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REMAKING EUROPE: THE NEW MANUFACTURING AS AN ENGINE FOR GROWTH

Reinhilde Veugelers, editor

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Remaking Europe: the new manufacturing as an engine for growth

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Foreword

A few years ago, the European Union's institutions promoted the goal of increasing the manufacturing sector's share of EU value added to 20 percent. Meanwhile, the labels 'made in Europe' or 'made in country x' resonate with many politicians in Europe while US president Donald Trump believes that his policies would create "millions of manufacturing jobs".

The different chapters of this report suggest that manufacturing is indeed a special sector. It scores high in terms of value added, salaries in the sector are often higher than elsewhere and innovation is strong. But calls for targeted industrial policy ring hollow: what constitutes 'manufacturing' is a fluid concept. New technologies shape industries while outsourcing and the breaking up of value-added chains create measurement problems. Finally, targeting one sector at the expense of others can lead to major distortions in a market economy and would likely hurt growth and jobs rather than helping.

This report revisits the old questions of whether we need a special industrial policy and if it should target specific sectors, technologies or even consumers. In response, the report proposes a more holistic approach. In my view, three questions are important. First, what kind of framework conditions are missing for different economic sectors to thrive in Europe? One aspect is access to a large and single market, which all too often is still fragmented by different national standards and regulations.

Second, how can policies be shaped that are pre-conditions for successful industries? EU policymakers shape the future of industry with numerous decisions. They decide what basic research to fund. They move more quickly on some regulations than on others. They promote specific educations systems, such as apprenticeship programmes. Third, important decisions on major infrastructure projects underpinning industry shape the future. Is broadband internet access readily available? Does Europe need its own cloud computing infrastructure? Have we agreed on a single standard for charging electric cars to enable the rapid creation of a sufficiently wide network of compatible charging stations?

A ‘hands-off’ approach, as is often propagated by ordoliberal economists, is thus not the way forward. Instead, the public sector needs to focus on intervention where it is necessary while avoiding the promotion of specific technologies at the expense of others. The state cannot pick winners but not taking the right decisions on basic infrastructure, smart regulation and the best education could leave Europe as a laggard for many generations.

Guntram B. Wolff, Director of Bruegel
September 2017

1 Introduction: Europe and the new manufacturing

Reinhilde Veugelers

Manufacturing takes up a central position in the agendas of many politicians. It used to provide plenty of jobs that did not require high skills. The idea that such jobs could be revived is behind the demand that products should be 'made in…' the countries that consume them, the calls from the European Union for a European industrial revolution and Donald Trump's promise to create "*millions of manufacturing jobs*".

The problem with such rhetoric is that it has as its reference point an old version of manufacturing. The new version of manufacturing (sometimes called Industry 4.0) also requires attention from politicians, but for different reasons than the provision of millions of old-style production-line jobs.

There is some good news from manufacturing that can underpin the policy discussion. After a long period of decline in manufacturing's share in total employment, the bottom seems to have been reached and the decline has stopped or at least its pace has slowed. The massive offshoring of manufacturing jobs to Asia has also slowed, with even some evidence of reshoring. The manufacturing sector is innovating, using new technologies to meet future demand, bringing new kinds of manufactured products to the market, reinventing existing products into new offerings and improving the efficiency of manufacturing processes. Examples of technologies used by innovative manufacturers include 3D printing, robotics, new materials, smart communication systems and 'big data' management.

Such innovations have changed how many, where and what type of manufacturing jobs are created. Digitalisation and robotics have powered the automation of production processes. Better transportation and information technology has allowed firms to unbundle different tasks making it possible to design and coordinate longer and more complex supply chains that cross national and firm boundaries. Value creation has shifted from the production and assembly of parts to their development and design, the management of the supply chain and after-sales servicing.

The trend towards more complex value chains has resulted in official statistics, which typically categorise firms according to what their largest block of employees does, misrepresenting the changes in the number of jobs in the manufacturing sector. A shift of jobs outsourced by manufacturing firms to other sectors (such as accounting, marketing and after sales services) might look like a loss of jobs for manufacturing, but is not a loss to the economy. Some trends cut the other way, with manufacturing firms turning themselves into sellers of services. Car manufacturers for example are reinventing themselves as providers of mobility services rather than producers and sellers of machines on wheels. Thanks to big data technologies, manufacturers can use the amount of data they accumulate on their products to sell related services. This has the potential to lead to a growth in jobs within manufacturing firms, but in their services departments. Apple is still classified as a manufacturer though it owns no factories.

There are other encouraging trends emerging from the new version of manufacturing. Thanks to digital technologies, such as 3D printing, the design and production of manufactured goods are increasingly interwoven, allowing high-tech production to remain close to the designers and engineers who thought up the product. Using new technologies to keep design and manufacturing tightly coupled can shorten lead times, which is particularly relevant in industries driven by fashion. Shorter value chains will allow production jobs to be located close to markets and/or the sources of technological know-how. This could bring back some of the previously offshored jobs. These new production jobs will however no longer be the jobs associated with old-style assembly lines.

This potential for growth in manufacturing-related jobs feeds the inclinations of politicians to support the revival of manufacturing. But the realisation of this potential requires (new) manufacturing firms fully to exploit the potential offered by new (digital) technologies and incumbent firms to reinvent themselves. These (re)new(ed) manufacturing firms will provide good jobs, but these will be jobs of the future, not the past; they need skill and adaptability.

It is clear that the policy discussion on the future of manufacturing requires an understanding of the changing role of manufacturing in Europe's growth agenda. Europe needs to know how it can realise the potential for industrial rejuvenation. How well are European firms responding to the new opportunities for growth, and in which global value chains are they developing these new activities? Does Europe have the right conditions for its economies to create and capture value from the activities that contribute most strongly and sustainably to Europe's growth and external competitiveness? And even if European manufacturing is taking up the new opportunities, the question remains whether rejuvenation will generate the same number and type of jobs as in the past. This discussion goes beyond a discussion about manufacturing production activities. It cuts across sectoral boundaries and the classic divide between manufacturing and services.

The evidence in this Blueprint shows that the challenge for European policymakers is how to promote and attract those high-value added activities within global chains that are the basis for sustainable growth and competitiveness. Such activities are not necessarily production related, but will increasingly have service-like characteristics and do not necessarily require all the activities of the whole value chain to be located at home.

This focus on high-value activities cuts across sectoral boundaries. High-value activities can be identified within all manufacturing sectors, both low-tech and high-tech, and extend into service activities. We thus need a clearer horizontal perspective on Europe's competitiveness, rather than a sectoral view. The discussion should be about establishing the right conditions for economies and firms to create and capture value from the activities that contribute most strongly and sustainably to Europe's growth and external competitiveness, wherever their intra-EU geographical or sectoral home base might be.

Imposing tariffs and taxes on companies that seek to move jobs overseas, as President Trump threatens to do, is not the way to go. Most manufacturing jobs that were lost are not going to return because they were not shipped abroad in the first place. Rather, they were lost because of the introduction of new ways of boosting productivity and reducing costs. Restricting trade will only disrupt the complex cross-border supply chains on which manufacturing firms rely to build global competitiveness. On the contrary, all kinds of trade costs should be reduced, and interconnecting infrastructure should be prioritised, to allow firms to participate in international value chains whenever that allows them to create more value.

A priority should be a policy framework that removes barriers and creates the framework conditions that give firms the incentive to develop innovative strategies to create new higher-value activities. As large, open and interconnected consumer markets remain a major motivator for business, an effective internal market and an innovation-friendly regulation and competition policy will and should remain EU priorities. Completing the single market, particularly the single market for supporting business services (including cross-border transport, digital and energy infrastructure), is perhaps the most important policy objective for reinforcing manufacturing's role in driving growth.

A further challenge is the structural shift from classic production jobs towards higher value-added types of jobs, and the implications this has for the labour market. Governments will need to facilitate this structural shift. This implies an education policy agenda to ensure that engineers and technical workers are in good supply and to provide more vocational training and retraining programmes to refresh the skills of current workers or laid-off workers.

As the challenges and trends are common for all value-added creating sectors, government intervention should be sufficiently horizontal. Governments should not succumb to the temptation to pick particular sectors.

In 2012, the European Commission published a communication on a new industrial policy[1] that set out a roadmap for reindustrialising Europe, with the aim of "*raising the share of industry in GDP from the current level of around 16 percent to as much as 20 percent in 2020*". Although the Commission stressed the need for a comprehensive vision "*mobilising all the levers available at EU level, notably the single market, trade policy, SME policy, competition policy, environmental and research policy in favour of European companies' competitiveness*", the communication returned to a more targeted approach, identifying six priority action lines (including key enabling technologies, clean vehicles and smart grids). The communication was followed by action plans for specific sectors. As argued in a previous Bruegel Blueprint[2], it is doubtful that targeting a minimum share of GDP for manufacturing and focusing on specific sectors and technologies is the right approach. The issue is not whether manufacturing is or should be important for economies, nor is it how many manufacturing jobs to have or save. Rather it is what type of activities Europe should focus on in the value chain for goods, which will allow the creation of sustainable jobs and growth in Europe. This discussion cuts across sectoral boundaries and requires a horizontal approach rather than a sectoral

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1 'A Stronger European Industry for Growth and Economic Recovery', available at http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52012DC0582.

2 This Blueprint updates and complements a previous Bruegel Blueprint: Veugelers, R. (ed) (2013) *Manufacturing Europe's future,* Blueprint 21, Bruegel, available at http://bruegel.org/2013/10/manufacturing-europes-future/.

view, establishing the right conditions for economies to create and capture value from activities that contribute most strongly and sustainably to Europe's growth and external competitiveness.

Further European Commission communications on industrial policy, such as the 2014 communication 'For a European Industrial Renaissance'[3] continued with this two-tiered strategy by emphasising a holistic horizontal approach with "*policies and actions for the modernisation of the industrial base and for the transition towards an ever more innovative, modern and sustainable economy*", while also developing sector-specific action plans that support key industrial sectors and specific actions directed at specific sectors, such as space and defence. Key enabling technologies remain a particular focus of the EU's industrial policy[4].

On 29 May 2017, the Council of the European Union called on the Commission[5] to provide a holistic EU industrial policy strategy in time for the spring 2018 European Council meeting. The Council of the EU emphasised that this should be based on integrated value chains and inter-clustering linkages, encompassing enterprises of all sizes operating in the manufacturing industry and related services sectors. The Council highlighted that "*this should embrace, amongst others, human capital, research, development and innovation, digital transformation, tackling efficiently and robustly unfair commercial practices, sustainable and affordable energy sources, resource efficiency, industrial servitisation and better regulation*". While this seems a call for a

3 Available at http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX-:52014DC0014.

4 These are a group of six technologies: micro and nanoelectronics, nanotechnology, industrial biotechnology, advanced materials, photonics, and advanced manufacturing technologies. They have applications in multiple industries and help tackle societal challenges.

5 'Conclusions on a future EU industrial policy strategy', available at http://www.consilium.europa.eu/en/press/press-releases/2017/05/29-compet-conclusions-future-industrial-policy-strategy/.

much-needed truly horizontal EU growth policy, as Bruegel scholars have already advocated (see footnote 2), it at the same time continues to mention the importance of the cumulative effect of policies and their consistency and states that "*the approach should include, when necessary, sectorial initiatives for sectors facing economic change and high growth potential sectors*".

The analysis in this Blueprint provides further support for a holistic, horizontal EU growth policy, which seems to be the direction taken in the latest European Commission communication. The effectiveness of the deployment of this industrial policy should be closely monitored, with regular empirical analyses and feedback to inform follow-on policy making. This monitoring should include a sectoral perspective, concentrating particularly on how Europe is faring in new emerging sectors that are still fragile. Such sectoral monitoring would allow assessment of how the multitude of policy instruments, from various policy domains and from EU, national or regional levels, interact to affect the efficiency of the sectoral eco-system and would underpin policy realignment when needed. Sectoral monitoring within an effects-based holistic horizontal growth policy can thus substitute for *ex-ante* targeting with specific actions and funding for selected 'strategic' sectors and technologies. Establishment of a unit inside the European Commission dedicated to such monitoring and analysis would allow for a long-term commitment and a critical scale for expertise building. As the analysis will integrate evidence from different Commission directorates, such a monitoring unit should sit at a central level within the Commission services, such as within the Secretariat-General or the European Political Strategy Centre.

A summary of the issues covered by this Blueprint is as follows:

Chapter 2, E*uropean and global manufacturing: trends, challenges and the way ahead* by Reinhilde Veugelers and Uuriintuya Batsaikhan, takes stock of the long-term trends in value added and employment in manufacturing. Despite its declining value added and employment shares, manufacturing continues to be a vital contributor to the EU's innovation performance and external competitiveness. But in order to sustain manufacturing's competitive advantage, a sufficient shift to higher value-added activities and higher-skilled jobs needs to take place. The EU needs to move up the innovation ladder from its current position in medium technology-intensive activities to high R&D intensity activities, on a par with the United States and Japan. Investment in services sectors is equally important. The chapter shows that market services sectors represent an increasing share of value-added growth, while non-market services sectors account for large part of within-EU productivity growth.

Chapter 3, *The competitiveness of European industry in the digital era* by Carlo Altomonte, Filippo Biondi and Valeria Negri, documents how recent productivity trends in European industry are related to the adoption of information and communications technologies and related investments. The aggregate productivity of manufacturing has substantially recovered in Europe, but its contribution to overall country productivity is small because the manufacturing sector is losing ground in terms of share of hours worked throughout the EU. Greater growth in IT capital stock is associated with better productivity performance, in terms of both labour productivity and total factor productivity. However, all indicators at industry or country-level are by definition averages, which reflect both leading and lagging firm performance and thereby could lead to so-called aggregation and dispersion biases. The effects of ICT capital investments are on average positive and significant for productivity, but these are essentially driven by the most productive companies Thus, while policies aimed at increasing digitalisation and the development of 'Industry 4.0' are powerful tools to foster the competitiveness of EU industry, they are also likely to increase the gap between the most successful companies and those left behind.

Chapter 4, *Firm growth dynamics and productivity in Europe* by Albert Bravo-Biosca, zooms in on firm growth as an important driver of economic growth. Despite the recognised importance of this process, there is limited cross-country comparable data to inform policy. The chapter presents a database that measures the distribution of firm growth in twelve countries. The data allows measurement of average growth and also the growth rate for all the percentiles of the growth distribution, broken down by size, sector and age. This shows that firms in the US grow and shrink more rapidly than in Europe, which has a much larger share of static firms. Having a higher share of static firms is associated with slower productivity growth.

Chapter 5, *A revival of manufacturing in Europe? Recent evidence about reshoring* by Dalia Marin, Reinhilde Veugelers and Justine Feliu, examines offshoring of European manufacturing jobs. Globalisation and the international division of labour have shaped the relocation of manufacturing jobs and raised concerns in advanced economies. In the era of advanced manufacturing technologies, the factors that matter for deciding on the location of manufacturing facilities and jobs are quickly evolving. With global value chains not expanding since 2011, we might have entered a new period of globalisation in which firms reorganise into shorter, regional or local value chains. The chapter identifies a slowly changing pattern of offshoring around the world driven particularly by reshoring by Chinese companies and significantly less offshoring to southern Europe. Activity moved from southern Europe to China and central and eastern Europe, leaving total offshoring activity mostly flat in most European countries.

Chapter 6, *Manufacturing in central and eastern Europe* by Maciej Bukowski and Aleksander Śniegocki, considers industrialisation in central and eastern European countries from a historical perspective. After 45 years of communism and centrally planned systems, a process of intensive industrialisation in the region and catching up with the west took place on the back of a rapid inflow of technology and know-how through foreign direct investment. After EU entry, central and eastern European countries rapidly integrated into European and global value chains. However, full quantitative and qualitative convergence with western Europe is likely to happen only in the next 20-30 years. Central and eastern European countries need to help their most productive manufacturing industries and services to invest in R&D, while continuing to attract foreign investment and know-how to close the technology gap, and training and retaining human talent.

Chapter 7*, Europe's comparative advantage in low-carbon technology* by Robert Kalcik and Georg Zachmann, examines low-carbon technologies, which have exhibited high growth rates and are predicted to attract increasing investment. The potential of countries to excel in these emerging sectors, specifically photovoltaics, batteries, wind turbines and electric vehicle technology, is assessed based on their current export and technological specialisations. Even if a country is currently not good at exporting or patenting in a certain sector, it might acquire this capability if it is strong in proximate sectors. A regional analysis yields insights into the strength of spillover effects and the locations of technology clusters.

Chapter 8, *From big oil to big data? Perspectives on the European energy industry of the future* by Simone Tagliapietra and Georg Zachmann, examines the future prospects of the European energy sector, which is going through a profound transformation, driven by decarbonisation and digitalisation. European oil and gas companies are reacting differently to these new challenges and, in several cases, there seems to be a lack of vision about how to adapt to the transformation towards a low-carbon system. European utilities are also struggling to reinvent themselves to make the best of the transition. While some are decisively pushing for a shift in their business models from electricity producers to smart-energy services providers, others find it more difficult to reshape their traditional business models.

Chapter 9, *Fintech in Europe: challenges and opportunities* by Silvia Merler, examines the future prospects of technology-enabled finance (fintech) in Europe. The recent rise of fintech has spurred the interest of financial markets and policymakers, and has raised concerns about the impact on the traditional banking business. Globally, the balance between competitive and collaborate fintech is in favour of the latter but in Europe, competitive fintech seems to prevail. EU countries have opted for different regulatory approaches. In the absence of internationally agreed regulatory standards for fintech, the distinction is between those national authorities that have acted within already existing frameworks, and those that have introduced new rules specifically for fintech. Dealing with fintech at EU level would help ensure that regulatory requirements are harmonised, which is important in light of fintech's potential financial stability risks.

Chapter 10, *Strengthening cross-border e-commerce in the European Union* by J. Scott Marcus, John Morales and Georgios Petropoulos, zooms in on the digital services sector in Europe, specifically online sales. The imperfect integration of the European market with regard to digital services and online sales represents a substantial lost opportunity for Europe. Online purchases are growing rapidly within the EU, but cross-border purchasing lags significantly behind domestic online purchasing. If e-commerce sales within the EU were as easy and cost-effective as domestic sales, retail prices would decrease both online and offline, while the consumer and producer surpluses associated with retail sales in the EU would increase. A coordinated cluster of measures will be needed to unlock the full potential of cross-border sales in the EU.

All the chapters illustrate how the European economy is taking advantage of new technological opportunities, is reshaping into international value chains to revitalise and refocus on high value-added activities,. However, this revitalisation process could take place much faster in Europe and could be spread more broadly across more countries, companies and sectors.

2 European and global manufacturing: trends, challenges and the way ahead

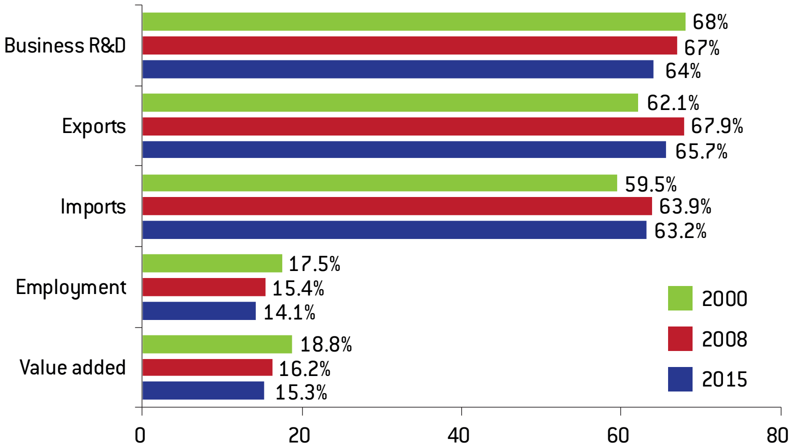
Reinhilde Veugelers and Uuriintuya Batsaikhan

2.1 EU manufacturing: key numbers

Manufacturing's share of European Union value added has been on a continuous decline for a number of years. Manufacturing now represents about 15 percent of total EU value added and 15 percent of its total employment. This drop in manufacturing activities is associated with a steady decline in demand for manufactured goods since the 1970s in the EU. Vihriälä and Wolff (2013) showed that the declining ratio is partially a result of the fact that the decrease in the relative price of manufactured goods has not been matched by an increase in demand for those goods.

This decline persists despite the European Commission setting out in 2012 a plan to reindustrialise Europe and *"raise the share of industry in GDP from the current level of around 16 percent to as much as 20 percent in 2020"* (European Commission, 2012b). This target now seems further away than it was in 2012. However, as already argued in a previous Bruegel Blueprint (Veugelers, 2013), this is a case of *"missing the wrong target"*: manufacturing will matter for the EU economy, not because of the sheer volume of activities and jobs it entails, but because of the nature of the activities and jobs it represents.

Figure 1: Manufacturing in the EU, key numbers, % of total economy

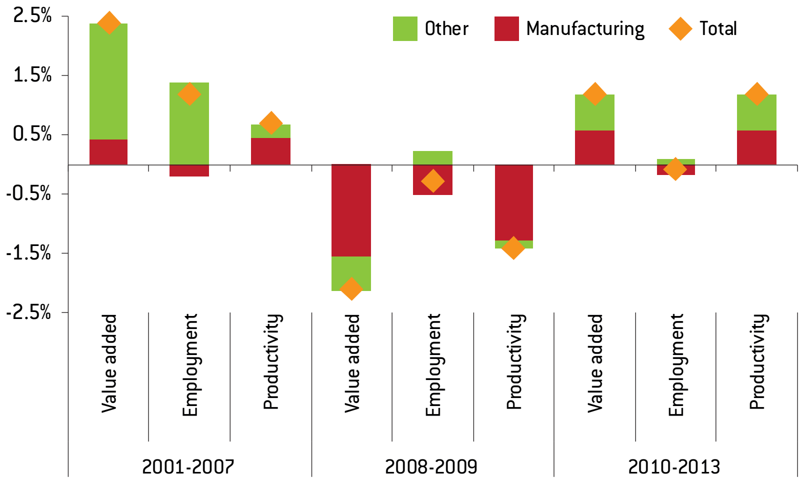


Source: Bruegel based on Eurostat for employment and value added, WTO for exports and imports and OECD for business R&D. Note: Business R&D latest data is for 2014 instead of 2015.

Rather than targeting how much manufacturing Europe should have, what matters for the EU economy is what manufacturing activities will offer high value added to EU society, supporting its sustainable growth. Figure 1 shows that although manufacturing's share of value added is only 15 percent, it accounts for 64 percent of all EU business R&D. In addition to being highly R&D-intensive, manufacturing disproportionately contributes to EU trade and competitiveness, with its value added and its exports/imports having a ratio of about one to four.

Although its size keeps declining, the manufacturing sector nevertheless remains an important contributor to overall EU growth, precisely because of the shift towards higher value added activities, as Figure 2 shows.

Figure 2: The contribution of manufacturing to total EU economic growth



Source: Bruegel based on Eurostat. Note: Growth rates are annual average growth rates over the periods. Total economy excludes 'agriculture, forestry and fishing'. Latest available sectoral data.

Manufacturing contributed negatively to employment growth in Europe throughout the period considered. However, despite losing 'weight', manufacturing still contributes to overall growth in value added because of its higher productivity growth compared to the rest of the economy. The manufacturing sector displayed a marked dynamism after the crisis years. Although manufacturing saw a big drop in value added growth and employment during the crisis period, the sector quickly recovered. After the crisis, manufacturing accounted for half of the EU's productivity growth and half of its value added growth, despite manufacturing's declining weight.

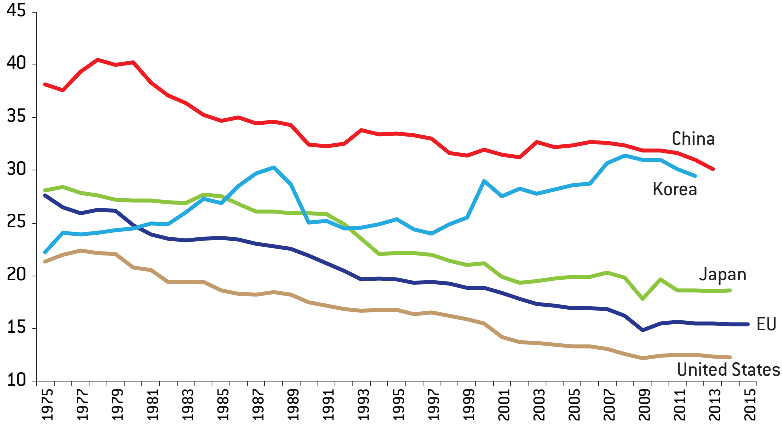
Rather than focusing on whether manufacturing will reach 20 percent of the EU's GDP by 2020, more fundamental questions are: what kind of manufacturing and which firms and sectors will generate high value-added, high productivity jobs? Will the EU manufacturing sector be able to adjust to these activities? This requires EU manufacturing to be sufficiently *creative*: to innovate and develop new, higher productivity and higher value added activities. At the same time, the sector needs to be sufficiently *destructive:* freeing resources from less productive activities.

While the manufacturing sector is an important source for higher value added activities in the EU economy, it is not the only source. Services, especially digital-technology intensive service sectors can and will be important contributors to employment, value added and productivity, because of their increasing share of value added and because of their scope for generating increasingly higher value added. The move to higher value added activities should not be seen as a shift from non-manufacturing into manufacturing, but will be the case for all economic activities and will continue to blur the boundaries between manufacturing and services. Manufacturing firms are most likely to create and capture more value added in the pre- and post-production services parts of their value chains.

2.2 The decline of manufacturing from global and historical perspectives

The decline in manufacturing is not a new phenomenon, but a continuation of a trend that started in the 1970s in all major advanced countries, illustrating its structural and general character (Figure 3). Manufacturing's share of value added declined in the EU from 27 percent in 1975 to 15 percent in 2015, while in the US it gradually dropped from 21 percent to 12 percent over the same period. After a notable dip during the crisis, the declining trend continued; it flattened out somewhat, but has nowhere revived. The situation in Asian countries is more variable: developments in Japan resemble those in the EU and US, while the decline in China has not been as rapid and manufacturing's share of Chinese value added remains more elevated than in other countries. In Korea, manufacturing value added picked up markedly after 2000.

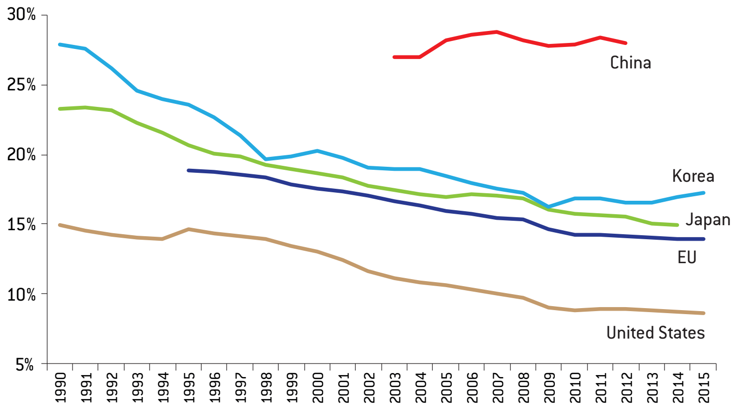
Figure 3: Manufacturing's share of value added, 1975-2015



Source: Bruegel based on OECD, World Bank and Eurostat. Note: EU, changing composition.

