Second, restructuring concerns both firms and whole sectors. While the responsibility for restructuring is always considered as primarily that of firms themselves, the issue becomes more complex and sensitive when it comes to the restructuring of sectors. It might be worth offering sectors some space to collectively rethink their role and place in the global arena, in order to collectively contribute to their own restructuring processes and to ensure, if needed, the orderly winding down of businesses. This topic becomes even more complex, but certainly not less relevant, when considering the impact of restructuring on value chains. Decisions by single companies — or sectors — can substantially influence the competitiveness of other, related companies or sectors.

The overall sector dimension should also be taken into account in all public policies and decisions relating to firms. In the field of state aid, for example, decisions taken on aid for large investment projects on the basis of regional development considerations are already assessed with a view to the impact on the sector, if the beneficiary has more than a 25% market share or, should the market be underperforming, if the capacity increase resulting from the investment exceeds 5% of the consumption of the market. State aid rules also exclude certain sensitive sectors from regional state aid (for example the steel industry). Furthermore, aid schemes targeting specific sectors have to be notified individually. The assessment of these schemes takes into account the impact on the sector concerned.

For all types of company adjustment strategies, the EU policy approach should continue to be based on identifying and taking into account the pro-competitive effects of projects and initiatives on the EU market. Such pro-competitive effects in turn can contribute to increasing the competitiveness of the companies involved.

6.5. Implications for the interface between industrial policy and other competitiveness-related policies

Any reflections on the general principles governing a policy approach have their litmus test in their practical application. This reality check is all the more important — yet particularly difficult — if the issues addressed are new and complex, necessitating a careful balancing of objectives (such as free trade vs targeted intervention) the implications of which are not fully clear in advance. This certainly applies to the developments discussed in this chapter, which form a moving target and which are only now starting to draw the attention of both policy makers and the wider public.

What is certain in such a context is that individual policies aiming to enhance competitiveness, such as industrial and competition policies but also trade, internal market and other policies, need to engage in a well coordinated exploitation of policy synergies based on sound and joint analysis of socioeconomic developments, which by necessity starts with fact finding. The discussion of the industrial and competition policy interface in the 2002 Competitiveness Report pointed to the existence of such synergies and the merits of exploiting them. Events since then have reinforced this observation.

The subsequent discussion in this section therefore advances and deepens this discussion in the light of recent and expected future developments. Two principles apply:

1. This discussion is driven by practical examples of particular relevance at this moment in time. They should not be seen as a complete list of issues to be addressed but rather as typical examples. In fact, new manifestations of the challenges facing

European industry materialise by the day, and any assessment of them needs to draw on the general tools discussed above and applied below in related fields.

2. The development of a consistent policy framework that addresses all challenges noted above has to be preceded by a sound analysis, including assessment of their likely impact on the main dimensions of European competitiveness. This will take time. In many instances, however, there is a need for swift and timely policy action, which in the absence of enhanced legal tools and instruments needs to build upon a reinterpretation and extension of the current framework. The following considerations therefore start from the legal status quo, which by no means excludes that bolder steps are considered and prepared in parallel.

6.5.1. Securing the strength of the European industrial value chain

The following remarks provide examples of how existing competition and trade policy instruments can be used and extended to continue safeguarding industrial competitiveness in the context of the challenges outlined above. The sub-section below starts with merger control and antitrust enforcement, whereas state aid rules are considered in a subsequent sub-section.

6.5.1.1. Applying merger control and antitrust enforcement to support industrial competitiveness

As discussed in section 6.3, the legislative framework evolves in line with broader socioeconomic developments. This also applies to competition rules, where European merger control and antitrust regimes have undergone significant changes over the last decade. The more economic approach to merger control, applied since the 2004 reforms and supplemented by the 2008 round of guidance documents,[191] has resulted in a framework that is increasingly focused on the economic impact of concentrations on competition in the European Economic Area (EEA). The antitrust rulebook has been developed with a similar objective in mind and provides increasingly better guidance on the relevant economic considerations to companies, which since 2003 are responsible for self-assessing that their conduct is in line with these rules.

These improvements constitute a shift towards a more sophisticated assessment of economic reality. It also allows the Commission to contribute to competitiveness through a more sophisticated evaluation of notified mergers and acquisitions. Despite the fact that many of the more than 2000 mergers notified to the Commission since 2004 have touched upon crucial industries or transactions with far-reaching economic consequences, the Commission has managed, with 1835 clearances, 117 conditional clearances and only three prohibitions, to ensure that these transactions are fully in line with the EU's competitiveness objectives.[192] In fact, the Commission has not prohibited any merger with any industrial policy relevance since the 2004 Merger Regulation entered into force.

In this context, it should be stressed that European merger control policy has not prevented European companies from becoming champions on global markets. The Commission's practice rather shows the contrary. Prominent cases, including EADS, Glaxo/Smithkline, GdF/Suez and SAP/Sybase, not only demonstrate that there is no inevitable antagonism between the idea of allowing companies to fully benefit from the enlarged Single Market

[191] The most important are the revised Merger Regulation No 139/2004 of 20 January 2004, the Horizontal Merger Guidelines (OJ 2004/C 31/03) of 05 February 2004, and the Non-Horizontal Merger Guidelines (OJ 2008/C 265/07) of 18 October 2008.

[192] Figures are for the period between January 2005 to March 2011 (referrals to the Commission or to the Member States explain the difference in figures).

'base camp' and the need to protect European consumers.[193] They also show that the European Commission, within and in accordance with existing EU competition rules, takes into account businesses' concerns about their competitiveness on markets outside the EU and the need for size in this regard — concerns that will become ever more pressing in the globalisation era — as 'Europe needs European champions that are able to grow on their own merits and to run with their legs in the global race.'[194]

The economic trends identified in the preceding sections and the dynamic character of the EU policy framework mean that decision making has to be constantly adapted. This does not necessarily require new rules; in fact, the current rules provide enough flexibility if properly interpreted.[195] It however calls for a vigilant eye for these new developments and a constant updating of the detailed application of the tools. For this reason, the Commission regularly assesses the effectiveness of its policy and enforcement tools in order to ensure that they reflect market realities and the latest economic learning and to take into account the interests and concerns voiced by industry.

A number of features in the application of EU merger control policy can be said to contribute to EU industrial competitiveness. The first concerns geographic market delineation or, more generally, the geographical scope of competitive constraints in evaluating mergers or market positions. At least as regards investment goods and intermediary products (less so for branded consumer goods), markets are becoming ever wider and falling transport costs coupled with better IT inter-linkages are increasingly facilitating global competition. In times of global integration, markets are becoming EEA-wide or wider. In this regard, the Commission is determined to maintain its current practice of assessing such developments as and when they materialise taking into account the specific facts of the case, e.g. by adequately taking rising competition from newly emerging countries into account (such as in the decision on Arsenal/DSP).

The massive increase in the division of labour on a global scale and the rise of globally distributed integrated value chains also require a special focus on the vertical relationships between companies. While this trend has proven, in essence, to be pro-competitive and to allow European enterprises to benefit from economies of specialisation, it has also added complexity and vulnerability to the environment that companies face. Again, it is primarily for companies to guard themselves against these risks (as exemplified by the recent trend to near-sourcing). The regulatory regime — merger control ex ante and antitrust ex post — will continue to face the task, among others, of preventing, respectively, the emergence of dominant positions in these value chains and the abuse of dominant positions or significant impediments to competition. The global reach of both policies (as the effect matters, not the location of companies) plays an important role if suppliers are concentrated outside the EU.[196]

In a more dynamic global environment, it may be increasingly relevant to evaluate the benefits and efficiencies brought by agreements and transactions. Where dynamic efficiencies can be expected to play a very prominent role, even though their evaluation is more difficult and requires more time, a pro-active approach is warranted. As regards specific merger

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[193] Speech by Vice-President Almunia on 28 September 2010 on 'The past and the future of merger control in the EU': http://europa.eu/rapid/pressReleasesAction.do?reference=SPEECH/10/486&format=HTML&aged=1&language=EN&guiLanguage=en; further examples include Lufthansa/SN Brussels Airlines, Lufthansa/Austrian Airlines, Air France/KLM, EDF/British Energy and Carrefour/Promodès.

[194] Mario Monti, *A New Strategy for the Single Market*, Report to the President of the European Commission, 09 May 2010.

[195] The core of substantive EU merger secondary law/guidance dates from 2004 and 2008. An (albeit important) exception is the Market Definition Notice (OJ 97/C 372/03), which has not been revised since 1997.

[196] Global sourcing also presents the problem of how to take into account indirect sales in cartel cases.

efficiencies, the Commission will look at such efficiencies where the parties make such claims (it being understood that it is for the parties in such cases to provide the necessary evidence from the outset).

As detailed in section 6.2.2 above, the governments of some emerging economies have a much greater role in the economy than is customary in the EU. These non-market interventions present some challenges for applying merger and antitrust rules to cases in the extensive grey area between the public and private sectors. The instruments developed to take into account public sector links in the Member States or other market economies are therefore applied to a much wider spectrum of possible government interference (e.g. to establish the true ownership/control of enterprises in non-market economies). In merger control for instance, the Commission's 2008 Consolidated Jurisdictional Notice provides a framework for assessing state influence on undertakings. This has also been employed in practice in cases involving non-EU state governments (recent examples are the Bluestar/Elkem, DSM/Sinochem and Petrochina/Ineos mergers). Quite often, the problem in such cases is the difficulty of obtaining from those countries the information necessary to perform a thorough assessment.

