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European Competitiveness Report 2013 :
Towards knowledge driven reindustrialisation

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EXECUTIVE SUMMARY

MAIN FINDINGS OF THIS REPORT:

- Although the weight of manufacturing in the EU economy is decreasing in favour of services, manufacturing is increasingly seen as a pivotal sector. However, critical mass in the form of a minimum production base is needed. Industrial policy supporting innovation and external competitiveness can play a role to reverse the declining trend.
- To this end, EU industrial policy needs to steer structural change towards higher productivity in manufacturing and better positioning of EU enterprises in the global value chain based on comparative advantages in knowledge and technology intensive products and services.
- This is a must and a challenge for two reasons. First, the EU is lagging behind in productivity gains relative to emerging industrial powerhouses and some of its major competitors. The EU-US productivity gap, for instance, is growing wider again after years of narrowing. It is linked to a production efficiency gap caused by regulations, lower investment in ICT and intangible assets. In some sectors there is also a 'commercialisation of research gap' between the EU and the US. Policies targeting not only creation of new technologies, but also knowledge diffusion through measures to stimulate the supply of skills on the one hand, and demand for R&D on the other can help bridge such gaps.
- Second, structural change is slow, path-dependent and needs to build on existing strengths, but can be stimulated by having the right institutional framework in place, covering education, research, technology and innovation policies but focusing also on the general quality of governance.
- On the positive side, the report documents that the existing strengths of EU manufacturing are substantial. The revealed comparative advantage of EU manufacturing is linked to complex and high-quality product segments. By gradually increasing the complexity of their products, EU manufacturing industries managed to maintain their competitive position in 2009 compared with 1995. Moreover, EU manufactured exports have less embedded foreign value added than exports by third countries such as China, South Korea, Japan and USA.
- The EU is a major producer of new knowledge in key enabling technologies. Its products based on industrial biotechnology or advanced materials have higher technology content than competing North American or East Asian products. Apart from advanced manufacturing technologies, EU products based on key enabling technologies are mature and need to compete on price. Adding more innovative and complex products to the product portfolio will help manufacturers move up the value chain.

THE COMPETITIVE PERFORMANCE OF EU MANUFACTURING

This year's edition of the European Competitiveness Report uses a number of traditional and advanced indicators of industrial competitiveness to provide insights into the strengths and weaknesses of EU manufacturing and draw implications for EU industrial policy. It shows that the EU has comparative advantages in most manufacturing sectors (15 out of 23) accounting for about three quarters of EU manufacturing output. They include vital high-tech and medium-high-tech sectors such as pharmaceuticals, chemicals, vehicles, machinery, and other transport equipment (which includes aerospace).

EU MANUFACTURING VALUE CHAINS CAN SUPPLY HIGH-TECH INTERMEDIATES FROM THE HOME MARKET

Furthermore, the report evaluates industrial competitiveness by looking at trade in value added to analyse the place of EU manufacturing in the global supply chains. The domestic and foreign content of a country's exports provide information on whether that country develops or merely assembles high-technology products. Analysis of manufacturing exports from China, the EU, Japan, South Korea and the US from 1995 to 2009 shows that foreign value added embedded in EU manufacturing exports – the part of value added coming from inputs imported from other parts of the world – is lower than for other countries. Conversely, EU added value in the exports of emerging industrial powerhouses increased more than that from other parts of the world. Between 1995 and 2009, when Chinese exports increased dramatically, EU industries managed to increase their value added content in Chinese manufacturing exports more than industries from other parts of the world. Japanese, South Korean and US value added content shares of Chinese manufacturing gross exports decreased during the same period. Summing up, the report finds that the EU has a higher share of domestic content of exports than established and emerging industrial competitors, while at the same time has a higher share of its intermediates in other countries' exports. This is evidence of a strong industrial base which allows EU enterprises to source most of their high-tech inputs (goods and services) domestically, while also supplying them to the rest of the world.

EU MANUFACTURING EXPORTS HAVE HIGHER DEGREE OF COMPLEXITY

A further evidence of the industrial strengths of the EU is the analysis of the sophistication (knowledge intensity) of EU exports of products with comparative advantages. This is an advanced indicator of non-cost competitiveness which shows that manufacturing industries in the EU have a higher degree of complexity. The report documents that EU exports have preserved their advantages thanks to developing sophisticated, knowledge-intensive products to address the cost advantages of emerging industrial powers. By gradually increasing the complexity of their products from 1995 to 2010, EU manufacturing industries managed to maintain their competitive position. By contrast, products from BRIC countries (Brazil, Russia, India, China) underwent major changes in the same period – goods produced by firms in wood industries, radio, TV and communication equipment industries, medical, precision and optical instruments industries, and furniture industries in BRIC countries have considerably improved in terms of their average complexity – but the majority of industries in BRIC countries still produce less complex products than EU industries. As a consequence, in 2010 the EU exported around 67% of products with revealed comparative advantage, while China had comparative advantage in 54% of its exports, the US in 43% of its products, and Japan in 24%.

A ROLE FOR INDUSTRIAL POLICY

The report however documents trends and developments which call for urgent and well-targeted industrial policy measures to build on the identified strengths and upgrade the competitiveness of EU manufacturing.

Of the 15 sectors with comparative advantages mentioned above, about two-thirds are in the low-tech and medium-low tech manufacturing groups. On a positive note though, even in those sectors EU competitiveness is based on high-end innovative products.

In the high-tech sectors, the EU has comparative advantages in pharmaceuticals but lags behind in computers, electronics and optical products, while in the medium-high tech industries its comparative advantages are lower than in the US and Japan. China and other emerging industrial powerhouses are also quickly gaining ground in the international competition in the knowledge-intensive sectors, successfully upgrading their exports from assembly to developing high-tech products and knowledge-intensive services.

With a view to identifying the drivers of non-cost competitiveness, the report looks at indicators of skills and investment in physical capital and intangibles to draw the relevant policy implications for guiding EU manufacturing to knowledge-based productivity gains.

US private spending on R&D (as a share of GDP) is almost 1.5 times that of the EU (2.7% in the US; 1.85% in the EU). A sector breakdown indicates that this is not a result of differences in industrial structures or US specialisation in knowledge-intensive sectors, but due to an overall underperformance of EU sectors in terms of R&D investment across all sectors. The output of research is new products, new technologies, new materials and processes. A rough indicator of this output is patents. The report documents that in a number of high and medium-high technology industries (such as pharmaceuticals, optical equipment, electrical equipment, medical and surgical equipment, telecom and office equipment, radio and TV and accumulators and batteries), the EU is lagging behind in terms of patenting. As the RCA (revealed comparative advantage) indicators show, EU export performance depends crucially on some of these sectors. It may be hard to preserve current EU comparative advantages in these industries if the EU loses its technology lead (as indicated by patent data). Another problem is that the transmission of research results from the laboratory to the market which seems to be more difficult in the EU than for its major competitors.

The implications for EU industrial policy of its export complexity is that targeting only high-tech sectors might be less rewarding than increasing the share of knowledge-intensive products in all tradable sectors, including medium-low tech and medium-high tech sectors. Moreover, some of the labour-intensive sectors with lower knowledge intensities may be better suited to tackle the EU's unemployment challenges than the high-tech sectors. About 40% of EU manufacturing employment is in low-tech sectors. Therefore the policy priority attached to key enabling technologies which lead to new materials and products in all manufacturing sectors has a strong potential to upgrade EU competitiveness not only in the high-tech sectors but also in the traditional industries.

LONG-TERM DYNAMICS OF STRUCTURAL CHANGE

Almost all countries follow a broadly similar pattern of structural change. As economic development gets under way, the share of agriculture in national employment and value added falls, and there is a rapid increase in the share of manufacturing and services. The resource reallocation process associated with structural change shifts economic activities from agriculture to industry and services.

DRIVERS AND IMPACT OF STRUCTURAL CHANGE

There are two central, possibly complementary, theories of the observed patterns of structural change. The first, supply-side, explanation highlights the differential patterns of technical change between sectors. Here, structural change can be viewed as a consequence of differential productivity growth rates across agriculture, industry and services, where technological progress is the main driving mechanism behind productivity growth. The second, demand-side, theory relates structural change to different income elasticities of demand between products and services of different sectors. These different elasticities provide a sorting mechanism on the development of sectors.

The increasing contribution of the service industry, at the expense of manufacturing, can also be partly explained by an increasing service content of manufacturing final output. This content reflects the total value of the services required for the development, production and marketing of a modern manufacturing product. The service content of manufacturing has been growing in the EU and elsewhere in the world. Currently about a third of the price of a manufacturing product in the EU is associated with integral services. Whilst manufacturing products too are used for producing services, the manufacturing content of services produced in the EU is only around 10 per cent.

The gradual rise in services and reduction in the manufacturing share of valued added do not mean that manufacturing can be ignored. It is still seen as a pivotal, though heterogeneous, sector with important production and demand linkages that play a significant role in the process of economic development.

The analysis in Chapter 2 confirms that the structural change across economies produces more diverse country profiles in manufacturing sectors than in services sectors. Wider tradability of manufactured goods leads to more variability.

Analysis also confirms that structural change is gradual and path dependent based on the specific capacities and capabilities of individual economies, which are important determinants of sector growth.

Structural change can generate both positive and negative contributions to aggregate productivity growth. On average, structural change appears to have only a weak impact on aggregate growth over short time periods.

THE ROLE OF INSTITUTIONS IN STRUCTURAL CHANGE

Institutions can positively affect structural change in a number of ways. For example, differences in the patterns of technology diffusion are considered to account for a sizable part of the divergence in incomes between rich and poor countries. Educational attainment can also be linked to product specialization patterns, with a positive correlation between high knowledge intensity and product complexity. Microeconomic evidence also suggests that credit market imperfections are important sources of differences in productivity across countries. Market frictions can also hinder structural change due to the existence of regulations and administrative burdens that inhibit the reallocation of resources across sectors and firms. Many factors can be identified such as certain types of taxes, labour market regulation, size-dependent policies or trade barriers in addition to regulations and costs of doing business in the formal sector.

STRUCTURAL CHANGE: POLICY IMPLICATIONS

Structural change is thus dependent on progressive policies and institutions that allow an efficient allocation of resources within economies. Policies and institutions that hinder such reallocation are a source of inefficiency and impede economic development. Policies to foster structural adjustments should be conceived in a broad way and span such different areas such as education policies, research, technology, and innovation policies, but also focus on the general quality of governance.

International trade is an important determinant of the development of sectoral shares in countries. The successful catch-up stories of Germany in 19th century, and Japan and South Korea in the 20th century, cannot be explained without taking into account international trade, comparative advantage in tradable goods and specific competencies and capabilities in the production of new and high-value added products. Here it is important to acknowledge that structural change that shapes economic development of countries is highly path-dependent and cumulative. Any change is rooted in present knowledge bases and constrained by existing specialisation patterns. Complementary capabilities need to be built up. Thus policies to support structural change should always start by taking into account the existing production structures of countries and regions, as well as the knowledge base of supporting institutions. Countries seeking to shift their industrial production up the technology ladder are likely to also need to increase and improve non-government services, such as education and business services.

The centrality of institutions and policies in the process of structural change leads to a view that the general quality of institutions is important to structural change. Policies that foster structural adjustments should therefore be conceived in a broad way and cover such different areas as education, research, technology and innovation policies, while also focusing on the general quality of governance.

DIFFERENCES IN PRODUCTIVITY GROWTH BETWEEN THE EU AND THE US: EVIDENCE FROM A GROWTH ACCOUNTING ANALYSIS

In the late 1990s and early 2000s, the US productivity lead resulted from a first mover advantage in ICT as is illustrated by the relevant growth accounting analysis. The EU experience reveals that movements in Total Factor Productivity (TFP) have followed US productivity developments, but with a time lag.

Prior to the financial and economic crisis of 2007-2008, the debate on the European productivity slowdown focused on the slower adoption of new technology as the main reason behind the EU's relative productivity under-performance. Moreover, industry-based studies revealed that the US productivity advantage was found in a few market services sectors, mainly trade, finance and business services.

The initial hypothesis was that the EU was lagging behind the US merely in the adoption of ICT but would eventually benefit from the same productivity gains. Chapter 3 reveals that high investments alone are not sufficient to boost economic growth and to guarantee a better productivity performance.

The EU is not only still lagging behind the US, but the productivity growth gap has recently increased.

THE CHANGES IN THE EU-US PRODUCTIVITY GAP FROM A SECTORAL PERSPECTIVE

The European failure to match the US acceleration in output and productivity between 1995 and 2004 has largely been attributed to developments in market services. The analysis reveals that the sector which contributed most to amplify the US productivity advantage was wholesale and retail trade, due to its strong productivity performance and its relatively large share in the economy. Other service sectors with sizeable contributions included professional, scientific, technical, administrative and support services, plus finance and insurance activities.

Throughout the period 2004-2007, two factors contributed to the reduction of the EU-US productivity gap, the acceleration of productivity in most EU manufacturing industries, and a robust performance of many EU services sectors.

In the US wholesale and retail sector, labour productivity slowed significantly between 2004 and 2007 compared to the exceptional performance observed in the previous period. On the other hand, the EU performance in the same sector improved substantially, reaching 3% productivity growth, nearly double the rate achieved in previous periods. In most EU services, labour productivity improved, particularly in professional, scientific, technical activities, and community, social and personal services. Overall, between 2004 and 2007, those sectors that contributed to narrowing the EU productivity gap relative to the US were the same ones which had caused EU productivity to stagnate in the previous decade.

During the financial crisis (2007-2010), labour productivity stalled in the EU, while in the US it continued to improve. The majority of manufacturing sectors in the EU experienced a fall in productivity levels, probably reflecting a higher exposure to global demand fluctuations than the services sectors. Manufacturing productivity as a whole, decreased by more than 1% annually, with chemicals down by more than 4%. In the US, manufacturing productivity grew by over 4% a year during 2007-2010. One of the few sectors to experience a worsening in productivity levels was chemicals. The majority of services activities though, experienced robust growth, particularly telecommunications, finance, insurance, IT and information services.

The sectors where the US productivity advantage increased are electrical and optical equipment and the majority of manufacturing sectors, as well as construction, and telecommunications. On the other hand, service sectors such as financial activities, business services, accommodation, food and some public services are among the EU sectors that helped narrow the gap during the most recent years. In the EU manufacturing sector, TFP was the main driver of the output growth up to 2007 but it was also the main cause of the declining productivity thereafter. In services, the picture is more heterogeneous. In the US, substantial TFP gains explain the productivity acceleration relative to the EU in the late 1990s. The finance and insurance sector in the US also experienced considerable ICT-driven productivity growth in the late 1990s and early 2000s.

TFP improvements in the EU wholesale and retail sector took place with some years' delay and contributed to closing the gap in the period just prior to the financial crisis. Since the crisis, the EU finance and insurance sector has also shown a considerably better performance than in the US.

THE ROLE OF KNOWLEDGE TRANSFER, ABSORPTIVE CAPACITY AND INSTITUTIONS FOR PRODUCTIVITY GROWTH

In the EU, too little has been invested in the skills and organisational changes necessary to reap the benefits of ICT technologies. Lower investments in intangible assets (R&D, human capital, etc.) are likely to explain a portion of the US-EU productivity gap as these factors affect a country's absorptive capacity, i.e. its ability to take advantage of technology developed elsewhere (international technology transfers). Given that the bulk of technological innovations is concentrated in a few leading countries, improvements in the absorptive capacity will be needed in order to assimilate foreign technologies.

DETERMINING THE EU-US EFFICIENCY GAP

Understanding why industries vary in their ability to use resources effectively, and identifying suitable policies to improve efficiency performance, requires the analysis to look into factors that cause industries to lose productivity and hence widen efficiency gaps.

The empirical results show that ICT plays a key role in reducing inefficiencies in the use of resources. In addition, more upstream regulation significantly increases the efficiency gap. In other words, administrative restrictions imposed on service market competition have widespread negative effects on production efficiency.

These results provide strong support for the hypothesis that a more competitive business environment reduces the efficiency gap. More flexible product market regulations, largely concentrated in key service-providing industries, are likely to raise efficiency levels across the whole economy. Regulatory changes in the labour market should also be tailored to restore the necessary balance between regular and temporary workers.

A few market service sectors were the main cause of the EU productivity disadvantage compared to the US during the emergence of ICT technologies (in the late 1990s). However, in the years leading up to the financial crisis, the EU experienced strong ICT-related labour productivity growth in these sectors, mirroring earlier developments in the US, and thereby reaching the US productivity levels. Since the crisis, the EU-US productivity gap has widened again.