The decline in manufacturing's employment share (Figure 4) in all countries also resembles a long-term structural trend, which might have bottomed-out lately, but shows no signs of reversing. The decline in the US is even more pronounced than in the EU, with a share below 10 percent in 2015. The decline in employment is greater than in value added for the US, indicating a shift in manufacturing to a situation in which fewer workers are generating more output (Oldensky and Moran, 2016). A similar trend is also observed in Korea, where manufacturing's share of value added is increasing while its share of employment is decreasing, suggesting that Korea is in a process of moving up the value-added ladder. For China, there are unfortunately only a limited number of years of comparable data. While the value added share of manufacturing in China shows some decline, this is not seen in manufacturing's employment share, perhaps reflecting the difficult restructuring of employment-intensive state-owned-enterprises (SOEs) in Chinese manufacturing.

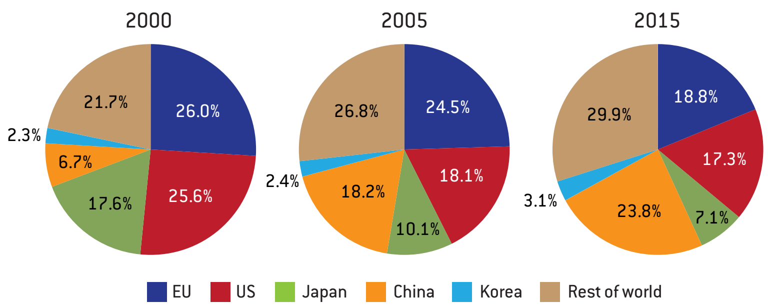
Figure 4: Manufacturing employment as a share of total employment, 1990-2015



Source: Bruegel based on OECD and Eurostat.

Despite the global nature of the shrinking of manufacturing, the pace of shrinkage is different in different economies. As a consequence, the global manufacturing hubs are shifting. Europe's share of global manufacturing value added has shrunk rapidly, especially after 2009 (Figure 5). Similar to the EU, the US and Japan are losing share. Korea is expanding its small share, but most notable is the rise of China as a global player, which has become the biggest player in global manufacturing, ahead of the EU and US according to 2015 figures.

Figure 5: Major economies' shares of global manufacturing value added

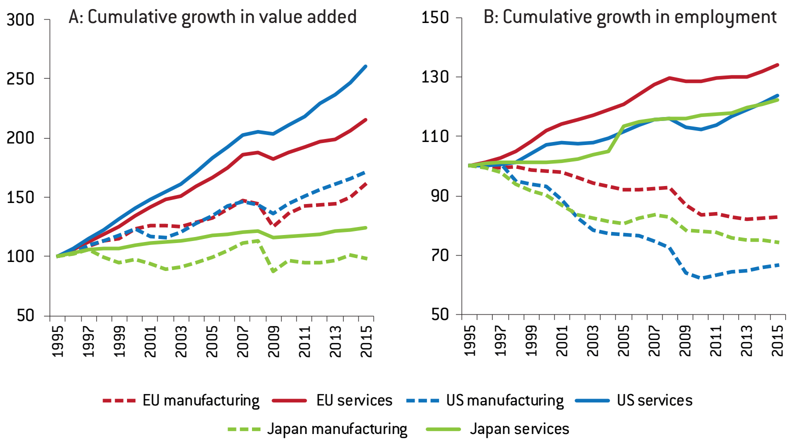


Source: Bruegel based on World Bank. Note: Data in current US dollars.

2.2.1 Manufacturing and services

The decline in manufacturing's share of total economy employment is a combination of a drop in the absolute numbers of those employed in manufacturing, together with an increase in in employment in services in the EU, US and Japan (Figure 6, panel B). EU services employment growth has actually outperformed that in the US and Japan. The drop in manufacturing employment was also more tempered in the EU. The decline in manufacturing's share of total economy value added is not a consequence of a drop in manufacturing's value added, but because the increase in services value added has outpaced the increase in manufacturing value added in the EU, US and Japan (Figure 6, panel A). In terms of value added growth, the EU trails the US, in manufacturing and particularly in services, with services value added growth in the US increasingly outstripping that in the EU.

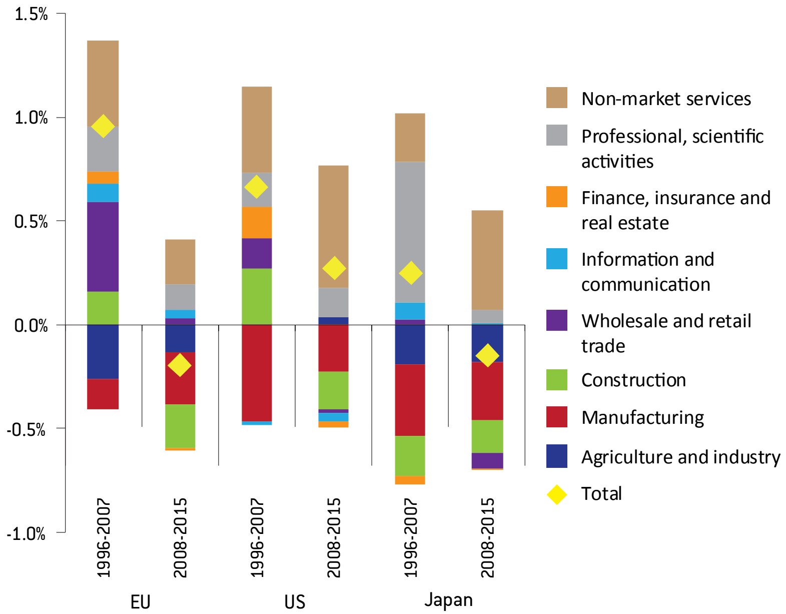
Figure 6: Manufacturing vs. service cumulative growth, 1995-2015



Source: Bruegel based on Eurostat, US Bureau of Economic Analysis, and Government of Japan Cabinet Office statistics.

Figure 7 illustrates again the big negative contribution of manufacturing to employment growth in the EU, the US and Japan. Pre-crisis, the negative contribution of manufacturing to employment growth was much smaller in the EU compared to the US and Japan, and overall employment growth was more positive. But after the crisis, manufacturing accounted for a larger share of the employment decline in the EU, similar to the US and Japan. Moreover, in the EU, non-market services, such as education, social work and public administration, made a smaller contribution to employment growth compared to the US and Japan.

Figure 7: Contribution to employment growth by sector, 1995-2015

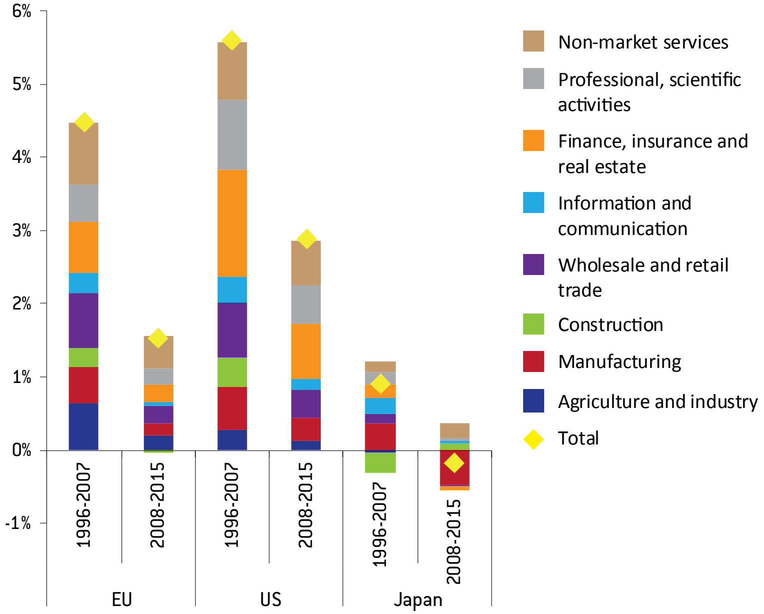


Source: Bruegel based on Eurostat, US Bureau of Economic Analysis, and Government of Japan Cabinet Office statistics. Note: Share weighted averages across periods. The numbers show the contribution of manufacturing.

Figure 8 shows how manufacturing has contributed more to US overall value added growth than to EU value added growth, particularly in the later period from 2008 to 2015. All services sectors also contribute more to US value added growth than services sectors in the EU.

The EU, therefore, still has scope to increase the contribution of both manufacturing and services to its value added. Professional (business) services and scientific activities are important sources of value added growth in the EU, US and Japan (Figure 8). Financial services lost their value added growth potential after the crisis. Non-market services remain an important driver of value added growth, but post-crisis the EU has trailed the US in this sector.

Figure 8: Contribution of sectors to value added growth, 1995-2015



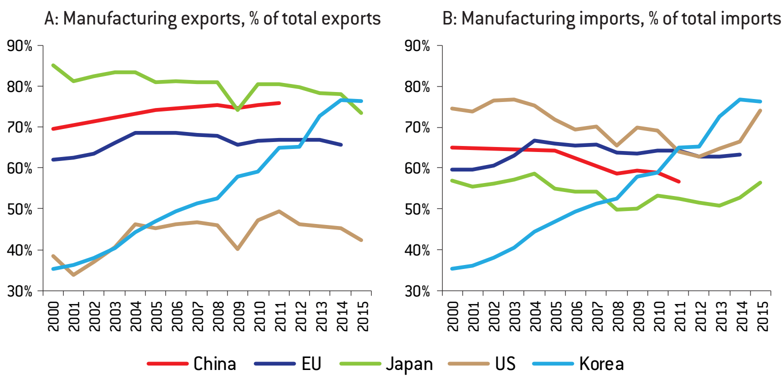
Source: Bruegel based on Eurostat, US Bureau of Economic Analysis, and Government of Japan Cabinet Office statistics. Note: Share weighted averages across periods. Numbers for manufacturing's contribution are shown.

2.2.2 Manufacturing trade in global value chains (GVCs)

As manufactured goods are more tradable than services, manufacturing remain an important contributor to economies' trade balances and external competitiveness. Manufacturing's share of EU exports has been and remains substantially higher than its share of value added and employment. Manufacturing exports still represent more than two thirds of total EU exports (Figure 9). It should be noted that the contribution of manufacturing to exports has been consistently lower in the US than in the EU, with the US being more services-intensive. This is in contrast with Asia, where the exports of Japan, China and Korea are increasingly more manufacturing based.

As a consequence of the increased integration of global value chains, firms in advanced countries have shifted some of their production to emerging markets, resulting in increasing trade volumes and an increasing share of trade being taken up by intermediate goods (what has been dubbed 'hyper-globalisation'). Panel B of Figure 9 shows the share of manufactured goods in imports. Most striking is the high share of manufactured goods in US imports, substantially higher than its share of exports. Chapter 5 digs deeper into the increasing integration of manufacturing into global value chains and comparative trends for the EU, US and China.

Figure 9: Manufacturing share of trade, 2000-15, major economies



Source: Bruegel based on OECD.

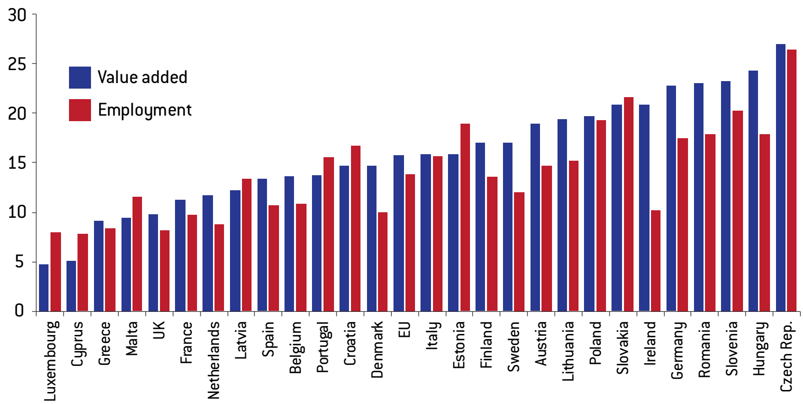
2.3 Manufacturing in the EU

2.3.1 Manufacturing value added and employment

The contribution of manufacturing to the overall economic performance of EU countries varies significantly (Figure 10).

In the central and eastern European countries, Germany and Ireland, manufacturing value added is above 20 percent of total value added, while in Luxembourg, Cyprus, Greece and the UK, the value added is below 10 percent. Manufacturing employment is highest in central and eastern European countries, especially in Estonia and Croatia. In Ireland and to a lesser extent in the Nordic countries, the difference between manufacturing's share of employment and of value added is significant, indicating a bigger concentration of manufacturing in higher productivity activities in these countries.

Figure 10: Manufacturing's shares of value added and employment, EU countries 2015, %

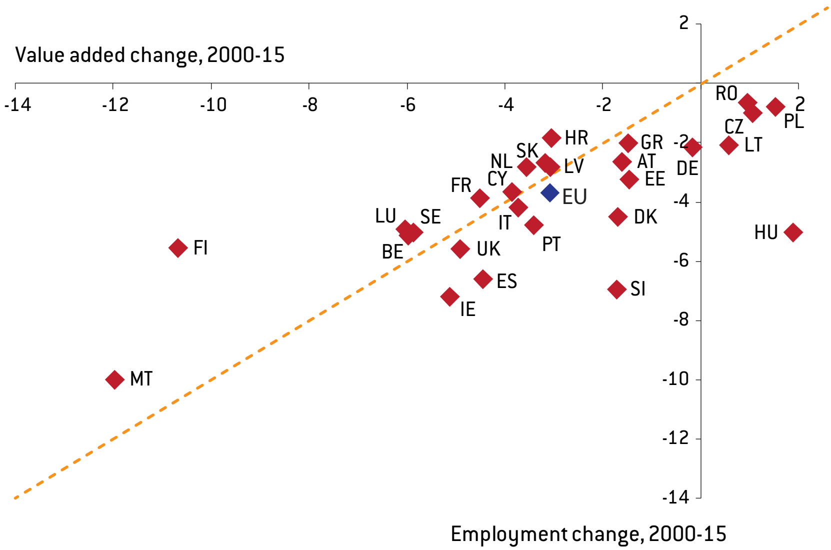


Source: Bruegel based on Eurostat.

Figure 11 looks at the differences between EU countries in terms of the trends in manufacturing's share of value added and employment from 2000 to 2015). For the EU as a whole, the manufacturing sector during this period saw its shares of value added and employment drop, with the latter more pronounced, indicating a manufacturing sector that is at a higher level of productivity in 2015 compared to 2000. Most EU countries are in line with this EU aggregate trend. No EU country saw an increase in manufacturing employment, while manufacturing's share of value added increased only in Lithuania, Poland, Romania, Hungary and the Czech Republic. This group of countries also saw the least reduction in manufacturing employment, with the exception of Hungary.

The largest reductions in manufacturing employment were recorded in Malta, Ireland, Slovenia, Spain, the UK and Finland. In Hungary, Slovenia, Germany, Estonia, Denmark, Ireland and Spain, the drop in employment has been larger than the drop in value added, indicating a restructuring towards higher productivity manufacturing activities.

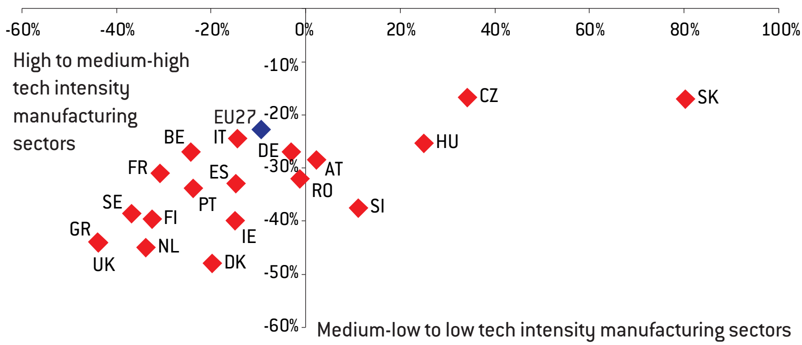
Figure 11: Changes to manufacturing value added and employment, 2000-15, %



Source: Bruegel based on Eurostat.

Figure 12 further illustrates the shift to higher value added activities in manufacturing, which is taking place through the shift from low to high technology-intensive manufacturing sectors. In the EU as an aggregate and in all EU countries, the drop in employment has been greatest in low- and medium-low technology-intensive manufacturing sectors, much greater than the drop in high and medium-high technology-intensive manufacturing sectors. In Slovakia, the Czech Republic, Hungary and Slovenia, high and medium-high technology sectors have expanded substantially.

Figure 12: Change in employment (numbers of employees) by technology intensity of the manufacturing sector, 2000-15



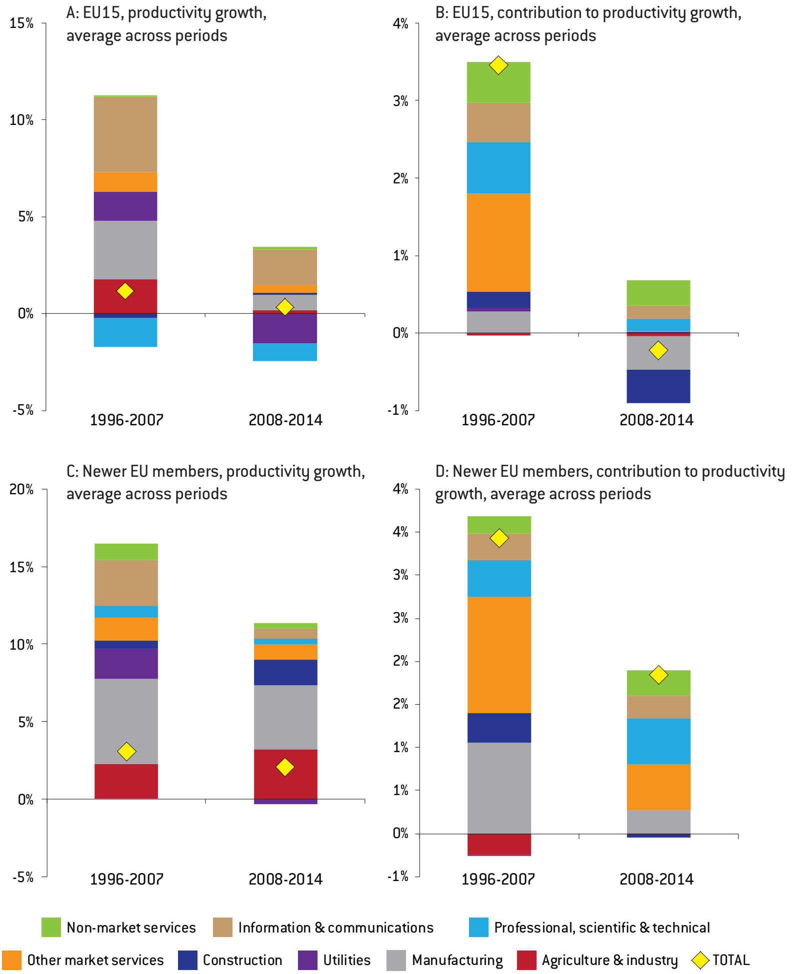
Source: Bruegel based on Eurostat. Note: Data for Croatia is not available .

2.3.2 Manufacturing productivity growth

Figure 13 looks more closely at the differences in the contribution of manufacturing to overall productivity growth in the EU15 pre-2004 member countries and those countries that joined the EU in 2004 and after. The split between pre and post 2004 accession countries is due to the fact that these group of countries exhibit different levels of sectoral productivity growth and contribution of different sectors to the productivity growth. In the early period (1996-2007), the contribution of manufacturing to productivity growth was still positive in both groups, albeit to a lesser extent in the EU15. In the later period (2007-14), the contribution of manufacturing to productivity growth turned negative for the EU15 countries but remained positive in countries that joined the EU in 2004 and after (panels B and D in Figure 13). For both groups of countries, services – particularly non-market services, ICT and professional services – are important contributors to overall productivity growth.

A sector's contribution to overall productivity growth is a combination of its weight and its productivity growth performance. When comparing panels B and D to panels A and C in Figure 13, we see that for the EU15, the negative contribution of manufacturing to total productivity growth in the later period is because the productivity growth in the manufacturing sector, although positive, was not sufficient to compensate for the loss in weight of the sector in the total economy. By contrast, in the countries that joined the EU in 2004 and after, manufacturing's productivity growth was sufficiently strong to compensate for the loss of manufacturing weight, such that overall, the manufacturing sector continued to contribute positively to the overall economy's productivity growth. For services, the outlook in terms of the contribution to productivity growth underlines the importance of this sector, especially information and communication, professional, scientific and technical services, and non-market services for both country groups.

Figure 13: Contribution of different sectors to productivity



Source: Bruegel based on Eurostat. Note: EU15 includes Austria, Belgium, Germany, the Netherlands, France, UK, Denmark, Italy, Spain, Ireland, Finland, Portugal, Greece, Luxembourg and Sweden. Newer EU members = countries that joined the EU in 2004 and after. Value-added based labour productivity measure is computed as a share-weighted average of industry-specific rates of change of value-added and employment, where weights reflect the current price share of each industry. Other market services include wholesale and retail trade, transportation, finance and insurance and real estate.

2.3.3 Manufacturing output, skill and wages

The shift in manufacturing employment and productivity has had major implications for wages (Figure 14). All countries have seen a drop in the total hours worked (a combined effect of a drop in the number of employees and number of hours worked per employee). This reduction in total hours worked has been associated with an increase in the productivity per hour worked, as reflected in the output/hour series. The increase in hourly productivity was smallest in Spain and Italy. It was much larger in the US than in most EU countries. Only Sweden, Ireland and the Czech Republic outperformed the US in terms of growth in output per hour worked.

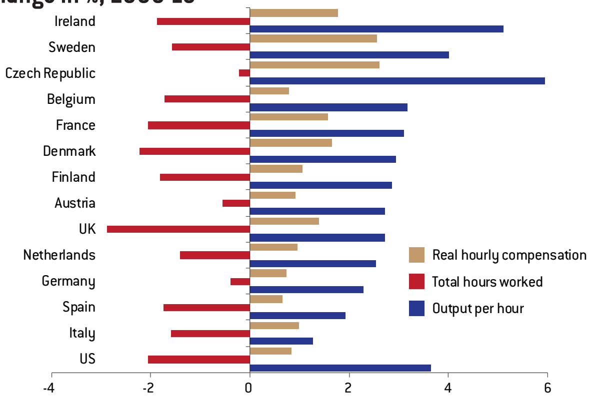
But how much of this higher productivity has translated into a higher real hourly wage for those remaining in the manufacturing workforce? How much of the higher value added is captured by labour? In all countries, the real hourly compensation increased, but to a lesser extent than the increase in output per hour. The discrepancy is greatest in the US, where the output per hour growth is more than four times the growth in real hourly compensation. The difference is the smallest in Italy, which also is the country with the smallest increase in output per hour.

Figure 15 shows the contribution of skill composition changes to manufacturing value added growth rates for various EU countries. The labour composition change (measured as the change in the share of higher skilled workers, proxied by their education, in the total manufacturing workforce), contributes positively to manufacturing value added growth in all countries and throughout the period, underlining the role of skills as a positive and significant contributor. However, the change in skill composition makes only a small contribution. In contrast, total hours worked is a big negative contributor to manufacturing's value added growth rate in France, Italy and Sweden. The exceptions are Germany and the UK in the most recent period, total hours worked contributes slightly positively.

Figure 15 also shows the importance of total factor productivity (TFP), a proxy for technological progress, as a major contributor to manufacturing value added growth, at least before the crisis period.

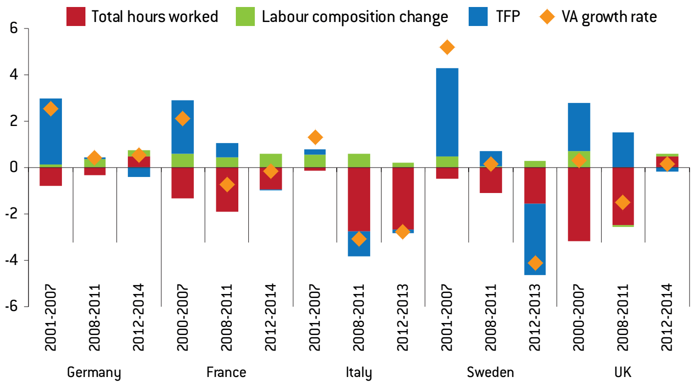
This is evident for all countries except Italy. TFP has however become less important and its contribution even seems to have turned negative in the most recent period. This is again a reminder that the contribution of manufacturing to value added growth through higher value added performance cannot be taken for granted.

Figure 14: Manufacturing output, compensation and total hours worked, average annual change in %, 2000-15



Source: Bruegel based on the Conference Board.

Figure 15: Growth in real value added in manufacturing, decomposed, selected countries, %



Source: Bruegel based on EU KLEMS.

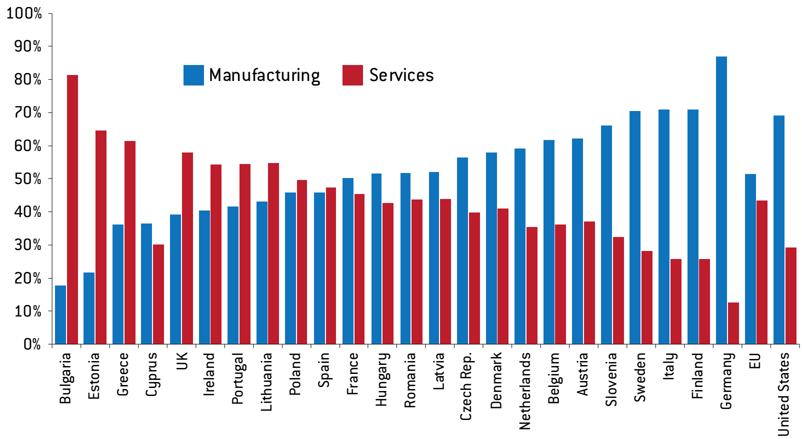
2.4 Manufacturing innovation

To further illustrate the scope for the manufacturing sector to contribute to overall economic growth through higher value added activity, we look in this section at the innovative profile of the EU manufacturing sector, compared to global competitors.

In contrast to its low shares of value added and employment, manufacturing accounts for almost two-thirds of total EU R&D investment. This reflects manufacturing's high innovation potential compared to other sectors (Figure 16). Nevertheless, manufacturing's share of overall R&D is gradually eroding, as service sectors' share of overall R&D increases.

Within the EU, manufacturing's share of R&D is 70 percent or more in countries such as Germany, Finland, Italy and Sweden. But in countries such as Estonia, the UK, Ireland, Portugal and Poland, the services share of R&D is already greater than that of manufacturing.