The pressure to restructure and the benefits from doing so are multiplied in an open economy with rapid technological progress. Since restructuring, in terms of adaptation to both cyclical and structural changes, is primarily the responsibility of firms, the regulatory framework must allow them to act on their responsibility. Companies aiming to restructure via mergers or acquisitions will in many instances depend on approval under the merger control regime. Restructuring attempts that do not go as far as a merger and which instead are implemented via coordination between companies must be in line with the antitrust rules on cooperation between undertakings. For both merger control and antitrust action the toolbox is in place — in merger control for example the failing firm defence, the counterfactual defence, or the efficiency defence can be cited, while antitrust action has the specialisation Block Exemption Regulations and the guidelines on horizontal cooperation agreements. Recent merger cases have included very elaborate restructuring analysis and have clearly demonstrated that a return to profits via the creation of a monopoly goes beyond reasonableness (e.g. Olympic/Aegean). Companies that need to exchange information on past and present strategic data (for example demand or capacities) that can be crucial for the allocation of production to high-demand markets may benefit from the more detailed guidance given in the revised Horizontal Guidelines.

Finally, the intensified competition between economic areas also requires a continued focus on the cost of doing business in Europe. An effective regulatory regime, maintaining the competitiveness of European industry, by its very nature requires resources from companies involved in proceedings. The Commission's efforts to reduce the length of investigations (e.g. through the recent introduction of settlement procedures) and increase the transparency and predictability of enforcement can contribute to keeping Europe attractive as a place to invest. This is even more important if one considers that multiple jurisdictions all over the world often wait with their assessment of a transaction until they know the final position of the European Commission. The Commission, as one of the leading role models for competition policy worldwide, has a natural role to play in aligning substantive and procedural tools around the world and thereby tackling the problem of the ever increasing cost of multi-jurisdictional filings and preventing inconsistent demands on enterprises from different national competition authorities.

6.5.1.2. Making full use of policy toolkits in the global context

Monitoring and assessing the risks of disruption of production chains as well as establishing the balance between economies of scale, security of supply and technological leadership in a specific economic context is the primary responsibility of businesses. They are closest to the market and thus have the best available information. Moreover, they are the first to feel the consequences. And yet, the increasing involvement of states, in particular non-EU non-market economies that have their own approach to the delineation between private and public interests, creates an asymmetry that European industry on its own cannot handle.

Traditional forms of disruptive threats to the EU's industrial value chains are usually directly linked to distorted price competition. Current European trade defence instruments (anti-dumping, anti-subsidy and safeguard measures), designed in conformity with WTO rules, enable the European Commission to address most of these issues. However, in the context of the internationalisation of value chains and 'low intensity protectionism', new threats to the integrity of value chains have emerged. On top of the risks outlined above, the recent economic and financial crisis has demonstrated how exposed key suppliers, which are often SMEs, can become if access to finance deteriorates, which is often unconnected to individual economic performance. In fact, one lesson from the crisis is that many European manufacturing sectors active in global value chains depend on the timely delivery of key inputs produced by a handful of relatively small suppliers, in some instances only one or two. In line with the concept developed in section 6.3.3, these can be considered as 'strategic', as they are often indispensible not only for a sector as a whole but for more than one single manufacturing activity. In addition, the products manufactured with their input have significance not only for applications in various sectors but also in specific public policy contexts.

Such strategic importance for the integrity of the European industrial fabric increasingly turns these companies into targets for acquisitions. From an industrial policy perspective, it is important to closely monitor and assess the consequences, the more so when public authorities in non-EU countries are involved in such transactions. For example, recent scientific research suggests that mergers and acquisitions by Chinese companies, which often are state-owned, are increasingly strategic, building upon the underlying principle of 'digesting rather than investing'.[197]

As a result, major EU competitors (including recently 'free trade' ones, such as Canada and Australia) have recently strengthened their policy toolkit to be able to prevent malpractices and better preserve national interests. Although some EU Member States have similar systems in place, the EU as a whole remains one of the most open economic blocs in the world. A careful and balanced analysis seems warranted to assess how to maintain this openness while taking into account the increasingly strategic dimension in global competition. This process would usefully build on input from and constant dialogue with European industry to flag risks. It could also involve a broader activation of existing frameworks, whether EU country teams abroad or information exchange mechanisms in the public realm.

As a complement, notably in the short run, existing instruments such as the Commission's merger control system can continue to be applied, either directly or through meaningful exploitation of unused opportunities, to provide a 'safety net' for takeovers that could potentially restrict competition, such as by blocking downstream access to an essential input or eliminating innovative 'mavericks' in a specific industry. In fact, merger control disallows such negative competitive effects unless sufficient clear-cut remedies are offered to offset them.

However, the EU merger control system is neutral as regards the origin of the merging parties and applies in the same way to EU and non-EU companies. It is firmly rooted in the idea that competitive market structures need to be maintained to benefit consumers and businesses. This neutrality ensures that the merger review process is transparent, manageable and predictable to the investing community. It is also in line with the EU's long-established commitment to openness to the rest of the world, and gives the EU a moral high ground in

[197] E.g. Ping Deng (2009): 'Why do Chinese firms tend to acquire strategic assets in international expansion?', Journal of World Business 44 (2009) 74–84.

arguing for non-discriminatory treatment at international level regarding the outgoing investments of European companies in third countries. At the same time, though, the merger control system ensures that global mergers and acquisitions do not have any negative impact on prices, innovation and choice in Europe.

Addressing efficiently both traditional and 'innovative' forms of threats to the integrity of the EU's industrial value chains requires the EU to develop a stronger horizontal coordination of its various instruments and policies. A more in-depth articulation of competition, trade and industrial policies has to be developed, in order to ensure a coherent and consistent approach to the protection of industrial value chains. A particularly crucial issue for this horizontal approach is the conditions under which such protection is allowed. An example from the current regulations governing trade defence instruments is the 'Community interest test' to determine whether the implementation of planned measures is in the interest of European industries, users and consumers. Such a mechanism for a horizontal approach would be based on the concept of European interest, as defined in section 6.3.3.

6.5.2. Enhancing the scope, impact and timing of targeted state support

Industrial policy objectives that aim to enhance competitiveness are complemented by state aid control, which aims to safeguard the undistorted functioning of the Single Market, in particular in a period when Member States' room for manoeuvre is limited by fiscal constraints due to the economic and financial crisis. While existing instruments could be screened for unused potential, including procedural improvements, any extensions to the existing framework should be considered with care and based on the proper identification of well-demonstrated needs.

6.5.2.1. Timely and efficient state aid assessment in a global context

Business success first and foremost depends on entrepreneurial vision and its translation into viable business plans. State aid often provides an indispensible additional impetus to bridge specific phases in the development of new products and processes not otherwise accommodated by the market, but it remains a supplement to and not the *raison d'être* for economic activity.

In order to speed up the decision-making process and to address the time issue as such, which is a key dimension for competitiveness, especially in R&D&I projects, it is essential to continue improving the information flow between the Commission and stakeholders. Despite the best efforts of the Commission to minimise the time state aid decisions take, long delays — often caused by inefficient information flows outside the Commission — still occur, which may in certain cases be incompatible with the often urgent financing needs of enterprises. The recent procedural simplifications and the adoption of the Best Practices Code help to address such shortcomings, in particular through the generalisation of early prenotifications. Beyond helping to save time, this also serves to clarify the context of a project from the beginning and to establish a clear view of the rationale and impact of any aid needed for European companies.

It is also essential to raise stakeholders' awareness of the need for the Commission to have access to useful and updated data on markets and sectors, in particular if they have global dimensions. While the Commission can in most cases rely on its own resources, there are specific situations where cross-sector information is required and where the early supply of such data by Member States and companies can accelerate the assessment of a project.

The time needed for assessment could also be reduced by more dynamic cooperation between the Commission and Member States. At the same time, sustained advocacy activities whereby the Commission seeks to explain to stakeholders the possibilities offered by the state aid framework, to enable them to make the best use of the rules, can also contribute to further reducing the length of the assessment process, for instance in the field of R&D&I. In fact, as most of the state aid rules currently in force are the result of legislation adopted following the 2005 State Aid Action Plan, they have so far been applied for a relatively short period of time. Therefore, both companies and Member State authorities still need to gain broader experience and sufficient knowledge of the practical use of these rules.

6.5.2.2. Maintaining a strong and diversified industrial base in Europe

To achieve the objective of maintaining a competitive and diversified industrial base, which could in turn contribute to the smart, sustainable and inclusive growth target set by the Europe 2020 strategy, the EU has to ensure that firms find the appropriate business environment they need to grow and innovate, to carry out their activities or to change their business models and strategies. This forward-looking strategy requires that access to finance is improved for all types of companies in the value chain, with a view to adequately addressing their needs and projects.

Globalisation trends put pressure on Europe as a location for doing business, not only directly but also through a lack of important suppliers or raw materials. From an industrial competitiveness perspective, state aid policy contributes to addressing this challenge by recognising that a strong competitive market structure in Europe is an objective of common interest. In general, and as explained above, effective access to finance must be ensured in a continuous way. State aid often contributes to improving such access to finance, in particular when the market does not provide sufficient alternative means of finance, for example through venture capital funds. Moreover, access to finance can be relevant for specific activities, such as R&D&I, where market failures exist. In this field, there is a need to consolidate the Single Market, which forms the base camp for European companies, in order to decrease the innovation divide between poor and developed regions. In fact, in a context of rigid fiscal constraints in several Member States, it is important to improve the use of the Structural Funds for innovation priorities. The experience gained within the current programming period should usefully guide any initiative to improve the status quo.

Moreover, difficulties in access to finance could hamper the development of projects in technologies where Europe is leader or intends to invest to become one, such as KETs, referred to in the Industrial Competitiveness Communication. In addition, lack of financial resources could prevent exploration and development of the unused innovation potential in services, essential to address the many societal challenges faced by the EU. In both cases, well-targeted state support can compensate for financial markets that have turned overly risk-adverse.

6.5.2.3. Support for early adjustment processes and restructuring of European enterprises

While companies and sectors know best their needs for restructuring and are in principle responsible for these processes, wherever necessary and appropriate state aid could usefully support such processes in various ways. As mentioned in section 6.4.4, all companies at almost all stages of their business life constantly adjust their business strategies: some may already find themselves in structural difficulties, whereas others are in a stable situation but in transitional adjustment.