Chapter 3 examines two main channels for raising productivity growth potential and closing the gap with the technology leaders. The first is the role of absorptive capacity and knowledge-base (intangible) assets (R&D and human capital) in activating international technology transfers. This mechanism has been found in the literature to be highly conducive to TFP growth through spillovers. However, its growth-enhancing effect is heterogeneous; the ability to accommodate the inflow of new technological knowledge by re-allocating factors or expanding new product lines is required.

The second channel is via production efficiency as a possible factor behind the widening productivity gaps between the EU and the US. There is evidence that technical efficiency is significantly higher in countries with less restrictive product market regulations or employment protection laws. Investments in ICT assets, on the other hand, help in reducing the gap with the most efficient country and/or industry.

Intangible assets (e.g. R&D, human capital, organizational change, etc.) are important sources of TFP growth and sustained long-run competitiveness. In this context, initiatives which stimulate investments in these areas may be particularly useful.

Similar measures may also be put in place to increase the number of qualified staff per firm. These measures could facilitate the hiring of highly qualified workers or promote workforce training. Other policies could be directed towards enhancing inputs such as ICT which can assist in the reorganisation of production. Specific ICT applications, such as enterprise software systems, increase productivity at firm level. These measures would also be viable for smaller firms which do not always have the necessary financial and human resources to undertake R&D activities and for that reason, seek alternative ways of increasing their competitiveness.

As regards the key role of financial resources on productivity performance, policies which increase access to finance for SMEs are needed. The above measures should be conceived and applied within an appropriate regulatory framework that will safeguard the stability of market regulation and facilitate the reduction of productivity and efficiency gaps.

A 'MANUFACTURING IMPERATIVE' IN THE EU — DECLINING MANUFACTURING SHARES OF VALUE-ADDED AND EMPLOYMENT

There are at least two well-documented reasons for the declining share of manufacturing value-added in GDP.

Firstly, the higher productivity growth in manufacturing implies that in the longer term prices of manufactures will decline relative to services, leading to a lower share of manufactures in value-added in nominal terms. Therefore, a declining value-added share of the manufacturing sector per se is not a reason for concern, but rather the logical consequence of a European manufacturing sector that is constantly becoming more efficient.

Secondly, demand structures characterised by low price elasticities of demand and high income elasticities for some services like education, tourism, health and cultural activities change the composition of demand as income increases. These elasticity differentials (discussed above in the context of structural change) compound the effect of the declining relative importance of manufacturing in value-added terms.

These two factors driving the downward trend of a manufacturing sector in relative terms can be countered by increased external competitiveness of the manufacturing sector and industrial policies working towards this end, as set out in Chapter 4.

ARGUMENTS FOR THE MANUFACTURING IMPERATIVE

Fears have been raised that the declining manufacturing share of GDP entails loss of manufacturing capabilities which, once lost, are hard to recover. Manufacturing capabilities specific to particular industries – even if they are low-technology industries – may at a later stage become important inputs for fast-growing new products.

There are at least three arguments for a 'critical size' of the manufacturing base:

- Manufacturing still accounts for a major part of the innovation effort in advanced economies and this translates into above-average contributions to overall productivity growth and thus to real income growth.
- There are very important 'backward linkages' from manufacturing to services which provide important inputs for manufacturing (in particular business services). Manufacturing has a 'carrier function' for services which might otherwise be considered to have limited tradability. This operates through international competitive pressure and has an added stimulus effect for innovation and qualitative upgrading for service activities. Another linkage is increased 'product bundling' of production and service activities in advanced manufacturing activities.

- Lastly, and related to the first argument, is the higher productivity growth in manufacturing which is important because the sector of origin of productivity growth may not be the sector which benefits most from the productivity growth.

THE EXTERNAL COMPETITIVENESS OF EU MANUFACTURING

There are also structural changes within the manufacturing sector, as explained in Chapter 2 above. These go in the direction of a mild but persistent shift towards more technology-intensive industries (chemicals, machinery, electrical equipment and transport equipment) which also tend to be less labour-intensive.

This mild trend towards advanced manufacturing industries reflects international specialisation patterns of EU Member States because in general technology-intensive industries offer more possibilities for building comparative advantages by product differentiation and quality aspects. At the same time, low-technology-intensive industries still accounted for almost 40% of EU manufacturing employment in 2009.

Traditionally, EU manufacturing has faced competition in more technology-intensive segments from producers in Japan, Korea or the US. However, over time competition from producers in BRIC countries is gradually changing and increasing.

Given the structural upgrading in emerging economies, competitive pressures from these countries are not limited to low-technology-intensive industries but are also felt in advanced manufacturing industries. Brazil, India and China all increased considerably their market shares in global value added exports of manufactures over a period of 15 years. It is especially the outstanding performance of Chinese producers, whose market share quadrupled between 1995 and 2011, which drove this change.

All in all, EU manufacturing seems to have managed to defend its positions on world markets. In general, the EU manufacturing sector is seen as rather well-diversified. Over time, the EU manufacturing sector has succeeded in upgrading product quality by engaging in R&D&I. The challenge is more demanding for low-tech and medium-low-tech industries for which this may require a higher degree of specialisation and entering or creating niche markets. Existing evidence suggests that many European firms follow such a ‘premium strategy’ within their respective industry. European firms typically operate in the top quality segments.

R&D in manufacturing is key to maintaining or expanding market shares for knowledge-intensive goods. It is therefore worrying that EU manufacturing has a lower R&D intensity per firm than the US and Japan. The R&D intensity in seven EU Member States, for which data are available, is only 62% of that of the United States.

R&D and innovation are not the sole ingredients for a highly productive and internationally competitive manufacturing sector. In order to differentiate products and charge higher price-cost mark-ups, manufacturing firms depend increasingly on sophisticated services inputs.

The ever tighter inter-linkages between the manufacturing sector and the increasingly dominant services sector in the EU economy work in two ways:

- Increased use of services inputs and services embedded in manufacturing products can increase the EU manufacturing sector’s competitiveness
- Through this increased interdependence, manufacturing can increase the tradability of services.

INDUSTRIAL POLICY AND THE EXTERNAL COMPETITIVENESS OF EU MANUFACTURING

Sectoral aid does not show any significant effects on extra-EU exports or value added per capita for export oriented firms. On the other hand, internationalisation measures are horizontal and have significant and positive effects on extra-EU exports.[1]

Other effective horizontal aid measures seem to be regional aid and aid for training of the employees.

An industrial policy providing funds to different parts of the innovation process have positive and significant effects on R&D intensities and patent application propensities for manufacturing firms in the EU-15 and EU-12 irrespective of firm size and technological intensity of the firm.

The effects on output of the innovation process, of the amount of the innovative sales or of public funding differ according to the geographical location of the firm, its size and its technological intensity. Public funding has positive and significant effects, in particular for EU-15 firms. Further positive and significant effects are found for high-tech and medium-high-tech and for SMEs.

These results suggest that there is potential to improve the targeting of public support and to make it more effective. Especially in the EU-12, and irrespective of the actual objectives of the support programmes, governments end up providing innovation support more often to larger firms than to their smaller competitors. Given that small firms in particular face considerable financial problems due partly to asymmetric information flows, they should be the primary target of public funds.

The special targeting of grants is one way to improve the allocation of public funds to SMEs. Other initiatives could include information campaigns about credits, cost-deductions and subsidised loans for new entrepreneurs. As financial problems occur mainly in the commercialisation phase, fostering venture capital investment would be another starting point.

[1] For the purposes of this report, internationalisation measures mean horizontal measures aimed at supporting internationalisation of commerce. (Export aid is generally prohibited under EU state aid rules).

RESEARCH COMMERCIALISATION

The EU is usually perceived as less effective at bringing research to the market when compared to its main competitors such as the US, Japan, and South Korea. The relative underperformance in research commercialisation in the EU has been attributed to a number of factors including the absence of an entrepreneurial culture and a less developed venture capital sector. The discussion about the main factors explaining the European innovation gap is related to the so-called European innovation paradox which suggests that Europe does not lag behind the US in terms of scientific excellence, but lacks the entrepreneurial capacity of the US to effectively commercialise inventions and step thereby on an innovation-driven growth path.

Analysis on the specific innovation-related factors and types of public funding on commercialization performance focused on the commercialisation of R&D efforts at firm level. In particular, the actual R&D performed internally and/or acquired from external sources, the research collaboration activities with different players such as customers, suppliers, public research institutions and other firms, and the firm's use of particular types of public funding for innovation were examined, using the Community Innovation Survey (CIS) micro-data. Focusing on the commercialisation of R&D efforts, innovation output was analysed in terms of innovative sales of companies.

The results of the analysis suggest that the impact of the R&D efforts on commercialization is positive for both manufacturing and non-manufacturing firms. It is observed that the firms which, in addition to their own R&D, also acquire R&D services externally tend to have higher share of turnover from innovative products. This external acquisition of R&D results can take place as a pure purchase of services, but also can be acquired in the framework of the inter-firm R&D cooperation.

Concerning the different forms of R&D cooperation activities the results are mixed across different groups and classes of firms. It can be seen that vertical cooperation (i.e. R&D cooperation with suppliers and/or customers) is positively associated with higher commercialization performance in firms coming from different size classes and different technology intensity groups.

The effects of public funding on the commercialization performance of firms appear to be positive in most classes and groups of firms considered. The relationship between the use of local public R&D support and the commercialisation performance shows positive across all different technology intensity domains. Public R&D support at the national level is positively related to the share of innovative turnover. Firms appear generally to have higher commercialisation performance when making use of EU-level public R&D support, with a consistently strong and positive effect of public funding being found especially for firms in medium-high and high-tech industries.

Bringing the most important findings together suggests a number of conclusions regarding the general patterns of innovation and commercialisation performance of European firms. When observing the behaviour of individual firms, the link between the R&D effort and the commercialisation performance is rather pronounced and a positive relationship is observed in number of cases, not only the R&D itself, but also its origin and the patterns of R&D cooperation among firms play a role.

In particular, the results suggest that local R&D support does positively affect firm commercialisation performance in all technology intensity and size classes. The effects of national and EU funding are positive and significant for all firms and manufacturing firms only, but mixed results are found for smaller subsamples. Overall, public funding has consistently positive effects on innovative sales for medium-high and high-tech sectors firms, while this statement is true to a lesser extent for firms in lower tech industries.

PRODUCTS AND TRADE BASED ON KEY ENABLING TECHNOLOGIES

Every two to three decades, an innovative concept or material comes along with the potential to bring about fundamental change throughout the economy. Silicon arrived in the 1940s, paving the way for the ICT revolution. In the 1970s, gallium arsenide made lasers ubiquitous in DVDs, CDs and modern telecommunications. The late 1980s witnessed the interconnection of several existing computer networks to create the internet. In the 1990s there was gallium nitrite, which revolutionised photonics and in particular solid state lighting. Right now the world is exploring the potential benefits of graphene, isolated as recently as 2004 and subsequently acknowledged by the 2010 Nobel Prize in physics, as well as by the European Commission which recently launched a ten-year flagship programme with a budget of EUR 1 billion to develop graphene technology. Decades from now, with the benefit of hindsight, people may look back at graphene as another game-changing discovery.

The stakes and potential gains are high. In 2011, the European Commission's first High-Level Group on Key Enabling Technologies (KETs) presented its final report which estimated the market for key enabling technologies to be worth USD 1,282 billion by 2015 (photonics 480 bn; micro and nanoelectronics 300 bn; advanced manufacturing systems 200 bn; advanced materials 150 bn; industrial biotechnology 125 bn; nanotechnology 27 bn). As 2015 approaches, it is of course crucially important to ensure that EU manufacturing is ideally placed to benefit as much as possible from this potentially huge and growing market. To that end, it is not enough for the EU to produce state-of-the art research results in key enabling technologies, there must also be mechanisms in place to bring those results to market in the form of commercial products, and there must be demand for the products. This was one of the key conclusions of the first High-Level Group's report. This report develops that theme by assessing the position of the EU in the production of and international trade in certain products based on key enabling technologies, including changes in EU competitiveness over time. Chapter 5 goes on to examine the specialisation of Member States in the production of, and trade in, products based on key enabling technologies.

EUROPE IS A MAJOR PRODUCER OF NEW KNOWLEDGE IN KEY ENABLING TECHNOLOGIES …

In terms of knowledge production, Europe appears to be doing well. Measured by its share of the global number of patent applications in each of the six key enabling technologies, Europe is maintaining a similar share as North America (US, Canada, Mexico) in most key enabling technologies, while East Asian patent applicants tend to be more productive than their European and North American counterparts. Unlike North American applicants though, European patent applicants have lost little or no ground in recent years: Europe's shares of global patent applications are similar to those reported in the 2010 edition of this report (EC 2010), whereas North American applications have fallen back. It is also important to underscore that in absolute terms, European patent applications are increasing from year to year in most key enabling technologies.

… BUT IS NOT ALWAYS IN A POSITION TO BENEFIT IN THE FORM OF PRODUCTS

But knowledge production is not synonymous with job creation and growth. In order to turn patents into marketable products based on key enabling technologies, manufacturers need to be well positioned in terms of the technology content of their products and in relation to the competition they face on the global market. Unit value analysis indicates that EU products based on industrial biotechnology and advanced materials have a higher technology content than North American or East Asian products in the same fields, while in advanced manufacturing technologies for other KETs the technology content is similar to North American but higher than East Asian products. In nanotechnology and micro- and nanoelectronics on the other hand, EU products have a relatively low and generally decreasing technology content.

The technology content should be seen against the backdrop of the competitive situation in which EU manufacturers have to sell their products. The analysis presented in Chapter 6 suggests that in all key enabling technologies except advanced manufacturing, EU manufacturers are predominantly up against price competition, and in three technologies – industrial biotechnology, nanotechnology and advanced materials – they are able to compete on price. This finding is new and runs counter to the generally held view that production costs are too high in the EU to enable manufacturers to compete on price. In photonics and micro- and nanoelectronics, where price competition prevails as well, EU manufacturers tend to have little or no price advantage and therefore struggle to compete with North American and East Asian manufacturers. This does not mean that EU manufacturers in those fields should exit the market or that policies to strengthen competitiveness should not be pursued. It simply reflects the fact that historically EU manufacturers have not had a price advantage on a market where price competition prevails.

The only key enabling technology in which quality competition dominates is advanced manufacturing technologies for other key enabling technologies, where EU manufacturers are able to compete with North American and East Asian rivals thanks to the superior quality of their products. The impact of the high technology content of EU products manifests itself in a possibility to compete with high-quality products even if they are more expensive than competing products made in North America or East Asia.

MOVING TO THE HIGHER END OF THE VALUE CHAIN

Having to compete mainly on price (in five of the six key enabling technologies) may not be an attractive growth model for EU manufacturers in the long run. Given its considerable knowledge production and the high technology content of EU products, a gradual shift away from the current portfolio of predominantly mature products – where firms compete more on price than quality – to more innovative and complex products could be an avenue to pursue. A step in that direction could be to focus on more integrated products than today, possibly combining more than one key enabling technology. Another idea could be to reinforce the cross-fertilisation of new technology developments between key enabling technologies.

Chapter 1.
THE COMPETITIVE PERFORMANCE OF EU MANUFACTURING

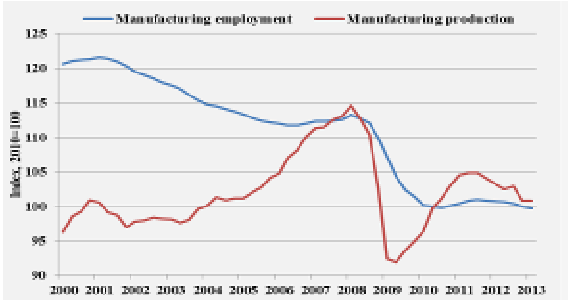
This chapter overviews the competitive performance of EU manufacturing vis-à-vis established and emerging global competitors. EU industries compete on the single market and on external markets by selling their products either at a lower price or with a higher quality than competitors.[2] Their ability to compete depends on a number of "drivers". Some of these drivers are necessary in order to compete with prices while other drivers are more essential for the development of products with characteristics and qualities that differentiate the industries' products from those of their competitors.[3] The analysis relies on a number of traditional indicators of international competitiveness, such as revealed comparative advantages, labour productivity and unit labour costs, but employs as well relatively novel indicators of exports in value added and complexity and exclusivity of exports.