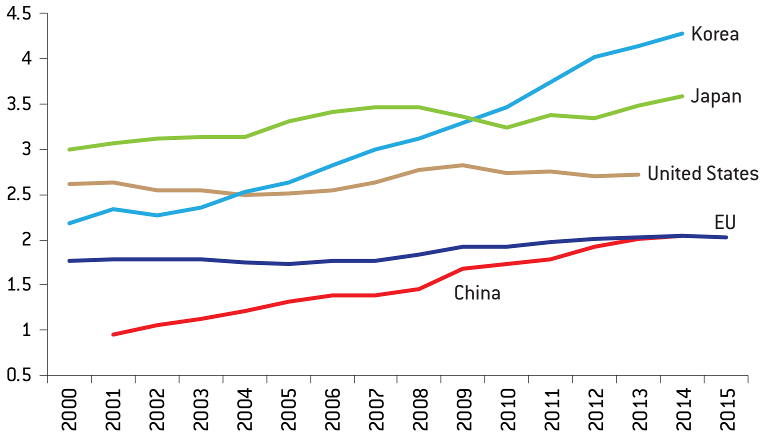
Figure 16: Manufacturing vs. services, shares of total business enterprise R&D expenditure, 2014



Source: Eurostat and OECD for the US.

It is well known that overall the EU has a problem with its innovation capacity, persistently lagging behind, and failing to catch up with, the US. Figure 17 clearly shows that the EU's R&D intensity remains stuck around 2 percent (in other words, the EU spends 2 percent of its GDP on R&D), consistently below the US and Japanese ratios, and despite a 3 percent target, set by the EU, being in place since 2000. This is in contrast to Korea and especially China, which have dramatically increased their R&D intensity levels. China caught up with the EU in 2014.

Figure 17: Total economy R&D intensity in %, 2000-15



Source: Eurostat. Note: R&D intensity = R&D spending as % of GDP.

The failure of the EU to improve its R&D performance has been widely analysed (see for example Veugelers and Cincera, 2015). The failure is generally attributed to the EU having its economic structure concentrated in medium-technology sectors, and failing to move into new, higher technology sectors with more scope for innovation-based growth. The EU's creative destruction problem holds both for the shift within manufacturing from lower-tech sectors into higher-tech new subsectors, and for the shift from manufacturing into higher-tech services sectors.

Using data on the largest R&D-spending firms worldwide (EC-JRC-IPTS Scoreboard), Table 1 shows that the shortfall in the EU's manufacturing innovation capacity relative to the US is not down to the within-sector underperformance of EU manufacturing firms (Cincera and Veugelers, 2010; Moncada, 2016). The R&D intensity of EU manufacturers compares well with that of their US counterparts within the same sectors (Table 1, left-hand columns). In some manufacturing sectors, such as aerospace and automobiles, EU firms even outperform their US rivals. The only exception is biotech, a small but nevertheless strategic sector, in which the EU has much smaller companies that are less R&D intensive compared to their US peers. The EU's biotech R&D gap compared to the US is primarily caused by the EU not having enough biotech firms (like Amgen or Genentech) that successfully transform into large global champions.

The overall lower R&D intensity of EU firms relative to US firms is rather a result of the lower presence of EU firms in high-tech sectors with a higher potential for innovation-based growth (Table 1, right-hand columns). Within manufacturing, the most R&D-intensive sectors are health (pharmaceuticals and biotechnology) and IT equipment (especially semiconductors and telecom equipments).

In the high R&D intensity sectors, such as semiconductors, EU firms are as R&D intensive as their US counterparts, but the EU simply does not have enough of these companies. In the US, the semiconductors sector has a share of more than 10 percent of overall corporate R&D. In the EU, the sector accounts for less than 3 percent and the share is declining. In telecom equipment, EU and US firms have comparable R&D intensity rates, but this sector's share of overall R&D is declining as the industry moves to Asia.

Table 1: R&D intensity by sector, and sectoral R&D shares in the EU and the US (2005-13)

R&D intensity of sectors (ICB-4)		Sectoral R&D Intensity WITHIN						Sectoral share BETWEEN					
		EU			USA			EU			USA		
		2005	2009	2013	2005	2009	2013	2005	2009	2013	2005	2009	2013
Selected high R&D intensity	Pharma	14.7	14.6	13.4	14.2	14.7	14	17.0	16.2	17.1	18.7	18.4	15.6
	Biotech	17.1	17.1	15.1	26.9	23.2	26.4	0.6	0.6	0.7	4.6	5.4	5.7
	Software	13.4	14.6	15.6	15.7	14.8	14.9	2.1	2.7	2.7	9.4	10.3	11.6
	Semiconductors	17.4	22	18.1	15.6	19.4	18.8	3.1	2.7	2.4	11.5	11.1	11.6
	Telecoms equipment	13.2	13.3	14.6	12.1	15.1	14.3	8.6	8.7	6.4	7.5	7.6	7.1
	Weighted average	14.5	14.9	14.3	15.6	16.6	16.7	31.4	30.9	29.3	51.7	52.8	51.6
Selected med-high R&D intensity	Aerospace and defence	8.2	5.8	5.8	2.9	3	3.3	8.0	6.4	6.2	3.9	4.7	3.5
	Automobiles and parts	4.5	5.6	5.5	3.7	4.1	3.8	24.3	22.4	26.8	11.4	7.3	6.7
	Chemicals	3.5	3.5	2	2.5	2.9	3.6	5.8	5.9	3.0	3.1	2.4	2.9
	Electronic equipment	5.8	6.3	8.1	6.3	7.7	4.4	1.0	1.1	1.7	7.8	6.5	9.0
	Industrial machinery	2.9	3	3.5	1.4	2.8	2.5	2.2	2.5	3.3	0.2	0.7	0.5
	Weighted average	5.0	5.2	5.2	4.2	4.8	3.9	41.3	38.3	41.0	26.4	21.6	22.6
Total (all sectors)		3.0	2.9	3.0	4.4	4.8	5.2	100	100	100	100	100	100

Source: Bruegel adapted from Moncado (2016) on the basis of http://iri.jrc.ec.europa.eu/scoreboard.html.

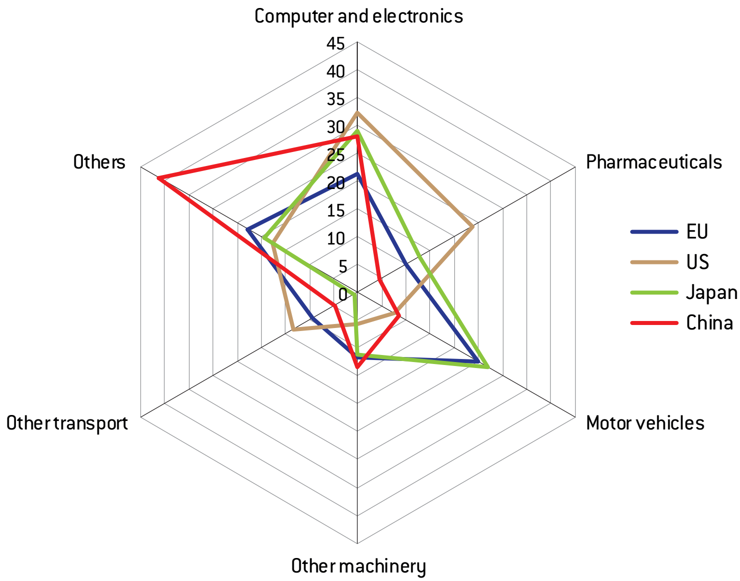
The EU concentrates most of its R&D in the medium-high-tech sectors, which have lower R&D intensity rates (lower part of Table 1).

Automobiles represents about a quarter of EU corporate R&D. In this sector, EU firms are outpacing their US counterparts in terms of R&D intensity, but this sector offers less scope for technological progress compared to high-tech sectors. The same holds for chemicals and industrial machinery. At the higher-tech end of the medium-high tech spectrum sits aerospace and defence. In this sector, EU firms are more R&D-intensive than their US counterparts, and their share of overall EU R&D is higher. In electronic equipment, EU firms are much more R&D-intensive than their US counterparts, but the EU has less weight than the US in this sector.

The services sector with the highest R&D intensity is software. Similarly to the semiconductors sector, EU software firms are as R&D intensive as their US counterparts, but the EU simply does not have enough software companies carrying out R&D activities compared to the US, where the software's share of overall corporate R&D is more than 10 percent, compared to less than 3 percent in the EU. The weak innovation position in this high-tech services sector might jeopardise the EU's potential for innovation-based productivity growth in services sectors.

Figure 18 is based on OECD R&D expenditure data and extends the comparison between the EU, US, Japan and China. It confirms that the US is specialised in high-technology intensive sectors such as computers and electronics and pharmaceuticals, while the EU focuses its manufacturing R&D in the medium-technology intensity sectors, such as motors vehicles. Japan is spread between high and medium-technology intensity sectors. China's profile covers the high-tech computer and electronics sectors and other less R&D-intensive sectors (see the chapter Appendix for a classification of the technology intensity of manufacturing sectors).

Figure 18: Manufacturing sectors' shares of total R&D expenditure, 2013

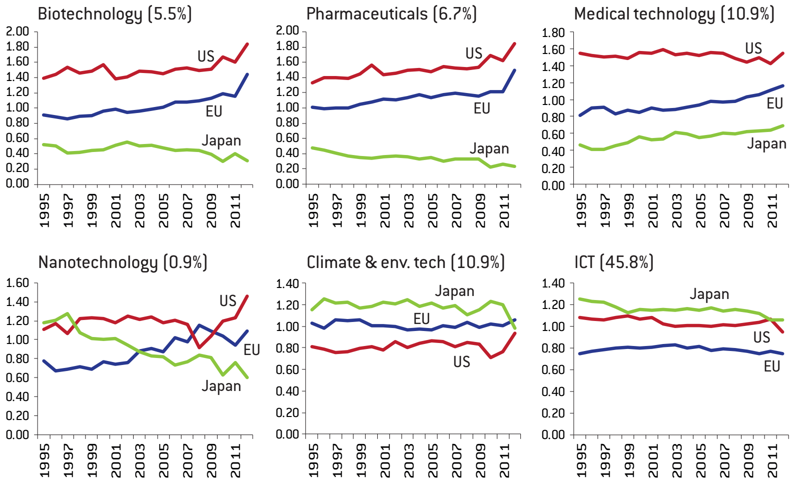


Source: Bruegel based on OECD.

Figure 19 uses patent statistics to look at the position of the EU in key technologies. The six technologies are those identified by the OECD as responsible for most of the growth in patenting: biotechnology, pharmaceuticals, medical technology, nanotechnology, climate and environmental technologies, and ICT. The numbers represent the EU's degree of specialisation in these technologies (as measured by the EU's share of patents in each technology, relative to the EU's share of total patents). Values above 1 mean a specialisation in a technology.

The EU clearly does not specialise in any of these key technologies, and leads in none of them, compared to the US and Japan. The EU is slowly increasing its degree of specialisation in most of the technologies, but not in digital or clean technologies. In clean technology, Japan has a clear specialisation and the US has recently sharpened its focus.

Figure 19: The EU's degree of specialisation in new technologies

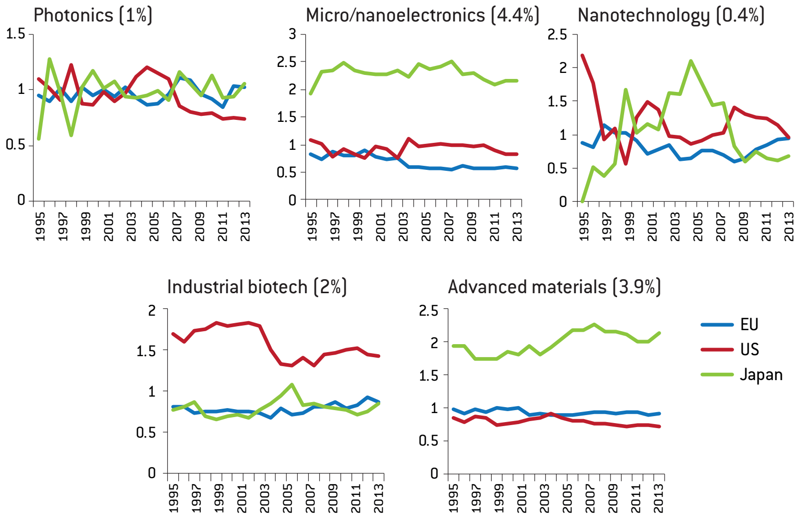


Source: Bruegel based on OECD. Note: Figures in brackets are each technology's share of total patents, 2012.

Europe has identified six key enabling technologies (KETs): micro and nanoelectronics, nanotechnology, industrial biotechnology, advanced materials, photonics and advanced manufacturing technologies. These are technology areas with potential applications in multiple industries and that could help tackle major societal challenges, and in which the EU has the scientific and technological strengths to become a global leader, but risks falling behind in the commercialisation of KET-based goods (European Commission, 2012a). KETs have become a fundamental part of the European Commission's manufacturing revival strategy and money has been earmarked for them under the EU's Horizon 2020 research programme. These KETs also figure prominently in the Industry 4.0 debates in the EU member states (Smit *et al*, 2016).

All the KETs are new and emerging areas, as shown by their small but fast-growing patent numbers. Figure 20 shows the development of patenting of KETs in the EU, the US and Japan in terms of each economy's share of KET patents, relative to its share of total patents. Values above 1 mean a specialisation in a technology. The EU is not specialised and does not have a clear leading position compared to US and Japan in any of the KETs. Japan is a clear innovation leader in micro nanotechnologies and advanced materials, whereas the US specialises in industrial biotechnology.

Figure 20: Patents in key enabling technologies (KETs)



Source: Bruegel based on PATSTAT. Note: Advanced manufacturing technologies are not included because of data limitations. IPC codes and classifications are based on Annex 2 of EC JRC Technical Report (2015). Figures in brackets are each technology's shares of total patents as of 2014.

2.5 Summary of main findings

- The decline of manufacturing value added and employment has been ongoing at least since the 1970s in major advanced countries, making it a long-term structural trend. At best the decline will bottom out, but it is unlikely to be reversed. As such, the European Commission's 20 percent target for manufacturing to contribute to EU GDP by 2020 does not look to be attainable.

- Despite its declining weight in the overall EU economy, manufacturing accounts for two-thirds of total R&D, provides half of productivity growth and represents 63 percent to 65 percent of exports and imports. Therefore, manufacturing will remain a vital sector in the EU for its innovation, productivity and trade potential.

- The importance of European manufacturing in the future and the sector's competitive advantage over major advanced and emerging economies will have to come from improved productivity growth performance. This will require a shift to higher value added activities.

- To boost EU manufacturing, greater capacity for creative destruction and reallocation of resources is needed. What matters in this process is (i) reallocation within manufacturing to sectors, activities and jobs with scope for high value added, and (ii) reallocation to higher value added services activities. Equally important is investing in the services sectors. The non-market services sector, professional and scientific services, information and communication and financial services account for the bulk of the positive contribution to value added growth in the EU, US and Japan. Moreover, non-market services, professional and information and communication services account for a large part of within-EU productivity growth.

- The absolute number of jobs in EU manufacturing has declined. At the same time output per hour and, to a lesser extent, real hourly compensation have increased in more EU countries and in the US. To put it simply, manufacturing is employing fewer workers who generate greater output for higher pay.

- Manufacturing is increasingly demanding higher skills. The skill composition (share of high skilled workers) has been contributing positively to manufacturing productivity growth in major EU economies since the mid-1990s. In this respect, the EU needs policies to ensure that those who are exiting manufacturing have sufficient skills to be able to re-enter the labour force, either by moving to another part of the manufacturing sector, or by entering an altogether different sector such as services. EU policies aimed at retraining, education including lifetime learning and support for entrepreneurial initiatives are crucial.

- When looking at the manufacturing sector's innovation-based higher value added trajectory, the signs are not very promising that this restructuring process is taking place sufficiently dynamically in the EU, compared to the US and, in some instances, Japan.

- The EU has innovation capacity mainly in medium-high technology sectors, particularly motor vehicles, chemicals and industrial technology, whereas the US is a leader in high R&D intensity sectors such as software, biotechnology and computer electronics. In this respect, there is room for the EU to expand its innovation potential by focusing on higher technology-intensive sectors including services sectors.

Appendix

Classification of manufacturing industries by technology intensity based on NACE Rev. 2, 2-digit level

Technology intensity	Manufacturing intensity
High-technology	Manufacture of basic pharmaceutical products and pharmaceutical preparations (21);
	Manufacture of computer, electronic and optical products (26)
Medium-high-technology	Manufacture of chemicals and chemical products (20);
	Manufacture of electrical equipment (27);
	Manufacture of machinery and equipment n.e.c. (28);
	Manufacture of motor vehicles, trailers and semi-trailers (29);
	Manufacture of other transport equipment (30)
Medium-low-technology	Manufacture of coke and refined petroleum products (19);
	Manufacture of rubber and plastic products (22);
	Manufacture of other non-metallic mineral products (23);
	Manufacture of basic metals (24);
	Manufacture of fabricated metal products, except machinery and equipment (25)
	Repair and installation of machinery and equipment (33)
Low-technology	Manufacture of food products (10);
	Manufacture of beverages (11);
	Manufacture of tobacco products (12);
	Manufacture of textiles (13);
	Manufacture of wearing apparel (14);
	Manufacture of leather and related products (15);
	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials (16);
	Manufacture of paper and paper products (17);
	Printing and reproduction of recorded media (18)
	Manufacture of furniture (31);
	Other manufacturing (32)

Source: Eurostat.

References

Cincera, M. and Veugelers, R. (2013) 'Young leading innovators and the EU's R&D intensity gap', *Economics of Innovation and New Technologies* 22(2): 177-198

European Commission (2012a) 'A European Strategy for Key Enabling Technologies — A bridge to growth and jobs', COM (2012) 0341

European Commission (2012b) 'A stronger European industry for growth and economic recovery', COM (2012) 582

Moncada-Paternò-Castello, P. (2016) 'Sector dynamics and demographics of top R&D firms in the global economy (No. 2016-06)', Directorate Growth & Innovation and JRC-Seville, Joint Research Centre

Moran T. and L. Oldensky (2014) 'The US manufacturing base: Four signs of strength', *Policy Brief* 14-18, Peterson Institute for International Economics

Smit, J., Kreutzer, S., Moeller, C., & Carlberg, M. (2016) 'Industry 4.0', Directorate General for Internal Policies, Policy Department A: Economic and Scientific Policy

Veugelers, R., and M. Cincera, M. (2015). 'How to turn on the innovation growth machine in Europe'., *Intereconomics*, 50(1), 4-9

Veugelers, R. (ed) (2013) *Manufacturing Europe's future,* Blueprint 21, Bruegel, available at http://bruegel.org/2013/10/manufacturing-europes-future/.

Vihriälä E. and G. Wolff (2013) 'Manufacturing as a source of growth in Southern Europe: opportunities and obstacles', in Reinhilde Veugelers (ed) *Manufacturing Europe's future*, Blueprint 21, Bruegel

3 The competitiveness of European industry in the digital era

Carlo Altomonte, Filippo Biondi and Valeria Negri[6]

In the current digital era, the competitiveness of European industry is strictly dependent on information and communications technology (ICT) and related investments. The forthcoming 'fourth industrial revolution,' dubbed Industry 4.0, will further heighten the role of ICT in industrial competitiveness. In fact, pervasive use of ICT and the development of so-called 'cyber-physical systems'[7] will help firms expand their product ranges, customise their services and respond better to client demand. Moreover, these developments could help reduce inefficiency in the use of capital and labour, for example by reducing inventories and transaction costs, which could lead to a more efficient matching of supply and demand and enable the growth of new markets. All these effects should lead to higher productivity growth[8].

In this chapter we assess the link between ICT and the competitiveness of EU industry, from macro and micro perspectives. From the

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6 The authors wish to thank Assolombarda Confindustria Milano Monza e Brianza for making their firm-level dataset on the performance of European firms available to us. Any error, opinion and omission in using this data is our sole responsibility.

7 Examples are smart grid, autonomous automobile systems, medical monitoring, process control systems, and robotics systems.

8 Several theories have been proposed to describe the dynamic effects of ICT revolution on competitiveness and to assess possible differences between countries. See in particular Jorgenson, Ho and Stiroh (2002, 2008), Gordon (2000, 2012), van Ark, O'Mahony and Timmer (2008) and Acemoglu *et al* (2014).

macroeconomic point of view, we show how and to what extent ICT has contributed to the value-added and productivity dynamics of the EU manufacturing sector. We then move to firm-level information, exploring in detail the link between the exposure of companies to digitalisation and their productivity, controlling for a number of additional characteristics often related to competitiveness, such as companies' internationalisation and innovation activities. We find that the effects of ICT are on average positive and significant for competitiveness (at the macro level), but that these effects are essentially driven by the most productive companies (the right tail of the productivity distribution at the micro level).

As a result, while ICT and Industry 4.0 are powerful policy tools to foster the competitiveness of EU industry, they are also likely to increase the gap between the most successful companies and those left behind, leading to an increase in territorial and social inequalities, potentially making appropriate accompanying policies necessary.

3.1 The macro view: manufacturing growth and its determinants

Starting with a macroeconomic overview, we use a standard growth accounting approach to assess the main contributions to value added growth in the manufacturing sectors of ten European countries[9]. Growth-accounting exercises typically focus on a given time period and are used to quantify how much of the rate of change in output can be accounted for by the rate of change in different observable inputs, while the residual is interpreted as a measure of the rate of change in Total Factor Productivity (TFP, ie unobservable technology). In this decomposition, the real value added growth of the manufacturing

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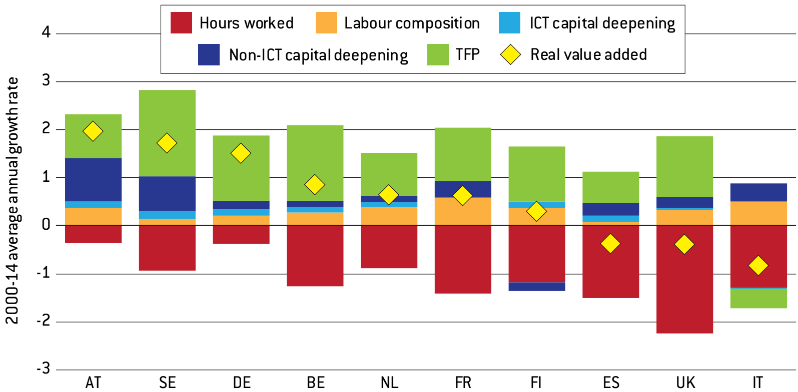
9 In this chapter we rely mainly on the recently updated EU KLEMS Growth and Productivity Accounts, which covers only 10 EU countries for the moment. New releases for all the other EU member states, the US, possibly Japan, and several aggregates are expected to become available in summer 2017. The project has been carried out by The Conference Board, with the financial support of the European Commission under the service contract ECFIN-163-2015/SI2.716986.

sector is broken down into the contributions of TFP growth, of ICT and non-ICT capital, and an hours worked component and a human capital component (based on the skill composition of the workforce).

Figure 1 shows the results of the decomposition of value added growth at constant prices between 2000 and 2014, on averages, for a number of EU countries.

Figure 1: Growth accounting decomposition of manufacturing real value added, 2000-14 averages

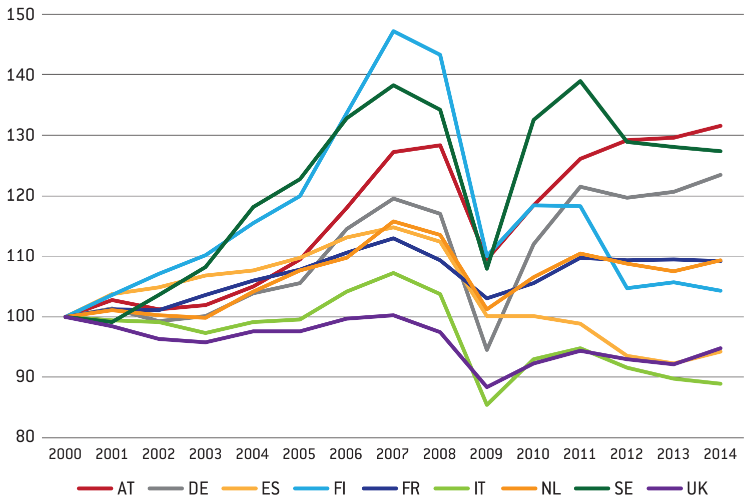


Source: Bruegel based on EU KLEMS Growth and Productivity Accounts, December 2016 revision.

Significant differences between countries clearly emerge from the data: average value added growth in real terms ranges from 2 percent in Austria to -1 percent in Italy. The impact of TFP growth was positive, though highly variable, in every country except Italy. The reduction of hours worked, however, acted as a drag on value added growth in all countries. Interestingly, with the exception of Italy and Finland, this is the only component that depresses average growth. **The contribution of ICT capital deepening is smaller but positive in every country considered, particularly in Sweden and Finland**. Finally, the increased availability to workers of fixed assets, machinery and equipment remains a positive driver, particularly to growth in Austria, Sweden and Italy.

These long-term averages, however, mask a great cyclicality of the value added generated by manufacturing. This was evident in particular during the crisis of 2008-09, as shown by Figure 2, which also shows great variation in the speed of recovery of different countries after the crisis.

Figure 2: Long-term dynamics of manufacturing real value added, 2000=100



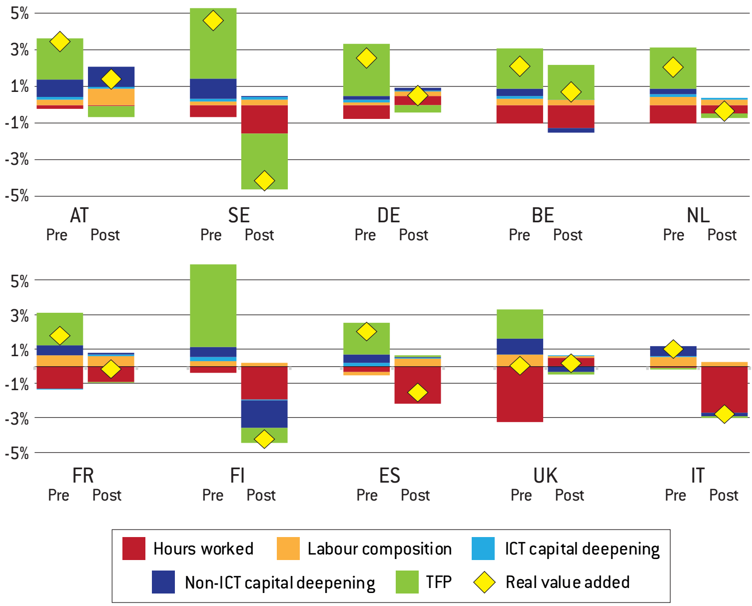
Source: Bruegel based on EU KLEMS Growth and Productivity Accounts, December 2016 revision.

In light of the latter, we replicate the analysis excluding the 2008-10 period. Figure 3 shows average contributions during the pre- and post-crisis periods.