Independently of any difficulties, such companies may need, at one point in time, state support in order to accompany the transition or to address their structural problems and ensure and/or restore long-term viability, as the biggest problem for firms undergoing restructuring is access to finance.

One of the main challenges encountered by European firms is the simultaneous expansion of their potential markets and the emergence of global competitors covering increasingly larger parts of the value chain. This double trend puts pressure on European firms, which have to modernise, innovate and access new markets at the same time. The main challenge for many of them is size; hence, it could be beneficial to further explore the potential for cross-border cooperation between firms, research centres, and Member States, for example in relation to KETs.

European state aid policy can indirectly contribute, within its own logic, to the promotion of such cross-border initiatives. For instance in the field of R&D&I, the current rules already encourage cooperation beyond national frontiers through a higher aid intensity applicable to cross-border projects. This possibility has so far not been much used by Member States, since it is still culturally and politically difficult for national authorities to fund the costs of a project which is not entirely located within their territory. However, in the face of increased global competition, trans-border cooperation between firms has to be understood as a necessity not only for the success of a project but for pursuing the strategic European interest as a whole, including the interests of the territories of the Member States granting the aid. In this respect, it may also be noted that the state aid notion of a 'project of common European interest', provided for by Article 107(3)(b) TFEU and the 2006 Framework on State Aids to R&D&I, has so far rarely been used by Member States.

6.6. Conclusions

The last decade has witnessed the emergence of trends that will permanently transform the arena in which European industry operates. Within the EU, enlargement has unleashed a socioeconomic dynamic that provides firms with new opportunities and a strong base camp, but the Single Market is as yet unfinished. Outside the EU, globalisation has greatly widened potential markets, but also intensified competition and resulted in the emergence of major new players on a global scale, not all of which play by the market economy rule book. The economic and financial crisis has resulted in fiscal constraints that reduce leverage at Member State level. As discussed in detail above, these challenges necessitate the stepping up of efforts to enhance the competitiveness of European industry, which in turn requires a strategic European response that bundles resources from lower levels of decision-making.

This chapter started by enquiring how the relationship between the EU's set of competitiveness-related policies (exemplified by but not confined to the EU's industrial and competition policies, considered to be complementary in the 2002 Competitiveness Report) could be further improved in the light of 'new challenges that emerge at an accelerating rate: new markets, new ways of doing business, new drivers of growth and of dynamic competition.'[198] The response is clear: more than ever, the global nature of the main challenges requires full use and, where possible and appropriate, better integration of individual policies and a streamlining of concepts and existing instruments. The great questions Europe faces today necessitate a horizontal approach that applies consistent policy tools to specific questions. The preceding analysis has provided examples for such an approach, but the list is not complete and grows by the day.

Much of what can and should be done does not require a radical overhaul of the rules that govern the system. Instead, it calls for a pro-active approach that uses unexploited potential within the existing framework and only extends it where demonstrably necessary. Implementing a European strategy is a question of will, not ability. The tools are in place, as are the drivers, which beyond the political players consist of the most important facet of competitiveness: European firms, which in many fields are global leaders and benchmarks for excellence. A closer alignment between the real needs of enterprises at global level and the practical will to offer solutions at short notice is the main deliverable all competitiveness policies have to provide. This is precisely what a symbiosis of industrial dynamism, competition policy rigour and the global reach of trade policy can deliver.

[198] European Commission (2002), p. 93.

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7. SECTORAL COMPETITIVENESS INDICATORS

Explanatory notes

Geographical coverage: all indicators in tables 7.1 to 7.8 refer to EU-27. The indicators in tables 7.9 and 7.10 refer to the individual Member States, EU-27, the US, Japan, Brazil, China, India and Russia.

Production index[199]: The production index is an index of final production in volume terms.

Labour productivity: this indicator is calculated by combining the indexes of production and number of persons employed or number of hours worked[200]. Therefore, this indicator measures final production per person of final production per hour worked.

Unit Labour Cost: it is calculated from the production index and the index of wages and salaries and measures labour cost per unit of production. “Wages and salaries” is defined (Eurostat) as “the total remuneration, in cash or in kind, payable to all persons counted on the payroll (including homeworkers), in return for work done during the accounting period, regardless of whether it is paid on the basis of working time, output or piecework and whether it is paid regularly wages and salaries do not include social contributions payable by the employer”.

Relative Trade Balance: it is calculated, for sector “i”, as (Xi-Mi)/(Xi+Mi), where Xi and Mi are EU-27 exports and imports of products of sector “i” to and from the rest of the World.

Revealed Comparative Advantage (RCA):

The RCA indicator for product “i” is defined as follows:

$$RCA_i = \frac{\dfrac{X_{EU,i}}{\sum_i X_{EU,i}}}{\dfrac{X_{W,i}}{\sum_i XW,i}}$$

where: X=value of exports; the reference group (‘W’) is the EU-25 plus 38 other countries (see list below); the source used is the UN COMTRADE database. In the calculation of RCA, X_{EU} stands for exports to the rest of the world (excluding intra-EU trade) and X_W measures exports to the rest of the world by the countries in the reference group. The latter consists of the EU-25 plus the following countries: Afghanistan, Albania, Algeria, Angola, Argentina, Armenia, Australia, Azerbaijan, Bahamas, Bahrain, Bangladesh, Belarus, Belize, Benin, Bhutan, Bolivia, Bosnia Herzegovina, Botswana, Brazil, Brunei, Burkina Faso, Burundi, Cambodia, Cameroon, Canada, Cape Verde, Central African Rep., Chad, Chile, China, China, Hong Kong SAR, China, Macao SAR, Colombia, Comoros, Congo, Costa Rica, Côte d'Ivoire, Croatia, Cuba, Dem. People's Rep. of Korea, Dem. Rep. of the Congo, Djibouti, Dominican Rep., Ecuador, Egypt, El Salvador, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Georgia, Ghana, Guatemala, Guinea, Guinea-Bissau, Haiti, Honduras, Iceland, India, Indonesia, Iran, Iraq, Israel, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Kuwait, Kyrgyzstan, Lao People's Dem. Rep., Lebanon, Lesotho, Liberia, Libya, Madagascar, Malawi, Malaysia, Maldives, Mali, Mauritania, Mauritius, Mexico, Mongolia, Montenegro, Morocco, Mozambique, Myanmar, Namibia, Nepal, Neth. Antilles, New Zealand, Nicaragua, Niger, Nigeria, Norway, Occ. Palestinian Terr., Oman, Pakistan, Panama, Paraguay, Peru, Philippines, Qatar, Rep. of Korea, Rep. of Moldova, Russian Federation, Rwanda, Saudi Arabia, Senegal, Serbia, Sierra Leone, Singapore, Somalia,, South Africa, Sri Lanka, Sudan, Suriname, Swaziland, Switzerland, Syria, Tajikistan, TFYR of Macedonia, Thailand, Timor-

199 The data are working-day adjusted for production.

200 The data are working-day adjusted for hours worked.

Leste, Togo, Trinidad and Tobago, Tunisia, Turkey, Uganda, Ukraine, United Arab Emirates, United Rep. of Tanzania, Uruguay, USA, Uzbekistan, Venezuela, Viet Nam, Yemen, Zambia, Zimbabwe.

For services, countries consist of EU-25 plus the following 75 countries: Albania, Algeria, Argentina, Armenia, Aruba, Australia, Azerbaijan, Bangladesh, Belarus, Bermuda, Bolivia, Bosnia & Herzegovina, Botswana, Brazil, Cambodia, Canada, Cape Verde, Chile, China,P.R.: Mainland, China,P.R.:Hong Kong, China,P.R.:Macao, Costa Rica, Croatia, Egypt, El Salvador, Ethiopia, The Gambia, Georgia, Guatemala, Guinea, Honduras, Iceland, India, Indonesia, Israel, Japan, Kazakhstan, Kenya, Republic of Korea, Kuwait, Kyrgyz Republic, Macedonia, Malaysia, Mauritius, Mexico, Moldova, Montenegro, Morocco, Mozambique, Namibia, New Caledonia, New Zealand, Norway, Pakistan, Panama, Paraguay, Peru, Philippines, Russian Federation, Saudi Arabia, Republic of Serbia, Seychelles, Singapore, South Africa, Sri Lanka Switzerland, Tanzania, Thailand, Tunisia, Turkey, Uganda, Ukraine, United States, Uruguay, Zambia.

Data sources: Tables 7.1 to 7.6 are based on Eurostat's indicators. Tables 7.7 to 7.9 are based on United Nations' COMTRADE. Table 7.10 is based on IMF, OECD and Eurostat data.