The chapter is organised as follows. The first section presents a brief overview of the impacts of the recession on the manufacturing sector. The second section focuses on the export performance of EU industries on world markets. The third section explains the export performance by analysing the drivers of EU price and non-price competitiveness. It looks at the dynamics of labour productivity and unit labour costs (ULC), as well as patenting and innovation output. R&D and innovation indicators however are not readily available for all the comparator economies.[4] Therefore they are used mainly for comparisons across EU industries and Member States.

1.1. DELAYED RECOVERY

EU manufacturing output decline reached its trough in the middle of 2009. Following a short-lived recovery manufacturing industries fell back into a double-dip recession at the end of 2011. Employment in manufacturing has been steadily declining for decades. The decline accelerated with the onset of the financial crisis (Figure 1.1).

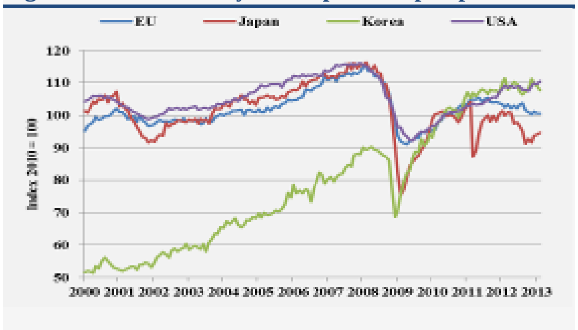
Figure 1.1. Double-dip of EU manufacturing production



Source: Own calculations using Eurostat data.

Even though the financial crisis had global repercussions, other parts of the world have been recovering faster. While the EU manufacturing hit the trough and began a rebound earlier than US manufacturing, since late 2011 the EU has been lagging behind. The recovery in the two previous recessions since 1990 was also faster in the US than the EU. Asia is also recovering faster than Europe. South Korean manufacturing for instance reached its pre-crisis peak in less than 18 months.[5] Similarly, the

Figure 1.2. EU recovery in comparative perspective



Source: Own calculations using Eurostat and OECD manufacturing output data.

2 This is a simplification more accurately describing the situation of firms selling just one product. Firms and industries also have other means of competing. Examples of other means to compete are combinations of goods with services, combinations of goods that are complementary to each other, establishment of distribution networks.

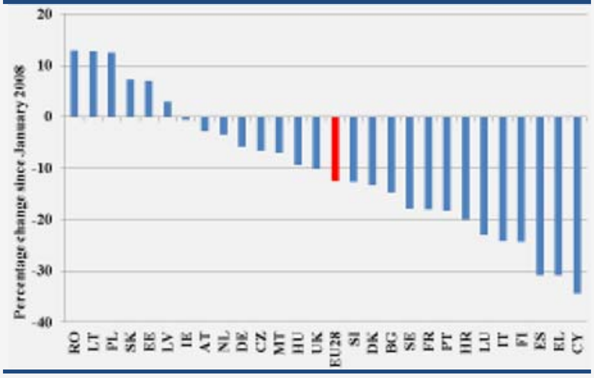
3 See European Commission (2010) for thorough analyses and discussions of price and non-price factors.

4 Data for R&D expenditures, business expenditures on R&D (BERD), are unfortunately published with a long delay. At the time of drafting this report, a comprehensive data set for EU Member States and OECD countries, is not available after 2008.

5 A sharp depreciation of the won by 31% from the first quarter of 2008 may partly explain the 10% growth in exports in 2009. Close relations with other Asian countries is another factor accelerating Korea's recovery. Especially the Chinese stimulus programme in 2009 contributed significantly as Korean exports to China accounted for 87% of the increase of exports during 2009. Other factors explaining the rebound of Korean manufacturing were the strong domestic demand growth, including fiscal expansion, and a relatively limited impact of the global financial crisis on Korean financial markets (OECD 2011)

initial rebound of Japan – which was hardest hit by the financial crisis – was impressive, but was interrupted by the 2011 Fukushima earthquake and tsunami (Figure 1.2).

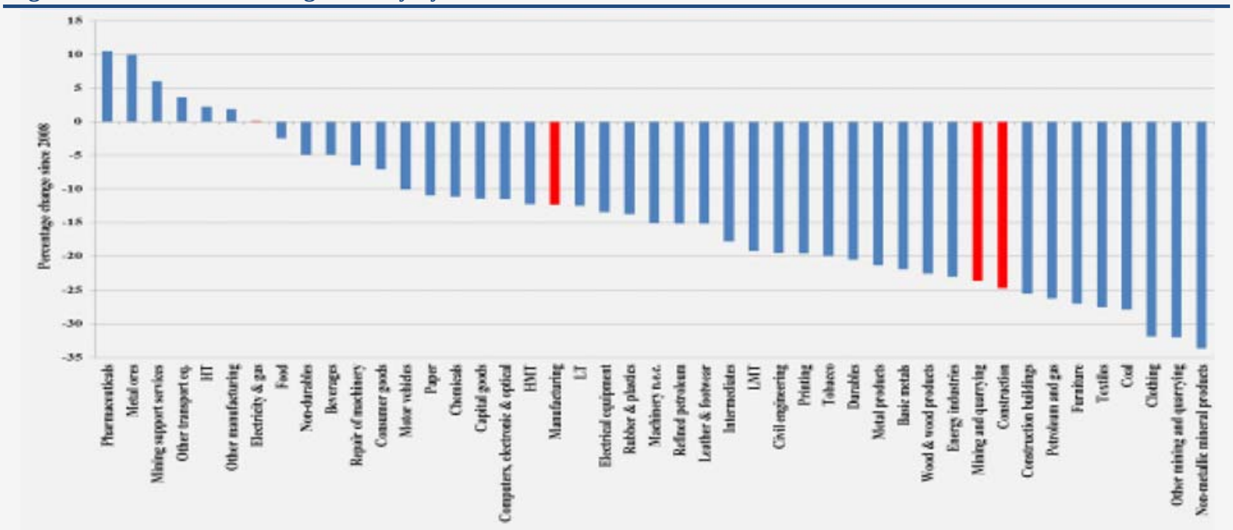
Figure 1.3. EU manufacturing recovery by member state



Source: Own calculations using Eurostat manufacturing output data as of March 2013.

Recovery has been much harder across the EU. While Romania, Poland, Slovakia and the Baltic states have already surpassed their pre-recession peak levels of industrial output, most of the member states are still below, with some of those in the south still close to the trough or may have not even started their recovery (Figure 1.3).

Figure 1.4. EU manufacturing recovery by sector



Source: Own calculations using Eurostat data. Developments are shown since the peak in EU aggregate manufacturing output in January 2008 to March 2013. HT, HMT, LT and LMT denote high-tech, medium-high-tech, low-tech and medium-low-tech manufacturing industries (see the annex for definitions)

A sector breakdown shows that few industrial sectors (among which pharmaceuticals and other transport equipment) have recovered their pre-crisis level of production (Figure 1.4). In principle, high-tech manufacturing industries were less severely impacted.

Food, beverages and non-durable consumer goods have fared relatively better than other industries since the outbreak of the financial crisis. The reason is that capital goods and intermediate goods industries are more sensitive to business cycle fluctuations than industries producing necessity goods and non-durable consumer goods, demand for which is less sensitive to variations in income.[6] Some medium-high technology industries produce capital and intermediate goods, which is why they experienced larger output decline.

Mining and construction were harder hit than total manufacturing. There is however a considerable variation within the aggregate mining and quarrying. Metal ores and mining support services have had a positive development since 2008. Some of this development is due to a high demand from the world market. On the other hand, some mining industries have been in decline for a longer period of time before the crisis. This is also true of some manufacturing industries such as furniture, clothing and textiles.

Since manufacturing was hit more severely than services industries, the shares of manufacturing to GDP fell in every Member State during the crisis.[7] Figure 1.5 presents the shares of manufacturing in GDP by country in 2012. The declining share of manufacturing output and employment has been a long-term trend driven by shift in domestic demand due to growth in incomes on the one hand and lower

6 See the discussion in European Commission (2009, 2011).

7 See for example European Commission (2013c) forthcoming on the developments of services since 2008. Total services declined by some 9% between the first quarters of 2008 and 2013 while the corresponding decline for total manufacturing amounted to some 12%. Certain services industries providing services with high income elasticities, for example transportation services and package holidays, experienced much stronger declines.

prices of manufactures due to higher productivity growth on the other (Nickell et al. 2008).[8] Increasing external demand for EU manufactured goods however can counter this trend provided that EU manufacturing industries compete successfully on world markets.

Figure 1.5. Manufacturing shares of GDP in the EU 2012

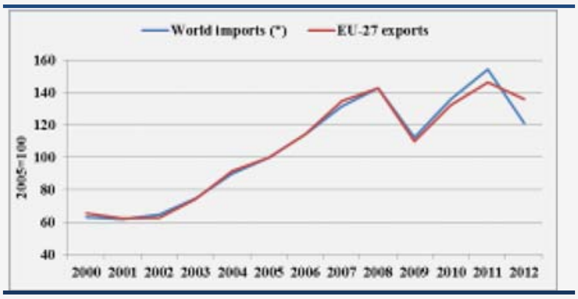
Source: Own calculations using Eurostat data. Note: 2011 value for Romania No data available for Bulgaria and Ireland.

1.2. EU INDUSTRIES' PERFORMANCES ON WORLD MARKETS

The recession which began in 2008 had a global impact. While public and private debt problems have constrained domestic demand in many Member States and delayed a full recovery from the crisis, demand for EU exports has risen. During 2010-2011 exports contributed more to GDP growth than domestic demand in most EU member states (Figure 1.6).

Following the decline in trade during 2009, world demand recovered faster than in the EU and world imports recovered quickly. A particularly strong import rise in China helped ease the recovery in East-Asian countries.[9] The rebound of world imports starting in 2010 have boosted as well EU exports (Figure 1.7).

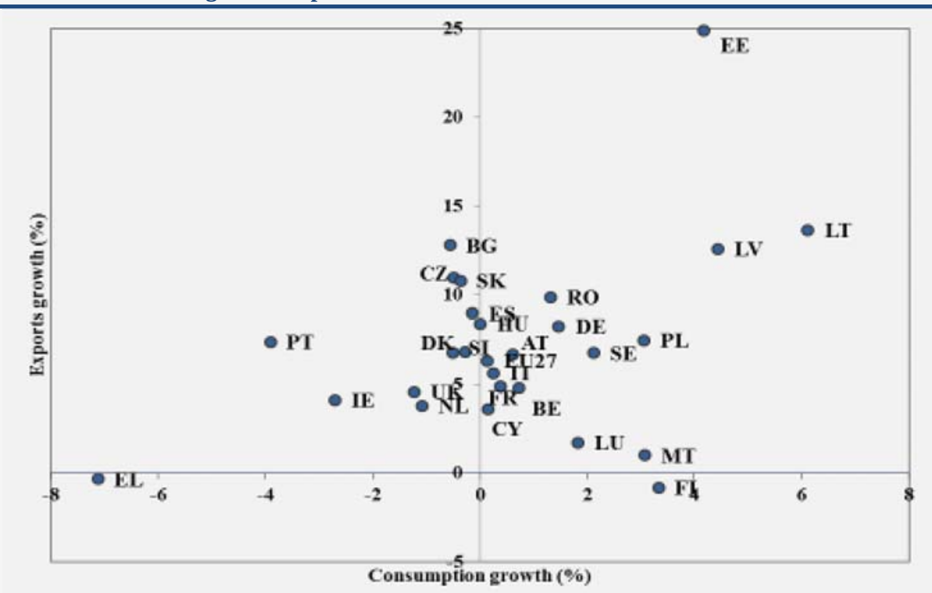
Figure 1.7. World imports and EU exports from 2000 to 2012



Source: UN COMTRADE Note: Trade data for 2012 is still incomplete at the time of drafting this report. Imports and exports in current value. (EU imports excluded)

This question will be explored using an indicator for competitiveness on world markets, the index of revealed comparative advantage (RCA). The RCA index compares the share of an EU sector's exports in the EU's total manufacturing exports with the share of the same sector's exports in the total manufacturing exports of a group of reference countries. RCA value which is higher than 1 means that a given industry performs better than the reference group and has comparative advantage, while value lower than unity indicates comparative

Figure 1.6. Contribution to GDP growth in per cent 2011-2012



Source: AMECO database, Commission services.

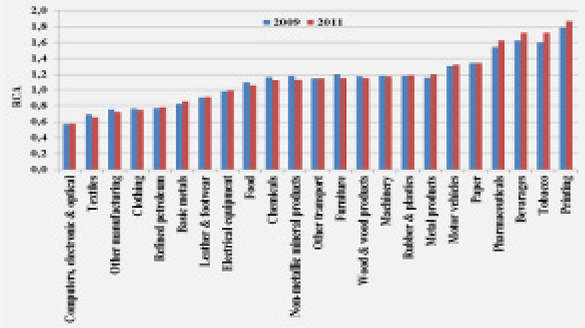
8 See chapter 2 for detailed analysis

9 European Commission (2012).

disadvantage.[10]

According to the RCA indices, some 15 manufacturing industries had comparative advantages in 2009 and 2011.[11] Two thirds of these are either low-technology or medium-low-technology industries. However, the EU has comparative advantages in most medium-high-technology industries as well as the high-technology sector of pharmaceuticals (Figure 1.8)

Figure 1.8. EU comparative advantages in 2009 and 2011



Source: UN COMTRADE

A comparison with major global competitors (including BRIC) in sectors grouped according to technology intensities in Table 1.1, shows that EU, Japanese and US manufacturing industries have RCAs in medium-high-tech sectors. Only Chinese high-tech manufacturing has RCA of 1, 56.[12]

Table 1.1. – Revealed comparative advantages by technology intensities in manufacturing 2011

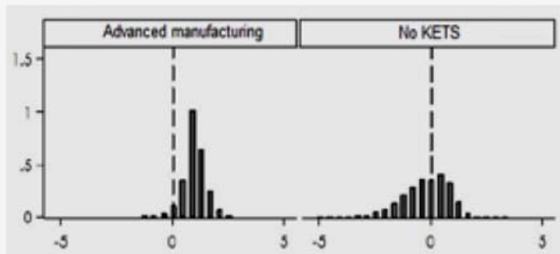
	High tech	Medium high tech	Medium low tech	Low Tech
EU	0.85	1.14	0.89	1.01
Japan	0.73	1.59	0.86	0.16
US	0.88	1.22	0.96	0.68
Brazil	0.32	0.76	0.87	2.50
China	1.56	0.72	0.85	1.29
India	0.40	0.49	1.93	1.33
Russia	0.08	0.45	2.74	0.49

Source: UN COMTRADE

The indicators above are calculated from trade data. Even though the industries can be classified according to technology intensities, it is hard to measure the real sophistication of a country's manufacturing using this kind of data, for at least two reasons. **The first reason has to do with the difficulty of observing the quality or complexity of the export products of a country or an industry**. Two products in the same sector or even two products with the same customs code can have different degree of complexity. **Secondly, for any given good, trade statistics do not provide information on the share of value added produced domestically (i.e. the domestic content of a country's exports)**. That makes it difficult to tell for example if an industry in a specific country is developing high-tech products or merely assembles them. These limitations complicate measurements and comparisons of industrial competitiveness. They also require that the picture of EU competitiveness based on RCA presented in Figure 1.8 be extended to account for these two additional indicators of international competitiveness.

Concerning the quality or complexity of a product, a recent strand of literature interprets the competitiveness of an industry in a certain country through its ability to produce relatively sophisticated products. Two key concepts in this respect are the diversification of the export mix of a given country or industry; and the sophistication or exclusiveness of the export mix.[13] Diversification by itself does not indicate strong capabilities in an economy with complex productive structures. It could very well be that a country whose industries produce a large number of products does so because the products are at the end of their life cycles, i.e. are standardised and can be produced at low costs. Countries with more complex productive structures will have industries that are able to produce more sophisticated and

Figure 1.9. Product complexity: comparison of advanced manufacturing goods with non-Key Enabling Technologies



Note: Product complexity is the average 2005-10. More density to the right means products in that category are more complex than average.

[10] See Balassa (1965). A disadvantage with the measure is that it can assume values between zero and infinity. See European Commission (2010a) for an alternative specification that constrains the index to range from -1 to +1 with positive values indicating revealed comparative advantages.