As Figure 3 shows, the **post-crisis period** has been characterised by a general slowdown in the average growth rate of real value added in the manufacturing sector. In most of the countries considered, this has been mainly driven by a **collapse in the contribution of TFP and**

a substantial decrease of non-ICT capital deepening, direct consequences of a drop in corporate investment. Furthermore, in Finland, Spain and Italy, where the depressive effects of the crisis were deeper, a remarkable reduction of hours worked (because of both redundancies and closures of firms) further worsened the situation.

Figure 3: Growth accounting decomposition of manufacturing real value added, excluding crisis period

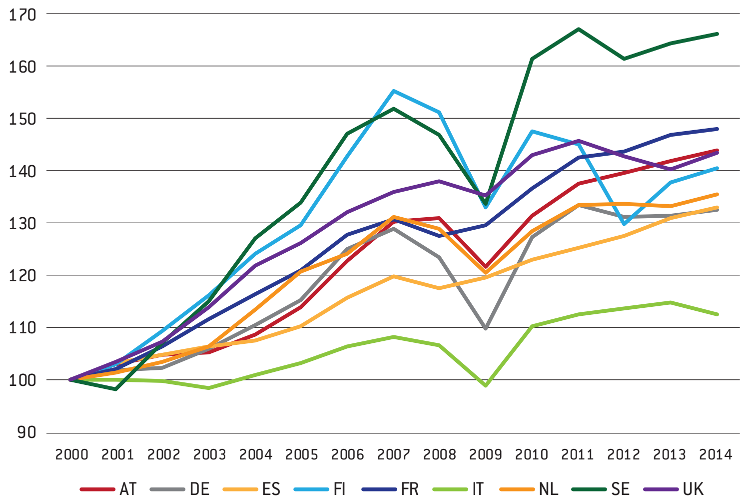


Source: Bruegel based on EU KLEMS Growth and Productivity Accounts, December 2016 revision. Note: * last year of post-crisis period is 2013.

3.2 Manufacturing vs. total economy: the same output with fewer jobs?

The aforementioned trends in value added and hours worked drove, though in opposite directions, the dynamics of labour productivity (Figure 4).

Figure 4: Long-term dynamics of labour productivity in manufacturing, 2000=100



Source: Bruegel based on EU KLEMS Growth and Productivity Accounts, December 2016 revision.

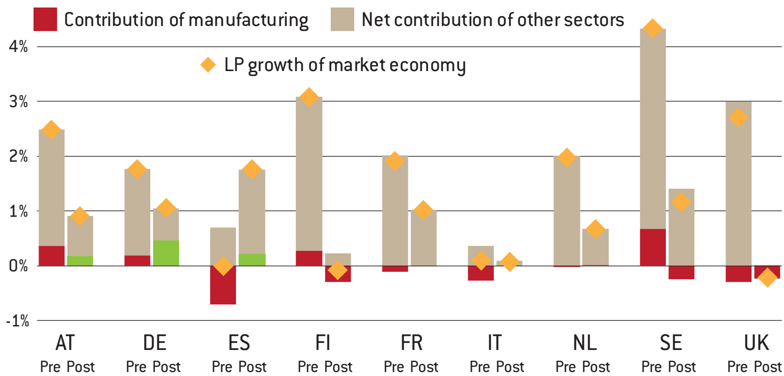
When the trends before and after the crisis are compared, a **slowdown in productivity growth** clearly emerges also for labour productivity. There is certainly a cyclical explanation for that, as similar dynamics were seen after the recession in 2001. In fact, this cyclical slowdown has been mainly **driven by an 'decoupling' of hours worked and production**: the share of hours worked in manufacturing has fallen by between 10 and 30 points in Europe since 2000 and has not recovered (with the only exceptions being Germany and Italy after 2013), while the share of manufacturing output has followed the typical dynamics of the crisis (fall and recovery during 2008-13). These trends in turn led to a cyclical recovery of manufacturing labour productivity.

To build on this evidence, we have estimated the contribution of the manufacturing sector to the growth of labour productivity in the total market economy of each country[10]. Figure 5 shows our estimates, providing a comparison of average contributions before and after the crisis.

Since 2011, the manufacturing sector has positively contributed to the productivity growth of the overall economy only in Austria, Germany and Spain. In France and Italy the manufacturing sector has at least stopped being a drag on productivity growth, while in the other countries the contribution was zero or even turned negative.

The changes in the contribution reflect both the changes in the relative share of hours worked in manufacturing (out of the total market economy hours worked) and the changes in labour productivity in each industry: in general, the **overall contraction of the contribution of manufacturing to the economy can be mainly attributed to the decreasing relevance of manufacturing in terms of hours worked**.

Figure 5: Contribution of manufacturing to labour productivity growth of market economy, average pre- (2001-07) vs. post-crisis (2011-14)



Source: Bruegel based on EU KLEMS Growth and Productivity Accounts, December 2016 revision.

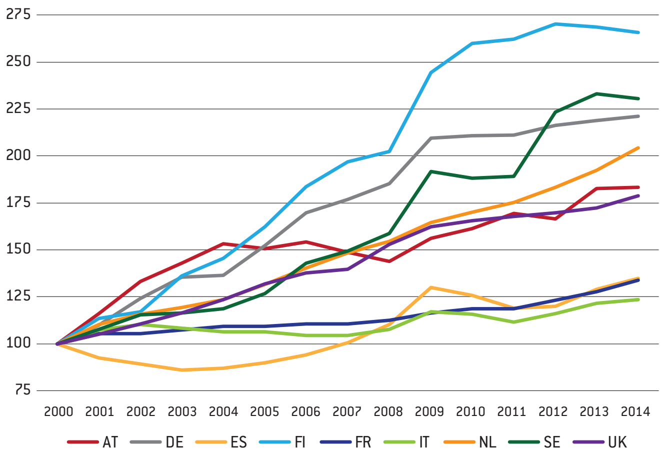
10 In line with the definition of EU KLEMS, the market economy covers all the industries included in the classification NACE Rev.2 with the exception of: real estate activities (cod. L); public administration and defence; compulsory social security (cod. O); education (cod. P); health and social work (cod. Q); activities of households as employers; undifferentiated goods- and services-producing activities of households for own use (cod. T); activities of extraterritorial organizations and bodies (cod. U).

We will now try to understand whether and to what extent the different trends in productivity we have reviewed are related to different degrees of digitalisation of manufacturing production across Europe.

3.3 The role of IT adoption in the manufacturing sector

To provide a macroeconomic overview of digitalisation in manufacturing, we use the estimates of capital stock available in the EU KLEMS database. In particular, we focus on the accumulated amount of computing equipment and computer software and databases. Figure 6 shows how the **IT intensity of manufacturing has evolved differently in different countries over the last fifteen years**.

Figure 6: Real IT capital stock per hour worked in the manufacturing sector, 2000=100



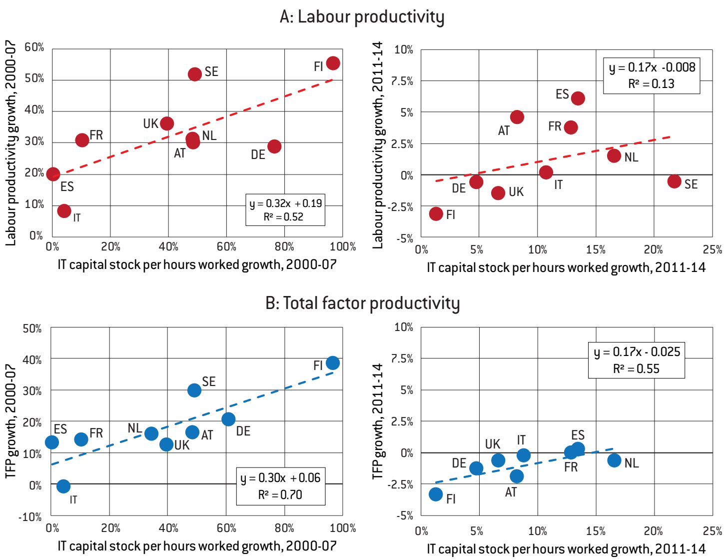
Source: Bruegel based on EU KLEMS Growth and Productivity Accounts, December 2016 revision. Notes: Real fixed capital stock (2010 prices). Belgium is missing because of unavailability of detailed capital input data.

The increasing adoption of information technology in manufacturing has been particularly marked in Finland, Germany and Sweden. Investments in IT capital have been significantly lower in the manufacturing sectors of Spain, Italy and France.

To investigate whether and to what extent these differences in IT capital deepening correlate with productivity performance, we compare the growth rates of the IT capital stock (divided by total hours worked) with productivity dynamics in the manufacturing sector.

Figure 7 shows scatter plots for labour and TFP, before and after the crisis. We find that **greater growth in IT capital stock in a country is associated with better productivity performance**, in terms of both labour productivity and TFP. However, it is worth noting how **the magnitude of this relationship changed after the 2008-09 crisis.** For both labour productivity and TFP, the estimated coefficient is lower in the latter period and the same holds for the R^2, meaning that the relationship between the two variables has been affected by other factors. This is not surprising, given the bumpy recovery of the European economy in the post-crisis period, with a significant contraction in aggregate demand.

Figure 7: Productivity and IT capital stock growth in manufacturing



Source: Bruegel based on EU KLEMS Growth and Productivity Accounts, December 2016 revision. Notes: TFP for Sweden was not available in 2014.

We replicate the analysis for different industries within the same group of countries. To account for industry-specific characteristics, we add to the univariate regressions industry dummies and weights based on the value added share of each industry (out of total manufacturing), in order to adjust for country-specific industrial composition. Table 1 shows the results. **The positive relationship during the pre-crisis period is confirmed also at industry level** (though with a slightly lower coefficient), **while in the more recent years the (decreased) IT adoption rate was not correlated with the slowdown in productivity growth**.

Table 1: Productivity & IT capital stock growth in manufacturing, industry-level correlations

	Pre-crisis period (2000-2007)				Post-crisis period (2011-2014)			
	LP growth		TFP growth		LP growth		TFP growth	
IT capital stock per hours worked growth	0.21***	0.29***	0.11***	0.11***	-0.025	-0.031	-0.02	-0.027
	(0.064)	(0.015)	(0.043)	(0.013)	(0.0617)	(0.019)	(0.0662)	(0.0217)
Constant	0.11	0.07***	0.08	0.06***	-0.008	-0.0007	-0.022	-0.02***
	(0.077)	(0.019)	(0.07)	(0.017)	(0.027)	(0.006)	(0.029)	(0.007)
Observations	88	88	88	88	88	88	80	80
R-squared	0.36	0.54	0.28	0.40	0.31	0.33	0.25	0.24
Value added share weights	No	Yes	No	Yes	No	Yes	No	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1								

Source: Bruegel. Note: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. TFP for Sweden was not available in 2014. Industry C19 (Coke and refined petroleum products) has been excluded.

3.4 From macro to micro: evidence from a new survey of firms' strategies

The mixed results in terms of the correlation between ICT investment and productivity growth in EU manufacturing through the crisis can be explored in more detail by looking at firm-level dynamics. As acknowledged by the OECD (Van Ark, 2005), "*within an industry, some leading firms invest heavily in ICT and organisational change and reap the accompanying productivity gains. But there are also laggards with lower productivity growth. These laggards may have also invested heavily in ICT, but were less successful in realising soft savings. Although in time these laggards are likely to either exit or catch-up with the leaders due to competitive pressures, this inevitably takes time. In the meantime, industry performance will reflect both leading and lagging firm performance*".

The latter aggregation effect could be particularly relevant in the post-crisis context. The weak economic cycle in Europe might in fact increase the delay during which ICT laggards are reaping the benefits of their investment, leading to the non-significant effect of ICT on productivity that we have found in our macro estimates.

In order to shed more light on this issue, we use a new firm-level dataset made available to us by Assolombarda, the largest local branch of the Italian entrepreneurial association (Confindustria). The dataset is a **representative sample of manufacturing firms with more than 10 employees operating in five large European regions**: Lombardy (Italy), Baden-Württemberg and Bavaria (Germany), Catalonia (Spain) and Rhône-Alpes (France) (Box 1).

Box 1: The Assolombarda Benchmark Dataset - 2013

The dataset uses as a methodological benchmark the 2010 EU-funded cross-country survey European firms in a global economy: Internal policies for external competitiveness (EFIGE). The questionnaire sent to firms covers seven different broad areas:

- Firm structure (company ownership, domestic and foreign control, management);
- Workforce (skills, type of contracts, training);
- Investments and related financing;
- Innovation, patent activity and R&D (and related financing);
- Export and internationalisation processes;
- Financial structure and bank-firm relationship;
- Market structure and competition;
- Bureaucracy and administrative context.

As the survey was run in early 2015, information is mostly collected as a cross-section for the last available budgetary year (ie 2013), although some questions cover the period 2011-13 and/or the behaviour of firms in comparison to the pre-crisis period or during the crisis. Data is integrated with balance sheet information from the Orbis database managed by Bureau van Dijk. For 2013, the regional distribution of available firms in the dataset is described in Table A1.

Table A1: Regional distribution of firms in the survey

Region	Number of Firms
Baden-Württemberg	99
Bayern	100
Cataluña	103
Lombardy	241
Rhône-Alpes	101
Total	644

To measure the exposure of firms to ICT, we exploit a question in the survey that asks firms to state if they adopted in 2013 one or more of: internal information management systems (eg ERP), advanced management systems (eg CRM or Groupware), systems for automatic information sharing between customers and suppliers (eg virtual marketplace)[11]. We define a variable digit as a dummy equal to 1 if the firm has a basic level of digitalisation of its management and marketing, ie it adopts at least one of the listed IT technologies.

We also use other control variables known in the literature to be correlated, along with ICT, with the productivity of firms. One of the most important is the internationalisation of a firm's activities – if the firm operates only on the domestic market or if it imports, exports, outsources or invests in a foreign country. The dummy variable *int_active* will detect whether the firm has pursued at least one of the above activities, or, in other words, if it participates in some way in global value chains. Another variable we consider is the firm's innovation status. The dummy *R&D* is set to a value of 1 if a firm performed any R&D activity in 2013. The dummy *fam_mgmt* meanwhile accounts for governance differences between firms: its value is 1 if a firm's board is entirely composed of members of the family that owns the company, thus operating a selection between family-managed/owned firms and others.

Table 2 reports the distribution of these variables in 2013 for each region, size class and industry[12], and for the overall weighted sample[13].

Only a small majority of the firms in our sample (55.9 percent) adopted at least one IT instrument in 2013, a result that suggests that the digital transition is still far from complete. Regarding internationalisation, a large majority (68 percent) of surveyed firms are internationally active, a figure that is likely related to the lower dimensional

11 Enterprise Resource Planning (ERP) is an example of a digital system for the management of internal information: it integrates all the relevant business processes (sales, purchases, accounting, etc) into the same platform. Customer Relationship Management (CRM) and Groupware software are two examples of advanced management tools. Virtual marketplaces are platforms through which digital information is shared between vendors and customers.

12 Industry defined as 4 macro-sector based on Eurostat-NACE Rev. 2 classification of 2-digit manufacturing industries by R&D intensities.

13 The weighting scheme adopted is described in the Appendix.

threshold of our sample (at least 10 employees); however most surveyed firms participate in international activities at the simplest level (only importing or exporting). Finally, most firms did not pursue any R&D activity in 2013, though there is an increasing likelihood of this kind of investment depending on the industry type. The percentage of firms totally managed by family is remarkably high in Lombardy and in the two German regions, consistent with known evidence of the prevalence of family firms in Italy and Germany.

Table 2: Descriptive statistics for selected variables of the survey, by region and size class

Region	Baden-Württemberg	Bavaria	Rhône-Alpes	Catalonia	Lombardy	Total Sample
% of digitalised firms	55.0	50.2	69.9	61.4	52.2	55.9
% of internationally active firms	58.3	56.7	73.2	80.6	72.7	68.2
% of firms performing R&D	40.2	39.2	53.7	28.4	39.9	39.7
% of family managed firms	47.5	45.8	19.2	41.3	63.5	49.2

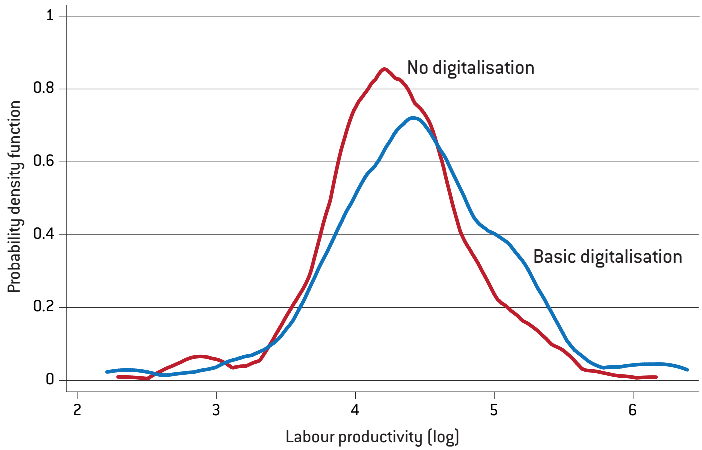
Class-size	Number of employees			
	10-49	50-249	250+	Total
% of digitalised firms	51.2	77	96.2	55.9
% of internationally active firms	65.1	84.9	98.1	68.2
% of firms performing R&D	35.9	59.4	76.5	39.6
% of family managed firms	53.5	20.1	1.4	49.2

Industry-type	Low technology	Medium-low technology	Medium-high technology	High technology	Total
% of digitalised firms	44.9	59.8	65.3	86.1	55.9
% of internationally active firms	61.2	67.5	80.9	86.1	68.2
% of firms performing R&D	34.9	35.3	54.8	56.6	39.6
% of family managed firms	55.9	47.6	43.1	15.2	49.2

Source: Bruegel based on Assolombarda Benchmark data.

Distinguishing by size class, it is not surprising to see that the percentage of firms pursuing digitalisation, performing R&D and being internationally active increases with size, while the share of firms with family management is lower for larger firms. Figure 8 shows the distribution of firm labour productivity in our sample (computed as the value added of each firm divided by the number of employees) relative to the digitalisation variable.

Figure 8: Distribution of labour productivity in 2013, by degree of firm digitalisation



Source: Bruegel based on Assolombarda Benchmark data.

This preliminary evidence confirms the idea that the **overall productivity distribution of firms that adopt at least one ICT tool dominates that of firms not using ICT**. This is confirmed also by running a Kolmogorov-Smirnov test for equality of distribution functions (results reported in the chapter Appendix). Controlling for different levels of ICT adoption (ie one, two or three of the IT tools covered by the survey) we obtain the results summarised in Table 3.

Table 3: Log of labour productivity by number of ICT instruments adopted

	No digitalisation	1 ICT instrument	2 or 3 ICT instruments
Median	4.22	4.39	4.54
Top 25% of firms	4.56	4.70	5.03
Std. Deviation	0.61	0.64	0.64
Observations	247	237	128

Source: Bruegel based on Assolombarda Benchmark data.

Not surprisingly the median productivity of firms grows in line with the number of ICT tools adopted, with a 4 percent productivity increase when adding one ICT tool, and a further increase of 2 percent when moving from one to two or more ICT tools. Firm-level data also makes it possible to look at these effects for the top 25 percent of firms in the productivity distribution. For the top firms, the adoption of one ICT instrument generates a 3 percent gain in productivity compared to the digitally non-active firms. Interestingly, for those 'top' firms, adding a second (or more) ICT tool is associated with an 8 percent increase in productivity compared to those firms that use just one digital tool. This is consistent with the intuition put forward by Van Ark (2005) and more recently by Andrews *et al* (2015), who, also using firm-level data, found an uneven process of technological diffusion in which global frontier technologies only diffuse to laggards once they are adapted to country-specific circumstances by the most productive (leading) firms.

To go beyond simple unconditional correlations, ie assessing whether and to what extent the positive relationship between digitalisation and labour productivity robustly holds at different parts of the firm level distribution, we have run different estimations, adding different controls at every step (Box 2).

Box 2: Econometric approach

The general framework is the following:

$$Labour\ Prod = digit \times \beta_1 + \boldsymbol{X} \times \beta'\ [FE]$$

The first specification (1) regresses the labour productivity on the three main dummy variables we analysed in the descriptive statistics part. Controlling for R&D and international activities is coherent with theory and previous researches: internationalisation was found to be positively correlated with labour productivity and even with digitalisation level via OLS regression. Similarly, activities in R&D could be seen as connected to a higher productivity firm. Thus, controlling for these two variables helps us to isolate the effect of digitalisation on productivity.

In the second specification (2), we add as a control the variable fam_mgmt, which describes if a firm's board is family-based. Adding this control operates a selection within our sample, investigating only family-owned firms. Family-managed firms are known to display on average lower levels of productivity as well as lower levels of ICT adoption (see Altomonte et al, 2012).

In all the regressions, we control for regional, sectoral and firm-size fixed effects. To investigate heterogeneous effects beyond the average, and thus exploring the different (if any) behaviour of leading compared to laggard firms, we exploit a simultaneous-quantile regression (considering the 20th, 40th, 60th and 80th percentiles of the productivity distribution).

Table 4 shows the results for the two specifications, for the quantiles of the productivity distribution. Table 4 also shows the average result for the whole sample.

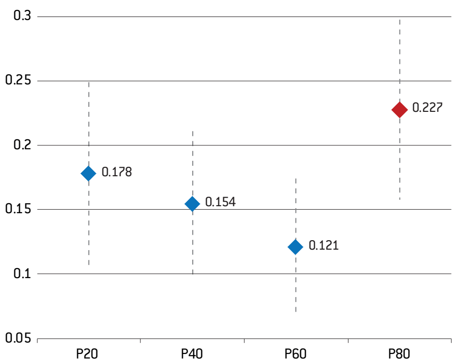
Table 4: ICT and productivity, quantiles and average effect – productivity levels

	Bottom 20%	Bottom 40%	Top 40%	Top 20%	Average
Specification (1)	0.18***	0.15***	0.12**	0.23***	0.16***
Specification (2)	0.15**	0.17***	0.16**	0.25***	0.18***

Note: * Significant at 10%. ** Significant at 5%. *** Significant at 1%. The table reports the coefficient of the digit variable in a quantile regression for the different percentiles, and a standard OLS specification for average effect. Specification (1) controls for internationalisation and R&D activities of firms. Specification (2) replicates specification (1) on family firms also controlling for a governance model carried out through family management. All regressions include regional, sectoral and firm-size fixed effects.

We found that **on average**, **digitalisation** (in the sense of adopting at least one of the three ICT tools) **is associated with higher productivity levels of firms** ranging, on average, from 16 percent to 18 percent depending on the underlying specification. The coefficient on *digit* is always positive and significant also for the entire productivity distribution. Consistent with our initial assumption, results show in particular that **when ICT is adopted by the top 20 percent most productive firms, it is associated with even higher productivity levels**. It is easy to visually gauge the differences between quintiles by plotting as an example the coefficient results for the first specification (Figure 9).

Figure 9: Estimated coefficient and 95% confidence intervals, first specification



Source: Bruegel.

In order to better link our firm-level analysis to the aggregate evidence we have reported, we computed the post-crisis growth rate of labour productivity of firms (2010-13), and used it as a dependent variable in a similar regression exercise. Table 5 summarises the coefficient results for the two specifications.

Overall, the result is positive and significant only for the last quantile, thus confirming the hypothesis that **only leading firms are able to gain from ICT adoption**. There, the gain over three-year growth from digitalisation ranges from 8 percent to 11 percent, depending on the specification. Interestingly, when we include in the sample only family-managed firms (specification 2), the gap between leaders and laggards is even larger.

Table 5: ICT and productivity, quantiles and average effect – productivity growth

	Bottom 20%	Bottom 40%	Top 40%	Top 20%	Average
Specification (1)	0.002	0.023	0.015	0.082*	0.008
Specification (2)	0.051	0.057	0.041	0.114**	0.056

Note: * Significant at 10%. ** Significant at 5%. *** Significant at 1%. The table reports the coefficient of the digit variable in a quantile regression for the different percentiles, and a standard OLS specification for average effect. Specification (1) controls for internationalisation and R&D activities of firms. Specification (2) replicates specification (1) on family firms also controlling for a governance model carried out through family management. All regressions include regional, sectoral and firm-size fixed effects.

3.5 Conclusion

We have assessed the link between ICT and the competitiveness of EU industry, from both a macro and a micro perspective. From the macroeconomic point of view, we have shown how and to what extent ICT has contributed to the value-added and productivity dynamics of the EU manufacturing sector. The productivity of manufacturing has substantially recovered in Europe, but its contribution to overall productivity is small because the manufacturing sector is losing ground in terms of share of hours worked throughout the EU.

When looking at these dynamics from the perspective of firms, we find that the effects of ICT are on average positive and significant for productivity, but that these are essentially driven by the most productive companies (the right tail of the productivity distribution at the micro level). This is in particular the case if we concentrate our analysis on productivity growth, and especially for firms that have family-based governance.

McKinsey (2016) estimates the EU to be operating at 12 percent of its digital potential, with huge differences within sectors and countries, and some evidence of the early impact of digitalisation, with a correlation in all sectors between productivity growth and digital intensity. Our analyses at the macro level are consistent with these findings.

While **ICT and Industry 4.0 are powerful policy tools to foster the competitiveness of EU industry** (the EU Digital Single Market is estimated to add €375 to €415 billion each year to the EU GDP), our analysis at the firm-level shows that these effects are **also likely to increase the gap between the most successful companies and those 'left behind'**.

This raises a key policy issue: as estimated by McKinsey (2016), Europe could add €2.5 trillion to GDP in 2025 if laggard sectors were to double their digital intensity, thus boosting GDP growth by 1 percent per year over the next decade. Failing to do so would represent a missed opportunity and, in light of our results, might also lead to an increase in territorial and social inequalities.

Appendix

We report the complete estimation results for the different specifications referred to in the text.