Table 7.1: EU-27 - Industry production index, annual growth rate (%)

Code (NACE Rev. 2)	Sector	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Average 2005-2010
B	MINING AND QUARRYING	1,9	-2,3	-3,1	0,5	-3,2	-2,2	-6,4	-4,1	0,3	-4,0	-10,9	-0,8	-4,
C	MANUFACTURING	1,2	4,8	0,2	-0,3	0,4	2,7	1,7	4,9	4,2	-1,7	-14,8	7,6	-0,
C10	Manufacture of food products	1,2	1,2	1,2	1,9	0,2	2,2	2,4	1,5	2,0	-0,6	-1,0	2,4	0,
C11	Manufacture of beverages	6,1	-0,5	2,6	2,6	1,6	-2,5	1,3	4,2	1,5	-2,0	-2,6	-1,3	-0,
C12	Manufacture of tobacco products	-3,2	-8,6	-2,9	-0,9	-6,9	-6,4	-4,0	-4,9	2,3	-16,9	-3,0	-5,9	-5,
C13	Manufacture of textiles	-5,6	0,3	-3,1	-4,8	-3,4	-4,7	-3,8	-0,7	-1,3	-9,7	-17,4	8,5	-4,
C14	Manufacture of wearing apparel	-9,2	-5,4	-4,1	-10,7	-6,1	-4,9	-8,9	2,4	2,4	-3,4	-11,2	0,7	-2,
C15	Manufacture of leather and related products	-4,1	-2,2	-5,2	-7,5	-7,2	-11,4	-9,1	-1,8	-1,6	-7,6	-13,0	3,0	-4,
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	3,3	6,9	-4,2	0,5	2,4	3,4	0,1	4,3	1,9	-8,7	-14,2	3,9	-2,
C17	Manufacture of paper and paper products	3,1	3,6	-2,3	3,4	1,7	3,2	-0,3	3,6	2,7	-3,5	-9,2	6,1	-0,
C18	Printing and reproduction of recorded media	2,4	0,9	-2,3	-0,1	-1,3	1,4	2,3	0,4	0,6	-2,5	-7,2	1,7	-1,
C19	Manufacture of coke and refined petroleum products	-4,8	4,7	0,4	-2,7	2,0	4,9	-0,8	1,6	-0,4	3,1	-7,8	0,2	-0,
C20	Manufacture of chemicals and chemical products	2,4	3,5	-0,9	2,7	-0,2	3,3	1,6	3,6	2,8	-3,2	-11,0	9,8	0,
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	8,5	5,2	10,4	8,9	5,3	-0,2	4,8	6,3	1,8	1,1	3,4	5,9	3,
C22	Manufacture of rubber and plastic products	2,1	5,0	-0,5	0,0	1,9	1,7	0,8	4,1	4,4	-4,4	-13,8	7,9	-0,
C23	Manufacture of other non-metallic mineral products	2,3	3,9	-0,6	-1,7	0,5	1,8	0,8	4,4	2,0	-6,7	-18,8	2,6	-3,
C24	Manufacture of basic metals	-3,8	4,1	-0,7	0,1	-0,5	4,9	-0,6	5,7	0,7	-2,7	-26,8	18,8	-2,
C25	Manufacture of fabricated metal products, except machinery and equipment	0,5	6,7	0,3	-0,5	0,8	2,6	1,6	5,0	5,9	-2,2	-22,2	7,4	-1,
C26	Manufacture of computer, electronic and optical products	5,0	12,7	-5,5	-6,6	1,5	7,7	4,6	10,1	11,4	2,6	-15,1	11,3	3,
C27	Manufacture of electrical equipment	2,3	9,5	-0,1	-3,0	-2,3	3,1	1,2	8,4	4,8	-0,1	-20,7	11,2	0,
C28	Manufacture of machinery and equipment n.e.c.	-1,9	6,0	1,4	-2,1	-0,8	4,1	4,0	8,4	8,4	2,0	-26,1	10,4	-0,
C29	Manufacture of motor vehicles, trailers and semi-trailers	3,6	7,0	2,3	0,8	2,0	5,2	1,8	3,1	6,2	-5,9	-24,2	21,1	-1,
C30	Manufacture of other transport equipment	-0,2	0,6	0,9	-4,1	1,4	0,9	2,7	9,1	3,9	4,7	-6,1	-2,8	1,
C31	Manufacture of furniture	3,2	1,6	-1,8	-4,5	-2,2	0,5	0,5	3,2	3,2	-4,2	-16,5	-0,9	-3,
C32	Other manufacturing	1,0	4,9	3,7	2,5	-0,8	1,7	1,2	5,0	2,1	-1,2	-5,9	8,0	1,
C33	Repair and installation of machinery and equipment	0,4	4,9	0,4	-3,7	-0,7	4,7	1,7	9,2	3,7	5,0	-8,9	3,8	2,
D	ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY	2,4	3,4	2,3	0,7	2,9	2,2	2,1	1,0	-0,7	0,1	-4,8	4,3	-0,
E	WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/
F	CONSTRUCTION	4,2	4,0	0,5	1,1	1,8	0,8	1,9	3,6	2,0	-3,8	-8,5	-4,1	-2,

N/A: Data not available
Source: Eurostat

Table 7.2: EU-27 - Number of persons employed, annual growth rate (%)

Code (NACE Rev. 2)	Sector	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Avera 2005-2
B	MINING AND QUARRYING	-8,0	-8,2	-3,3	-4,7	-4,5	-4,6	-3,2	-3,9	-3,5	-1,4	-3,7	-4,5	
C	MANUFACTURING	-1,8	-0,5	0,0	-2,0	-2,0	-1,9	-1,4	-0,7	0,5	-0,3	-7,1	-3,7	
C10	Manufacture of food products	-0,6	-0,6	-0,6	-0,9	-0,5	-1,2	0,0	-0,1	0,0	-0,1	-2,0	-0,5	
C11	Manufacture of beverages	N/A	N/A	-1,8	-1,2	-1,8	-1,4	-1,5	-1,4	-0,2	-1,2	-6,3	-1,6	
C12	Manufacture of tobacco products	-9,1	-3,7	-3,3	-0,4	-5,5	-5,3	-2,6	-1,5	-9,4	-8,0	-5,2	-5,5	
C13	Manufacture of textiles	-6,7	-3,6	-3,3	-5,1	-7,2	-6,2	-4,5	-5,9	-5,2	-6,4	-12,9	-5,3	
C14	Manufacture of wearing apparel	-3,9	-5,7	-3,3	-3,7	-4,0	-6,2	-7,7	-5,7	-5,6	-6,4	-12,8	-9,2	
C15	Manufacture of leather and related products	-6,5	-3,3	-1,1	-1,0	-4,4	-6,8	-5,8	-2,7	-3,1	-5,2	-12,0	-3,9	
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	-0,2	-0,8	-1,2	-1,8	-1,3	-1,4	-0,8	-0,8	0,9	-2,2	-12,1	-3,9	
C17	Manufacture of paper and paper products	-3,3	-1,5	-1,6	-1,0	-2,8	-1,6	-2,6	-2,6	-2,7	-2,0	-5,1	-2,6	
C18	Printing and reproduction of recorded media	-0,8	-0,6	-0,4	-2,2	-4,0	-1,9	-3,3	-1,6	0,0	-2,3	-7,0	-5,2	
C19	Manufacture of coke and refined petroleum products	-2,1	-1,3	-2,1	-3,0	-3,3	-2,1	-3,3	-3,5	1,3	-0,8	-2,7	-4,3	
C20	Manufacture of chemicals and chemical products	-2,8	-2,7	-0,8	-1,7	-2,6	-3,2	-2,1	-1,2	-0,6	-2,3	-4,6	-2,5	
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	N/A	N/A	2,0	2,3	-0,4	-2,8	-1,1	1,9	0,8	-2,1	-3,6	-0,8	
C22	Manufacture of rubber and plastic products	-0,8	2,4	0,9	-0,9	0,2	-0,1	-0,7	-0,8	1,6	0,5	-6,8	-1,2	
C23	Manufacture of other non-metallic mineral products	-2,1	-0,5	-0,7	-2,3	-2,7	-2,1	-1,0	-0,5	1,4	-2,0	-10,3	-5,4	
C24	Manufacture of basic metals	-3,5	-4,2	-0,3	-4,0	-3,2	-3,9	-1,1	-1,0	-0,4	-0,4	-8,2	-6,0	
C25	Manufacture of fabricated metal products, except machinery and equipment	0,1	0,9	0,8	-1,1	-1,2	0,1	-0,3	1,3	3,3	2,6	-8,2	-4,8	
C26	Manufacture of computer, electronic and optical products	-2,0	4,2	1,8	-5,9	-4,5	-2,9	-1,3	-0,8	1,1	-1,9	-8,4	-4,4	
C27	Manufacture of electrical equipment	-1,6	1,5	0,1	-3,9	-4,1	-1,3	-0,6	1,0	2,5	1,2	-8,1	-3,0	
C28	Manufacture of machinery and equipment n.e.c.	-2,6	-2,0	1,0	-1,4	-2,2	-2,4	-0,9	0,8	2,9	2,1	-5,6	-5,6	
C29	Manufacture of motor vehicles, trailers and semi-trailers	0,2	2,1	1,7	-1,0	-0,3	0,2	-0,8	-1,0	-0,2	0,9	-9,0	-2,6	
C30	Manufacture of other transport equipment	-2,2	-2,2	-0,3	-1,5	-2,7	-1,7	0,3	0,6	2,8	2,0	-2,8	-5,5	
C31	Manufacture of furniture	N/A	N/A	0,4	-3,3	-0,1	-2,5	-2,5	-1,1	0,3	-2,1	-9,0	-6,3	
C32	Other manufacturing	-1,8	-5,3	0,9	-1,6	-0,2	-1,0	-1,8	-0,3	0,3	0,2	-2,8	-1,1	
C33	Repair and installation of machinery and equipment	-1,8	-4,9	-0,1	-2,8	-2,4	-1,0	-0,5	0,3	0,4	3,8	-2,1	-3,5	
D	ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY	-3,3	-3,9	-2,9	-4,3	-4,3	-3,8	-2,5	-1,3	-1,5	-0,8	3,0	1,0	
E	WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	-0,7	1,0	-1,4	-0,4	0,4	-0,8	-1,8	1,4	0,5	-0,5	0,4	-0,2	
F	CONSTRUCTION	1,1	-0,4	0,1	-0,5	0,6	1,4	2,5	4,1	4,9	-0,9	-7,6	-5,4	

N/A: Data not available

Table 7.3: EU-27 - Number of hours worked, annual growth rate (%)