[11] One should note that the manufacturing industries above are represented for the two-digit level NACE classification. This is a relatively high level of aggregation which includes a great many industries.

[12] These aggregates mask significantly differences not only between the industries entering the aggregates but also between the different EU Member States.

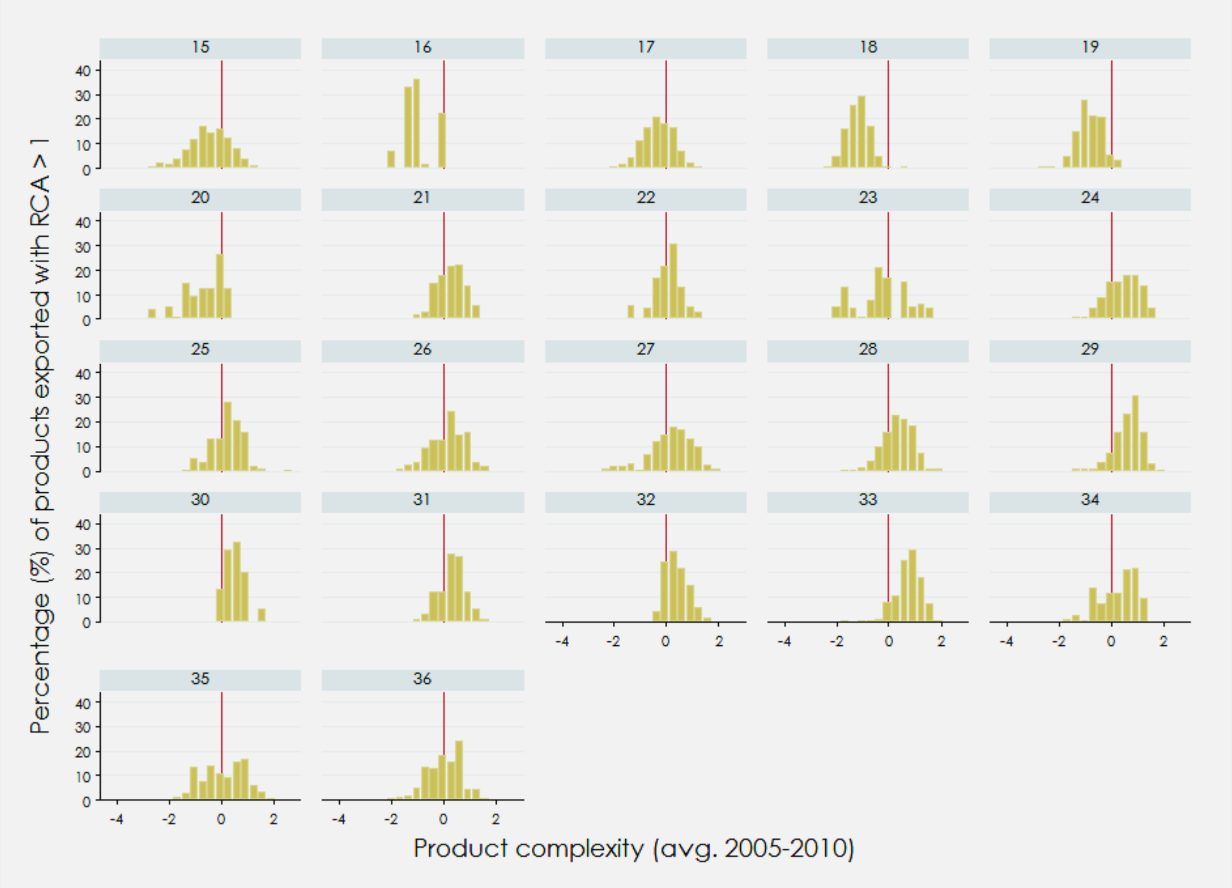
[13] See Annex 1 for a description of the methodology for calculating complexity of products. The description is based on Reinstaller, A. et .al (2012). See also Felipe et. al. (2012 pp. 36-68).

exclusive products.[14] These countries have a knowledge base or critical mass large enough to produce sophisticated products.

The complexity of products can be illustrated by comparing the type of products produced by advanced manufacturing vis-à-vis the other manufacturing sectors. Figure 1.9 shows how complexity is distributed within the category advanced manufacturing technologies and in those sectors that do not belong to key enabling technologies. In the first category most products are more complex than average while the second shows a more even distribution between complex and less complex goods.[15]

The figure below focuses on EU products with revealed comparative advantages (values of RCA above 1). The results show that quite a high share of products with RCA in the categories of basic and fabricated metals (NACE 27 and NACE 28), machinery and equipment n.e.c. (NACE 29), office machinery and computers (NACE 30) and motor vehicles (NACE 34) are products of higher than-average complexity. For example, more than 90% of the products for which the manufacturing industry medical, precision and optical instruments (NACE 33) have revealed comparative advantages are more complex than the average products sold on world markets by the same industries in other countries.

Figure 1.10. Percentage of total products for which EU manufacturing industries have revealed comparative advantages in different levels of complexity: averages 2005-2010 NACE Rev. 1



Source: Reinstaller et. al. (2012). BACI database. Note: Products are sorted according to their complexity score on the horizontal axes. The average world market shares for each country's products are shown on the vertical axes.

Calculating revealed comparative advantages for products according to different degrees of complexity, across EU manufacturing industries for 2005-2010 average value, shows how successful EU manufacturing industries are in competing with goods of different degrees of complexity.

EU manufacturing industries have revealed comparative advantages also for low complex products such as tobacco (NACE 16), clothing (NACE 18), leather (NACE (19) and wood (NACE 20) (Figure 1.10)

Given that competitiveness is a dynamic state, it is interesting to see how the EU manufacturing industries' products change in terms of complexity over time. EU manufacturers producing the most

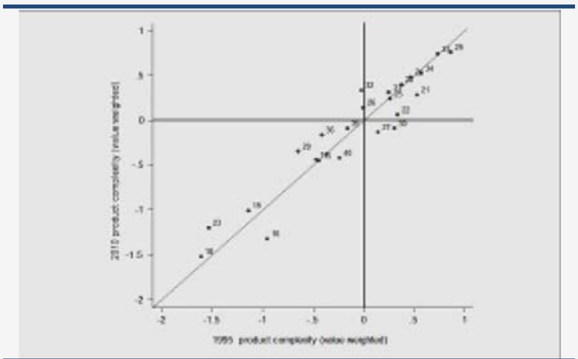
[14] See Hausmann and Hidalgo (2011); Hausman, Hwang and Rodrik (2007)

[15] See also the discussion in European Commission (2013a).

complex items: chemicals (NACE 24), machinery and equipment (NACE 29), medical, precision and optical instruments (NACE 33) and motor vehicles (NACE 34) maintained their position in 2010 compared to 1995. Industries producing electrical machinery and apparatus n.e.c. (NACE 31) and radio, TV and communication equipment (NACE 32) managed to upgrade their products, while industries producing office machinery and computers (NACE 30) were not able to upgrade their average complexity, (Figure 1.11.)[16]

Larger changes have taken place over time in products supplied by BRIC countries. Products from wood industries (NACE 20), radio, TV and communication equipment (NACE 32), medical, precision and optical instruments (NACE 33) and furniture industries (NACE 36) have considerably improved the average complexity of their products, (Figure 1.12)[17]

Figure 1.11. Development of product complexity at EU manufacturing industry level between 1995 and 2010 NACE Rev. 1.



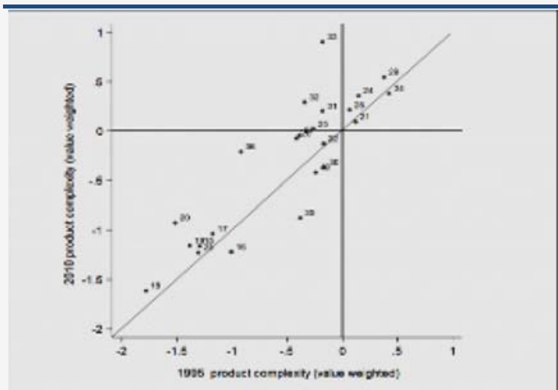
Source: Reinstaller et. al. (2012). BACI database. Note: Products are sorted according to their complexity scores 1995 and 2010 on the axes.

Even though industries in the BRIC countries managed to upgrade their products considerably between 1995 and 2010, the majority of industries in these countries still produce less complex products than their counterparts in the EU. In fact, manufacturing industries in the EU have a high degree of complexity. This is further confirmed by the observation that the EU exported about 67% of products with revealed comparative advantage in 2010. In comparison, the US only has a comparative advantage in 43% of products, China in 54% and Japan in 24%.[18]

The EU is a highly diversified economic area, which is further confirmed by Figure A2 to A6 in the annex to this chapter. More industries in the EU than in Japan and South Korea are able to secure big market shares in a larger number of export products. Manufacturing industries in the US are more advanced competitors in this respect. China has developed over time more industries able to produce relatively complex products than before. Chinese manufacturing industries are however still predominantly competitive in product categories with lower complexity.[19] Reinstaller et al (2012) show that EU exporters, together with those in the US, Japan and South Korea are more able to capture larger shares of the world market by offering more exclusive products which rely on a broader knowledge base.[20]

The analysis of export complexity and exclusivity feeds into the broader discussion of the upgrade of a country's productive structure and comparative advantages. It is discussed in the context of the differences in structural change across countries in chapter 2 of this report.

Figure 1.12. Development of product complexity at BRIC countries' manufacturing industries' levels between 1995 and 2010



Source: Reinstaller et. al. (2012). BACI database. Note: Products are sorted according to their complexity scores 1995 and 2010 on the axes.

The issue of separating the domestic content of production from foreign content is related to the increased international fragmentation of production which gives rise to increased intra-industry trade in intermediate goods. In traditional trade statistics the

16 The lines crossing zero at the horizontal and vertical axes denote the average complexity of industries' products in 1995 and 2010 respectively. A dot above the 45 degree line indicates that an industry has managed to increase its average complexity between 1995 and 2010.

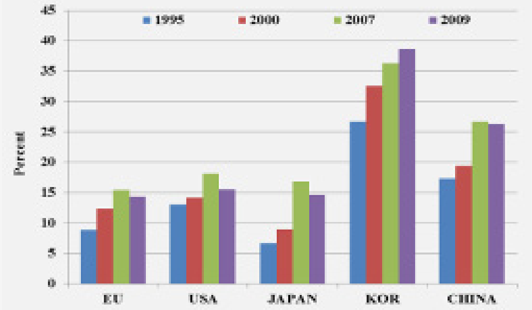
17 The lines crossing zero at the horizontal and vertical axes denote the average complexity of industries' products in 1995 and 2010 respectively. A dot above the 45 degree line indicates that an industry has managed to increase its average complexity between 1995 and 2010.

18 See Reinstaller et al, 2012.

19 ibid

20 Regression analyses show that increases of product complexity of EU manufacturing products are positively associated with increases of world market shares, employment and value added growth in the EU manufacturing sector. See Reinstaller et al, (2012 pp 32-33).

Figure 1.13. Lower extent of foreign value added embedded in EU manufacturing exports



Source: WIOD.

value of imported intermediate goods is included in the export value of the final product that is exported. One possibility is to adjust gross export flows for imported intermediates by means of global input-output statistics. The resulting exports only capture the value added which is generated domestically in the production of goods destined for export (see Johnson and Noguera, 2012; Stehrer, 2012) but exclude foreign value added associated with imported intermediates. Value added export also exclude the part of value added which is created domestically but is used in domestic production.[21]

Table 1.2. Domestic and foreign value added content of gross manufacturing exports by source country in 1995 and 2009 (%)

	EU		CHINA		JAPAN		KOREA		US	
	1995	**2009**	**1995**	**2009**	**1995**	**2009**	**1995**	**2009**	**1995**	**2009**
Domestic	91.1	85.6	82.7	73.6	93.3	85.4	73.3	61.3	86.9	84.5
Foreign	8.9	14.4	17.3	26.4	6.7	14.6	26.7	38.7	13.1	15.5
EU	–	–	2.8	5.1	1.2	1.8	4.4	5.2	3.7	3.3
CHINA	0.3	2.3	–	–	0.4	2.4	1.7	6.7	0.4	2.5
JAPAN	1.0	0.7	3.8	3.3	–	–	6.3	4.7	2.2	0.9
KOREA	0.3	0.4	2.0	1.8	0.5	0.5	–	–	0.6	0.4
US	2.3	2.4	2.0	3.4	1.4	1.6	5.1	3.8	–	–
AUSTRALIA	0.2	0.2	0.5	1.3	0.3	0.9	1.1	1.8	0.1	0.2
BRAZIL	0.2	0.4	0.1	0.6	0.1	0.2	0.3	0.4	0.2	0.3
CANADA	0.4	0.4	0.4	0.5	0.3	0.3	0.7	0.5	1.8	2.0
INDONESIA	0.1	0.2	0.5	0.4	0.3	0.6	0.6	1.2	0.1	0.1
INDIA	0.1	0.3	0.1	0.3	0.1	0.1	0.2	0.3	0.1	0.3
MEXICO	0.1	0.2	0.0	0.2	0.1	0.1	0.1	0.2	0.7	1.2
RUSSIA	0.8	1.5	0.3	0.7	0.1	0.4	0.4	1.0	0.2	0.3
TURKEY	0.1	0.3	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.1
TAIWAN	0.2	0.2	1.8	1.8	0.3	0.4	0.6	0.9	0.5	0.3
Rest of world	2.8	5.0	2.9	7.1	1.7	5.2	5.4	11.9	2.4	3.8

Source: WIOD

A related concept is value added content in trade. This concept measures the domestic and foreign value added embodied in a country's gross exports. The measure provides information on how much value added from the exporting and other countries is embodied in a country's gross exports. A large share of foreign value added content in a country's exports is indicative of a less sophisticated part of the production process, such as the assembly of a product.[22] Figure 1.13.compares foreign value added of exports from China, the EU, Japan, Korea and the US from 1995 to 2009. It shows that foreign value added embedded in EU manufacturing exports is lower than that of the other global competitors.

The effects of the financial crisis on trade and global value chains are visible in the figure as the shares of foreign value added content ceased to increase after 2007. An exception is Korea which hosts a large number of Japanese multinational firms.[23]

Foreign value added embedded in gross exports can be broken down by source. This will show whether countries and their industries succeed in selling intermediate inputs to be used in the gross exports of other countries. The value added content of manufactured gross exports by source is closely related to the measure of vertical specialisation (Hummels et al, 2001). Between 1995 and 2009 when Chinese exports increased dramatically, EU value added in Chinese manufacturing exports increased more than that of industries from other parts of the

[21] See chapter 4 in this report.

[22] See Stehrer (2012) for an extensive discussion of these two concepts.

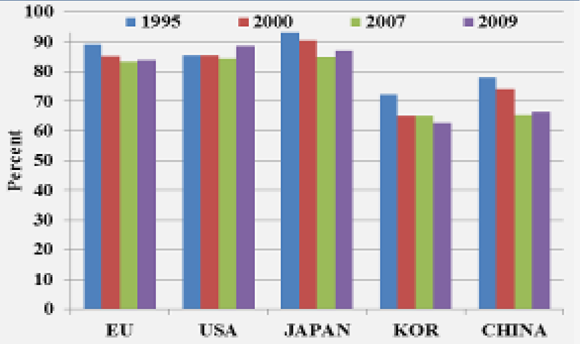
[23] OECD (2011). See also previous OECD Economic surveys for Korea.

world (Table 1.2). Japanese, Korean value added in Chinese manufacturing exports decreased during the same time. The increased presence of inputs from the rest of the world in Chinese, Japanese and Korean manufacturing gross exports suggest that there is a strong inter-Asian production network masked in this aggregate.

One reason for a relatively lower foreign content of EU manufacturing gross exports is that most of the value chains in which EU firms participate are regional, i.e. within the EU. The manufacturing aggregate masks differences across industries. The value chains involving EU industries producing chemicals, electrical equipment and transport equipment are more global, with a higher foreign content of manufactured exports.

Another reason for a lower foreign content of exports can be that the ability to produce most of the value added content of high-tech production – and exports – within a country can be an indication of complex productive structures. A look at the domestic value added content embedded in manufacturing high-tech exports reveals that the EU, Japan and the US are better able than Chinese or Korean counterparts to source most of the input factors necessary for high-tech production at home (Figure 1.14).