Table 5: First specification on productivity levels

$$\ln\,(Labour\ Prod) = digit \times \beta_1 + rd \times \beta_2 + intActive \times \beta_3\ [FE]$$

	ln_lp	ln_lp	ln_lp	ln_lp	ln_lp
Quantile	P20	P40	P60	P80	linear
digit	0.178***	0.154***	0.121**	0.227***	0.161***
	0.066	0.054	0.052	0.068	0.052
rd	0.039	0.018	0.121**	0.101	0.062
	0.063	0.052	0.062	0.070	0.052
int_active	0.224***	0.146**	0.103	0.222**	0.183**
	0.078	0.063	0.065	0.089	0.059
Region FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Size class FE	Yes	Yes	Yes	Yes	Yes
Constant	3.983***	4.306***	4.513***	4.771***	4.454***
Observations	618	618	618	618	612
Pseudo R2	0.1087	0.1041	0.0904	0.1065	0.1399

* Significant at 10%. ** Significant at 5%. *** Significant at 1%

Table 6: Second specification on productivity levels

$$\ln\,(Labour\ Prod) = digit \times \beta_1 + rd \times \beta_2 + intActive \times \beta_3 + famMgmt \times \beta_4\ [FE]$$

	ln_lp	ln_lp	ln_lp	ln_lp	ln_lp
Quantile	P20	P40	P60	P80	linear
digit	0.152**	0.177***	0.162**	0.251***	0.176***
	0.068	0.061	0.069	0.078	0.059
rd	-0.024	0.028	0.056	0.018	0.011
	0.068	0.066	0.075	0.089	0.061
int_active	0.228***	0.142*	0.147*	0.157	0.159**
	0.079	0.077	0.081	0.104	0.069
Fam_mgmt	-0.191**	-0.118*	-0.116*	-0.132	-0.162***
	0.082	0.061	0.066	0.092	0.059
Region FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Size class FE	Yes	Yes	Yes	Yes	Yes
Constant	4.166***	4.457***	4.472***	4.863***	4.492
Observations	488	488	488	488	488
Pseudo R2	0.1282	0.1157	0.1005	0.1224	0.5867

* Significant at 10%. ** Significant at 5%. *** Significant at 1%

Table 7: First specification on productivity growth

$$lp\_3\_year\_growth = digit \times \beta_1 + rd \times \beta_2 + intActive \times \beta_3\ [FE]$$

	growth_ lp_3	growth_ lp_3	growth_ lp_3	growth_ lp_3	growth_ lp_3
Quantile	P20	P40	P60	P80	linear
digit	0.002	0.023	0.015	0.082*	0.008
	0.045	0.036	0.024	0.045	0.033
rd	-0.034	0.021	0.005	-0.039	-0.025
	0.043	0.033	0.028	0.038	0.032
int_active	0.019	-0.034	0.045	0.036	0.027
	0.049	0.040	0.031	0.056	0.038
Region FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Size class FE	Yes	Yes	Yes	Yes	Yes
Constant	-0.174	-0.019	0.073	0.239*	0.076
Observations	604	604	604	604	604
Pseudo R^2	0.0218	0.0134	0.0302	0.0351	0.0273

* Significant at 10%. ** Significant at 5%. *** Significant at 1%

Table 8: Second specification on productivity growth

$$lp\_3\_year\_growth = digit \times \beta_1 + rd \times \beta_2 + intActive \times \beta_3 + famMgmt \times \beta_4\ [FE]$$

	growth_ lp_3	growth_ lp_3	growth_ lp_3	growth_ lp_3	growth_ lp_3
Quantile	P20	P40	P60	P80	linear
digit	0.051	0.057	0.041	0.114**	0.056
	0.051	0.038	0.029	0.047	0.037
rd	-0.067	0.006	-0.005	-0.058	-0.032
	0.051	0.041	0.032	0.045	0.037
int_active	-0.032	-0.031	0.039	0.017	0.038
	0.065	0.042	0.031	0.061	0.044
fam_mgmt	-0.049	-0.021	0.012	0.034	0.0046
	0.062	0.036	0.029	0.049	0.039
Region FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Size class FE	Yes	Yes	Yes	Yes	Yes
Constant	-0.249*	-0.003	0.024	0.244	0.022
Observations	474	474	474	474	474
Pseudo R2	0.0232	0.0131	0.0325	0.0498	0.0264

* Significant at 10%. ** Significant at 5%. *** Significant at 1%

Weighting scheme

Absolute weights have been constructed, splitting the sample into 72 cells by 2 digit NACE Rev. 2 manufacturing industries and the three size classes on which the stratification has been carried out. First, from Eurostat Structural Business Statistics (year 2010), we computed the composition of each region's economic activity by industry and firm size class (ie the population distribution). Second, we repeated the same exercise using the data effectively collected (ie the sample distribution). Then, for each region, the absolute weight for firms in industry *k* and size class *j* was built as follows:

(A1)

$$aw_{kj} = \frac{Pfirms_{kj}/Pfirms}{Sfirms_{kj}/Sfirms}\left(\frac{Pfirms}{Sfirms}\right)$$

where *Pfirms*$_{kj}$ is the number of firms in industry *k* and size class *j* for the population in a given region; *Sfirms*$_{kj}$ is the number of firms in industry *k* and size class *j* in the sample; *Pfirms* and *Sfirms* are the total number of firms in the population and in the sample, respectively. By construction, firms belonging to the same sampling interval (ie to the same combination industry/size classes) share the same weight. The sum of weights over the firms is equal to the total number of firms in the sample by region.

Results of Kolmogorov-Smirnov tests for equality of two distribution functions

We ran a two-sample Kolmogorov-Smirnov test to verify the statistical significance of the differences between the labour productivity distribution functions of firms with 'no-digitalisation', '1 ICT tool' and '2 or 3 ICT tools'.

Smaller Group	Diff	p-value	Exact
A (ie non-digitalised)	0.1638	0.001	
B (ie 1 ICT tool)	-0.0108	0.972	
Combined K-S	0.1638	0.003	0.002

Smaller Group	Diff	p-value	Exact
A (ie 1 ICT tool)	0.1388	0.039	
B (ie 2-3 ICT tools)	-0.0308	0.852	
Combined K-S	0.1388	0.078	0.070

Note: Diff is the measure of the discrepancy between the two empirical distribution functions of the two groups. The first line tests the hypothesis that labour productivity distribution for group A contains smaller values than for group B. Conversely, the second line tests the hypothesis that labour productivity distribution for group A contains larger values than for group B. The null hypothesis for the final line is that the distributions are equal. From the results of the tests, we can clearly reject the hypothesis that the two distributions are equal to each other in both cases.

References

Acemoglu, D., D. Dorn, G.H. Hanson and B. Price (2014) 'Return of the Solow paradox? IT, productivity, and employment in US manufacturing,' *The American Economic Review*, 104(5): 394-399

Altomonte, C., T. Aquilante and G.I. Ottaviano (2012) *The triggers of competitiveness: the EFIGE cross-country report,* Blueprint 17, Bruegel

Andrews, D., C. Criscuolo and P. Gal (2015) 'Frontier Firms, Technology Diffusion and Public Policy: Micro Evidence from OECD Countries,' *OECD Productivity Working Papers 2*, OECD Publishing

Gordon, R. J. (2000) 'Interpreting the "One Big Wave" in US long-term productivity growth,' in van Ark, B., S. Kuipers and G. Kuper (eds) *Productivity, Technology, and Economic Growth*, Kluwer Publishers, Boston

Gordon, R. J. (2012) 'Is US economic growth over? Faltering innovation confronts the six headwinds,' *NBER Working Paper* No. 18315, National Bureau of Economic Research

Jäger, K. (2016) 'EU KLEMS Growth and Productivity Accounts 2016 release – Description of Methodology and General Notes,' available at http://www.euklems.net/

Jorgenson, D.W., M.S. Ho and K.J. Stiroh (2002) 'Information technology, education, and the sources of economic growth across US industries,' mimeo

Jorgenson, D.W., M.S. Ho and K.J. Stiroh (2008) 'A retrospective look at the US productivity growth resurgence,' *The Journal of Economic Perspectives*, 22(1): 3-24

McKinsey & Company (2016) *Digital Europe: Pushing the Frontier, Capturing the Benefits*, McKinsey Global Institute

Van Ark, B. (2005) 'Towards an Integrated System of Growth, Productivity and National Accounts for the European Union,' OECD Workshop on Productivity Measurement

Van Ark, B., M. O'Mahony and M. Timmer (2008) 'The productivity gap between Europe and the United States: trends and causes,' *The Journal of Economic Perspectives*, 22(1), 25-44

4 Firm growth dynamics and productivity in Europe

Albert Bravo-Biosca[14]

4.1 Introduction

Creative destruction is one of the driving forces of economic growth. But despite the importance of firm growth dynamics in this process, limited data is available to compare firm growth dynamics in different countries. This chapter summarises the results of a multi-country data collection initiative led by FORA and Nesta that aimed to fill this gap. We collected harmonised micro aggregated data from official business registers, which provide quasi-universal coverage of business activity in all economic sectors, and developed a new database of firm growth distributions for 12 countries, including the United States and several small and large European economies. Based on this, we discuss a series of stylised facts, identify differences in firm growth dynamics

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14 This chapter builds on a longer working paper published by Nesta (Bravo-Biosca, 2016) available at: www.nesta.org.uk/wp16-03. The data in this chapter was collected as a part of a joint Nesta-FORA project in collaboration with Henrik Lynge Hansen, Glenda Napier and Ditte Petersen, and with support from the International Consortium for Entrepreneurship (ICE). This initiative would not have been possible without the generous collaboration of many researchers and statistical agencies in the participating countries that provided the data underlying this database. For this I would like to thank Werner Hölzl (Austria), Sonja Djukic, Chris Johnston and Chris Parsley (Canada), Henrik Lynge Hansen (Denmark), Henri Kahonen, Petri Rouvinen and Mika Pajarinen (Finland), Stavroula Maroulaki and Theano Tyfoxylou (Greece), Patrizia Cella and Caterina Viviano (Italy), Rico Konen (Netherlands), Geoff Mead (New Zealand), Svein Myro and Christian L. Wold Eide (Norway), Valentín Llorente Garcia (Spain), David Brown, Ronald Davis and Javier Miranda (US) and, last but not least Michael Anyadike-Danes and Mark Hart (UK).

in different countries (particularly between Europe and the US) and examine the effect of firm growth dynamics on productivity growth.

Differences between countries in firm growth dynamics have attracted much interest, particularly of policymakers. However, most cross-country research has focused on firm entry and exit rather than firm growth because of data constraints. Bartelsman *et al* (2004) concluded that entry and exit rates in developed countries are fairly similar, but that there are substantial differences between the US and Europe in the growth rates of surviving new entrants. European countries have fewer high-growth firms than the US (OECD, 2008). And, while the US and Europe have similar numbers of companies in the ranking of the world's 500 largest companies by market capitalisation, only three of the European companies on the list were founded after 1975, in sharp contrast to 25 in the US (Véron, 2008).

We expand on this work by examining the full distribution of firm growth across countries. In other words, we do not just look at the 'average firm' or at a subset of firms, whether the youngest, the largest, or the fastest growing, but provide a complete picture of how firms expand and shrink in each economy, using comparable data extracted on the basis of the same methodology and definitions, in partnership with national statistical offices or local researchers. We identify sizeable differences, with US firms growing and shrinking much faster than European firms, which are much more likely to remain stable across sectors and sizes.

Firm growth dynamics can help explain differences between countries in aggregate productivity growth, such as the widening productivity gap between Europe and the US over the last two decades (Ark *et al*, 2008). The reallocation of output and labour towards more productive plants accounts for about half of total factor productivity growth in US manufacturing (Baily *et al*, 1992; Haltiwanger, 1997). A more dynamic growth distribution implies faster resource reallocation, and is also a signal of greater competitive pressure, which force firms to improve their performance and raise within-firm productivity growth

(Bartelsman *et al*, 2004). We test whether country-industry pairs with fewer static firms are associated with faster productivity growth and find this to be case. Larger shares of growing and shrinking firms are both associated with faster labour and total factor productivity growth.

Schumpeterian growth models also predict that experimentation and selection become more important as industries converge to the global technology frontier (Acemoglu *et al*, 2006). While firms that are far from the frontier can improve their productivity by imitating what others have already invented, at the frontier they need to innovate. But innovation is risky and the outcome uncertain, so only the successful few expand while the unsuccessful shrink. Our findings support this hypothesis. A very static business growth distribution has a particularly strong negative effect on productivity growth, the closer industries are to the global technology frontier.

4.2 The database

We measured the distribution of firm growth using confidential microdata extracted from official business registers in 12 countries: Austria[15], Canada[16], Denmark, Finland, Greece, Italy, the Netherlands, New Zealand, Norway, Spain, the UK[17] and the US.

Business registers are assembled from data collected from social security records, tax records, censuses and/or other administrative

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15 The data for Austria is extracted from social security records, in which the administrative unit can be both the establishment and the firm (the firm chooses how to report), so while it is the most internationally comparable source of data available, there are some limitations in its comparability.

16 Canada only provided data for firms with 10-250 employees, so any aggregate indicator referring to firms with ten or more employees only includes data for the 10-250 size class for Canada.

17 This work ccontains ONS statistical data, which is Crown copyright and reproduced with the permission of the controller of HMSO and the Queen's Printer for Scotland. The use of the ONS statistical data in this work does not imply the endorsement of the ONS in relation to the interpretation or analysis of the statistical data. This work uses research datasets which may not exactly reproduce National Statistics aggregates.

sources[18]. Thus, they provide the most comprehensive coverage of economic activity in any country, covering the universe of firms (in contrast to commercial providers, whose coverage of business activity is limited and differs in different countries). However, access to the data is very restricted, so we followed the approach of other researchers (Bartelsman *et al*, 2004; Brandt, 2004; OECD, 2008) and partnered with each country's national statistical office or, alternatively, with researchers based there with permission to access to the microdata. We provided them with a methodology manual and a code file to extract data, building whenever feasible on the Eurostat-OECD *Business Demography Manual* (2007), which most business registers are required to follow. The datasets submitted were then scrutinised to identify potential inconsistencies and, if necessary, subjected to a process of revision with each country partner.

We collected data on employment growth between 2002 and 2005. In addition, whenever feasible, we also collected data for other three-year periods (2004-07 or 2005-08), for longer time periods (5-year growth or longer) and for turnover growth. The population of firms consists of all active employer enterprises (with at least one employee) in the private sector (ISIC sector 10_74) that survived during the measurement period. In addition to non-survivors, enterprises born in the initial year were also excluded from the analysis. The overall number of firms in the participating countries that satisfy these criteria is six million, employing over 120 million people in 2002.

For each firm we computed the average annualised growth rate and placed the firm into one of 11 growth categories[19]. The data was then col-

18 See Bravo-Biosca (2016) for a detailed description of the database and the data sources for each country, as well as coverage, exclusions and limitations. The paper also includes a separate appendix available online with additional information on the database, and extensive supplementary tables and figures, which provide data for all the indicators discussed here (and others) at a more disaggregated level.

19 Specifically, $growth_{j,t,t\text{-}3} = [(employees_{j,t}/employees_{j,t\text{-}3})^{1/3}\text{-}1] \times 100$. The 11 growth intervals considered are:]-∞;-20[, [-20;-15[, [-15;-10[, [-10;-5[, [-5;-1[, [-1;1[, [1;5[, [5;10[, [10;15[, [15;20[and [20; ∞[.

lapsed into 11 cells that summarise the growth distribution, containing the number of firms for which the growth rate falls within the interval. In addition, for each cell, the initial and final number of employees (and turnover, whenever feasible) were also computed. Overall statistics on the number of employer-firms surviving from time t-i to t relative to the total number of employer-firms at time t-i were also produced.

Growth distributions were constructed at the aggregate country level and also broken down for up to 51 sectors, 10 size classes and 10 age intervals. Any cell containing a number of firms below the confidentiality threshold established by each national statistical office was blanked out and codified as missing to avoid the release of legally-protected confidential information.

While business registers provide some of the most accurate firm-level data available, there are also limitations to the data collected. In particular, our measures of firm growth are substantially more accurate than the data on job creation. Therefore, we focus most of the discussion here on the dynamics of firm growth and how this impacts productivity, rather than delving into issues of job creation[20].

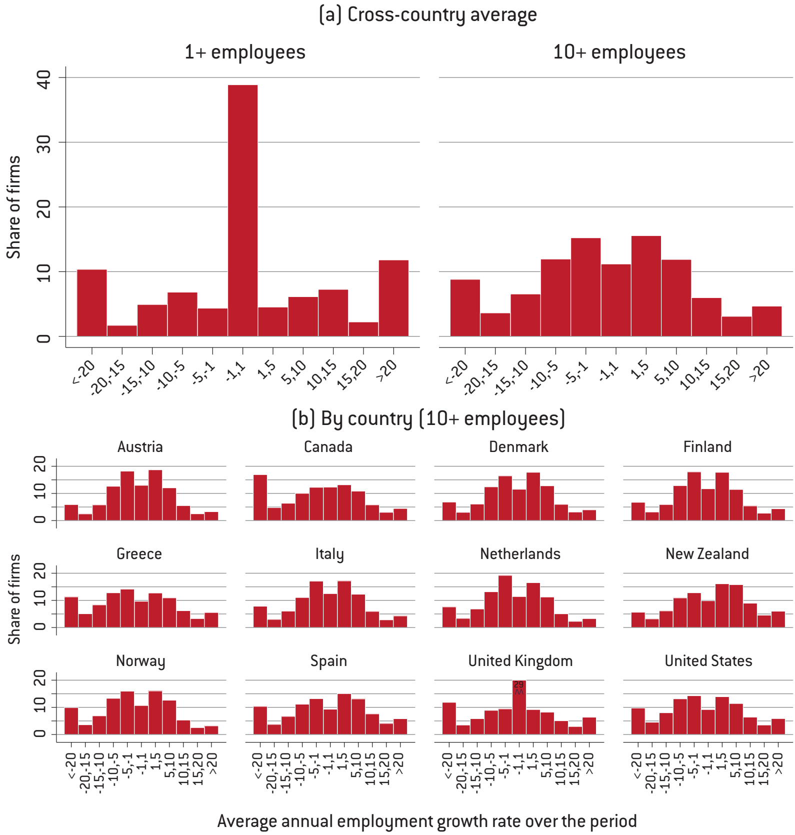
4.3 Some stylised facts about firm growth dynamics

Figure 1 shows the distribution of firm growth across different size classes and countries[21]. Each column indicates the share of firms with average annual employment growth rates over a three-year period falling within that growth interval (with the range covering 11 intervals from less than -20 percent to more than +20 percent employment growth per annum).

20 Anyadike-Danes *et al* (2015) and Calvino, Criscuolo, & Menon (2015) provide a more thorough answer to the question of who creates jobs.

21 For brevity, the figures in this section focus on the cross-country average and present only the data collected for the first period (2002-05). In order to avoid the cross-country average being driven by extreme values, the highest/lowest values are replaced by the second highest/lowest values when computing the average.

Figure 1: Distribution of firm growth - shares



The growth distribution looks very similar in all the covered countries, with the exception of the UK (Figure 1.b)[22]. Extreme bursts of growth or decline occur quite regularly. This high level of growth and contraction leads to very high job reallocation rates across surviving incumbents,

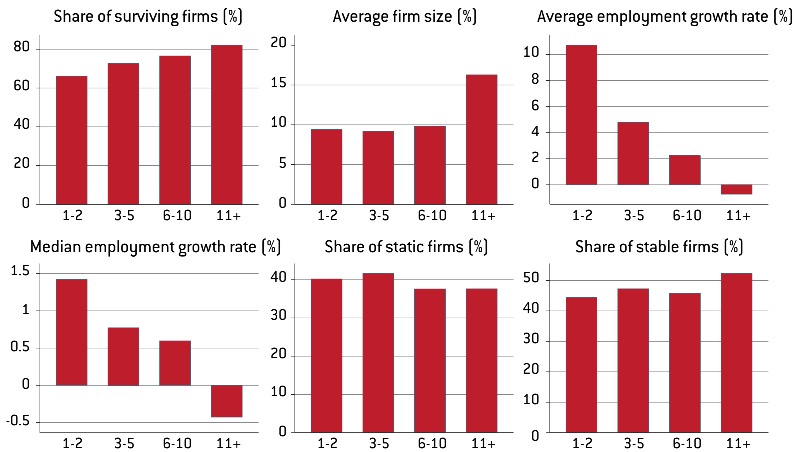
22 We follow the ECB's recent practice of generally referring to the new bank supervisory policy framework in the euro area as 'European banking supervision,' and to its own supervisory arm as 'ECB banking supervision': see ECB (2016a), page 4, footnote 1.

with the share of jobs created or destroyed by incumbents over a three-year period around 30 percent on average.

The top panel in Figure 2 shows the up-or-out dynamic already documented in the literature (for example Haltiwanger *et al*, 2010). Young firms have lower survival rates than more mature firms. But conditional on survival, they experience higher growth on average. This up-or-out dynamic is particularly strong for very young firms (1-2 years). They are 25 percent more likely to exit than the average firm, but conditional on surviving, they grow 3.5 times faster.

However, the up-or-out pattern is much less evident when looking at the full growth rather than only averages. The last two plots in Figure 2 show that there is a large share of firms which neither expand nor contract over a three-year period. Whether young or old, about 40 percent of surviving firms are static, with an average annual employment growth rate between -1 and 1 percent.

Figure 2: Firm dynamics by age (1+ employees)



Bravo-Biosca (2016) presents several other stylised facts that emerge from the analysis of the database, so we only highlight another one here: the concentration of job creation and destruction in a minority of firms. Most firms experience small changes in employment, so aggregate employment growth is disproportionally driven by large employment changes in a small number of firms. Firms in the top growth interval, which corresponds to the share of high-growth firms according to the OECD definition[23], only represent 4.5 percent of surviving firms with 10 or more employees, yet they account for about 40 percent of all jobs created by all firms with ten or more employees (even if there are some important differences between countries). Job destruction is also concentrated. Less than 10 percent of firms decline by more than 20 percent a year on average over the period, yet they account for 45 percent of jobs lost by surviving firms with 10 or more employees.

4.4 Firm growth dynamics: differences between countries

Next we briefly consider some of the differences in firm dynamics that emerge in different countries. Differences are substantial for several of the metrics. Figure 3 summarises the full growth distribution for the US and the average for the European countries included in the sample. Each bar in the lower panel indicates how much higher/lower in percentage terms the share of firms with a growth rate falling within that interval is, relative to the US. European countries have on average larger shares of static firms and lower shares of both growing and shrinking firms. In other words, the US displays a more dynamic firm growth distribution than the average European country included in the sample.

23 The OECD and Eurostat define high-growth firms as all enterprises with 10 or more employees at the beginning of the observation period with average annualised growth in employment (or turnover) greater than 20 percent over a three-year period. See Bravo-Biosca (2011) for additional evidence on high-growth firms using this database.

Figure 3: Europe vs. US firm growth distribution (10+ employees)

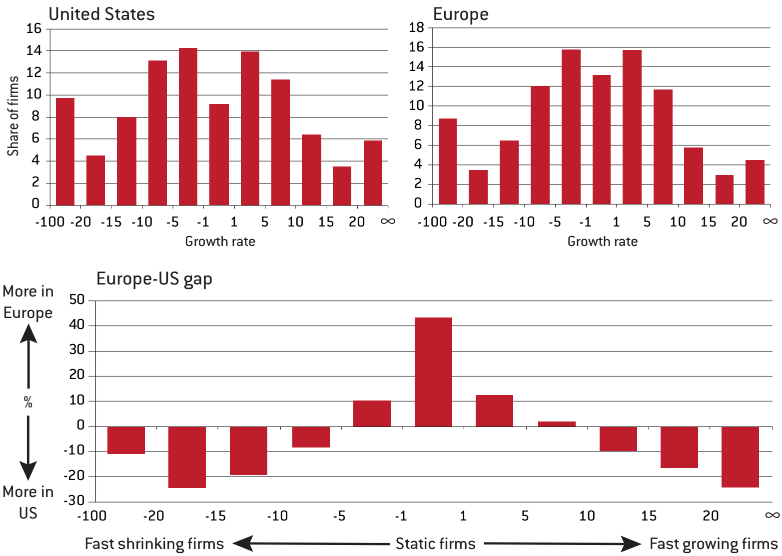


Figure 4 plots the growth distribution relative to the US by country. The same pattern emerges: firms in the US grow and shrink more rapidly than in European countries, which have a much larger share for which employment does not vary much (up or down). This pattern holds for a majority of countries, sectors and sizes classes. A similar pattern emerges when comparing the growth distribution for young firms in the US and in the European countries for which we have data.

Figure 5 considers two other metrics that also capture the differences between countries in business dynamism. The left panel shows excess job reallocation for all firms with one or more employees, which (partially) controls for business cycles effects by taking out job churn that results from economy-wide net employment changes. This is higher in the US than in all continental Europe countries, with the surprising exception of Greece, suggesting that there is a much more active process of resource reallocation across incumbent firms in the US. The right panel plots the percentiles of the growth distribution, the interquartile range and the range between the 90th and the 10th percentile (p90-p10) by country, sorted according to the interquartile range. There are also sizeable differences, both when looking at the percentiles at the extremes of the distribution and when looking at the interquartile and p90-p10 ranges, with the US ranking higher than most European countries.

Figure 4: Firm growth distribution relative to the US by country (10+ employees)

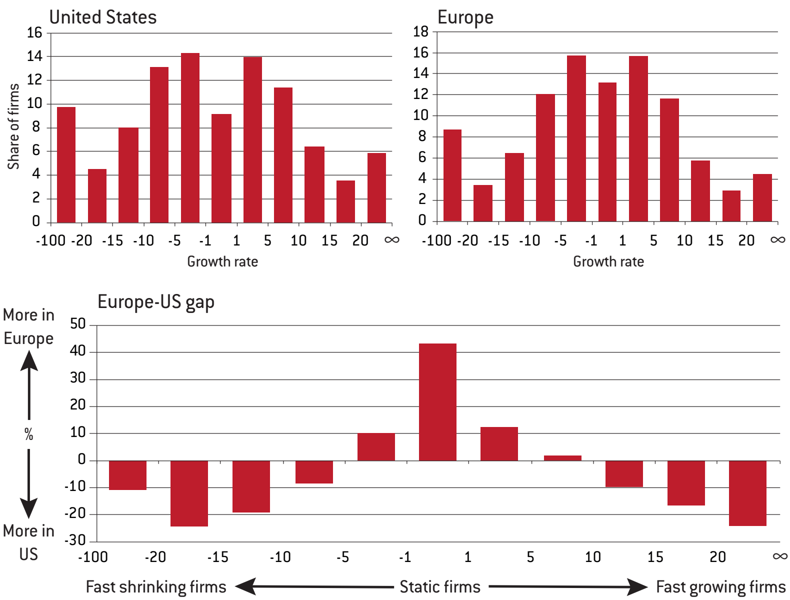
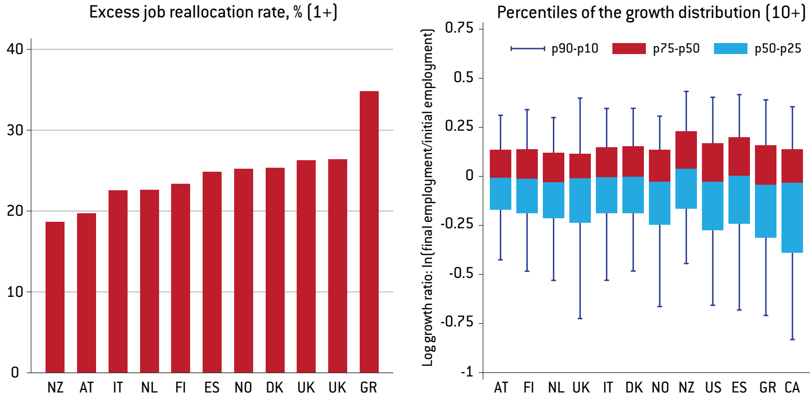


Figure 5: Business dynamism in different countries



One of the potential effects of a less dynamic growth distribution is that it becomes more difficult to challenge incumbents. Figure 6 looks at the differences in performance of SMEs compared to large firms and young firms compared to old firms in different countries. Specifically, the two measures considered are the average employment growth rate and job creation as a share of initial jobs (in other words, net and gross job creation rates). Each bar corresponds to the difference in percentage points between the rate for SMEs/young firms and the rate for large/old firms. Again, the differences are substantial, with countries like the US displaying a much larger gap than most European countries in the sample.