Code (NACE Rev. 2)	Sector	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Average 2005-2010
B	MINING AND QUARRYING	N/A	N/A	-3,0	-5,0	-6,1	-3,6	-3,2	-4,0	-2,8	-1,3	-4,6	-2,8	-3,1
C	MANUFACTURING	N/A	N/A	-1,2	-2,4	-2,4	-1,2	-1,6	-0,1	0,3	-0,7	-9,3	-0,7	-2,2
C10	Manufacture of food products	N/A	N/A	-1,2	-2,3	-1,8	-0,2	-0,7	0,2	-0,4	0,1	-2,8	0,2	-0,5
C11	Manufacture of beverages	N/A	N/A	-0,7	-3,8	-0,8	0,3	-2,9	-3,5	-0,7	-2,0	-4,8	-3,6	-2,9
C12	Manufacture of tobacco products	N/A	N/A	2,2	-2,5	-8,9	-5,9	-4,2	-5,6	-3,1	-9,5	-6,7	-2,6	-5,5
C13	Manufacture of textiles	N/A	N/A	-3,4	-4,7	-6,5	-5,6	-5,2	-5,0	-2,7	-5,6	-14,7	0,6	-5,6
C14	Manufacture of wearing apparel	N/A	N/A	-4,1	-3,5	-3,9	-3,8	-3,8	-3,9	-5,3	-6,5	-14,3	-8,4	-7,8
C15	Manufacture of leather and related products	N/A	N/A	-2,4	-3,4	-3,9	-3,8	-4,3	-1,2	-3,9	-5,8	-11,0	-0,6	-4,6
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	N/A	N/A	-3,8	-2,0	-1,9	-0,4	-1,4	0,0	0,0	-2,9	-12,8	-0,1	-3,3
C17	Manufacture of paper and paper products	N/A	N/A	-2,0	-2,3	-0,9	-1,8	-2,3	-1,4	-1,4	-3,5	-7,2	-1,1	-3,0
C18	Printing and reproduction of recorded media	N/A	N/A	-0,4	-3,7	-4,0	-3,3	-2,6	-0,4	0,2	-1,5	-5,5	-3,9	-2,3
C19	Manufacture of coke and refined petroleum products	N/A	N/A	-2,2	-4,2	-1,6	-0,4	-0,3	-3,4	1,1	2,6	-8,1	-3,0	-2,2
C20	Manufacture of chemicals and chemical products	N/A	N/A	-2,2	-2,6	-2,5	-1,9	-2,8	-1,4	-1,4	-1,8	-5,2	-0,7	-2,1
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	N/A	N/A	0,3	2,0	-0,1	-1,3	-1,8	0,0	0,4	-0,6	-3,6	-1,7	-1,1
C22	Manufacture of rubber and plastic products	N/A	N/A	0,0	-1,5	-1,3	0,0	-1,5	1,5	0,8	-0,5	-9,1	2,0	-1,2
C23	Manufacture of other non-metallic mineral products	N/A	N/A	-2,5	-3,2	-3,3	-1,3	-1,1	0,0	0,6	-2,5	-11,9	-1,1	-3,1
C24	Manufacture of basic metals	N/A	N/A	-2,2	-3,7	-5,0	-2,4	-2,1	-0,2	-0,4	-1,2	-12,6	0,3	-2,9
C25	Manufacture of fabricated metal products, except machinery and equipment	N/A	N/A	-0,6	-1,3	-1,8	-0,3	-0,8	1,5	2,5	3,2	-11,1	-0,1	-1,0
C26	Manufacture of computer, electronic and optical products	-1,2	3,6	0,2	-5,0	-4,0	-2,5	-1,7	-0,5	1,1	-1,1	-11,5	-2,5	-3,0
C27	Manufacture of electrical equipment	N/A	N/A	-1,1	-2,7	-3,7	-1,3	-1,8	2,3	1,7	1,0	-12,9	1,8	-1,4
C28	Manufacture of machinery and equipment n.e.c.	N/A	N/A	-0,6	-2,3	-2,4	-1,3	-1,2	1,5	2,8	1,2	-11,4	-1,1	-1,5
C29	Manufacture of motor vehicles, trailers and semi-trailers	N/A	N/A	0,5	-1,1	-0,9	0,5	-0,7	-1,0	0,7	-1,5	-14,1	4,0	-2,6
C30	Manufacture of other transport equipment	N/A	N/A	-1,1	-2,5	-2,2	-2,1	0,1	1,8	2,1	1,1	-3,8	-5,4	-0,9
C31	Manufacture of furniture	N/A	N/A	0,3	-4,4	-3,2	-1,4	-3,2	0,9	0,5	-3,1	-11,1	-3,2	-3,3
C32	Other manufacturing	N/A	N/A	-0,7	-2,2	-2,0	-0,4	-2,1	-0,2	0,9	-0,1	-4,6	0,4	-0,7
C33	Repair and installation of machinery and equipment	N/A	N/A	-2,5	-3,4	-3,7	-2,8	-0,8	1,5	-0,4	2,2	3,3	-4,3	0,4
D	ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY	N/A	N/A	-1,6	-4,8	-5,0	-2,9	-1,0	-1,9	-1,0	-0,5	2,6	1,2	0,1
E	WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	N/A	N/A	-1,8	-1,3	-0,3	0,3	-3,4	-0,5	0,7	1,3	-1,3	0,1	0,0
F	CONSTRUCTION	1,5	1,8	-1,5	-3,1	-1,1	0,2	5,9	3,5	2,7	-1,6	-8,8	-6,9	-2,3

N/A: Data not available
Source: Eurostat

Table 7.4: EU-27 - Labour productivity per person employed, annual growth rate (%)

Code (NACE Rev. 2)	Sector	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Average 2005-2010
B	MINING AND QUARRYING	10,7	6,4	0,2	5,5	1,3	2,5	-3,3	-0,3	3,9	-2,6	-7,4	3,8	-0,6
C	MANUFACTURING	3,0	5,3	0,2	1,7	2,4	4,7	3,1	5,7	3,7	-1,4	-8,3	11,7	2,1
C10	Manufacture of food products	1,8	1,8	1,9	2,9	0,7	3,4	2,4	1,7	2,0	-0,5	1,0	2,9	1,4
C11	Manufacture of beverages	N/A	N/A	4,5	3,9	3,5	-1,2	2,8	5,7	1,7	-0,8	3,9	0,3	2,1
C12	Manufacture of tobacco products	6,5	-5,1	0,4	-0,5	-1,4	-1,2	-1,5	-3,5	12,9	-9,7	2,3	-0,4	0,1
C13	Manufacture of textiles	1,2	4,1	0,2	0,3	4,1	1,6	0,7	5,5	4,1	-3,5	-5,1	14,6	2,9
C14	Manufacture of wearing apparel	-5,5	0,3	-0,8	-7,2	-2,1	1,4	-1,3	8,6	8,5	3,2	1,9	10,9	6,5
C15	Manufacture of leather and related products	2,5	1,1	-4,2	-6,6	-3,0	-4,9	-3,5	1,0	1,5	-2,5	-1,1	7,2	1,1
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	3,5	7,8	-3,0	2,4	3,8	4,8	0,9	5,2	1,0	-6,7	-2,4	8,1	0,9
C17	Manufacture of paper and paper products	6,6	5,1	-0,7	4,4	4,7	4,8	2,4	6,3	5,5	-1,6	-4,3	9,0	2,9
C18	Printing and reproduction of recorded media	3,2	1,5	-1,9	2,1	2,8	3,4	5,8	2,1	0,6	-0,2	-0,3	7,3	1,9
C19	Manufacture of coke and refined petroleum products	-2,7	6,1	2,6	0,3	5,4	7,2	2,6	5,2	-1,7	4,0	-5,3	4,7	1,3
C20	Manufacture of chemicals and chemical products	5,4	6,4	-0,1	4,4	2,5	6,7	3,8	4,8	3,4	-0,9	-6,7	12,6	2,4
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	N/A	N/A	8,2	6,4	5,7	2,6	6,0	4,3	1,0	3,3	7,3	6,7	4,5
C22	Manufacture of rubber and plastic products	3,0	2,5	-1,4	0,9	1,7	1,8	1,5	4,9	2,8	-4,9	-7,5	9,2	0,7
C23	Manufacture of other non-metallic mineral products	4,5	4,4	0,1	0,7	3,2	3,9	1,8	5,0	0,6	-4,8	-9,5	8,5	-0,2
C24	Manufacture of basic metals	-0,3	8,7	-0,4	4,3	2,8	9,2	0,5	6,8	1,1	-2,3	-20,2	26,4	1,2
C25	Manufacture of fabricated metal products, except machinery and equipment	0,4	5,7	-0,5	0,6	2,0	2,5	1,9	3,6	2,5	-4,7	-15,3	12,8	-0,7
C26	Manufacture of computer, electronic and optical products	7,1	8,2	-7,1	-0,8	6,3	10,9	6,0	11,0	10,2	4,6	-7,3	16,5	6,7
C27	Manufacture of electrical equipment	4,0	7,8	-0,2	1,0	1,9	4,5	1,8	7,4	2,2	-1,3	-13,7	14,6	1,4
C28	Manufacture of machinery and equipment n.e.c.	0,7	8,1	0,4	-0,7	1,4	6,7	4,9	7,6	5,3	-0,1	-21,7	16,9	0,7
C29	Manufacture of motor vehicles, trailers and semi-trailers	3,4	4,8	0,6	1,8	2,3	5,0	2,7	4,1	6,4	-6,7	-16,7	24,4	1,4
C30	Manufacture of other transport equipment	2,0	2,9	1,2	-2,6	4,2	2,6	2,4	8,4	1,1	2,6	-3,4	2,8	2,2
C31	Manufacture of furniture	N/A	N/A	-2,2	-1,2	-2,1	3,1	3,1	4,4	2,9	-2,1	-8,3	5,7	0,4
C32	Other manufacturing	2,9	10,7	2,7	4,2	-0,6	2,8	3,1	5,3	1,8	-1,4	-3,1	9,2	2,3
C33	Repair and installation of machinery and equipment	2,2	10,3	0,5	-1,0	1,7	5,8	2,3	8,8	3,3	1,2	-6,9	7,6	2,6
D	ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY	5,9	7,6	5,3	5,3	7,5	6,2	4,7	2,3	0,8	0,9	-7,5	3,3	-0,1
E	WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	CONSTRUCTION	3,1	4,4	0,4	1,6	1,2	-0,6	-0,6	-0,5	-2,8	-2,9	-1,0	1,4	-1,2