Figure 1.14. Lower extent of domestic value added content in high-tech manufacturing exports from China and Korea



Source: WIOD.

The analyses in European Commission (2011b) show that Chinese exports of high-tech manufacturing depend to a large extent on high-tech intermediate imports from other countries. This is evidenced by relatively low values per unit of high-tech export against relatively high values per unit of imported intermediate goods.[24]

24 High-tech industries here include NACE 30 to 33, i.e. it include also the medium-high-tech group NACE 31, as it is based 2-digit NACE Rev. 1.1 classification and the aggregation of industries in the World Input-Output Database (WIOD).

1.3. DRIVERS OF SECTORAL COMPETITIVENESS

This section assesses sectoral performance looking at drivers of external competitiveness. The development over time of cost and price competitiveness is analysed first. This is followed by analysis of indicators of determinants of non-price competitiveness.

Labour cost and productivity

Developments in labour costs should be assessed in relation to labour productivity. A common measure is unit labour cost (ULC), which is defined as the ratio of labour compensation to labour productivity.

Labour compensation and labour productivity can be measured either relative to the number of workers or the number of hours worked. Increases in labour costs exceeding labour productivity growth imply lower profits on markets where the competition is intense and where firms are price takers. Developments in ULC can therefore be regarded as measures of cost competitiveness on markets of non-differentiated products. It should be noted that at given labour costs, ULC developments are heavily influenced by business cycle fluctuations impacting labour productivity growth through larger variations in production than in employment or hours worked.

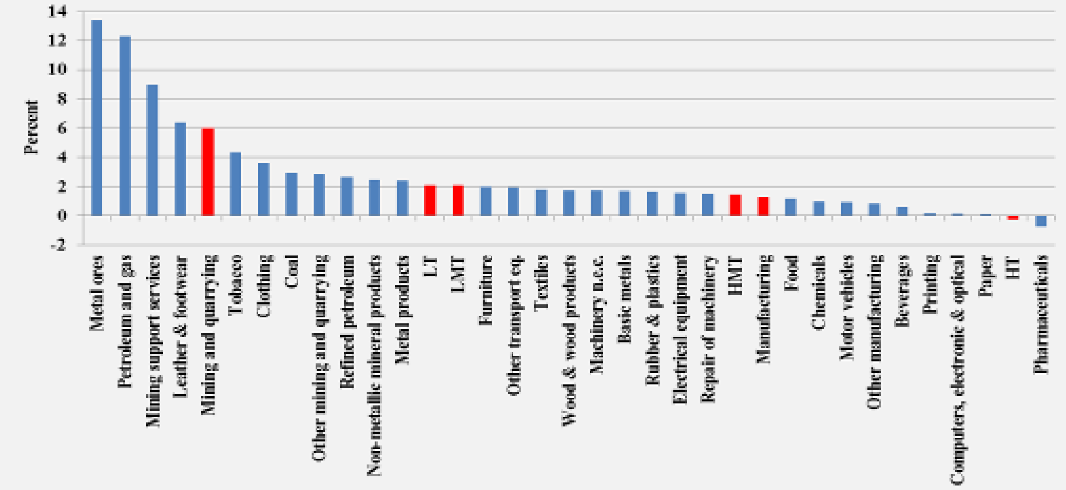
For firms which produce homogenous goods and face strong competition from low-cost countries, labour costs are an important means to remain competitive. ULC may however not be a good indicator for firms which produce differentiated goods with some characteristics that allow the firms some room of manoeuvre to set the prices themselves. Such firms producing goods with higher value added are more frequently found in high-tech and medium-high-tech manufacturing industries. Their goods are often combined with some kind of services aiming at satisfying demand for differentiated goods in high-income segments of different markets. Labour normally constitutes a smaller proportion of total costs and input factors for such firms, rendering the ULC less useful as a measure of competitiveness.

ULC based on the number of employees in manufacturing and mining industries are compared below. High-tech and medium-high tech industries display lower ULC growth rates. ULC growth rates for manufacturing are considerably lower than for mining for the whole period and for different sub-periods (Figure 1.15).

Comparisons of different industries in the EU provide some insight into the competitiveness of these sectors. It is however more meaningful to compare developments of indicators of EU competitiveness with the same indicators for industries from other parts of the world which compete with EU firms.

ULC developments for aggregate EU and US manufacturing are compared in Figure 1.16.[25] Figure 1.19 shows that US unit labour costs advantages are driven mainly by labour productivity. As can be seen below, a larger fall in EU labour productivity growth following the outbreak of the crisis is reflected in a

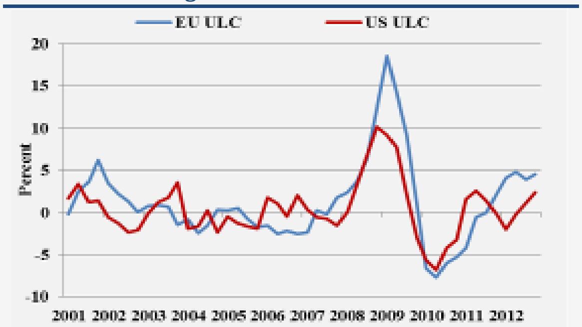
Figure 1.15. More favourable developments of unit labour costs in high- and medium-high-tech industries 2001-2012



Source: Own calculations using Eurostat data. Note: Annual growth 2001-2012 in ULC based on employment (%). HT, HMT, LT and LMT denote high-tech, medium-high-tech, low-tech and medium-low-tech manufacturing industries respectively.

higher growth of unit labour costs (Figure 1.16).

Figure 1.16. Similar developments of ULC in EU and US manufacturing industries

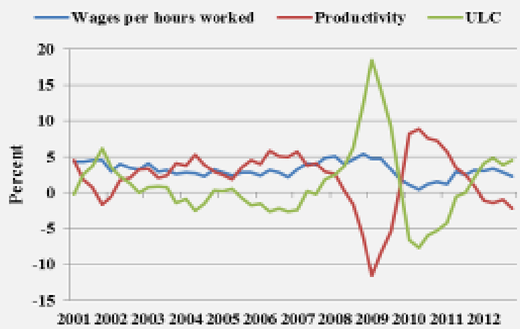


Source: Own calculations using Eurostat and Federal Reserve data. Note: Growth rates in percent. ULC based on hours worked.

Most of the recent variations in EU manufacturing unit labour costs are due to fluctuations in labour productivity growth. Taking the analysis one step further, faster decline of output relative to employment during the slump accounts for most of the losses in labour productivity in the EU at the start of the crisis. Between the first quarters of 2008 and 2009, production decreased by 19% while hours worked fell by 8% (Figure 1.17). This can partly be explained by labour market rigidities in Europe on the one hand and labour hoarding on the other (e.g. enterprises avoid the higher cost of recruiting and retraining when demand picks up by keeping skills in-house in time of slump).

Growth of labour productivity is important both for price and non-price competitiveness. Labour productivity, and especially multi-factor productivity, is often seen as indicator of technical progress. An increased labour productivity means more output is produced with less labour, which can be due to technological or organizational improvements and other non-observable factors. Labour productivity growth is often used as an indicator of price or cost competitiveness as by increasing productivity firms can lower their prices at given labour costs.

Figure 1.17. Fluctuations in EU ULC are mainly caused by variations in labour productivity growth



Source: Own calculations using Eurostat data. Note: Growth rates in percent. ULC based on hours worked.

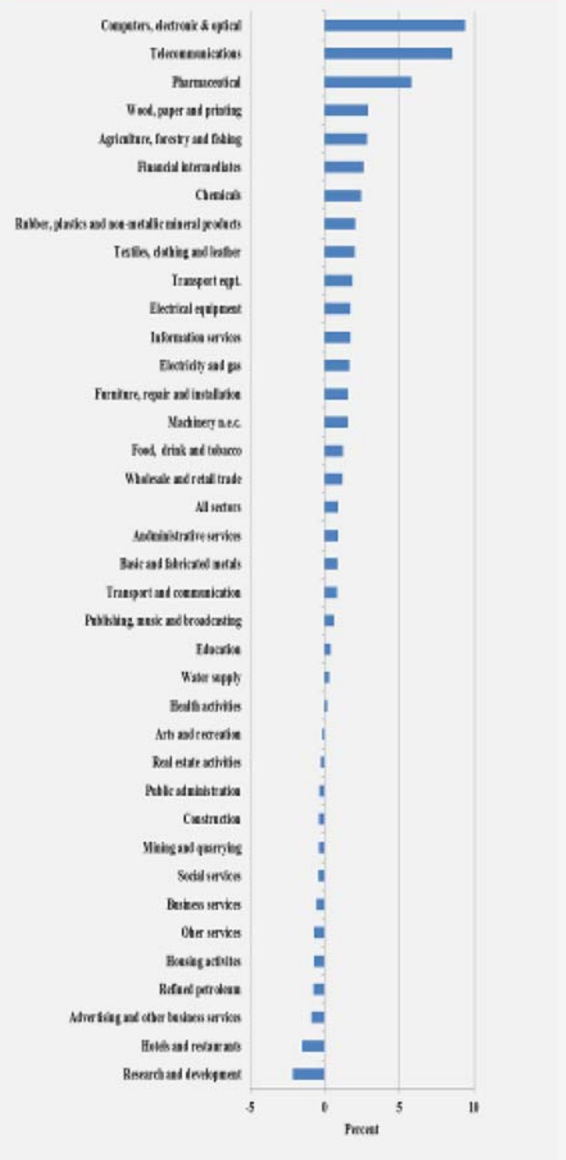
Between 2000 and 2011 labour productivity, measured as value added per employee, grew faster in high-tech manufacturing and knowledge-intensive

[25] It would be more interesting to compare ULC developments between different types of EU and US manufacturing industries. It is however hard to make these comparisons, because of different industrial classifications.

ICT sector. Some low-tech and medium low-tech industries such as textiles and rubber and plastics also performed relatively well and above the manufacturing average. The lowest productivity growth rates are observed in labour intensive services (Figure 1.18)

The relationship between labour productivity growth

Figure 1.18. Highest labour productivity growth in ICT manufacturing and pharmaceuticals



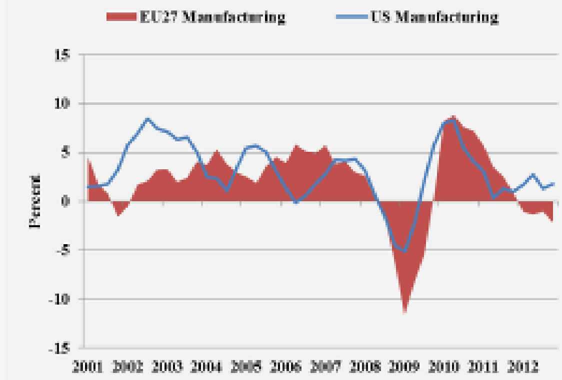
Source: Own calculations using Eurostat data. Note: Annual growth in productivity per person employed 2000-2012 (%).

and market share gains is not straightforward. Firms in industries facing tough competition from low-cost producers (e.g. textiles and other low-tech sectors) are forced to rationalize their production in order to survive. Productivity growth in such a case may occur together with a declining share of the world market.[26] Therefore it is more informative to compare productivity growth rates with these of EU major competitors.

Labour productivity growth in US manufacturing in 2000-2011 was 3.5% on average against 2.4% in EU manufacturing.[27] Large part of this difference has occurred in the beginning of the millennium, even though a larger decline of labour productivity in the EU between 2008 and 2010 contributed to it too. Figure 1.19 shows that during recessions manufacturing employment (in hours worked) tend to decline more in the US than in the EU. Therefore at similar decline of demand and output manufacturing labour productivity declines more in the EU.

The remainder of this section examines non-price competitiveness of EU manufacturing. Accounting for the determinants of non-price competitiveness however, is a challenging task. There is a rather large spectrum of factors which determine the good's quality and its value for the customer.[28]

Figure 1.19. Manufacturing labour productivity in EU and US



Source: Own calculations using Eurostat and OECD data. Note: Annual growth in labour productivity per hours worked (%).

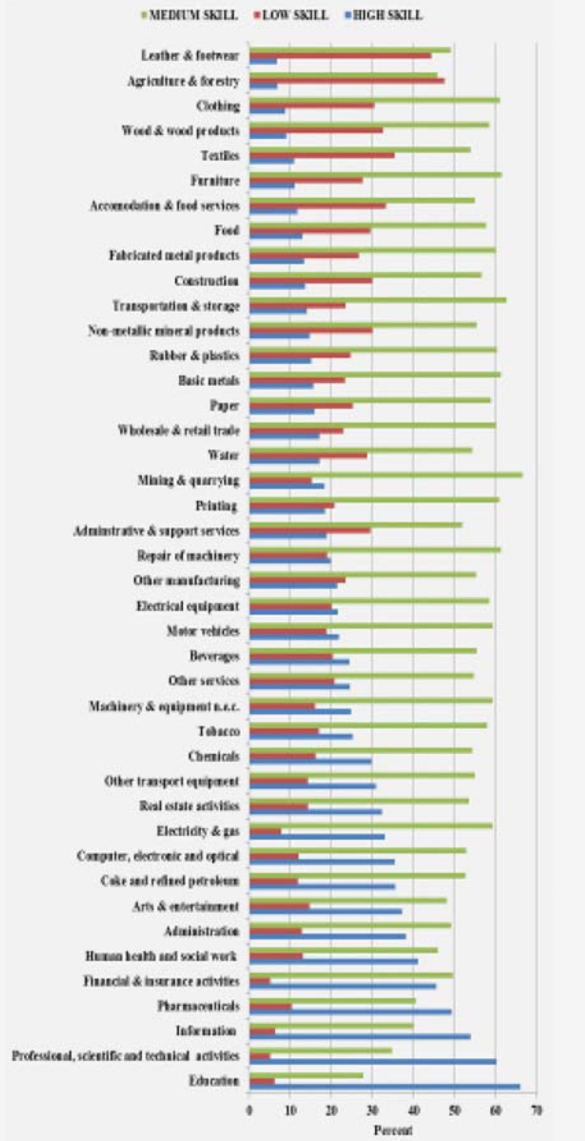
Innovation activities of firms resulting in product and process innovations as well as marketing and organization innovations are often regarded as non-price competitiveness factors. The discussion in European Commission (2010a) addresses also the quality and variety of inputs such as intermediate goods, service inputs, or the framework conditions under which firms operate. The analyses here will

26 In the worst case, firms are forced to close down non-profitable plants and reduce the labour force in order to rationalize. This would, if all other factors are equal, bring about all things equal yield and an increase in d industry productivity growth.

27 Measured as changes from a quarter in one year relative to the same quarter in the previous year.

28 See the discussion of how to define and measure for example the quality of goods in NUTEK (1997).

Figure 1.20. Skill and knowledge intensities (% of total employment)



Source: Own calculations using Eurostat's labour force survey data.

focus on human capital, physical capital, R&D and innovation and the use of services inputs.[29]

Skills

Labour and skills are not perfectly mobile, i.e. they cannot be moved across sectors without cost. The labour force consists of individuals possessing different types of skills and levels of education. This heterogeneity makes hiring and firing costly as they entail search and transactions costs. Highly educated labour with a certain set of skills can be difficult to find within any given period of time. This makes firms reluctant to make this kind of labour redundant during recessions. Adding to this reluctance are the sometimes firm specific skills that the labour force acquires within the firm.

These characteristics of the labour force mean that it is necessary to discuss **skills and human capital** as an input factor which can explain differences in growth between countries. Human capital is not easily measured. An often used proxy for accumulated knowledge is educational attainment. It is an imperfect measure since it is not capable of taking into account the whole stock of knowledge built up by skills and experience acquired after school from vocational or on-the-job training and learning by doing.[30] This indicator has however the advantage of being easily available. It is used here to analyse the distribution of employment by education across sectors based on the International Standard Classification of Education (ISCED)[31].

The market and non-market services sectors of education, information and communication and financial activities are the most human-capital intensive. Manufacturing industries which produce goods that require a relatively high share of high-skilled labour are pharmaceuticals, refined petroleum products and computer, electronic and optical industries. Around 50% of the labour force in pharmaceutical firms has tertiary education. The smallest share of low-skilled workers is found in financial services where only 5% of the labour force have no educational qualifications beyond primary level. More than 25% of the workforce in manufacturing industries producing chemicals, other transport and tobacco are also classified as highly-skilled.