One possible interpretation is that a larger gap is a signal that the country's institutional framework makes it relatively easier for younger and smaller firms to challenge incumbents. However, this is not the only possibility. In some circumstances a poor institutional background can also lead to large gaps in the growth rates of younger and smaller firms relative to large firms, which could help explain the position of countries such as Italy and Greece in Figure 6[24].

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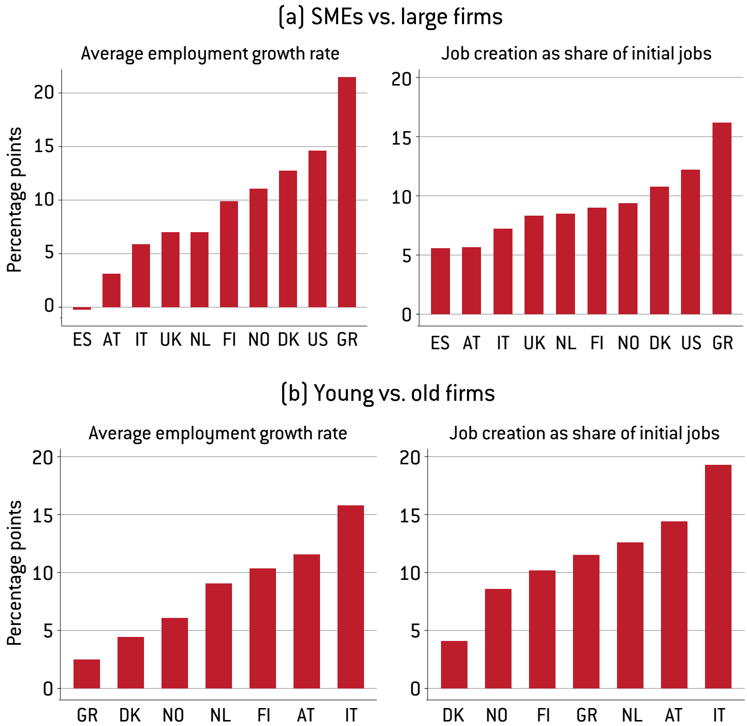
24 For instance, Arellano *et al* (2009) show that small firms grow disproportionally faster than larger firms in less financially developed countries, because limiteda access to external finance constraints their growth to what their current cashflows can fund.

Figure 6: Challenging incumbents – gap by country (1+ employees)



Note: Each bar corresponds to the difference in pp between the rate for SMEs/young firms and the rate for large/old firms.

4.5 Firm growth dynamics and productivity growth

We next examine whether differences in the distribution of firm growth impact productivity growth. There are several channels through which a more dynamic firm growth distribution could potentially lead to faster productivity growth. From a pure accounting perspective, a more dynamic firm growth distribution speeds up the reallocation of labour and capital, most likely from unproductive incumbents towards innovative firms that have successfully developed superior practices. It might also have an additional indirect effect, increasing competitive pressures that force firms to improve their internal practices or else shrink and exit. A more dynamic firm growth distribution might also signal an environment in which firms are willing to experiment and put new ideas into practice, while being able to backtrack and shrink without major consequences if they do not succeed. Hence there is also a dynamic effect, since knowing that it will be easy to scale up tomorrow if an invention is successful increases the incentives to invest in innovation today. By contrast, a large share of static firms might indicate instead an unwillingness to take risks to innovate, since trying out a new business model, exploring a new technology or launching a new product often requires a firm to expand its capabilities, even if only temporarily and with no certainty of success (Saint-Paul, 1997; Bartelsman *et al*, 2008).

These effects are however not unambiguous. High levels of resource reallocation might not lead to higher productivity if, for instance, resource allocation is directed towards the more unproductive firms, either because they have better access to finance, they are well-connected, their managers are prone to mistakes or care more about empire-building than improving performance, or when a speculative bubble distorts the allocation process. Even when this is not the case, resource reallocation also generates significant adjustment costs for firms and workers. Firms might lose the intangible capital embedded in their workers, deter them from taking risks and face disruption in their organisations, resulting in lower productivity. Employees are likely to lose firm-specific knowledge and skills and face significant uncertainty (Hall, 1995). Moreover, a more dynamic growth distribution can increase frictional unemployment because of job search and matching frictions, particularly in poorly functioning labour markets with high unemployment rates (Mortensen and Pissarides, 1994). Finally, too much competition can also reduce incentives for experimentation (Aghion *et al*, 2005).

Which of these effects dominate can depend on the position of the country relative to the world technology frontier. As countries get closer to the frontier, experimentation and selection become more important (Acemoglu *et al*, 2006). First, at the frontier, innovation replaces imitation as the main driver of productivity growth, so experimentation is more important. Second, the reallocation of resources to more productive firms might also play a more significant role at the frontier, since only a fraction of the firms that attempt to innovate succeed, while many others fail to improve their productivity. In contrast, imitation is less uncertain and does not require as much skill, so further from the frontier, within-firm productivity improvements across the board are more feasible (Acemoglu *et al*, 2006). Finally, the effect of competition on innovation and productivity growth is also stronger at the frontier (Aghion *et al*, 2005; Aghion *et al*, 2009). Altogether, these different channels suggest that the impact of a more dynamic growth distribution should be stronger, the closer the country is to the technology frontier.

We use standard OLS to test whether a more dynamic growth distribution is associated with faster productivity growth, as the literature suggests it should. Firm growth dynamics are clearly endogenous, so the results need to be interpreted with this in mind[25].

The baseline specification regresses annual total factor productivity (TFP) growth for industry *j* in country *i* from 2002 to 2005 on the share of static firms, which is a measure of the (lack of) dynamism of the firm growth distribution. The share of static firms is defined as the share of all surviving firms with 10 or more employees[26] with annual average employment growth between -1 percent and 1 percent (>1 percent are growing firms, <-1 percent are shrinking firms). We include country (μ) and industry (τ) fixed effects in the regression to mitigate omitted

25 An alternative approach would have been to use standard productivity growth decompositions (Bartelsman *et al*, 2005), which compute the share of productivity growth accounted by within-firm improvements, the entry and exit of firms and the reallocation of resources across continuing firms. They however require firm-level productivity data and, in addition, do not capture the indirect effect that a more dynamic firm growth distribution may have on within-firm productivity growth arising, for instance, from stronger competition.

26 The distribution of firm growth is less informative when firms with 1-9 employees are included, since growth rates for very small firms are of a different order of magnitude by construction, and they dominate the distribution. Therefore here we only consider the distribution for firms with 10 or more employees.

variables concerns, and control for the distance to the frontier to account for potential convergence effects. Industry-country specific shocks can also shift the distribution of firm growth, so we control for employment growth at the industry-country pair level.

$$TFPgrowth_{ij} = \beta_0 share_{ij} + \beta_1 employmentgrowth_{ij} + \beta_2 distancefrontier_{ij} + \mu_i + \tau_j + \varepsilon_{ij}$$

We use EUKLEMS data for industry-level productivity measures. Annual TFP growth is value-added based and annual labour productivity growth (which we use as a robustness check) is defined as gross value added per hour worked by persons engaged (O'Mahony and Timmer, 2009). We exclude outliers, which are defined as those industry-country pairs with TFP growth of more than two standard deviations away from the industry or country mean[27]. Employment growth corresponds to the average annual growth in the industry's number of employees over the period, also from EUKLEMS. Distance to frontier is defined as $-\ln(TFP_{ij}/TFP^{leader(j)})$ at the beginning of the period, in which $TFP^{leader(j)}$ corresponds to the highest TFP level for industry *j* across countries (as long as it is within two standard deviations from the mean for the industry)[28]. TFP levels data is obtained from the GGDC Productivity Level Database (Inklaar and Timmer, 2008), which also builds on EUKLEMS, and specifically corresponds to value-added based (double deflated) multi-factor productivity.

Table 1 reports the results of this exercise. Each of the 144 observations corresponds to an industry-country pair, with eight countries[29] and up to 22 industries included in the regressions. All regressions are estimated using OLS, with standard errors in parentheses clustered both at country and industry level. Column 1 reports the results of the

27 The main conclusions remain if outliers are not excluded (although interactions with distance to frontier lose their significance).

28 Any TFP level data point higher than the industry mean plus two standard deviations is coded as missing and not used to determine the frontier.

29 TFP data at the industry level is only available for a subset of countries: Austria, Denmark, Finland, Italy, Netherlands, Spain, UK and US.

baseline specification, with country and industry effects but without any additional control. The coefficient indicates that a 1 percentage point increase in the share of static firms is associated with -0.187 percentage points lower annual TFP growth, and is significant at the 1 percent level. Controlling for convergence effects with the industry's distance to the technology frontier and for potential industry shocks with employment growth does not make a difference (column 2)[30].

Table 1: Firm growth dynamics and productivity growth

	(1) TFP growth	(2) TFP growth	(3) TFP growth	(4) TFP growth	(5) TFP growth	(6) LP growth	(7) LP growth
Share of static firms	-0.187***	-0.193***		-0.265***		-0.220**	
	(0.068)	(0.065)		(0.080)		(0.107)	
Share of growing firms			0.251***		0.342***		0.352**
			(0.082)		(0.119)		(0.136)
Share of shrinking firms			0.171**		0.233***		0.164*
			(0.070)		(0.078)		(0.093)
Average employment growth		-0.123	-0.154	-0.142	-0.177***	-0.393***	-0.452***
		(0.115)	(0.100)	(0.094)	(0.064)	(0.125)	(0.093)
Distance to frontier		0.0315	0.0513	-2.009	12.67**	-2.239**	12.86***
		(0.563)	(0.580)	(1.240)	(5.719)	(1.061)	(4.644)
Distance to frontier x							

30 Controlling in addition for average firm size in the industry also leads to the same conclusions.

Share of static firms				0.143**		0.144***	
				(0.064)		(0.054)	
Share of growing firms					-0.177*		-0.209**
					(0.097)		(0.082)
Share of shrinking firms					-0.124*		-0.107
					(0.073)		(0.067)
Observations	144	144	144	144	144	144	144
R-squared	0.538	0.544	0.555	0.561	0.574	0.616	0.647

Notes: Each observation corresponds to an industry-country pair, with 8 countries and up to 22 industries included in the regressions. All columns are estimated with OLS, with standard errors in parentheses clustered both at country and industry level. EU KLEMS data is used for productivity measures. Annual TFP growth is value added based and annual labour productivity growth is defined as gross value added per hour worked by persons engaged (O'Mahony and Timmer 2009). The share of static firms is the share of all surviving firms with 10 or more employees with annual average employment growth between -1% and 1% (>1% are growing firms, <-1% are shrinking firms). Annual employment growth at the industry-country pair level controls for potential business cycles effects. Distance to frontier is defined as $-\ln(TFP_{ij}/TFP^{leader(j)})$ at the beginning of the period. TFP levels used to compute distance to frontier are value added based and double deflated (Inklaar and Timmer 2008). Columns 4-7 include interactions between distance to frontier and the share of static/growing/shrinking firms. All regressions include country and industry fixed effects. *, **, *** indicate significance at the 10%, 5% and 1% level respectively.

A low share of static firms could be driven both by a high share of growing and/or shrinking firms. Therefore, the results could just be picking up some positive correlation between growing industries and TFP growth not captured by average employment growth, with no relationship to selection processes. Column 3 replaces the share of static firms with the shares of growing and shrinking firms. While the coefficient for the growing share (0.251) is higher than for the shrinking share (0.171), they are both large and significant. Consequently, this supports the hypothesis that industries with a higher degree of selection, that is, with a higher share of growing and shrinking firms and fewer static ones, experience faster productivity growth.

Experimentation and selection may become more important the closer to the technology frontier an industry is. Columns 4-5 examine this hypothesis. The interactions between distance to frontier and the shares of static, growing and shrinking firms are significant and with the right sign. Far from the frontier, a large share of static firms is not associated with lower TFP growth, while at the frontier it is. The same finding arises when looking at the share of growing and shrinking firms. Thus, this evidence suggests that a dynamic firm growth distribution becomes more important for productivity growth the closer countries get to the technology frontier, as predicted by Acemoglu *et al* (2006).

A variety of methodological issues arise when estimating TFP, which could potentially affect comparisons between countries and industries. Therefore, for robustness we also consider labour productivity growth as an outcome variable, since it is subject to relatively fewer measurement issues. Columns 6-7 show that the same patterns emerge, even if with somewhat lower significance levels.

Summing up, these results suggest that a 5 percentage point higher share of static firms is associated with 1 percentage point lower annual productivity growth (both for TFP and labour productivity), and that this negative effect becomes stronger as countries converge to the technology frontier.

Is this a big or small effect in economic terms? In the decade prior to the financial crisis, Europe's annual TFP growth lagged the US by 1 percentage point on average (Ark *et al*, 2008), while differences between countries in the share of static firms averaged several percentage points. Alternatively, a one-standard deviation increase in the share of static firms is associated with 1.1 percentage points lower annual TFP growth. Therefore, the magnitude of the coefficient and the implied correlation are non-negligible.

4.6 Final remarks

There are at least three takeaways from our analysis. First, the firm growth distribution displays a very regular pattern in different countries and sectors, with a small minority of firms accounting for the majority of job creation and destruction. There is a limited up-or-out dynamic, with a large number of companies neither growing nor exiting. The average growth rate and its dispersion falls with firm age and size, but not in an equal way.

Second, there are also significant differences between countries. Much of the policy debate in Europe around business growth has been framed around its lacklustre performance in generating high-growth firms that become global champions. This evidence clearly shows that differences go beyond that. The US has more high-growth firms than Europe, but this is only one part of the picture. European countries have a less dynamic firm growth distribution overall, with slower growth and slower contraction, and unless this is recognised, we are likely to draw the wrong policy conclusions.

Third, differences in the dynamism of the growth distribution can have a substantial impact on a country's productivity performance. Specifically, a 5 percentage point higher share of static firms is associated with 1 percentage point lower productivity growth, whether measured using TFP or labour productivity. Moreover, this relationship becomes stronger as countries converge to the global technology frontier and innovation becomes more important.

It is important to understand the institutional drivers behind these differences in firm growth dynamics, and what policy levers exist to address them. While there is a growing body of work looking at some these questions, much of this work has focused exclusively on entrepreneurial activity. Two recent exceptions are Bravo-Biosca *et al* (2016), who use this data to examine the impact of labour regulation and financial institutions on firm growth dynamics, and Calvino *et al* (2016), who show that poor polices and framework conditions disproportionally hinder start-ups relative to incumbents.

There are still many unanswered questions, but also some clear steps that policymakers could take to unlock the potential of European firms.

First, policymakers should improve the regulatory framework, making it easier for businesses to scale up across Europe and enabling faster resource reallocation between firms. While it would be difficult in the current political environment, creating a new European single market for entrepreneurs (or a common EU 29th regime for start-ups) would probably be the most impactful reform. Sitting alongside the 28 national regimes without replacing them, this new regime would give new start-ups the option, but not the obligation, to operate under the same set of simplified rules and procedures across the EU (or the countries that chose to participate in this regime), while still preserving member states' rights over issues such as tax rates or employment rights, among others. It would be an opportunity to rethink how business activity is regulated and how this regulation is implemented and enforced, and would open the door to the creation of a new system adapted to the twenty-first century, not one inherited from the nineteenth century as we have today.

Second, better ways to protect workers should be found. While a more dynamic business environment will help to accelerate productivity growth, the benefits will not be shared equally, so there will be winners and losers. A world in which people switch jobs regularly will lead to increased uncertainty for workers, higher frictional unemployment and faster depreciation of firm-specific human capital. Therefore, a more dynamic firm growth distribution will not be sustainable unless we rethink our safety nets. Adopting the Scandinavian flexisecurity model (protecting individuals rather than jobs) or the Austrian labour regulation system (which allows portability of severance packages across companies) are alternatives worth considering.

Third, measures should be taken to improve the ecosystem, since businesses don't operate in a vacuum. Without good access to talent, knowledge, infrastructure and finance, it is difficult for businesses to grow. Rethinking our approach to industrial policy, with more active participation from businesses themselves, could help to address some of these gaps. Almost 25 years ago, Paul Romer suggested the idea of self-organising industry boards (Romer, 1993), in which firms in an industry collectively determine what industry-specific public goods to support and pay for them through a government-mandated levy. It might be time to revisit this idea, taking advantage of collective intelligence tools that didn't exist a quarter of a century ago (such as crowdsourcing and crowdfunding platforms) to create a more flexible levy that overcomes the weaknesses of the original proposal.

Fourth, more impactful government support schemes should be developed, which requires more experimentation with new approaches and better learning. Every year European governments spend €150 billion on different forms of business support. It is important to make sure that it actually has the intended effect. Despite recent initiatives such as the LSE-based What Works Centre for Local Economic Growth or the Nesta-led Innovation Growth Lab[31], we still know very little about what works and what doesn't. More experimentation with new support schemes and better evidence about their effectiveness should therefore be an important priority. There are several measures that governments could take to achieve that, such as embedding an experimental mindset in their own programme development activities, setting up a European experimentation fund for innovation and growth, and making much better use of the data already available.

31 See www.whatworksgrowth.org and www.innovationgrowthlab.org.

References

Acemoglu, D., P. Aghion, P and F. Zilibotti (2006) 'Distance to frontier, selection, and economic growth,' *Journal of the European Economic Association,* 4(1), 37-74

Aghion, P., N. Bloom, R. Blundell, R. Griffith and P. Howitt (2005) 'Competition and Innovation: An Inverted-U Relationship,' *The Quarterly Journal of Economics,* 120(2), 701-728

Aghion, P., R. Blundell, R. Griffith, P. Howitt and S. Prantl (2009) 'The Effects of Entry on Incumbent Innovation and Productivity,' *Review of Economics and Statistics,* 91(1), 20-32

Anyadike-Danes, M., C.-M. Bjuggren, S. Gottschalk, W. Hölzl, D. Johansson, M. Maliranta and A. Myrann (2015, April) 'An international cohort comparison of size effects on job growth,' *Small Business Economics,* 44(4), 821-844

Arellano, C., Y. Bai and J. Zhang (2009) 'Firm Dynamics and Financial Development.' *NBER Working Paper* No. 15193

Ark, B. v., M. O'Mahony and M. P. Timmer (2008) 'The Productivity Gap between Europe and the United States: Trends and Causes,' *Journal of Economic Perspectives,* 22(1), 25-44

Baily, M. N., C. Hulten, D. Campbell, T. Bresnahan and R. E. Caves (1992) 'Productivity Dynamics in Manufacturing Plants,' in Winston, C. Brookings Papers on Economic Activity, Microeconomics 1992, Brookings Institution

Bartelsman, E. J., J. Haltiwanger and S. Scarpetta (2004) 'Microeconomic Evidence on Creative Destruction in Industrial and Developing Countries,' *World Bank Policy Research Working Paper* No. 3464

Bartelsman, E. J., J. Haltiwanger and S. Scarpetta (2005) 'Measuring and Analyzing Cross-country Differences in Firm Dynamics,' *NBER Conference on Research in Income and Wealth. Producer Dynamics: New Evidence from Micro Data*

Bartelsman, E., E. Perotti and S. Scarpetta, S (2008) 'Barriers to Exit, Experimentation and Comparative Advantage,' *mimeo*

Brandt, N. (2004) 'Business Dynamics in Europe,' *OECD Science, Technology and Industry Working Papers* No. 2004/1

Bravo-Biosca, A. (2011) 'A look at business growth and contraction in Europe,' *Nesta Working Paper* No. 11/02

Bravo-Biosca, A. (2016) 'Firm growth dynamics across countries: Evidence from a new database,' *Nesta Working Paper* No. 16/03

Bravo-Biosca, A., C. Criscuolo and C. Menon (2016) 'What drives the dynamics of business growth?' *Economic Policy,* 31(88), 703-742

Calvino, F., C. Criscuolo, C and C. Menon (2015) 'Cross-country evidence on start-up dynamics,' *OECD Science, Technology and Industry Policy Papers* No. 2015/06

Calvino, F., C. Criscuolo, C and C. Menon (2016) 'No Country for Young Firms?: Start-up Dynamics and National Policies', *OECD Science, Technology and Industry Policy Papers* No. 29

Eurostat and OECD (2007) 'Eurostat-OECD Manual on Business Demography Statistics'

Hall, R. E. (1995) 'Lost Jobs', *Brookings Paper on Economic Activity, 1*, 221-256

Haltiwanger, J. (1997) 'Measuring and Analysing Aggregate Fluctuations: The Importance of Building from Microeconomic Evidence', *Federal Reserve Bank of St. Louis Economic Review*, 55-77

Haltiwanger, J., R. S. Jarmin and J. Miranda (2010) 'Who Creates Jobs? Small vs. Large vs. Young', *NBER Working Paper* No. 16300

Inklaar, R and M. P. Timmer (2008) 'GGDC Productivity Level Database: International comparisons of output, inputs and productivity at the industry level', *GGDC Research Memorandum* 104

Mortensen, D. T. and C. A. Pissarides (1994) 'Job Creation and Job Destruction in the Theory of Unemployment', *The Review of Economic Studies,* 61(3), 397-415

O'Mahony, M. and M. P. Timmer (2009) 'Output, Input and Productivity Measures at the Industry Level: the EU KLEMS Database', *Economic Journal*, 119(538), pp. F374-F403

OECD (2008) 'Measuring Entrepreneurship: A Digest of Indicators'

Romer, P. M. (1993) 'Implementing a National Technology Strategy with Self-Organizing Industry Investment Boards', *Brookings Papers on Economic Activity*(2)

Saint-Paul, G. (1997) 'Is labour rigidity harming Europe's competitiveness? The effect of job protection on the pattern of trade and welfare', *European Economic Review*, 499-506

Véron, N. (2008) 'The Demographics of Global Corporate Champions', *Bruegel Working Paper* No. 2008/03

5 A revival of manufacturing in Europe? Recent evidence about reshoring

Dalia Marin, Reinhilde Veugelers and Justine Feliu

5.1 Introduction

The shipping of manufacturing jobs out of western Europe and the United States, particularly to Asia and China, continues to provoke strong views. Some claim that offshoring will continue to characterise the manufacturing sector in the west; offshoring might even become more important. Others claim the digital revolution will lead to a revival of manufacturing jobs in Europe. With robots, artificial intelligence, 3D printing and other advanced manufacturing technologies, the cost of labour will be a less important factor in deciding where to locate manufacturing facilities and jobs. As a result, production of industrial goods might as well take place in high-wage western countries. If this is indeed happening, we should see in the aggregate data an end to offshoring and even signs of reshoring, at least of the return of jobs that were offshored in search of lower labour costs. In this chapter we look at the most recent trends in offshoring to provide more evidence about this important aspect of European manufacturing.

5.2 Global value chains, offshoring and reshoring

The relocation of manufacturing jobs to low-wage countries has been a defining feature of globalisation since the 1990s. The last two decades have witnessed deep changes to the international division of tasks (see, for example, Baldwin, 2009). The new model of international division of labour evolves around global value chains, ie the sourcing of goods and services from around the globe to take advantage of differences in costs and quality of factors of production, even to the level of individual tasks. This structural change in the productive economy has occurred as a consequence of the substantial reductions in trade barriers, tariffs and transportation costs (Feenstra, 1998), but perhaps more importantly because of the development and diffusion of information and communication technologies (Milgrom and Roberts, 1990; Nordas, 2004). Rapid advances in ICT have resulted in a marked reduction in the costs associated with coordination of complex activities within and between companies over long distances.

Global value chains and international specialisation at the level of tasks have led firms to adopt much more complex sets of internationalisation strategies, involving offshoring. Offshoring firms outsource parts of their value chains internationally to other companies (inter-firm) or to affiliated companies located abroad (intra-firm). They import components and export finished goods or semi-finished goods for further processing and trade (see for example Saliola and Zanfei, 2009; De Backer *et al*, 2013).

This fragmentation of manufacturing across borders in global value chains is associated with unprecedented growth in trade since 1990. Arvind Subramanian and Martin Kessler of the Peterson Institute have labelled this 'hyperglobalisation', in which world trade has soared much more rapidly than world GDP. According to Subramanian and Kessler's (2013) estimates, overall trade in goods and services rose from about 19 percent of world GDP in the early 1990s to an unprecedented 33 percent in 2011.

One way of measuring the rising importance of global value chains is to look at the share of intermediate goods and components in trade, or the share of imported components in exports (Feenstra and Hanson, 1996; De Backer *et al*, 2013). These estimates range from 30 to 40 percent of world trade (see for example Hummels, Ishii and Yi, 2001).

For Europe, international value chains have a specific regional character: De Backer *et al* (2013) showed that EU member states are strongly integrated into European value chains, concentrated in the 15 pre-2004 EU members (with Germany as a central player). Also, most offshoring by French firms went to other EU countries, primarily to the 15 pre-2004 EU members (Fontagné and D'Isanto, 2013). Marin (2011) showed that intra-firm trade – trade between parent firms in western Europe and their affiliates in eastern Europe – accounts for between 20 percent and 70 percent of total trade between these two regions.

A much discussed phenomenon for the revival of manufacturing in the west is reshoring, ie the relocation of production from abroad back home. Several trends might be driving reshoring. First, the cost structure of production is changing in emerging countries. Wages have been increasing, eroding these countries' cost advantages in labour-intensive activities. Companies can respond to these rising labour costs by automating factories in emerging countries or by relocating production to other emerging countries where labour costs are still low. But they can also re-shore specific activities. Second, technological advances support reshoring. Digitalised and additive manufacturing, which relies on automation combined with new materials and new production technologies, will cut the cost of producing smaller batches of a wider variety of products, making 'manufacturing on demand' (more) economically feasible. This also enables manufacturing to take place closer to demand. With the share of labour costs reducing and the increasing importance of being close to demand, firms are increasingly setting up often shorter value chains in higher-cost countries close to their major markets.

The growing appeal of reshoring does not imply a large number of extra jobs at home, however. The expectation is that reshored production will create only a limited number of additional jobs and these jobs will increasingly be high skilled (De Backer *et al*, 2016). Nor would reshoring automatically mean the end of offshoring (De Backer *et al*, 2016). Offshoring to emerging countries is likely to remain an important strategy, even when costs are rising in these countries, because emerging countries and their growing middle classes offer large and rapidly growing markets for manufactured products. Rather, companies seem to be developing more diversified sourcing strategies and considering more options in structuring their production processes, tempering long and complex value chains with a regional rebalancing (De Backer *et al*, 2016).

Company surveys and anecdotal evidence suggest the reshoring trend is becoming stronger. For instance, the Boston Consulting Group (2011) suggested that reshoring could lead to a manufacturing renaissance in the United States. A PwC survey in 2014 found that two-thirds of 384 euro-area firms said that they had relocated some activities during the past 12 months and 50 percent planned to do so in the next 12 months. Evidence for reshoring in aggregate statistics is hard to find. De Backer *et al* (2016) find no evidence of reshoring or of an end to offshoring. Marin (2014) used World Input-Output Data and did not find any evidence of reshoring. IMF research attributes the slowdown in the growth of trade since 2011, at least partly, to a decline in the growth of global value chains.