N/A: Data not available
Source: Eurostat

Table 7.5: EU-27 - Labour productivity per hour worked, annual growth rate (%)

Code (NACE Rev. 2)	Sector	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Average 2005-2010
B	MINING AND QUARRYING	N/A	N/A	-0,1	5,8	3,1	1,5	-3,3	-0,1	3,2	-2,7	-6,6	2,1	-0,9
C	MANUFACTURING	N/A	N/A	1,5	2,2	2,9	3,9	3,3	5,0	3,9	-1,0	-6,1	8,3	1,9
C10	Manufacture of food products	N/A	N/A	2,4	4,3	2,1	2,4	3,1	1,3	2,4	-0,7	1,8	2,2	1,4
C11	Manufacture of beverages	N/A	N/A	3,3	6,6	2,4	-2,8	4,3	7,9	2,2	0,0	2,3	2,3	2,9
C12	Manufacture of tobacco products	N/A	N/A	-5,0	1,6	2,2	-0,6	0,2	0,7	5,6	-8,1	4,0	-3,4	-0,4
C13	Manufacture of textiles	N/A	N/A	0,3	-0,1	3,3	1,0	1,5	4,5	1,5	-4,4	-3,1	7,8	1,2
C14	Manufacture of wearing apparel	N/A	N/A	0,0	-7,4	-2,3	-1,1	-5,3	6,6	8,1	3,4	3,6	9,9	6,3
C15	Manufacture of leather and related products	N/A	N/A	-2,9	-4,3	-3,5	-7,9	-5,0	-0,6	2,4	-1,9	-2,2	3,6	0,2
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	N/A	N/A	-0,5	2,5	4,4	3,8	1,5	4,3	1,9	-6,0	-1,6	4,0	0,5
C17	Manufacture of paper and paper products	N/A	N/A	-0,3	5,9	2,7	5,1	2,1	5,0	4,2	0,0	-2,2	7,3	2,8
C18	Printing and reproduction of recorded media	N/A	N/A	-2,0	3,8	2,8	4,8	5,0	0,8	0,4	-1,0	-1,8	5,8	0,8
C19	Manufacture of coke and refined petroleum products	N/A	N/A	2,6	1,6	3,7	5,3	-0,5	5,2	-1,5	0,5	0,3	3,3	1,5
C20	Manufacture of chemicals and chemical products	N/A	N/A	1,3	5,4	2,3	5,3	4,5	5,0	4,3	-1,4	-6,1	10,5	2,3
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	N/A	N/A	10,1	6,8	5,5	1,1	6,8	6,3	1,3	1,7	7,2	7,7	4,8
C22	Manufacture of rubber and plastic products	N/A	N/A	-0,5	1,5	3,3	1,7	2,3	2,6	3,6	-3,9	-5,1	5,8	0,5
C23	Manufacture of other non-metallic mineral products	N/A	N/A	1,9	1,5	3,9	3,1	1,9	4,4	1,4	-4,3	-7,8	3,7	-0,6
C24	Manufacture of basic metals	N/A	N/A	1,5	3,9	4,8	7,5	1,5	5,9	1,1	-1,5	-16,3	18,5	0,9
C25	Manufacture of fabricated metal products, except machinery and equipment	N/A	N/A	0,9	0,8	2,6	3,0	2,4	3,5	3,3	-5,2	-12,5	7,5	-1,0
C26	Manufacture of computer, electronic and optical products	6,2	8,8	-5,7	-1,7	5,8	10,5	6,4	10,7	10,2	3,8	-4,0	14,2	6,7
C27	Manufacture of electrical equipment	N/A	N/A	1,0	-0,3	1,4	4,5	3,1	6,0	3,0	-1,1	-8,9	9,2	1,4
C28	Manufacture of machinery and equipment n.e.c.	N/A	N/A	2,0	0,2	1,6	5,5	5,3	6,8	5,5	0,7	-16,6	11,6	1,1
C29	Manufacture of motor vehicles, trailers and semi-trailers	N/A	N/A	1,8	1,9	2,9	4,7	2,5	4,2	5,5	-4,4	-11,8	16,4	1,5
C30	Manufacture of other transport equipment	N/A	N/A	2,1	-1,6	3,7	3,1	2,6	7,1	1,8	3,6	-2,4	2,8	2,5
C31	Manufacture of furniture	N/A	N/A	-2,1	-0,1	1,0	2,0	3,8	2,3	2,7	-1,2	-6,1	2,4	0,0
C32	Other manufacturing	N/A	N/A	4,4	4,9	1,2	2,1	3,4	5,2	1,1	-1,1	-1,4	7,6	2,2
C33	Repair and installation of machinery and equipment	N/A	N/A	2,9	-0,3	3,1	7,7	2,5	7,6	4,2	2,8	-11,8	8,5	2,0
D	ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY	N/A	N/A	3,9	5,8	8,3	5,3	3,1	2,9	0,3	0,6	-7,2	3,1	-0,1
E	WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	CONSTRUCTION	2,7	2,2	2,0	4,3	2,9	0,6	-3,8	0,1	-0,7	-2,2	0,3	3,0	0,1

N/A: Data not available
Source: Eurostat

Table 7.6: EU-27 - Unit labour cost, annual growth rate (%)

Code (NACE Rev. 2)	Sector	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Average 2005-201
B	MINING AND QUARRYING	-4,2	-2,8	8,2	-0,9	7,2	4,3	1,3	8,6	4,8	11,2	11,8	2,4	7
C	MANUFACTURING	1,4	-0,3	2,7	1,2	0,2	-1,4	-0,6	-2,4	-0,2	5,7	10,1	-6,8	1
C10	Manufacture of food products	1,5	-0,3	2,2	0,9	2,7	-0,7	-0,8	0,3	1,4	5,2	1,2	-0,3	1
C11	Manufacture of beverages	N/A	N/A	0,8	-1,7	2,3	3,9	-1,6	-4,1	0,9	5,0	1,7	-1,1	0
C12	Manufacture of tobacco products	5,0	10,5	5,8	1,0	8,2	8,5	5,7	6,7	-3,5	16,6	3,8	-1,2	4
C13	Manufacture of textiles	6,6	9,6	1,9	3,3	0,7	0,8	0,9	-2,5	0,8	9,0	5,7	-9,3	0
C14	Manufacture of wearing apparel	10,1	15,6	1,1	9,3	2,4	1,8	4,2	-3,6	-0,5	3,4	2,1	-5,3	-0
C15	Manufacture of leather and related products	4,7	15,4	9,2	7,4	4,3	9,3	6,0	4,6	4,9	10,3	4,8	-1,2	4
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	-0,8	-5,1	5,6	-0,7	-2,0	-0,7	0,9	-0,5	3,9	12,1	5,3	-5,3	2
C17	Manufacture of paper and paper products	-0,5	-0,4	5,0	-2,6	-1,8	-1,7	1,4	-3,3	-1,3	4,1	4,3	-5,2	-0
C18	Printing and reproduction of recorded media	0,2	3,7	5,4	0,3	-1,3	-1,1	-1,7	-0,6	0,7	4,8	1,9	-6,3	0
C19	Manufacture of coke and refined petroleum products	6,8	6,5	0,9	6,8	-4,8	-1,4	4,1	2,3	2,8	4,0	8,2	2,3	3
C20	Manufacture of chemicals and chemical products	-1,1	1,7	2,5	-1,9	1,7	-3,3	-0,6	-3,7	0,0	5,1	9,6	-8,9	0
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	N/A	N/A	-5,8	-2,8	-0,6	1,0	-3,1	-3,6	4,0	0,1	-3,6	-4,7	-1
C22	Manufacture of rubber and plastic products	1,3	-0,1	3,4	1,4	-0,2	0,6	0,2	-2,9	-0,8	7,9	8,4	-5,4	1
C23	Manufacture of other non-metallic mineral products	0,0	-2,4	2,1	2,8	0,2	-1,0	0,5	-1,8	2,4	9,3	12,7	-3,7	3
C24	Manufacture of basic metals	4,1	-2,2	-3,4	-1,4	0,4	-3,5	3,0	-2,4	3,5	6,1	23,1	-14,3	2
C25	Manufacture of fabricated metal products, except machinery and equipment	2,1	-4,7	3,9	1,8	-0,1	0,1	-0,1	-1,1	0,8	10,1	15,4	-7,1	3
C26	Manufacture of computer, electronic and optical products	-2,4	-0,1	11,8	3,6	-5,8	-7,4	-4,6	-8,7	-7,7	0,2	9,9	-11,8	-3
C27	Manufacture of electrical equipment	-0,4	-4,4	2,7	2,1	0,2	-1,3	-0,7	-4,2	0,6	5,0	13,1	-8,5	0
C28	Manufacture of machinery and equipment n.e.c.	3,9	-2,8	2,8	3,0	1,8	-1,9	-2,6	-3,7	-1,5	3,8	27,1	-9,0	2
C29	Manufacture of motor vehicles, trailers and semi-trailers	1,3	0,8	1,0	0,8	0,4	-2,8	-0,4	0,0	-5,4	9,1	16,2	-15,3	0
C30	Manufacture of other transport equipment	3,7	1,4	3,7	8,2	0,6	-1,4	0,3	-4,7	1,5	1,7	8,8	3,5	2
C31	Manufacture of furniture	N/A	N/A	5,5	4,6	-1,0	-1,3	0,1	-0,3	0,4	6,6	11,5	-3,5	2
C32	Other manufacturing	0,9	-11,0	0,7	-0,5	1,5	0,4	-1,3	-2,5	3,1	4,4	3,3	-5,8	0
C33	Repair and installation of machinery and equipment	2,1	-1,1	3,8	4,6	0,6	-3,0	0,5	-5,8	0,7	2,2	12,5	-7,2	0
D	ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY	-1,4	-1,5	-1,0	2,0	-1,6	-1,2	0,1	4,3	5,1	4,5	9,2	-1,9	4
E	WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/
F	CONSTRUCTION	-0,6	-3,8	3,5	2,5	0,2	1,2	6,0	2,6	7,3	7,8	2,4	-1,5	3