Low-technology manufacturing sectors like textiles, clothing and leather have small shares of highly skilled labour, as do labour-intensive service sectors such as hotels and restaurants and agriculture and forestry (Figure 1.20)

Investment

Investment in physical capital increases output capacity of firms and their labour productivity. It also improves total factor productivity by bringing technology, innovation and intangibles, thereby

[29] Some of these, and other, non-price competitiveness factors are analysed by means of regression analysis in European Commission (2010a).

[30] For a discussion of proxies for human capital in empirical studies, see Greiner, Semmler and Gong (2005). On different ways of measuring the stock of human capital, including a discussion on the limitations of educational attainment as a proxy for human capital, see OECD (1998).

[31] ISCED identifies levels of education from 0 to 6 and is used to measure the proportions of low-skilled, medium-skilled and high-skilled labour for each sector (see annex 3 for definitions)

facilitating reorganisation and adaptation of the production process to shifts in consumer demand. Conversely, lower investments today impacts negatively not only current growth performance, but also future growth prospects through a lower capital stock but also through a lower future innovation and productivity growth, as much of the R&D and innovation is embedded in physical capital.[32]

The investment ratios presented in Table 3.1 below are defined as the ratio of **gross fixed capital formation** (GFCG) to value added.[33] Sectors with a high share of large capital intensive firms such as transport equipment, electricity and gas, water supply, transportation and storage as well as real estate activities have high investment ratios. The statistical classification with aggregation of sectors sometimes distorts the picture. The tobacco industry, which is capital intensive and dominated by large firms, is grouped together with food and beverages industries.

That lowers the average investment ratio for this aggregation of sectors. The investment ratios are relatively stable over time with some significant exceptions. Following the financial crisis, production in petroleum industries fell by some 40% in 2009 while investments remained as high as the previous year. A possible reason for maintaining a high investment against drop in demand could be that the downturn was perceived as temporary, that the prices of investment goods declined, or the investment cycle in extracting industries has longer-term time horizon and is less responsive to short-term fluctuations of demand, or for other strategic reasons. In any case, the investment ratio in this industry increased to 0.61 in 2009. It should be noted that data on gross fixed capital formation are not complete. Table 1.3 is based on data for only 20 Member States,[34] for 8 of which 2011 data is missing.[35]

R&D and innovation

R&D and innovation are indicators of non-price competitiveness describing attempts by producers to increase their competitiveness by improving supply side conditions as well as trying to influence demand for their products. R&D expenditures can improve the supply by introducing technology which improves the production process and lower production costs. Outcomes of R&D can also be innovations in the form of new, improved or differentiated products which can increase the competitiveness of firms by making demand for their products less price elastic.[36]

The adoption and use of technology determines how efficiently input factors are combined in order to achieve growth in the long run. The indicators below describe the technology in the EU industries from different angles. The indicators represent different stages of the R&D&I process. R&D expenditures can be regarded as input indicators while patents and firms introducing new and/or improved products to a higher extent measure outputs of the R&D&I processes.

Due to insufficient coverage of R&D statistics across sectors and countries since 2007, the discussion in this section cannot include more recent period. This may not be as serious a drawback as it seems. The process from investing in R&D to developing new products can be very long, especially in industries such as pharmaceuticals where the process also includes rigorous and carefully regulated testing of the products. It may therefore be that the data represented in the figures below more accurately describes the situation today than more recent data would do. Data on R&D today should be seen as indication of future technology and innovation results.

32 See for example the discussion in European Commission (2010a).
33 Fixed assets; buildings, machinery and equipment, transport equipment, office machinery and hardware, software and intangible fixed asset are included in this aggregate.
34 BE, CZ, DK, DE, EL, ES, FR, IT, CY, LT, LU, HU, NL, AT, PL, PT, SI, SK, FI and SE.
35 DE, ES, CY, NL, AT, PL, PT and SI.
36 See European Commission (2010a), p 123, and related references, for a discussion of firms' attempts to differentiate products in order to increase their competitiveness

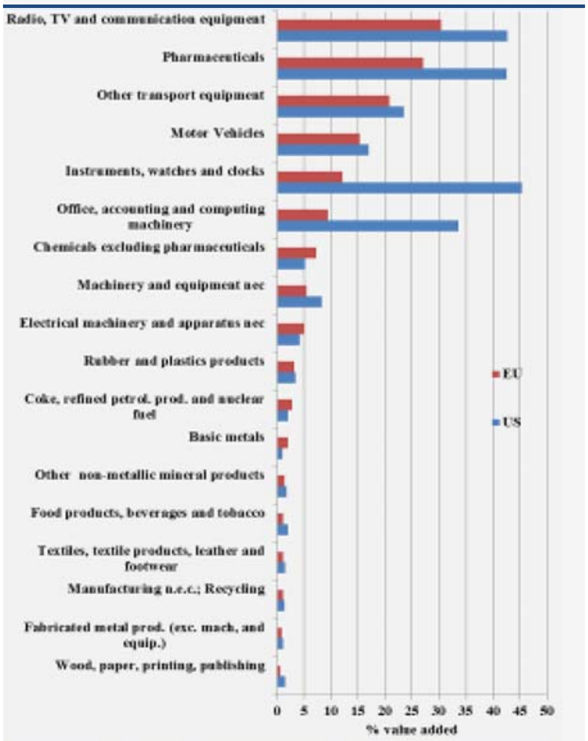
Table 1.3. Investment ratios in 20 Member States

		2007	2008	2009	2010	2011
TOTAL	**Total**	**0.25**	**0.24**	**0.22**	**0.22**	**0.22**
A	Agriculture, forestry and fishing	0.37	0.39	0.39	0.34	0.35
B	Mining and quarrying	0.25	0.22	0.28	0.24	0.27
C10-C12	Food, drinks and tobacco products	0.19	0.20	0.17	0.17	0.21
C13-C15	Textiles, clothing, leather and footwear	0.12	0.12	0.10	0.11	0.15
C16-C18	Wood, pulp and paper and printing	0.20	0.21	0.17	0.17	0.21
C19	Refined petroleum products	0.35	0.36	0.61	0.41	0.27
C20	Chemicals	0.19	0.21	0.19	0.16	0.26
C21	Pharmaceuticals	0.15	0.15	0.14	0.13	0.18
C22_C23	Rubber and plastics	0.20	0.20	0.16	0.16	0.21
C24_C25	Basic metals and metal products	0.18	0.19	0.18	0.17	0.21
C26	Computers, electronic and optical products	0.18	0.18	0.18	0.19	0.28
C27	Electrical equipment	0.13	0.13	0.12	0.11	0.14
C28	Machinery and equipment n.e.c.	0.12	0.13	0.12	0.10	0.13
C29_C30	Transport equipment	0.20	0.23	0.23	0.18	0.32
C31-C33	Furniture, repair and installation of machinery and equipment	0.11	0.11	0.10	0.11	0.13
D	Electricity and gas	0.37	0.36	0.38	0.39	0.37
E	Water supply	0.49	0.48	0.45	0.46	0.43
F	Construction	0.16	0.15	0.10	0.11	0.10
G	Wholesale and retail trade	0.12	0.12	0.10	0.10	0.10
H	Transportation and storage	0.37	0.39	0.36	0.37	0.37
I	Accommodation and food service activities	0.12	0.12	0.10	0.10	0.12
J58-J60	Publishing, motion picture and broadcasting	0.23	0.23	0.21	0.22	0.26
J61	Telecommunications	0.29	0.29	0.25	0.27	0.28
J62-J63	Computer programming and consultancy activities	0.16	0.17	0.15	0.16	0.18
K	Financial and insurance activities	0.11	0.14	0.12	0.11	0.10
L	Real estate activities	0.73	0.68	0.61	0.60	0.58
M69-M71	Legal and accounting activities and architectural and engineering activities	0.09	0.09	0.08	0.08	0.10
M72	Scientific research and development	0.27	0.26	0.26	0.28	0.29
M73-M75	Advertising and market research, other professional services, scientific and veterinary activities	0.09	0.09	0.08	0.09	0.12
N	Administrative and support service activities	0.35	0.34	0.26	0.28	0.31
O	Public administration and defence	0.27	0.27	0.27	0.25	0.21
P	Education	0.09	0.09	0.09	0.09	0.09
Q86	Health care	0.12	0.12	0.11	0.11	0.10
Q87-Q88	Residential care activities and social work activities	0.13	0.12	0.11	0.11	0.07
R	Arts, entertainment and recreation	0.35	0.34	0.33	0.31	0.21
S	Other service activities	0.09	0.09	0.08	0.08	0.07

Source: Own calculations using Eurostat data.

EU R&D expenditures represented 1.85% of GDP in 2007 against 2.7% in the US. The bulk of the difference between the EU and the US is found in private enterprise R&D. An EU aggregate has been formed in order to analyse R&D intensities by sectors (i.e. R&D expenditures relative to value added). The aggregate represents more than 80% of total R&D expenditures in the EU. The analysis focuses on Business enterprise R&D expenditures (BERD) by economic activity. Public expenditures in terms of sectoral R&D are not reflected in the data.

Figure 1.21. US firms spend more on R&D in almost all sectors



Note: The EU is represented by 17 countries: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Netherlands, Poland, Portugal, Spain, Sweden and the UK. The industries are classified according to ISIC Rev 3.1.

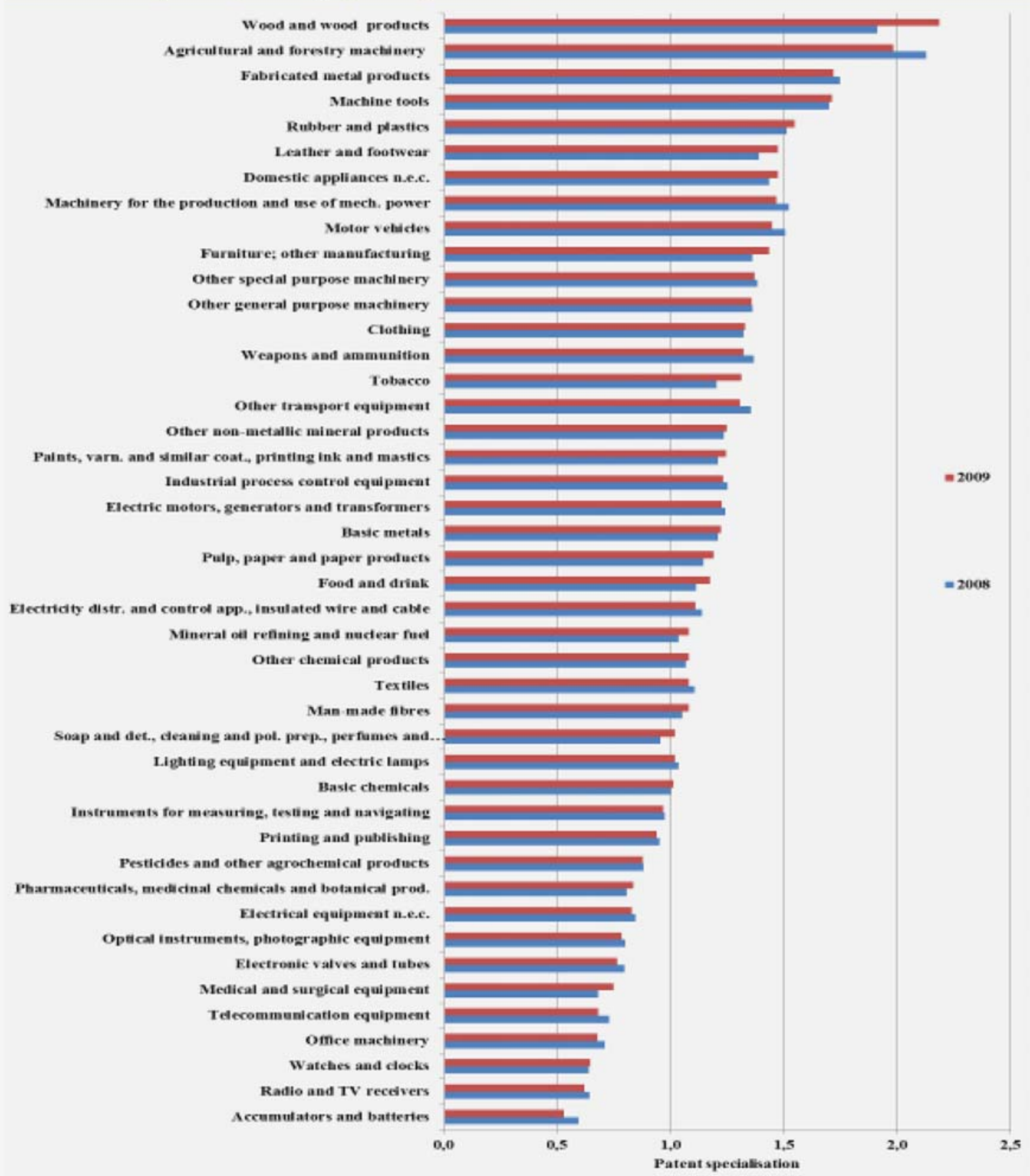
This aggregate for EU manufacturing sectors is compared with US manufacturing (Figure 1.21). The comparison shows that R&D intensity in US manufacturing is higher, not due to differences in industrial structures but to an overall smaller investment in R&D in the EU across all sectors.

Patent statistics are often used to compare countries' and industries' knowledge output. Even if indicators of patenting and the underlying statistics are subject to uncertainty and even bias, the information is of interest.[37]

Patent statistics reflect the output of the research process undertaken by firms. The statistics provide information on a large number of manufacturing sectors and the coverage over time allows trends and correlations with other economic developments to be analysed. As data are available for many countries, it is possible to calculate the performance of an EU sector relative to say, global performance. The measure is calculated in the same way as RCA indices for manufacturing exports (see the annex for a complete definition of the measure).

[37] Griliches (1990) discusses a number of issues related to patents, including the advantages and drawbacks. See also Pavitt (1985), Silverman (2002) and Griliches (1984).

Figure 1.22. Relatively lower patenting by EU high-tech industries



Source: Own calculations using Eurostat data. Note: The aggregate "World" includes Iceland, Lichtenstein, Norway, Switzerland, Turkey, Russia, South Africa, Canada, the US, Mexico, Brazil, China, Japan, South Korea, India, Israel, Taiwan, Singapore, Australia and New Zealand.

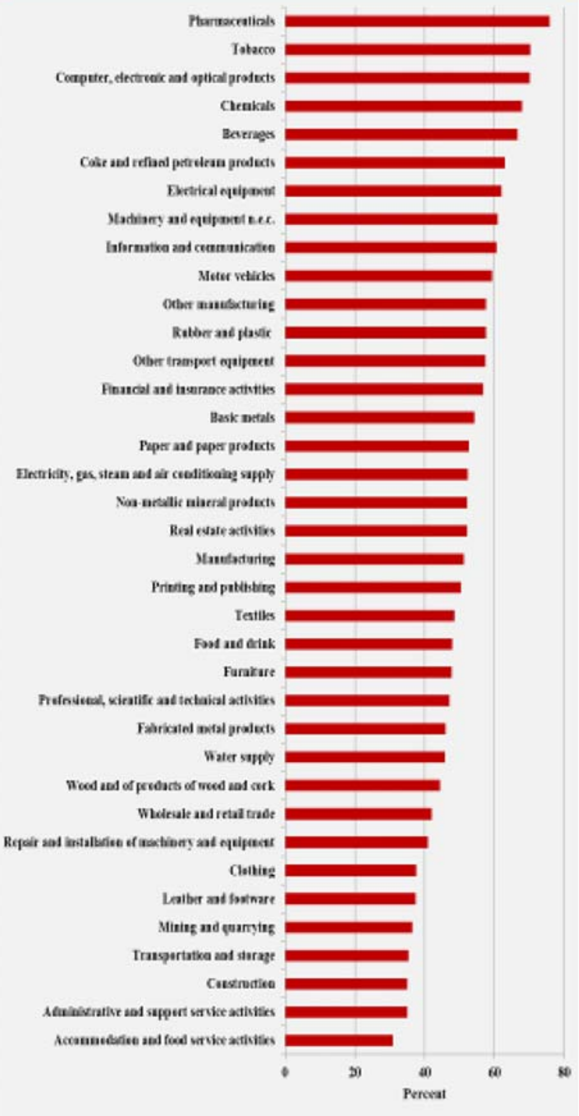
Values larger than 1 indicate that the EU industry has a 'patent specialisation' relative to the world. The indicator shows that EU manufacturing industries perform better than the world in a number of industries. However, many high and medium-high-technology industries such as pharmaceuticals, office machinery electrical equipment industries perform relatively worse than the world (Figure 1.22)[38].