The World Input-Output Data was updated at the end of 2016 (see Timmer *et al*, 2016). In this chapter we revisit the reshoring versus offshoring question by looking at the pattern of off- or re-shoring in more recent years.

5.3 Recent evidence on off- and re-shoring

To measure offshoring, we use, in line with the literature, the extent to which firms, sectors and countries use imported intermediates (see the chapter Appendix). The intermediate import ratio (IIR) (Feenstra and Hanson, 1996) is the share of imported intermediates in total intermediates used by a sector or country. Firms, sectors and countries that are heavily import-dependent for their intermediates are assumed to be more involved in global value chains.

As we cannot identify whether or not imports of intermediates are within-firm, our offshoring analysis cannot distinguish outsourcing (ie between firms sourcing internationally) and insourcing (ie within firms, between affiliates sourcing internationally), and will cover both.

We calculate the intermediate import ratio (IIR) per country using the World Input-Output Data (WIOD). The WIOD was created and collected by Timmer (see Timmer, 2012, and Timmer, 2015). It records the amount of intermediates consumed by ISIC Rev.4 (NACE 2.0) industry, country of origin and destination country for a sample of 43 countries.

We look at the patterns of offshoring in manufacturing for the major EU economies (Germany, France and the UK) and the US as offshoring countries, being the destinations for imported intermediates. We also look at China as an offshoring nation.

As offshoring destinations (or countries of origin for imported intermediates) we consider:

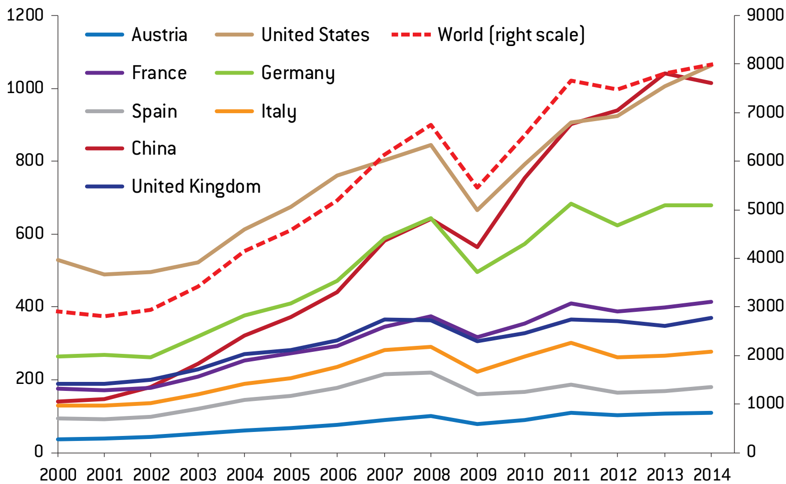
- Southern Europe (Italy, Spain, Portugal and Greece),
- Central and eastern Europe (Poland, the Czech Republic, Hungary, Slovakia, Slovenia, Romania and Bulgaria),
- Emerging economies (China, India, Indonesia, Brazil and Mexico). Among these, we look specifically at China as a major destination for offshoring.

Most of these destination regions can be considered as comprising countries with lower labour costs, compared to the origin countries. But some, like China, are also important as a destination market for consumption.

5.3.1. Recent trends in the overall volume of offshoring

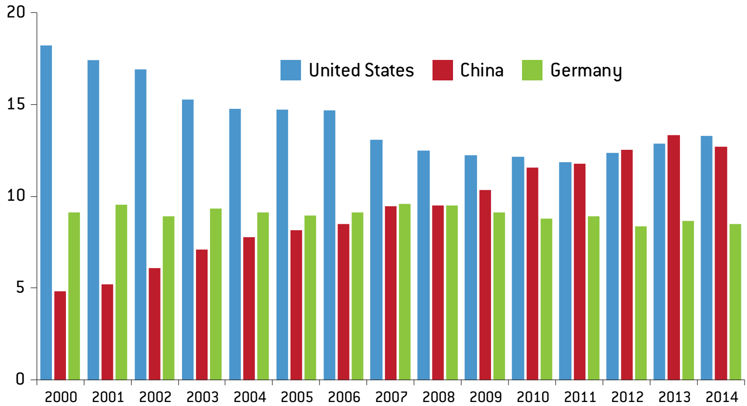
We first look at the absolute size of the flows of imported intermediate goods for a selection of importing countries (Figure 1). Imports of intermediate goods in billion US$ have been increasing since 2000. The 2008 crisis caused a dip, but the increase in intermediate goods imports resumed its rise soon after. In Europe, Germany accounts for the largest inflow of imported intermediates. Germany's intermediate imports doubled from 2000 to 2014 from, respectively, $300 billion to over $600 billion. France increased its intermediate imports from $200 billion to $400 billion. But the largest flows of imported intermediates go the US. The US increased its flows from $500 billion to $1050 billion. China is typically considered a destination for offshoring by western firms. But China has also undergone a large increase in flows of imported intermediates. China's imported intermediates increased fivefold after 2001 to about $1000 billion in 2013. Figure 2 shows more clearly how over the last 15 years China has become a major offshorer matching the US, thus establishing itself as a pivotal anchor in global value chains.

Figure 1: Imports of intermediate goods into selected countries in US$ billions, 2000-14



Source: Bruegel.

Figure 2: Imports of intermediate goods into the United States and China as a share of total worldwide imported intermediate goods, %, 2000-14



Source: Bruegel.

To characterise the offshoring phenomenon we need to look at imported intermediates relative to domestically sourced intermediates. Figure 3 shows the IIR for the largest EU countries, the US and China. Several features are noteworthy:

- Although the US and China are responsible for the highest flows of imported intermediates, their IIRs are much lower than those of European countries, reflecting the greater integration of European countries into global value chains. With over 25 percent of imported inputs, Austria is most integrated into value chains followed by Germany (almost 20 percent) and France (17 percent), compared to the US and China with about 8 percent and 5 percent of imported inputs, respectively.

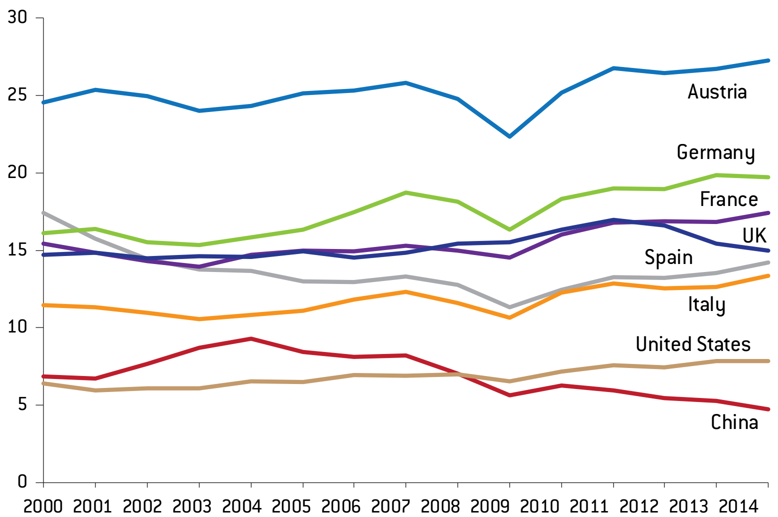
- Before the financial crisis of 2008-09, offshoring expanded in all countries except China where it already started to drop in 2004 (and then again in 2010).

- The financial crisis of 2008-09 was a short period when offshoring fell substantially in all countries. But after the financial crisis the share of imported intermediates quickly recovered.

- Offshoring started to drop in China in 2010. But already in 2004 China started to reorient its offshoring activity back to the domestic market, using domestically produced rather than foreign-sourced intermediates. Perhaps this early reshoring activity was already an expression of China's overall reorientation away from outside activity towards domestic value chains.

- Most importantly, offshoring stopped expanding more recently in all countries. In the UK, we see clear signs of reshoring.

Figure 3: Countries' imports of intermediate goods as a share of total intermediates consumption in %, 2000-14

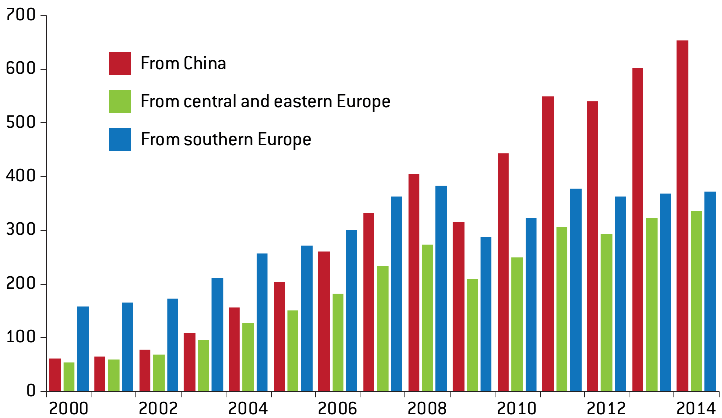


Source: Bruegel.

5.3.2 Offshoring destinations

In this section we examine how European countries and the US used the low-cost destinations in central and eastern Europe, southern Europe and China for their offshoring activities. Figure 4a shows that although flows of intermediates from all three regions have increased, the growth of intermediates imports from China has been the most marked, while southern Europe has lagged. While in 2000 southern Europe was much more important than either China or central and eastern Europe as an offshoring destination, in 2014 it was only marginally ahead of central and eastern Europe, while China has doubled in size.

Figure 4a: Imports of intermediate goods from selected regions to the world, US$ billions, 2000-14

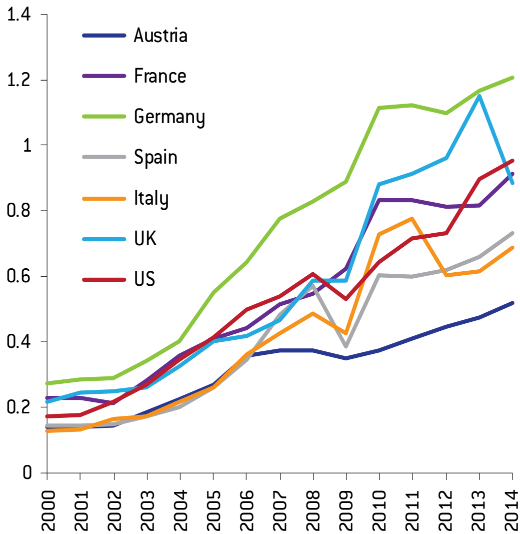


Source: Bruegel.

5.3.2.1 Offshoring to China

Figure 4b illustrates the offshoring pattern into China from the various western countries. Offshoring to China from all western countries has increased dramatically over the last 14 years. But Germany in particular stands out. It imported 1.2 percent of its inputs used in production from China in 2014, a substantial rise compared to 0.3 percent in 2000. In 2014 the US, the UK and France imported about 0.9 percent of their inputs from China (from 0.2 percent in 2000). Thus, in contrast to the anecdotal evidence, firms in rich countries, with the possible recent exception of the UK, show no evidence of reshoring from China, but are rather increasing their offshoring to China.

Figure 4b: Imports of intermediate goods from China, % of total consumption of intermediate goods, 2000-14

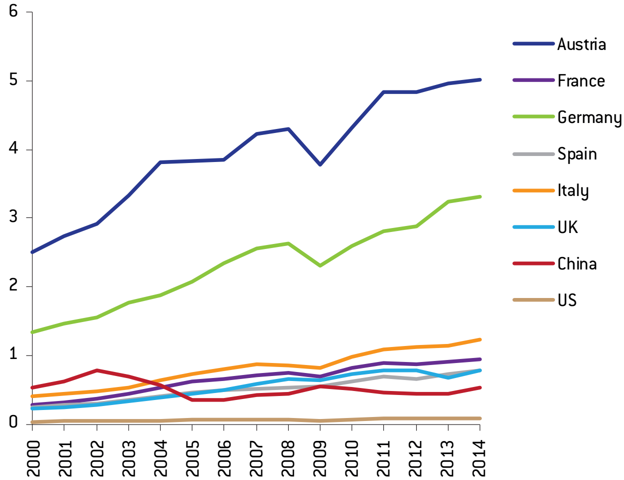


Source: Bruegel.

5.3.2.2 Offshoring to central and eastern Europe

Figure 4c shows the offshoring pattern for central and eastern Europe, which has become an important location for all European countries. There are no signs that central and eastern Europe is being crowded out by China as an offshoring destination for western European countries. Central and eastern Europe is a major destination for Austria's and Germany's value chains and is growing in importance. In 2013 Austria imported over 5 percent of its inputs from central and eastern Europe, and Germany imported over 3 percent (in 2000, Austria imported 2.6 percent and Germany 1.3 percent from the region). In contrast, for the UK, central and eastern Europe as a location for global value chains was already of minor importance, and has become less important since 2012.

Figure 4c: Imports of intermediate goods from central and eastern Europe, % of total consumption of intermediate goods, 2000-14

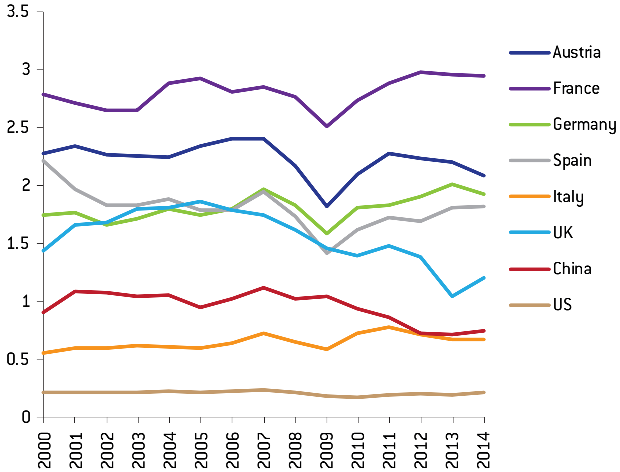


Source: Bruegel.

5.3.2.3 Offshoring to southern Europe

Figure 4c shows the offshoring pattern with respect to southern Europe. As a location for offshoring activity, southern Europe has lost out. Austria, the UK and China in particular have withdrawn from southern Europe since 2011. For France, southern Europe was and remains an important offshoring destination.

Figure 4d: Imports of intermediate goods from southern Europe, % of total consumption of intermediate goods, 2000-14



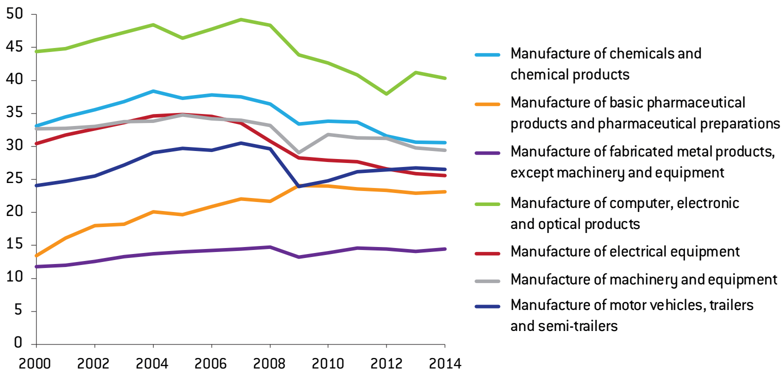
Source: Bruegel.

5.3.3 Sectoral Patterns

Figure 5 examines imports of intermediate goods by sector. The sector with the highest offshoring ratio is *computer, electronic and optical products*: at its peak in 2006, about 50 percent of intermediate goods used in this sector were imported from abroad. But more recently, the sector has seen some reshoring, a trend that already started before the crisis. Another offshoring-heavy sector is *chemicals*, with a peak IIR of 40 percent in 2004, though the sector's offshoring ratio has been slowly declining, reflecting a mild reshoring trend. *Electric equipment and machinery* has a smaller but still substantial offshoring ratio, which has also been declining for some time. In contrast to chemicals, the *pharmaceutical* sector was typically less intensively involved in offshoring. But this has been changing, as this sector has seen an increase in its IIR from below 15 percent in 2000 to about 25 percent in 2014, bringing it more into line with other sectors.

In all sectors, China is becoming more important as an offshoring destination, even for these sectors for which on average there is a reshoring trend. Hence, when sectoral reshoring takes place, it is not from China. Southern Europe has not been able to benefit from increased offshoring by in any sector, which was already evident before the 2008-09 crisis.

Figure 5: Imports of intermediate goods by selected sectors, % of total consumption by that sector of intermediate goods, 2000-14



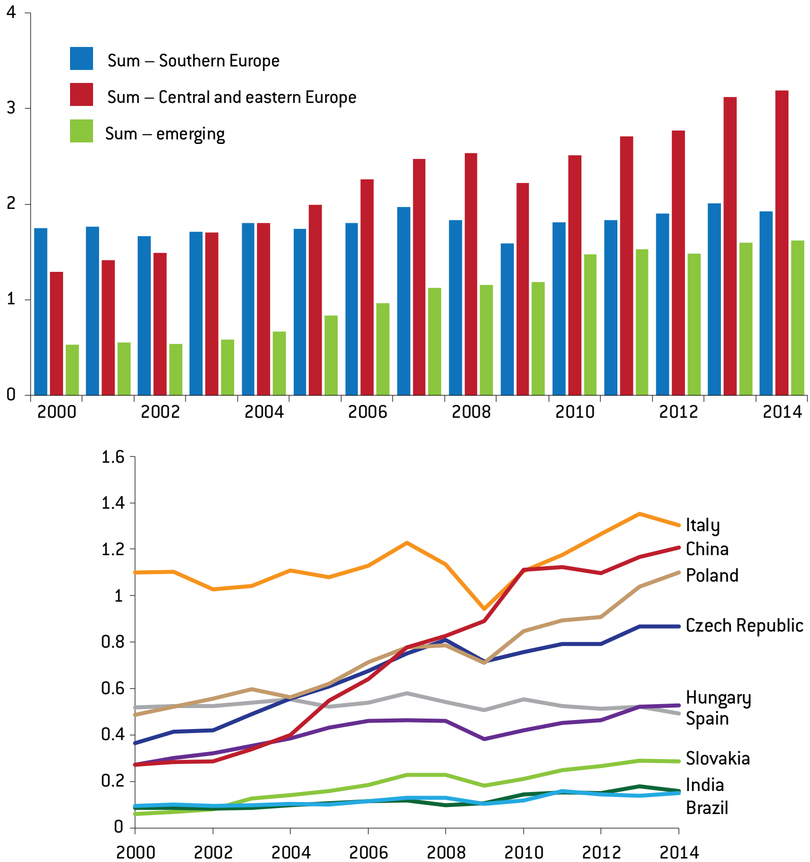
Source: Bruegel.

5.4 An analysis of recent offshoring/reshoring trends for selected countries

We close the analysis by exploring the offshoring trends for Germany, France, the UK, the US and China[32]. A distinct pattern of value chains emerges from the analysis of individual countries.

32 An analysis by sector and for other European countries can be found on the Bruegel website, www.bruegel.org.

Figure 6: Total imported intermediate goods as % of total consumption of intermediate goods in Germany, by selected regions/countries, 2000-14



5.4.1 Germany

Overall Germany is a major importer of intermediate goods, the largest importer in the EU. Germany imports about 20 percent of its intermediate consumption in manufacturing, a ratio that has been gradually increasing over time. The aggregate numbers show no signs of reshoring to Germany. There have been some shifts however in the regions from which Germany imports intermediate goods. In 2000, the major region for Germany was still southern Europe, with Italy by far the most important offshoring region for Germany. But by 2014, although Italy is still the largest offshoring destination for German manufacturing, China had steeply risen as an offshoring destination for German manufacturing, as have Poland and the Czech Republic. China's is particularly remarkable considering that in 2000 it constituted only 0.27 percent of Germany's total imports of intermediate goods. Germany's offshoring to central and eastern Europe surpassed its offshoring to southern Europe in 2005 and the trend is continuing, making central and eastern Europe by far the main offshoring region for Germany in 2014.

5.4.2 France

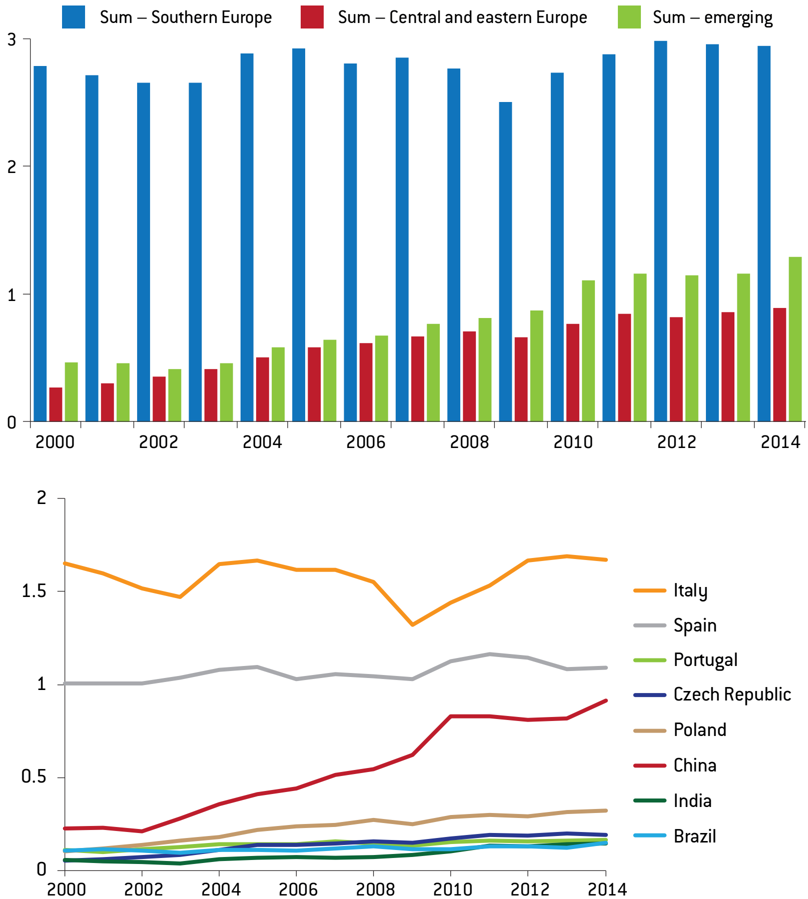
France is the second largest importer of intermediate goods into the EU. Its IIR has been around 15 percent, below the German ratio. It has only slightly increased over time, by less than Germany. Also for France, the aggregate numbers give no signs of reshoring. Unlike Germany, for France, southern Europe is the most important offshoring region, with Italy and Spain its main offshoring destination countries. This remained fairly stable from 2000 to 2014. At the same time, we see an increasing role for emerging markets as offshoring destinations, because of a steep rise in the importance of China as an offshoring destination. To a lesser extent, the role of central and eastern Europe has increased. Although China is becoming more important as an offshoring destination for France, it is still less important than it is for Germany.

5.4.3 United Kingdom

The UK overall has a similar IIR to France (around 15 percent), below German levels. But since 2011, the UK's IIR has dropped slightly, reflecting a small reversal of offshoring. This reshoring seems to come from southern Europe, which used to be the major destination of UK manufacturing offshoring. Italy and Spain have dropped significantly as sources of imports of intermediate goods for UK manufacturing.

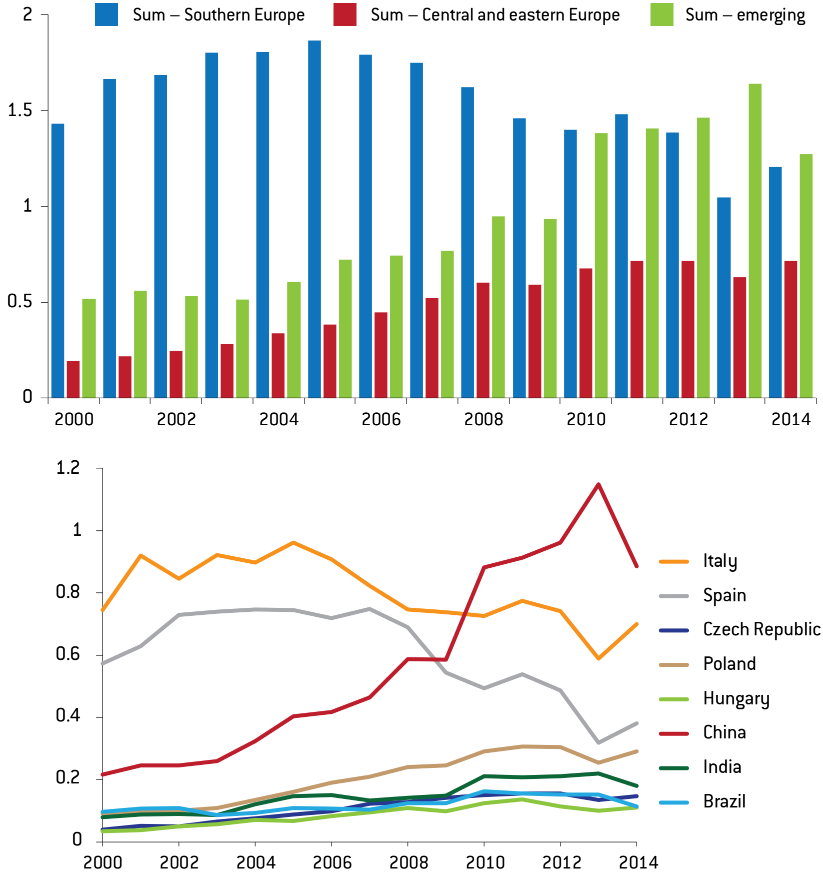
Central and eastern Europe has risen somewhat (see eg Poland), but most spectacular is the rise of China as an offshoring destination for the UK. It became in 2009 the largest source of imported intermediate goods for UK manufacturing. Therefore any reshoring taking place to the UK is not coming from China (with perhaps the latest year as an exception), but mostly from southern Europe.

Figure 7: Total imported intermediate goods as % of total consumption of intermediate goods in France, by selected regions/countries 2000-14



Source: Bruegel.

Figure 8: Total imported intermediate goods as % of total consumption of intermediate goods in the UK, by selected regions/countries, 2000-14



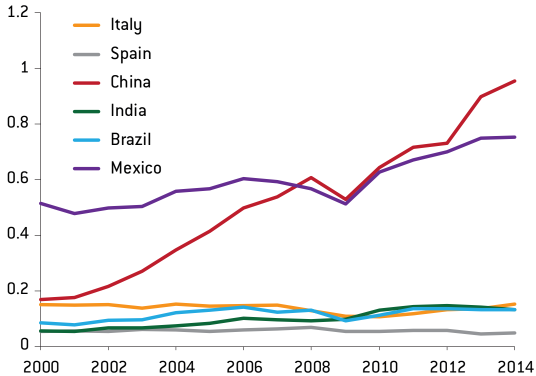
Source: Bruegel.