N/A: Data not available
Source: Eurostat

Table 7.7: EU-27 - Revealed comparative advantage index

Code (NACE Rev. 2)	Sector	2007	2008
C10	Manufacture of food products	1,20	1,12
C11	Manufacture of beverages	1,61	1,59
C12	Manufacture of tobacco products	1,52	1,55
C13	Manufacture of textiles	0,81	0,76
C14	Manufacture of wearing apparel	0,76	0,76
C15	Manufacture of leather and related products	0,96	0,91
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	1,15	1,18
C17	Manufacture of paper and paper products	1,28	1,30
C18	Printing and reproduction of recorded media	1,20	1,62
C19	Manufacture of coke and refined petroleum products	0,84	0,84
C20	Manufacture of chemicals and chemical products	1,13	1,13
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	1,47	1,53
C22	Manufacture of rubber and plastic products	1,18	1,21
C23	Manufacture of other non-metallic mineral products	1,22	1,19
C24	Manufacture of basic metals	0,92	0,88
C25	Manufacture of fabricated metal products, except machinery and equipment	1,18	1,19
C26	Manufacture of computer, electronic and optical products	0,60	0,60
C27	Manufacture of electrical equipment	0,98	0,99
C28	Manufacture of machineryand equipment n.e.c.	1,14	1,18
C29	Manufacture of motor vehicles, trailers and semi-trailers	1,22	1,22
C30	Manufacture of other transport equipment	0,85	0,88
C31	Manufacture of furniture	1,27	1,24
C32	Other manufacturing	0,80	0,78

Note: there was a transition from NACE REV 1 to NACE REV 2, therefore the data are only available from 2007
Source : own calculations using Comtrade data

Table 7.8: EU-27 - Relative trade balance (X-M)/(X+M)

Code (NACE Rev. 2)	Sector	2007	2008	2009
C10	Manufacture of food products	-0,03	-0,03	-0,03
C11	Manufacture of beverages	0,21	0,20	0,20
C12	Manufacture of tobacco products	0,03	0,06	0,06
C13	Manufacture of textiles	-0,01	-0,01	-0,02
C14	Manufacture of wearing apparel	-0,19	-0,19	-0,21
C15	Manufacture of leather and related products	-0,07	-0,07	-0,08
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	0,00	0,02	0,04
C17	Manufacture of paper and paper products	0,04	0,04	0,06
C18	Printing and reproduction of recorded media	0,08	0,05	0,04
C19	Manufacture of coke and refined petroleum products	-0,03	-0,01	-0,05
C20	Manufacture of chemicals and chemical products	0,03	0,03	0,05
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0,07	0,08	0,08
C22	Manufacture of rubber and plastic products	0,04	0,04	0,04
C23	Manufacture of other non-metallic mineral products	0,08	0,08	0,09
C24	Manufacture of basic metals	-0,06	-0,03	0,01
C25	Manufacture of fabricated metal products, except machinery and equipment	0,09	0,09	0,10
C26	Manufacture of computer, electronic and optical products	-0,11	-0,11	-0,11
C27	Manufacture of electrical equipment	0,07	0,08	0,08
C28	Manufacture of machineryand equipment n.e.c.	0,16	0,17	0,20
C29	Manufacture of motor vehicles, trailers and semi-trailers	0,06	0,08	0,08
C30	Manufacture of other transport equipment	0,13	0,11	0,11
C31	Manufacture of furniture	0,04	0,04	0,03
C32	Other manufacturing	-0,04	-0,04	-0,04

Note: there was a transition from NACE REV 1 to NACE REV 2, therefore the data are only available from 2007
Source : own calculations using Comtrade data

Table 7.9: RCA in manufacturing industries in 2009: EU countries, US, Japan and Brazil, China, India and Russia.

Table 7.9: Revealed comparative advantage index in manufacturing industries in 2009 - EU countries, Japan and Brazil, China, India and Russia.

	Food	Bevarages	Tobacco	Textiles	Clothing	Leather & footwear	Wood & wood products	Paper	Printing	Refined petroleum	Chemicals	Pharmaceuticals	Rubber & plastics	Non-metallic mineral products	Basic metals	Metal products	Computers, electronic & optical	Electrical equipment	Machinery	Motor vehicles	Other transport	Furniture	Other manufacturing
	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27	C28	C29	C30	C31	C32
Austria	0,92	2,06	0,85	0,71	0,55	0,75	4,45	2,23	1,30	0,26	0,50	1,33	1,36	1,41	1,24	1,99	0,41	1,34	1,47	1,27	0,71	1,42	0,78
Belgium	1,35	1,08	0,98	0,87	0,78	1,02	0,83	0,97	7,21	1,07	2,10	3,40	1,06	1,13	1,04	0,72	0,22	0,43	0,68	1,16	0,24	0,60	1,12
Bulgaria	1,45	0,94	3,10	1,37	3,70	1,31	1,56	0,42	0,29	2,61	0,56	0,69	0,82	2,18	2,82	0,66	0,30	1,11	0,72	0,29	0,34	1,39	0,33
Cyprus	2,06	1,43	34,64	0,11	0,54	0,42	0,24	0,40	0,23	0,00	0,53	4,53	0,37	0,39	0,37	0,63	0,92	0,30	0,55	0,33	1,52	0,80	2,69
Czech Rep.	0,47	0,74	1,54	0,93	0,38	0,39	1,53	1,04	1,32	0,17	0,50	0,28	1,70	1,83	0,67	2,01	0,98	1,51	1,15	2,18	0,51	1,49	0,78
Denmark	3,08	0,77	1,86	0,73	1,52	0,79	1,31	0,69	0,99	0,73	0,62	1,28	1,18	1,50	0,35	1,57	0,49	1,18	1,53	0,33	0,61	2,75	0,86
Estonia	1,23	2,08	0,45	1,49	1,12	0,65	8,16	0,78	0,01	3,48	0,68	0,10	1,31	1,60	0,42	1,90	0,39	1,42	0,65	1,13	0,29	3,00	0,54
Finland	0,33	0,51	0,02	0,23	0,16	0,26	4,79	8,57	0,75	1,49	0,58	0,44	0,86	0,78	1,19	0,97	0,78	1,51	1,57	0,36	1,30	0,29	0,49
France	1,18	3,93	0,59	0,60	0,72	1,05	0,66	1,05	1,15	0,58	1,33	1,70	1,12	0,98	0,76	0,92	0,43	0,92	0,88	1,22	3,23	0,66	0,76
Germany	0,78	0,66	1,80	0,54	0,51	0,38	0,87	1,24	2,43	0,29	1,05	1,33	1,29	1,03	0,77	1,24	0,54	1,17	1,62	1,77	1,35	0,85	0,64
Greece	2,70	1,81	5,69	1,75	2,12	0,71	0,56	0,73	1,47	2,10	0,90	1,65	1,25	2,57	1,96	1,01	0,25	0,78	0,40	0,11	1,18	0,36	0,39
Hungary	0,84	0,40	0,02	0,33	0,30	0,52	0,82	0,87	0,15	0,36	0,52	0,85	1,22	1,17	0,31	0,76	1,75	1,72	0,79	1,87	0,16	0,98	0,26
Ireland	1,25	1,62	0,40	0,08	0,07	0,06	0,35	0,10	0,00	0,15	3,38	6,27	0,28	0,22	0,05	0,20	0,88	0,22	0,29	0,04	0,39	0,09	1,44
Italy	0,93	2,12	0,02	1,38	1,59	3,01	0,53	1,01	1,25	0,72	0,68	0,91	1,36	2,02	0,98	1,73	0,20	1,13	1,90	0,74	0,95	2,55	0,95
Latvia	1,61	4,15	3,35	1,15	1,24	0,37	18,34	0,78	0,65	0,70	0,60	1,12	0,87	1,59	1,43	1,43	0,43	0,59	0,60	0,75	0,50	2,77	0,55
Lithuania	2,02	1,17	5,65	1,14	1,42	0,33	3,36	0,85	1,00	4,93	1,35	0,37	1,18	0,77	0,23	1,00	0,23	0,51	0,52	0,68	0,51	6,01	0,38
Luxembourg	0,92	0,88	6,33	2,05	0,38	0,44	2,13	2,37	0,21	0,02	0,52	0,16	3,72	2,56	4,04	1,11	0,33	0,67	0,84	0,73	1,18	0,11	0,25
Malta	0,63	0,21	1,32	1,19	0,36	0,16	0,05	0,02	1,74	0,09	0,33	2,10	1,46	0,42	0,04	0,40	2,55	1,70	0,39	0,04	0,81	0,35	1,97
Netherlands	2,11	1,44	5,36	0,49	0,57	0,66	0,31	0,92	0,73	2,03	1,63	0,83	0,82	0,48	0,58	0,75	1,14	0,54	1,00	0,36	0,41	0,40	0,83
Poland	1,41	0,47	4,77	0,62	0,72	0,36	2,40	1,55	0,48	0,43	0,65	0,27	1,68	1,54	0,86	1,70	0,66	1,29	0,56	2,03	1,09	4,98	0,30
Portugal	1,17	3,76	5,30	1,98	2,24	3,30	4,51	2,61	0,99	0,63	0,62	0,34	1,83	3,55	0,60	2,02	0,31	0,98	0,52	1,45	0,14	2,62	0,30
Romania	0,33	0,23	5,93	1,13	2,53	2,81	3,98	0,29	0,04	1,29	0,44	0,30	1,38	0,53	0,88	0,97	0,50	1,40	0,76	1,99	1,54	3,90	0,30
Slovakia	0,46	0,51	0,00	0,40	0,49	1,22	1,79	1,33	0,63	0,89	0,39	0,15	1,28	1,15	1,14	1,57	1,40	0,98	0,61	2,35	0,27	1,72	0,29
Slovenia	0,59	0,59	0,00	0,69	0,44	0,64	3,19	1,85	0,19	0,34	0,81	2,04	1,64	1,54	0,90	1,88	0,23	2,05	0,99	1,84	0,33	3,09	0,49
Spain	1,60	2,22	0,33	0,84	1,22	1,35	0,88	1,29	0,46	0,53	1,06	1,21	1,21	2,21	1,02	1,16	0,21	0,89	0,70	2,43	1,04	0,85	0,38
Sweden	0,53	0,91	0,24	0,33	0,32	0,21	3,98	5,68	0,14	1,30	0,73	1,53	0,91	0,64	1,04	1,01	0,76	1,12	1,27	0,97	0,40	1,62	0,54
United Kingdom	0,70	3,32	0,93	0,53	0,60	0,46	0,19	0,76	1,10	1,30	1,36	2,33	0,92	0,73	0,74	0,79	0,70	0,71	1,08	1,15	1,49	0,38	1,09
EU-27	1,10	1,62	1,60	0,69	0,76	0,91	1,18	1,34	1,79	0,77	1,16	1,54	1,18	1,18	0,82	1,16	0,57	0,98	1,18	1,30	1,15	1,20	0,75
USA	0,91	0,66	0,29	0,53	0,15	0,21	0,58	1,19	0,67	1,04	1,46	1,13	1,03	0,70	0,71	0,91	1,03	0,89	1,37	0,96	0,50	0,46	1,59
Japan	0,09	0,06	0,08	0,48	0,02	0,03	0,02	0,26	0,20	0,41	1,00	0,18	1,08	0,94	1,25	0,67	1,18	1,12	1,65	2,13	1,51	0,14	0,46
Brazil	5,09	0,12	0,61	0,45	0,05	1,96	2,05	2,77	0,24	0,69	0,97	0,32	0,75	1,10	1,91	0,83	0,14	0,56	0,67	0,95	1,38	0,69	0,19
China	0,37	0,09	0,15	2,52	2,75	2,56	0,96	0,37	0,15	0,26	0,44	0,20	0,91	1,37	0,46	1,27	1,87	1,42	0,72	0,22	0,76	2,01	1,11
India	1,03	0,09	0,50	2,86	2,46	1,36	0,12	0,21	1,05	3,18	0,93	0,85	0,54	0,79	1,10	0,82	0,25	0,42	0,43	0,34	1,00	0,28	5,88
Russia	0,66	0,37	1,69	0,08	0,02	0,11	3,82	1,08	0,09	9,03	1,33	0,06	0,31	0,64	3,89	0,37	0,12	0,24	0,24	0,15	0,52	0,22	0,05