Other things equal, a lower-than-average patenting of EU manufacturing firms implies that EU industries are less able to develop new and/or improved products or production processes. This could translate into future losses of competitiveness.

[38] It should be noted that the indicator is based on patent applications to the EPO. The indicator might therefore be biased in favour of EU manufacturing industries as there is a tendency for non-EU industries to patent relatively less frequently at the EPO than at the USPTO. Triad patent families for industries which could take this bias into account were not available at the time of drafting of this report.

Firms engage in product innovation in order to develop new or improve existing products. The purpose is to produce products that have certain qualities that differentiate them from their competitors. If they succeed they will face less elastic demand thus having some ability to set their own prices and be less reliable on labour costs and input prices to compete. By engaging in process innovation

Figure 1.23. More innovative enterprises in manufacturing industries than in mining and service industries



Source: Own calculations using Eurostat data. Innovative enterprises as a percentage of total enterprises in the 2010 CIS innovation survey.

firm aim at implementing new production processes that increase their productivity and/or lower their production costs. Firms also engage in organisational and marketing innovations to the same end.

EU manufacturing industries are more prone to engage in **innovation** activities than services industries.[39] This is confirmed by the number of innovative enterprises by sector as well as by the number of innovations according to data from Community Innovation Survey (CIS). Firms producing pharmaceuticals, tobacco, computers, chemicals and beverages have relatively higher shares of innovative enterprises in all enterprises in the 2010 CIS. Pharmaceutical, ICT and chemical firms were most successful in bringing new or improved products to market between 2008 and 2010 according to the Community Innovation Survey. It should however be noted that innovation comes easier for firms in some industries than others. Improving a beverage or tobacco product by introducing a new flavour is probably easier and less costly than developing a new car model.

Few firms in low-tech manufacturing industries such as clothing, wood and leather, construction industries and in service industries (administration, hotels and restaurants) are engaging in innovative activities (Figure 1.23)

Services industries engage in process innovation to a higher extent than product innovation. Market services engage in process innovation almost to the same extent as manufacturing firms (Figure 1.24)

The use of services in manufacturing

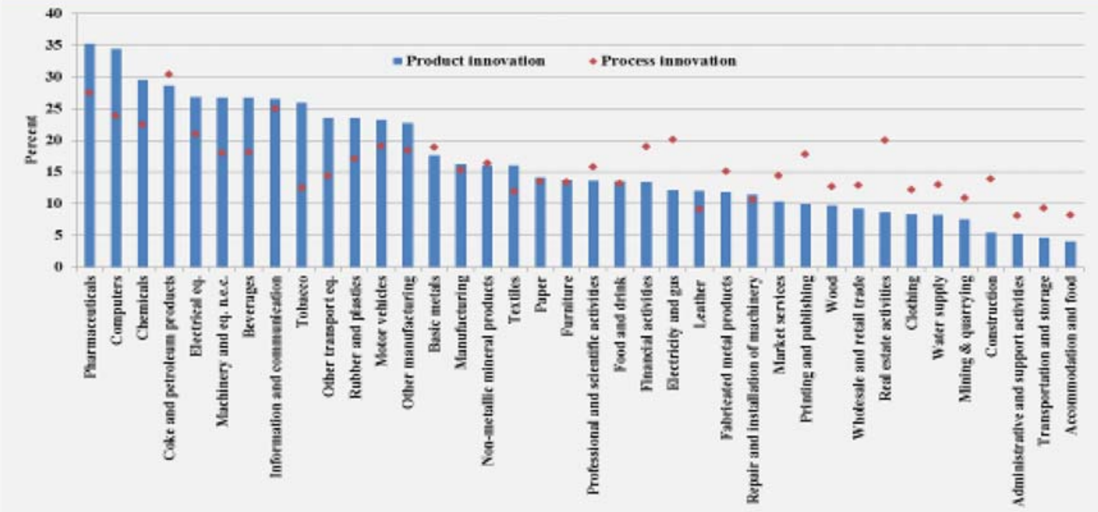
Manufacturing firms have increasingly used services over time. This shows up on the input side as well as the output side. They have increased their services intensity in order to increase their productivity and thereby also their competitiveness. Manufacturing firms use services to differentiate their products from their competitors.

On the input side, manufacturing firms' use of intermediate services has increased over time. The increase has been most pronounced for services provided by knowledge-intensive business services firms (European Commission 2010). But manufacturing firms are also producing more of the services in-house. This turns up in the increased share of employees with services-related occupations over time. Having access to this kind of labour makes it easier for manufacturing firms to provide their physical goods with services characteristics and to engage in services innovations. High-tech manufacturing firms producing ICT and electronic and optical equipment and pharmaceuticals are the most frequent innovators in EU manufacturing. But firms in the refined petroleum and coke sectors are

[39] The figures are calculated as averages for different sectors across the EU countries. The interpretation of the figure should be treated with caution since there are gaps in the dataset. The averages for tobacco, administration, accommodation and food and real estate activities are based on ten or fewer observations.

also responsible for a relatively high level of services innovations.[40] Low-technology industries engage in

Figure 1.24. Pharmaceutical and ICT firms more successful in innovation



Source: Own calculations using Eurostat data. Data from the 2010 Community Innovation Survey.

services innovation much less than the EU manufacturing average (Figure 1.25)

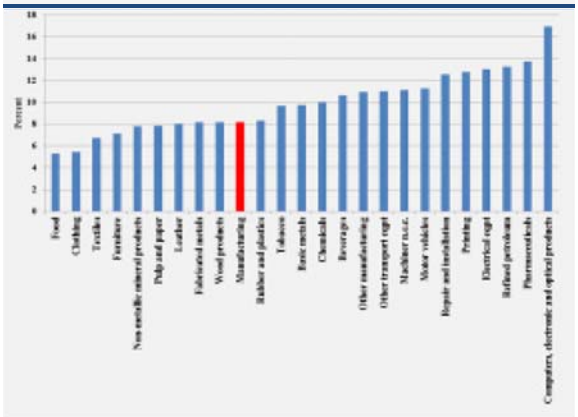
On the output side, services have increased over time as a share of manufacturing output (European Commission 2011). But manufacturing firms not only produce more "pure" services than previously. The contents of manufacturing goods have changed as more and more services are embedded in physical products.

The latter trend is a natural consequence of manufacturing firms trying to differentiate their products. This is a response not only to intensified competition from low-cost producers in emerging countries but also attempts to satisfy increased demand for varieties of goods which increase as incomes rise. Upgrading the products may also make customers willing to pay a premium for them if the products are perceived to be of high enough quality.

This makes demand for these products less price elastic. EU manufactured exports consist to an increasing extent of embedded services. Domestic services account for most of the services value-added – around 90% across all industries, except in coke and refined petroleum where 25% of services value-added is imported. The largest total share of services value added embedded in exports is also to be found in industries producing coke and refined petroleum (Figure 1.26).

One of the most prominent characteristics of increased globalisation is the way production

Figure 1.25. Manufacturing firms' services innovations in 2010



Source: Own calculations using Eurostat data. Note: Manufacturing enterprises that developed services innovations as percentages of total enterprises in the CIS innovation survey 2010. Data are not available for Denmark, Germany, Greece and the UK.

processes are sliced up between different locations, according to their comparative advantages. Technological progress, especially in communications, and lower transportation costs are major factors behind the emergence of global value chains (GVCs). Firms participate in GVCs in order to increase their competitiveness or better satisfy demand in different foreign markets. Focusing on the first of these motives, engagement in GVCs may increase a firm's competitiveness by enhancing access to cheaper or higher-quality intermediate inputs (OECD 2013). Industries in OECD countries using a higher share of **imported intermediates** display on average a higher productivity. The effects arise mainly in three ways. Firstly through lowering prices, as more intermediate imports lead to stronger competition among intermediate producers. Secondly

[40] See also Lofalk (2013) for an analysis of the servicification of Swedish manufacturing. The industries producing refined petroleum and coke are among the most "servicified" manufacturing industries.

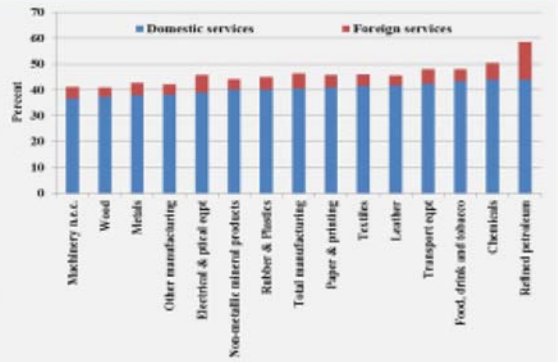
through increasing the supply of varieties of intermediates as imports grow. Finally through increased productivity as new imported intermediates may be more suited for the technology of final goods destined for the foreign markets. Gaining access to foreign knowledge by using imported intermediates may also lead to higher innovation as the firms' knowledge bases increase (OECD 2013).

CONCLUSIONS AND POLICY IMPLICATIONS

This chapter uses a number of advanced indicators of international competitiveness to provide insights into the strengths and weaknesses of EU manufacturing and to draw implications for EU industrial policy. It finds that the EU has comparative advantages in most of its manufacturing sectors. These sectors include such vital high and medium-high tech sectors as pharmaceuticals, chemicals, vehicles, machinery, other transport equipment (which includes airspace), but also low and medium low tech sectors such as food, beverage, tobacco, paper and plastic. On the downside, in the high-tech sectors Europe has comparative advantage only in pharmaceuticals while EU electrical equipment and computer, electronic and optical products lag behind in international competitiveness.

The EU has comparative advantage in the broad category of medium-high tech industries (1.14), but it is smaller than that of Japan (1.59) and the US (1.22).

Figure 1.26. Services value added in EU manufacturing gross exports 2009



Source: WIOD.

The development of RCA overtime shows that China is quickly gaining ground. Actually only China has comparative advantage in the aggregate broad category of high-tech industries (1.56) leaving far behind in high-tech export specialization the US (0.88), the EU (0.85) and Japan (0.73).

This is the state of play of competition in broad categories of industries grouped according to technology intensities. Taking the analysis further down to product level, however, presents Europe into much better position on the world market. In 2010 67% of European exports have revealed comparative advantage, while China has comparative advantage in 54% of products, and US and Japan export respectively 43% and 24% of their products with comparative advantage.

Indicators of revealed comparative advantage (RCA) are derived from trade data. They do not provide information about the sophistication of the export product and how much of it is produced in the export country (i.e. the domestic share of export value added). Looking at the complexity of EU exports shows that the sectoral comparative advantages of EU industries even in the medium-high tech group is based on higher complexity (knowledge intensity) of exports than the average. For instance in medical precision and optical instruments 90% of products with RCA are more complex than the average products exported by other countries. The analysis shows that the present comparative advantages of the EU industries are a result of maintaining and upgrading the sophistication of EU exports over the last 15 years. At the same time the emerging industrial powers (e.g. BRIC) have achieved much faster upgrade of their exports, but are still lagging behind the EU industries in sophistication of exports. Even though China has RCA in the high-tech category, it is still based on products with lower complexity.

The analysis of exports in value added provides new insights to the international performance of EU manufacturing. It shows that advanced economies have higher domestic content of exports as thanks to their strong industrial base they can afford to supply domestically at competitive terms most of the inputs needed for their exports. Thus the domestic value of exports of EU, US and Japan is around 85 %, while that of China is 73.6% and that of Korea is 61.3%. Chinese high-tech exports for instance seem to rely heavily on high-tech imports of intermediates. For the sector of electrical equipment for example China's market share in gross exports is 9 p.p. higher than its market share in exports in value added.[41] This is evidenced by the relatively low values per unit of finished high-tech exports against the relatively high unit values of imported high-tech inputs.

About 20% of the foreign inputs in Chinese exports comes from the EU, which is higher than US and Japan (about 13% each). This is a result of faster growth of EU share during the last 15 years of Chinese export boom.

These indicators present the EU position in the global competition in manufacturing goods. They however cannot inform policy about why EU is there and whether and how it can perform better. Therefore the analysis looks at those factors that can explain

[41] See Chapter 4 for details

industrial performance and if properly targeted by policy can improve it. Competitiveness is above all a result of productivity gains. Accordingly, the analysis departs from labour cost and productivity of EU manufacturing, but goes further to explore such determinants of total factor productivity as input of skills, R&D and innovation intensities, fixed capital formation and the contribution of services to manufacturing competitiveness.

It shows that between 2000 and 2011 labour productivity in the US has grown by 3.5% in average against 2.4% in the EU. This is largely explained by the fact that during downturns the US seems to do better in labour productivity growth. One reason is that employment in the US adjusts faster than employment in EU to shrinking demand for goods and services. Productivity is the major driver of the US superior performance vis-à-vis Europe in terms of unit labour cost (ULC), which is one of the common explanatory indicators of cost and price competitiveness. A possible implication of this comparison is that the EU labour market needs to gain flexibility in order to allow faster and more efficient adjustment of labour to shifts in demand. Labour market rigidities are often explained by employment protection. During the slump however employment adjustment lagged behind drop in demand not just because employers could not lay-off workers, but because in the technology-intensive sectors they chose to keep them to avoid the cost of re-hiring and re-training when demand picks up. Therefore shortage of skills and resultant hoarding of labour may be additional reason explaining why labour demand response to decline in output is more sluggish in Europe than in the US. Chapter three looks into more depth at the efficiency and productivity deficits of EU manufacturing and the relevant policy responses.

Labour costs however have decreasing weight in EU manufacturing competitiveness for two reasons. First, the analysis shows that EU exports rely mainly on knowledge-intensive products rather than on low-tech labour intensive products. On the other hand emerging economies are catching up fast not only in the level of technology but also in terms of wages. Therefore what is more important for Europe's competitiveness in the present day global supply chains is total factor productivity (TFP). It accounts for that part of GDP growth which cannot be attributed to measurable factor inputs, and is explained by skills, technology and process innovation, and investment in intangibles.

US private spending on R&D (as a share of GDP) is almost 1.5 times that of the EU (2.7% in the US vs. 1.85% in the EU). A sector break-down indicates that this is not a result of differences in industrial structures or US specialization in knowledge-intensive sectors, but to an overall underperformance of EU sectors in terms of R&D investment across all sectors.[42] The output of research is new products, new technologies, new materials and processes. A rough indicator of this output is patents. The chapter documents that in a number of high and medium-high technology industries (such as pharmaceuticals, optical equipment, electrical equipment, medical and surgical equipment, telecom and office equipment, radio and TV and accumulators and batteries), the EU is lagging behind in patenting. As the RCA indicators show, EU export performance depends crucially on some of these sectors. It may be hard to preserve EU current comparative advantage in these industries if it loses its technology lead as indicated by patent data. Another problem is that the way of EU research from the lab to the market seems to be more difficult than that of major competitors. This is an important problem which deserves a more detailed study. This report is trying to look for explanation in Chapter 4 and Chapter 5.

The implications of EU exports' complexity for industrial policy is that targeting only high-tech sectors might be less rewarding than increasing the share of knowledge intensive products in all tradable sectors including medium-low and medium-high tech sectors. Moreover some of the labour intensive sectors with lower knowledge intensities may be better suited to tackle EU's unemployment challenges than the high-tech sectors. About 40% of EU manufacturing employment is in low-tech sectors. Therefore the policy priority attached to key-enabling technologies which leads to new materials and products in all manufacturing sectors has strong potential to upgrade EU competitiveness not only in the high-tech sectors but also in the traditional industries. Chapter 5 in this report analyzes EU performance and prospects in the competition in KET-based products.

[42] See Chapter 4 of this report for further details.

REFERENCES

Balassa, B., ‘Trade Liberalisation and ‘Revealed Comparative Advantage’, *Manchester School of Economic and Social Studies*, 1965, Vol. 33, pp. 99–123.

European Commission (2009), *EU Industrial Structure 2009, Performance and competitiveness*, Enterprise and Industry DG, Office for Official Publications of the European Communities, Luxembourg.

European Commission (2010a). *Product Market Review 2010-2011.* European Economy 8. Directorate-General Economic and Financial Affairs, European Commission.

European Commission (2010b). “European Competitiveness Report 2010”

European Commission (2011a). “European Competitiveness Report 2011”

European Commission (2011b), *EU Industrial Structure 2011, Trends and Performance,* Enterprise and Industry DG, Office for official publications of the European Communities, Luxembourg.