Source: Own calculations using COMTRADE data

Table 7.10: Revealed comparative advantage index in service industries in 2009 - EU countries, US, Japan and Brazil, China, India and Russia.

	Communication	Computer and information	Construction	Finance	Insurance	Other business services	Personal, cultural and recreational	Transportation	Travel
Austria	1,17	0,63	0,88	0,26	0,94	1,08	0,45	0,80	1,52
Belgium	2,00	0,91	0,63	0,52	0,68	1,61	0,67	0,97	0,54
Bulgaria	1,30	0,40	2,02	0,07	0,82	0,37	0,70	0,73	2,31
Cyprus	0,40	0,26	0,34	2,79	0,35	0,71	0,40	1,34	0,77
Czech Republic	0,82	0,84	0,58	0,03	0,26	0,86	0,46	1,51	1,07
Denmark	0,47	0,56	0,24	0,16	0,35	0,77	0,73	2,17	0,47
Estonia	1,30	0,51	1,17	0,15	0,08	0,62	0,21	1,93	0,77
Finland	0,57	4,92	1,75	0,21	0,31	1,93	0,03	0,00	0,52
France	1,12	0,16	1,41	0,17	0,20	0,80	1,01	1,37	1,26
Germany	0,73	0,92	1,62	0,59	0,80	1,12	0,41	1,39	0,55
Greece	0,30	0,12	0,23	0,04	0,33	0,14	0,33	2,36	1,10
Hungary	0,91	0,93	0,66	0,12	0,04	0,95	4,49	1,16	1,15
Ireland	0,33	6,54	0,00	1,21	5,15	1,30	0,00	0,00	0,24
Italy	0,61	0,12	0,85	0,87	0,50	1,06	0,93	0,85	1,49
Latvia	1,06	0,55	0,32	0,86	0,30	0,61	0,22	1,81	0,80
Lithuania	1,11	0,18	0,59	0,14	0,00	0,30	0,37	1,97	1,25
Luxembourg	2,22	0,30	0,26	7,86	2,26	0,51	1,60	0,19	0,29
Malta	0,58	0,33	0,00	0,83	0,60	1,11	18,12	0,47	1,14
Netherlands	2,08	1,20	1,14	0,20	0,28	1,48	0,83	1,02	0,61
Poland	0,90	0,52	1,74	0,19	0,04	1,01	0,44	1,07	1,32
Portugal	1,20	0,27	1,05	0,12	0,28	0,79	1,24	0,91	1,83
Romania	3,62	1,73	1,77	0,24	0,22	1,14	0,72	1,07	0,54
Slovak Republic	1,40	0,78	0,67	0,67	0,50	0,56	0,77	1,08	1,60
Slovenia	1,85	0,44	1,53	0,08	0,63	0,72	0,75	0,88	1,78
Spain	0,69	0,84	1,15	0,50	0,65	0,95	1,24	0,52	1,86
Sweden	1,46	2,11	0,32	0,32	0,81	1,60	0,86	0,63	0,80
United Kingdom	1,36	0,85	0,36	3,15	2,21	1,26	1,26	0,51	0,57
EU-27	1,07	1,09	0,90	1,12	1,07	1,07	0,88	0,97	0,90
USA	0,99	0,58	0,58	1,89	1,60	0,91	3,17	0,57	1,32
Japan	0,20	0,11	3,03	0,47	0,27	1,23	0,11	1,65	0,32
Brazil	0,55	0,14	0,02	0,80	0,61	2,11	0,28	0,55	0,87
China	0,32	0,72	2,06	0,04	0,44	1,18	0,06	1,10	1,10
India	0,56	7,74	0,27	0,45	0,64	0,53	0,44	0,77	0,47
Russia	1,32	0,53	2,65	0,34	0,46	1,08	0,76	1,08	0,97

Source: IMF, OECD

ANNEX

LIST OF BACKGROUND STUDIES TO THE EUROPEAN COMPETITIVENESS REPORT 2011

Some parts of the European Competitiveness Report 2011 are based on, or use, material prepared by a consortium led by WIFO, the Austrian institute for economic Research:

Chapter 1 – "Crisis, recovery and the role of innovation" was written by Jorge Durán and benefitted from research assistance by Giorgos Alaveras and from contributions by Mats Marcusson. Comments and suggestions are acknowledged to João Libório, Maya Jollès and Ágnes Magai. Statistical assistance is acknowledged to Luigi Cipriani.

Chapter 2 – "Convergence of knowledge intensive sectors and the EU's external competitiveness" was coordinated by Mats Marcusson and is based on the background study "Convergence of knowledge intensive sectors and the EU's external competitiveness" by Sabine Biege (2), Martin Borowiecki (1), Bernhard Dachs (1), Joseph Francois (4), Doris Hanzl (4), Johan Hauknes (3), Angela Jäger (2), Mark Knell (3), Gunther Lay (2), Olga Pindyuk (4), Doris Schartinger (1) and Robert Stehrer (4).

(1) AIT, Austrian Institute of Technology.
(2) ISI, Fraunhofer Institute for Systems and Innovation Research.
(3)NIFU STEP, Norwegian Institute for Studies in Innovation, Research and Education.
(4) wiiw, Vienna Institute for International Economic Studies.

Chapter 3 – "European Competitiveness in Space Manufacturing and Operations" is based on the background study "Competitiveness of the European Space sector" by Robert Piers, Dick Mans, Konstantina Laparidou, Koen Berden, Afke Mulder, Jurgen Vermeulen and Sophie Willems (*Ecorys Rotterdam*).

Chapter 4 – "Access to non-energy raw materials and the competitiveness of EU industry" was coordinated by Ágnes Magai and is based on the background study "Access to non-energy industrial raw materials and the competitiveness of EU industry" by Valentijn Bilsen, Sjouke Beemsterboer, Ruslan Lukach, Elissavet Lykogianni, Pieter Staelens, Miriam Van Hoed, Jan Wynen (all from *IDEA Consult*) and Andreas Unterstaller (*Ecorys Brussels)*

Chapter 5 – "EU Industry in a Sustainable Growth Context" was coordinated by João Libório and is based on the background study "EU Industry in a Sustainable Growth Context" by Koen Rademaekers, Koen Berden, Jan Maarten de Vet, Matthew Smith, Jeron Van de Laan, Afke Mulder (all from *ECORYS*) and Elissavet Lykogianni and Miriam Van Hoed (both from *IDEA Consult*).

Chapter 6 – "EU Industrial Policy and Global Competition: Recent Lessons and Way Forward" was coordinated by Joachim Schwerin and co-drafted by Adriana Czechowska, Torsten Frey, Joachim Schwerin, Edouard Simon, Kamila Skowyra and Marie-Laure Wyss (all from *DG ENTR, Unit B2*). The chapter has substantially benefited from comments and suggestions from Chris Allen, Petar Angelov, Manfred Bergmann, Maya Jollès, João Libório and Konstantin Pashev.