European Commission (2012). “European Competitiveness Report 2012. Reaping the benefits of globalisation”

European Commission (2013a). Short-term Industrial Outlook, January 2013. Directorate-General Enterprise and Industry

European Commission (2013b). Short-term Industrial Outlook, July 2013. Directorate-General Enterprise and Industry

European Commission (2013c), EU Industrial Structure 2013, Trends and Performance?, Enterprise and Industry DG, Office for official publications of the European Communities, Luxembourg.

Felipe, J. et. al. (2012). "Product complexity and economic development", Structural Change and Economic Dynamics, 23 (2012), 36-68.

Foray, D., David, P. A. & Hall, B."Smart Specialisation - The Concept", Knowledge Economists Policy Brief no. 9, June 2009, DG RTD.

Greiner, A., Semmler, W. & Gong, G. (2005). "The forces of economic growth - a time series perspective". Princeton University Press, Section 4.3.

Griliches, Z. (ed.) (1984), "R&D, Patents and Productivity" The University of Chicago Press, International Monetary Fund, Balance of Payments and International Investment Position Manual, sixth edition.

Griliches, Z. (1990), ‘Patent statistics as economic indicators: a survey’, Journal of Economic Literature, Vol. XXVIII, pp. 1661–1707.

Hummels, D., Ishii, J., and Yi, K.M., (2001), 'The Nature and Growth of Vertical Specialization in World Trade', Journal of International Economics, Vol. 54 No. 1.

OECD (1998), Human Capital Investment – An international comparison, Center for Educational Research and Innovation, Paris.

OECD (2011). OECD Economics Surveys: Korea 2010. OECD, Paris.

Pavitt, K. (1985), ‘Patent statistics as indicators of innovative activities: possibilities and problems’, Scientometrics, Vol. 7, pp. 77–99.

Silverman, B. (2002), Technological resources and the logic of corporate diversification, Routledge, Chapter 4.

Reinstaller, A., Hölzl, W., Kutsam, J., and Schmid, C., (2012), ‘The development of productive structures of EU Member States and their international competitiveness’, Report prepared under Specific Contract No SI2-614099 implementing the Framework Contract ENTR/2009/033 for the European Commission, DG Enterprise and Industry.

Hausmann, R., Hidalgo, C. A. (2012), “The network structure of economic output”, Journal of Economic Growth, 16, pp. 309-342.

Hausmann, R., Hwang, J., Rodrik, D. (2007) “What you export matters”, Journal of Economic Growth, 12(1), pp. 1-25.

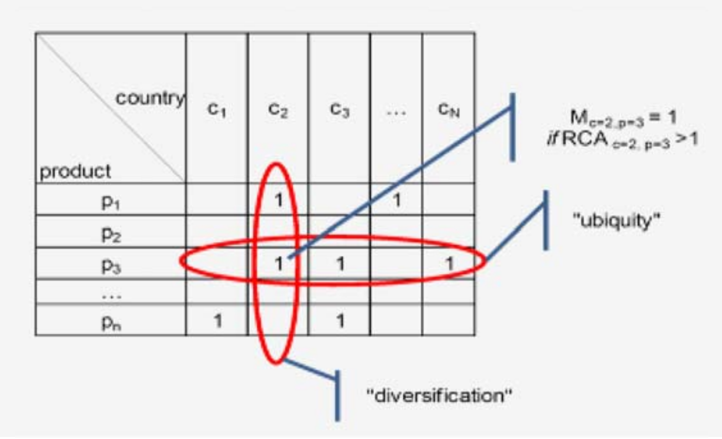
NUTEK (Swedish National Board for Industrial and Technical Development) (1997). "Market Shares, Relative Prices and Quality. A study of Sweden's international competitiveness".NUTEK B 1997:9, Stockholm.

Stehrer, R. (2012). “Trade in Value Added and the Value Added in Trade”. WIOD working Paper 8 (2012) 1-19.

ANNEX 1
DIVERSIFICATION AND UBIQUITY OF PRODUCTS

The analytical approach is based on Hidalgo et al. (2007) and Hidalgo and Hausmann (2009). This approach uses trade data to construct measures for the diversification of an economy and the sophistication of the products it exports. Data from the *Base pour l'Analyse du Commerce International* (BACI) database developed at the Centre d'Études Prospectives et d'Informations Internationales (CEPII) have been used. The dataset contains data for 232 countries and 5,109 product categories classified using the Harmonized System at the 6-digit level. The data cover the years 1995 till 2010. The methodological approach aims to capture, in a few indicators, the productive capabilities in an economy.[43] Figure A1 shows how these indicators are constructed. A country is linked to a product if the countries have revealed comparative advantage (RCA) in this product. The implicit assumption is therefore that a country disposes of capabilities or factor endowments that convey a competitive advantage in this product.

Figure A 1. Diversification and ubiquity of countries and products



If the matrix shown in the figure above is summed up **column-wise** over products p one obtains a measure for the diversification of a country c.

$$k_{c,0} = \sum_p M_{c,p} \cdots \text{diversification} \quad (1)$$

Where k is the measure of diversification. M is an indicator which assumes the value of one (1) if RCA >1 for a country c exporting a product p.

If on the other hand the matrix is summed up **row-wise** one obtains a measure for the ubiquity of comparative advantage in the trade of a specific product p. This measure tells us how many countries c have a comparative advantage in trading this product.

$$k_{p,0} = \sum_c M_{c,p} \cdots \text{ubiquity} \quad (2)$$

By combining these two indicators it is possible to calculate through recursive substitution how common products are that are exported by a specific country,

[43] A short an intuitive description of the methodology is available in European Commission (2013a) http://ec.europa.eu/enterprise/policies/industrial-competitiveness/competitiveness-analysis/index_en.htm.

$$\rightarrow k_{c,n} = \frac{1}{k_{c,0}} \sum_{p} M_{c,p}\, k_{p,n-1} \text{ ... for } n \geq 1, \quad (3)$$

and how diversified the countries are that produce a specific product

$$\rightarrow k_{p,n} = \frac{1}{k_{p,0}} \sum_{c} M_{c,p}\, k_{c,n-1} \text{ ... for } n \geq 1. \quad (4)$$

n in (3) and (4) denotes the number of iterations in the computations. See also Table A 1. If formula (3) goes through an additional iteration the indicator now tells us how diversified countries are that export similar products as those exported by country c. An additional iteration for formula (4) then tells us how ubiquitous products are that are exported by product p's exporters. Table A 1 gives an overview on how the indicators can be interpreted.[44] Only the first three iterations of the indicator are presented below. The indicators k_(p,max) and k_(c,max) provide for any product p, (k_(p,max)), its level of complexity, and for any country c, k_(c,max), the level of complexity of the productive structures of its economy.

These two indicators are calculated by going through as many iterations necessary until the ranking of the countries and the products in terms of the k_(p,max) and k_(c,max) values do not change anymore. The number of iterations necessary to obtain this convergence may thus vary from year to year.

Table A 1. Interpretation of the indicators calculated using the Method of Reflections, first three pairs

n	country	product
0	$k_{c,0}k_{c,0}$: number of products exported by country c, diversification → "How many products are exported by country c?"	$k_{p,0}k_{p,0}$: number of counries exporting product p, ubiquity → "How many countries export product p?"
1	$k_{c,1}k_{c,1}$: average ubiquity of products exported by country c → "How common are the products exported by country c?"	$k_{p,1}k_{p,1}$: Average diversification of the countries exporting product p → "How diversified are the countries exporting product p?"
2	$k_{c,2}k_{c,2}$: Average diversification of countries with a similar export basket as country c → "How diversified are countries exporting similar products as those exported by country c?"	$k_{p,2}k_{p,2}$: Average ubiquity of the products exported by countries exporting product p → "How ubiquitous are the products exported by product p's exporters?"

Source: Abdon et al. (2010), p. 8, following Hidalgo - Hausmann (2009), Supplementary material p.8

The assumption underlying this analytical framework is that countries need a large set of complementary and non-tradable inputs. Hausmann and Hidalgo refer to this as capabilities (see also Hausmann and Hidalgo 2011). If countries differ in these capabilities and products differ in the type of capabilities that are needed to produce and successfully trade them, countries with more capabilities will be more diversified. On the other hand, products that require more capabilities will be successfully exported only by those countries that have these capabilities, and as a consequence they will be less ubiquitous.

The indicators therefore capture on the one hand the variety of goods produced by an economy and to what extent this product mix represents a unique source of comparative advantage for the economy. They do so by conceiving these relationships as a network and by expressing the properties of each node in the network as a combination of the properties of all its neighbours. This approach therefore exploits information from the global trade network to construct indicators that capture important aspects of the level of economic development and the competitiveness of economies by exploiting the fact that the economic fortunes of countries are intertwined via trade, foreign direct investment, and financial capital flows.

44 Higher iterations than those presented in the table are increasingly difficult to interpret.

The supply of products in one country is highly dependent on economic activities in multiple foreign countries and changes in production networks spread across countries and continents. When countries and regions transform as a result of economic, technological, political, or institutional change, the nature of foreign trade changes as well, and trade data therefore capture such changes.

ANNEX 2
WORLD EXPORT SHARES AT PRODUCT LEVELS OVER PRODUCT COMPLEXITY BY NACE, EU27 AND COMPETING COUNTRIES

Figure A 2. World export shares at the product level over product complexity by NACE sector, EU 27

Source: Reinstaller et. al. (2012). BACI database

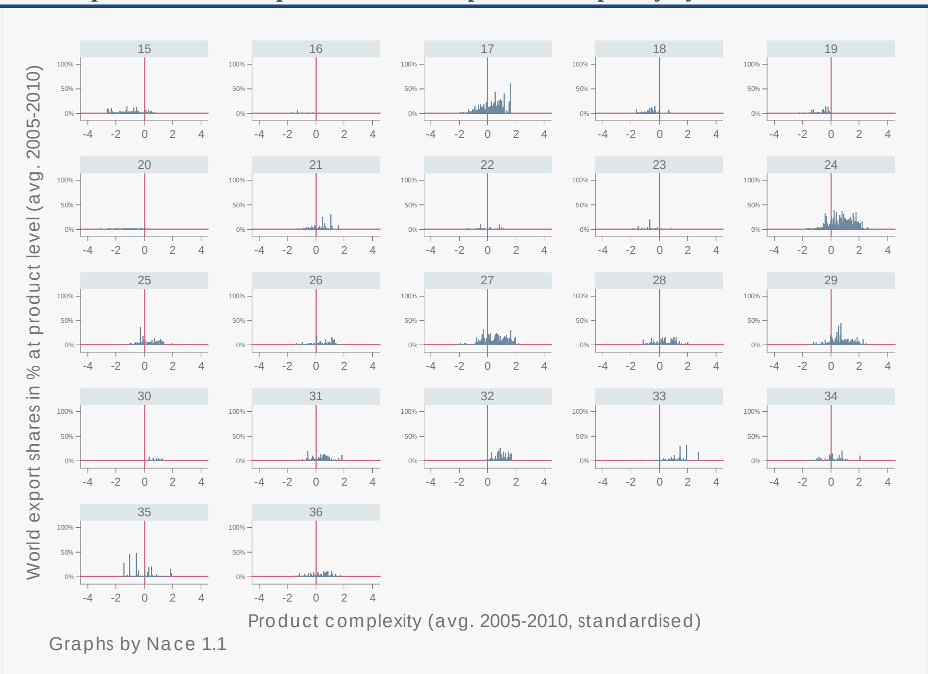
Figure A 3. World export shares at the product level over product complexity by NACE sector, US

Source: Reinstaller et. al. (2012). BACI database

Figure A 4. World export shares at the product level over product complexity by NACE sector, Japan

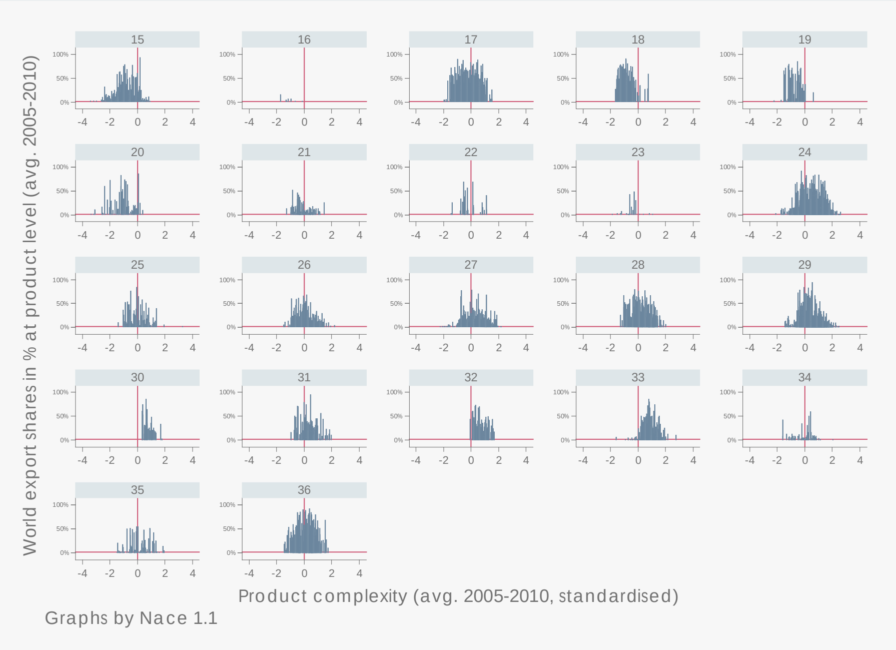
Source: Reinstaller et. al. (2012). BACI database

Figure A 5. World export shares at the product level over product complexity by NACE sector, Korea



Source: Reinstaller et. al. (2012). BACI database

Figure A 6. World export shares at the product level over product complexity by NACE sector, China



Source: Reinstaller et. al. (2012). BACI database

ANNEX 3
DEFINITIONS OF MEASURES AND CLASSIFICATIONS USED

The patenting, i.e. the number of patent applications, of a given EU manufacturing industry relative to total EU manufacturing patent applications are compared to the number of patent applications of the same industry in the world relative to the number of total patent applications in manufacturing in the world.[45] The indicator, PAT, measures the EU manufacturing industries' relative patenting performance:

$$PAT = \frac{PAT_i^{EU} / \sum_i PAT_i^{EU}}{PAT_i^{World} / \sum_i PAT_i^{World}}$$

where:

PAT_i^{EU}: number of patents filed by EU industry 'i'

$\Sigma i\ PAT_i^{EU}$: number of patents filed by all EU manufacturing industries

PAT_i^{World}: number of patents filed by World industry 'i'

$\Sigma i\ PAT_i^{World}$: number of patents filed by all manufacturing industries in the World

Box A.1: Using International Standard Classification of Education to define skill categories

The International Standard Classification of Education (ISCED) differentiates seven levels of education.

Level 0: pre-primary

Level 1: primary education

Level 2: lower secondary

Level 3: upper secondary

Level 4: post-secondary non-tertiary

Level 5: first stage of tertiary education

Level 6: second stage of tertiary education.

The publication has aggregated the levels in three categories so that total employment in each sector can be broken down in three skill categories instead of seven:

Low skilled: Level 0, Level 1 and level 2

Medium skilled: Level 3 and level 4

High-skilled: Level 5 and level 6

Manufacturing industries classified according to technological intensity (NACE Revision 2)

High-technology manufacturing

21 Manufacture of basic pharmaceutical products and pharmaceutical preparations

26 Manufacture of computer, electronic and optical products

[45] See Annex 1 for a more detailed description of the indicator

Medium high-technology manufacturing

20 Manufacture of chemicals and chemical products

27 to 30 Manufacture of electrical equipment, Manufacture of machinery and equipment n.e.c., Manufacture of motor vehicles, trailers and semi-trailers, Manufacture of other transport equipment

Medium low-technology manufacturing

19 Manufacture of coke and refined petroleum products

22 to 25 Manufacture of rubber and plastic products, Manufacture of other non-metallic mineral products, Manufacture of basic metals, Manufacture of fabricated metal products except machinery and equipment

33 Repair and installation of machinery and equipment

Low-technology manufacturing

10 to 18 Manufacture of food products, beverages, tobacco products, textiles, wearing apparel, leather and related products, wood and of products of wood, paper and paper products, printing and reproduction of recorded media

31 to 32 Manufacture of furniture, other manufacturing