5.4.4 The US

Although the US accounts for the largest volume of imported intermediate goods, its IIR is below 10 percent, which is much lower than EU countries (see Figure 3). This ratio has remained fairly stable over time, ie no signs of major increases in offshoring, but also no strong evidence of reshoring in aggregate.

For the US, inarguably Mexico has been a main destination for offshoring throughout the period under analysis. At the same time, the data shows the remarkable rise of China as an offshoring destination for the US. The rise was so rapid that in 2008 China's share reached that of Mexico, and has kept on growing since 2009.

Figure 9: Total imported intermediate goods as % of total consumption of intermediate goods in the US, 2000-14, by selected countries



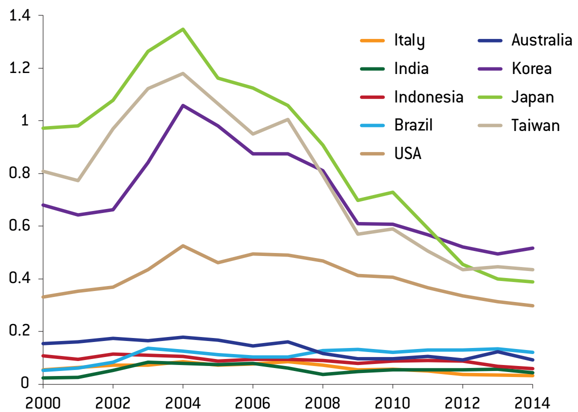
Source: Bruegel.

5.4.5 China

While China has figured prominently in the discussion about offshoring as a destination, it is also a major source of offshoring demand, almost on par with the US in absolute volume of imports of intermediate goods. But like the US, China is much less offshoring-intensive: it imports less than 10 percent of its intermediate goods and seems to have been gradually but consistently reshoring since 2004, with less than 5 percent of its consumption of intermediate goods imported from abroad in 2014. The sector with the highest share of imported components in 2000 was *computer, electronic and optical products* (around 40 percent). This sector has witnessed a reshoring trend but still has the highest ratio (above 20 percent in 2014) compared to other sectors. China's reshoring is in line with its ambition to catch up and move up the value chain and produce key components for its manufacturing sectors locally rather than import them from abroad.

Japan, Taiwan and Korea are the main countries from which China imports intermediate goods, but all three countries have become less important in this respect. The US has remained fairly stable as an offshoring destination for China. The numbers are negligible for European countries as origins for Chinese imports. Because of data limitations, we cannot analyse the developments in the low-wage countries in south and Southeast Asia as offshoring destinations for China.

Figure 10: Total imported intermediate goods by country, % of total consumption of intermediate goods in China, 2000-14



Source: Bruegel.

5.5 Conclusions

Global value chains around the world have not expanded substantially since 2011. This suggests that we are approaching a new era of globalisation in which firms reorganise into shorter, regional or local value chains. Can we interpret this as a sign of a revival of manufacturing in Europe?

We find that the curtailment of the expansion of global value chains since 2011, as shown by the trends in IIRs, has been particularly driven by reshoring activity in the UK and China, while in all other countries offshoring has remained flat or has even increased slightly.

When we examine the regions from which countries have withdrawn their offshoring activity, southern Europe stand out. All major importing countries retreated from southern Europe.

Central and eastern Europe has been able to maintain its position as a destination for offshoring, except for the UK. But the expansion of offshoring to central and eastern Europe has slowed in all countries.

This stands in contrast to China as a destination for offshoring. All countries continued to expand their offshoring to China after 2011 except for the UK (most recent years available). Interestingly, Germany has the strongest link with China via its global value chains, surpassing the US and the UK, while France has the weakest link.

Thus, the slowdown in the expansion of value chains around the world is not driven by China becoming less important as an offshoring destination. It has more to do with China reshoring back to its large home market.

To conclude: we find a change in the pattern of offshoring around the world that is driven in particular by reshoring to China and a withdrawal of most countries from southern Europe as a destination for offshoring. Activity moved from southern Europe to China and central and eastern Europe, leaving total offshoring activity flat in most countries. It remains to be seen whether these changes in the pattern of offshoring continue or go into reverse. Answering this question will require a more detailed analysis of the ultimate drivers of offshoring. We leave this for future work.

Appendix: Measuring offshoring and reshoring

The traditional definition of offshoring is based on the concept of moving an activity from the domestic market to a location abroad. A firm is said to offshore when it exports a part of its productive activity to another country. Estimating offshoring trends using data about imported intermediate goods might therefore sound a bit counterintuitive.

The idea behind using imported intermediate goods data to measure offshoring is the following. Each country's use of imported intermediate goods is assumed to come from previously offshored activities. Adding up the total amount of imported intermediate goods (ie the sum of intermediate goods produced abroad – excluding the domestically sourced intermediate goods) and dividing this amount by the total consumption of intermediate goods gives us the share of imported intermediate goods in percent of total consumption of intermediate goods. Imported intermediate goods are assumed to be the result of a supply chain's decomposition and we can therefore treat the share of imported intermediate goods as a measure of offshoring, ie the percentage of intermediate goods consumed/used domestically but that are produced abroad. This gives us the following expression:

Where is the country and stands for intermediate import ratio. Countries that spread different production stages across different countries will need to import the refined inputs from other countries and thus are expected to experience a higher share of inputs from imports.

References

Baldwin, Richard (2009) 'The Great Trade Collapse: Causes, Consequences and Propects', *VoxEU.org*, 27 November

De Backer, Koen, and Sebastien Mouridot (2013) 'Mapping Global Value Chains', *OECD Trade Policy Papers* No. 159, OECD Publishing, Paris

De Backer, Koen, Carlo Menon, Isabelle Desnoyers-James and Laurent Moussiegt (2016) 'Reshoring: Myth or Reality?' *OECD Science, Technology and Industry Policy Papers* No. 27, OECD Publishing, Paris.

Feenstra, Robert C. (1998) 'Integration of Trade and Disintegration of Production in the Global Economy', *Journal of Economic Perspectives* 12(4): 31-50

Feenstra, Robert C. and Gordon H. Hanson (1996) 'Globalization, Outsourcing, and Wage Inequality', *American Economic Review* 86(2): 240-245

Fontagné, Lionel and Aurelien D'Isantom (2013) 'Global value chains: International sourcing primarily to the European Union', *Insee Premiere* 1451, June

Hummels, David Jun Ishii and Kei-Mu Yi (2001) 'The nature and growth of vertical specialization in world trade', *Journal of International Economics* 54(1): 75-96

IMF (2016) 'Global Trade: What's behind the Slowdown?' chapter 2 in *World Economic Outlook*, International Monetary Fund, Washington

Marin, Dalia and Linda F. Rousová (2011) 'The Organization of European Multinationals', *Discussion Papers in Economics* 12453, University of Munich, Department of Economics

Marin, Dalia (2014) 'Globalisation and the rise of the robots', *VoxEU.org*, 15 November

Milgrom, Paul and John Roberts (1990) 'The Economics of Modern Manufacturing: Technology, Strategy, and Organization', *American Economic Review* 80(3): 511-528

Nordas, Hildegunn K. (2004) 'The global textile and clothing industry post the Agreement on Textiles and Clothing', *Discussion Paper* No 5, World Trade Organisation

Saliola, Frederica and Antonello Zanfei (2009) 'Multinational firms, global value chains and the organization of knowledge transfer', *Research Policy* 38(2): 369-381

Subramanian, Arvind and Martin Kessler (2013) 'The Hyperglobalization of Trade and Its Future', *Working Paper Series* WP13-6, Peterson Institute for International Economics

Sirkin, Harold L., Michael Zinser and Douglas Hohner (2011) *Made in America, Again: Why Manufacturing Will Return to the US*, August, Boston Consulting Group

Timmer, Marcel P., Abdul A. Erumban, Reitze Gouma, Bart Los, Umed

Temurshoev, Gaaitzen J. de Vries, Iñaki Arto, Valeria Andreoni, Aurelien Genty, Frederik Neuwahl, Jose M. Rueda-Cantuche, Alejandro Villanueva, Joe Francois, Olga Pindyuk, Johannes Pöschl, Robert Stehrer and Gerhard Streicher (2012) 'The World Input-Output Database (WIOD): Contents, Sources and Methods,' *IIDE Discussion Papers* No 20120401, Institute for International and Development Economics

Timmer, Marcel P., Erik Dietzenbacher, Bart Los, Robert Stehrer and Gaaitzen J. de Vries (2015) 'An Illustrated User Guide to the World Input-Output Database: the Case of Global Automotive Production,' *Review of International Economics* 23: 575–605

Timmer, Marcel P., Bart Los, Robert Stehrer and Gaaitzen J. de Vries (2016) 'An Anatomy of the Global Trade Slowdown based on the WIOD 2016 Release,' *GGDC Research Memorandum* 162, University of Groningen

6 Manufacturing in central and eastern Europe

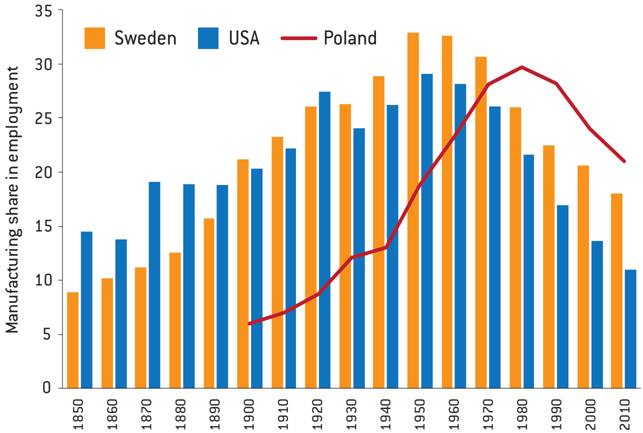
Maciej Bukowski and Aleksander Śniegocki

6.1 The legacy of the past

6.1.1 Delayed industrialisation

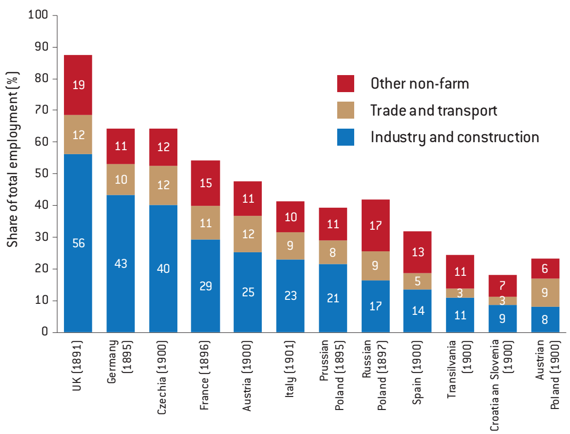
Central and eastern Europe remained on the peripheries of European industrialisation for nearly the entire twentieth century. Compared to western Europe, central and eastern European countries were distinguished primarily by the intermittent nature of their development, the main cause of which was major institutional breaks that affected the region several times over the period. Nevertheless, today's level of industrialisation in the Czech Republic, Hungary, Poland, Slovakia and Romania largely reflects patterns already visible in the nineteenth century. Because of coal deposits and a favourable geographic location, Silesia started to industrialise in the mid-nineteenth century and participated in the second industrial revolution more or less at the same time as western Europe. Other territories of eastern Prussia and Austria-Hungary industrialised more slowly, which was linked to their unfavourable position within these larger political organisms and to the delayed construction of transport and energy infrastructure. The least-industrialised parts of central and eastern Europe are the former territories of the Russian Empire (eastern Poland, Lithuania, Latvia and Estonia), and Romania and Bulgaria, which in the nineteen century separated from the largely underdeveloped Ottoman Turkey. In the nineteen century, growth in these areas was slowed by the combination of poor institutions (late end of serfdom), poor human capital (high illiteracy), absence of transport infrastructure (lack of roads, railways and ports) and very low urbanisation.

Figure 1: Share of manufacturing in total employment, selected countries (1850-2010)



Source: Edvinsson (2005), NBER, World Bank WDI.

Figure 2: Employment structure around 1900



Source: Kuklo *et al* (2013).

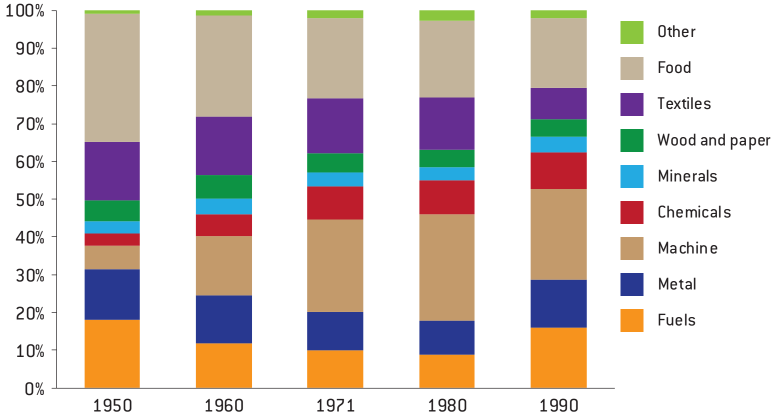
In general however, by the outbreak of the first world war, central and eastern Europe has already started to industrialise (Figures 1-2), in line with a standard sequence of development (Broadberry *et al*, 2008): from light (primarily cotton and food processing) to heavy industry (coal, steel, mechanical and chemical). Without the crises of the interwar period, which were particularly painful for the region, its level of development in the mid-twentieth century would certainly have exceeded that of Spain, Portugal or Greece, where industrialisation started several decades later.

By the outbreak of the second world war, Poland, Romania and Czechoslovakia had managed to rebuild their industrial bases to where they had been prior to the interwar period, though with visible changes in the branch structure and geographical allocation of production, and with the state as the main engine of development. However, the level of development of Poland, Hungary and Romania relative to western Europe changed little between 1920 and 1939. Poor infrastructure, limited export opportunities, low urbanisation and significant human capital deficits slowed downed the industrialisation process. State policy could not effectively counterbalance these shortfalls as its ambition was rather to build heavy industry from scratch, whereas the comparative advantage of central and eastern Europe lay rather in the development of less capital- and skill-intensive branches. It can be said that the interwar industrialisation attempt was confronted with the limitations of the technological leap model in an unfavourable external environment with strong internal structural and institutional constraints (Leszczyński, 2013; Koryś, 2015).

6.1.2 The Socialism era

During the second world war, the industrial base in the territories of the future Polish People's Republic, eastern Germany and Czechoslovakia was largely removed or destroyed and transport infrastructure was decapitated, though – for Poland – the shift to the west resulted in access to much better capital stock than that which was lost in the east. Hungary, Romania and Bulgaria, where no large-scale military action took place escaped war damage to a great extent. However, the entire region came under Soviet rule, determining the course of its economic development for another 45 years.

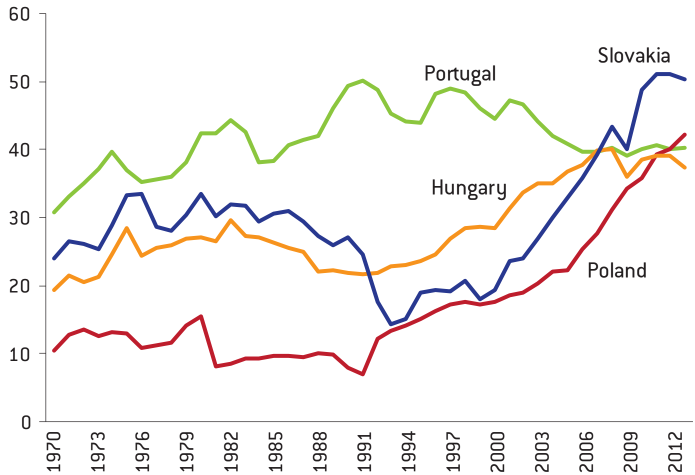
Figure 3: Industrial production in the Polish People's Republic 1950-90



Source: Kuklo *et al* (2013).

Unsurprisingly, industrialisation in central and eastern Europe during the 1950s followed the Soviet pattern (Bałtowski, 2009): companies were nationalised, and pre-war industrial elites were deprived of influence over their own enterprises, which started to operate within the logic of multi-year production plans designed by the communist party nomenclature. Because of exclusion from international financial markets, the accumulation of capital had to rely on local resources. Therefore industry developed at the expense of agriculture, whose surplus was taken over by collectivisation or compulsory purchase of food at artificially low prices. These funds were directed to the development of the mining sector, steel processing and the military complex, bending the production structure even more strongly than before the war towards resource-intensive production. This was accompanied by an increase in macroeconomic productivity as hidden unemployment in agriculture was replaced by more productive employment in manufacturing. However, the intra-sectoral effects of Stalinist industrialisation were rather small and the labour productivity of individual industries remained substantially below western standards. Nevertheless, after about five years, central and eastern Europe managed to return to levels of production and industrial employment last seen in the late 1930s. As this recovery was based on the resources inherited from the pre-war period – buildings, machines, infrastructure – the regional and international differences, running from the south-east (Romania and Bulgaria) to the northwest (Czechoslovakia, Polish Silesia, Pomerania, Warmia and Masuria) were maintained.

Figure 4: Industrial production per capita, selected countries, relative to the USA 1970-2013



Source: Own estimates based on data from Groningen Growth and Development Centre, OECD, UN.

The thaw of the 1960s did not change this situation very much despite the reorientation of resources towards a model much better suited to social needs (Bukowski *et al*, 2015). The means of production remained under state control, but the production structure shifted towards light industry (Figure 3) equalising the impact of industrialisation on regional development. In the least urbanised countries (Poland, Bulgaria and Romania) the migration from rural to urban areas continued, leading to certain improvements in the quality of life and providing industry with a greater number of workers.

The development gap between the two sides of the iron curtain did not shrink however. When the market economies of the European south – Italy, Spain, Greece and Portugal – were effectively catching-up with the more industrialised north (Eichengreen, 1995), the eastern countries were severely constrained by the limitations of central planning (Figure 4). In the absence of market competition and private property, the ability of the socialist enterprises to absorb and disseminate innovations was so low that the technological gap dividing the east and the west widened. The USSR, Poland, Czechoslovakia, Romania, Hungary and the German Democratic Republic struggled to produce substitutes for most western consumer goods, and eastern European cars, television sets and household appliances clearly fell behind the west in terms of technological sophistication, production quality and variety.

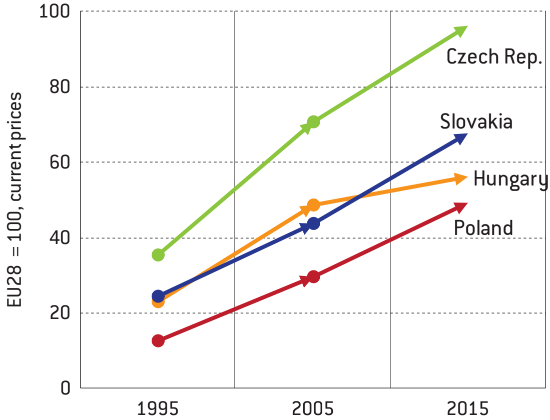
Deficiencies in quality control, discipline and organisation of work, marketing and distribution isolated even the most industrialised parts of the Eastern Bloc from the global economy. Without the market test, they could sell only to the uncompetitive COMECON (Council for Mutual Economic Assistance) market, but even there they were – because of very low labour productivity – largely unable to satisfy the demand. By the internal logic of a centrally planned economy it was impossible to reward individual effort, productivity and creativity, and therefore socialist industry was unable to approach the standards required by western customers amplifying the mistakes of central planners when they decided to import outdated technologies instead of attracting private foreign investment (Bałowski, 2009). In the 1980s the economic bankruptcy of the socialist system became apparent throughout the Eastern Bloc when economic growth visibly slowed down. In some cases (Poland and Romania) this led to significant supply shortages and a visible reduction in the average quality of life. An attempt to spur domestic production through large-scale investment programmes financed by foreign loans was unsuccessful, whereas limited reforms that created some space for individual entrepreneurship were too small to make a difference.

6.1.3 Economic transition

From 1989, Poland and shortly thereafter the remaining satellite states of the USSR began to make a sequence of intense political, social and economic changes collectively called the Transition. As a consequence, central and eastern Europe was reintegrated with the rest of Europe and the global economy, resulting in spectacularly intense industrialisation accompanied by the deep restructuring of the industrial base. At first these processes advanced in the fastest-reforming states: Slovenia, Poland, the Czech Republic, Slovakia and Hungary. Later they reached Romania, Bulgaria and the Baltic states. Because of the numerous failings of the socialist economy, even relatively small organisational changes and limited investment in new machinery and equipment could significantly increase the value of industrial production wherever market expectations were easy to meet.

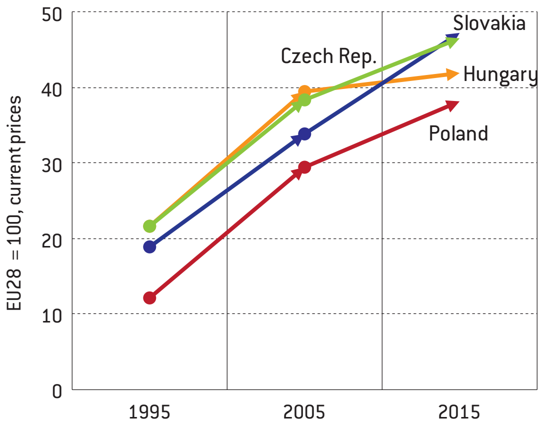
At the same time, the international competitiveness of many industrial sectors was very low. The new economic reality required manufacturing enterprises to rapidly improve their production efficiency, and also their quality and structure, distribution channels, management methods and the discipline and organisation of work. Most of the socialist workplaces employed a very large number of poorly managed and, as a rule, low-skilled workers, making the employment restructuring one of the most obvious efficiency reserves. This resulted in a sharp increase in unemployment, but also in significant resource management improvements. Not all branches of the post-socialist industry could cope with the reality of the market economy and much more developed external competition. Excessive production capacity in the mining, metallurgy and defence industries matched the needs of the material-intensive socialist economy, but did not meet the expectations of the market for economic, technical and environmental reasons. Consequently, employment in heavy industry in central Europe dropped by several hundred thousand workers, and many of the least efficient or most environmentally harmful plants were closed.

Figure 5: Manufacturing value added per capita in central and eastern Europe 1995-2015 (EU28 = 100)



Source: Bukowski and Śniegocki (2017).

Figure 6: Manufacturing value added per worker in central and eastern Europe 1995-2015 (EU28 = 100)

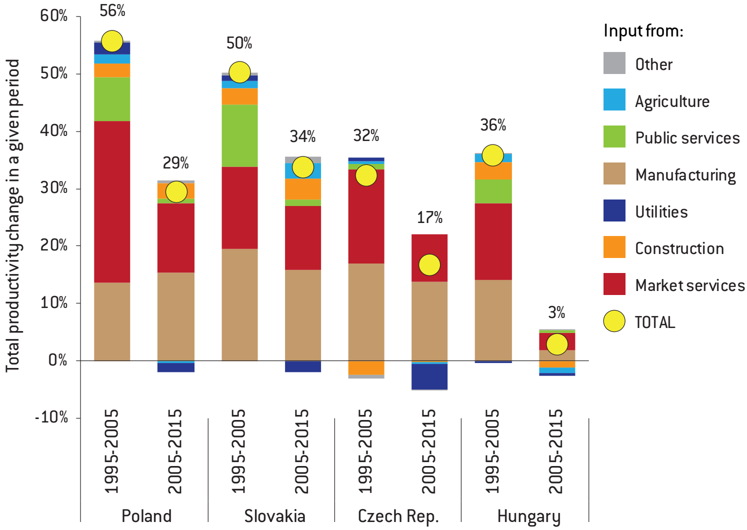


Source: Bukowski and Śniegocki (2017).

A deep crisis affected the parts of the manufacturing sector in central and eastern Europe that was exposed to global competition, especially from Asia. Many textiles, clothing or electronics companies in central and eastern Europe failed because of competition from cheaper or better-quality imports. This had major regional repercussions, translating into high unemployment in traditional industrial districts. The macroeconomic dynamics of central European manufacturing, however, were very different: the output of closed plants was soon made up for by increased output from privatised enterprises or new companies founded by emerging entrepreneurs and foreign capital. The post-transition crisis in the fastest-reforming countries – Slovenia, the Czech Republic, Poland, Slovakia and Hungary – was short-lived, and their economies in just a few years returned to the pre-transition level of development.

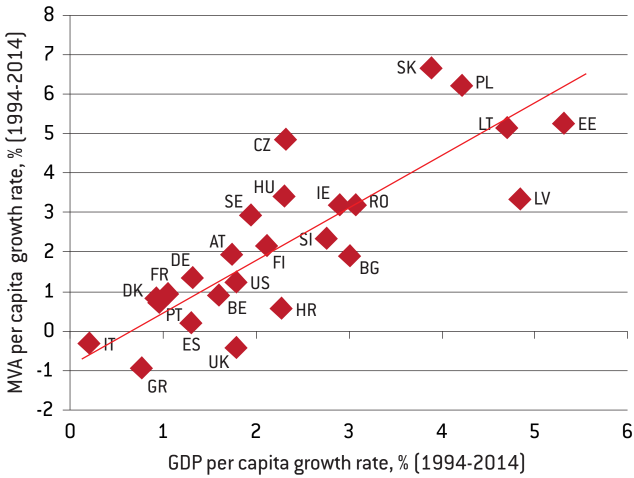
The structure of central European industry changed. Manufacturing employment shrunk by 20-30 percent, largely mirrored by higher labour productivity and product quality. Exports started to grow, as did the level of industrialisation (measured by the value of industrial production per capita) from an initially very low level. The gap compared to western Europe was however so great that even those countries like Poland and Slovakia, which have rapidly increased their productivity (Figures 5 and 6), still have not reached the western level. Currently, the Polish and Hungarian manufacturing sectors produce in *per-capita* terms about 50 percent of the EU average (measured at market exchange rates). For Slovakia and Slovenia, the figure is 70 percent and for the Czech Republic 96 percent. For comparison, at the start of the transformation, *per-capita* industrial production varied between from 10 percent to 15 percent of the EU average in Bulgaria, Romania and Poland, was 25 percent in Hungary and Slovakia, and about 30 percent in the Czech Republic and Slovenia.

Figure 7: Contribution to economic growth of manufacturing and other sectors in central and eastern Europe 1995-2015



Source: Bukowski and Śniegocki (2017).

Figure 8: GDP per capita and manufacturing value added per capita growth rates 1994-2014



Source: Bukowski and Śniegocki (2017).

The intensive industrialisation of central and eastern Europe has clearly marked its economic growth (Figure 7). Each additional percentage point of industrial output growth can be estimated to have translated into about 0.7 percentage point of additional GDP growth. The fastest growing economies in the region have been Poland, Slovakia, Lithuania and Estonia, where industrialisation has also been most rapid. However, only the Baltic countries have taken full advantage of the economic potential of the industrialisation process, though they do not belong to the most industrialised parts of central Europe. GDP growth in Poland, Slovakia and the Czech Republic was about 1-2 percentage points lower than could be expected based on the growth rate of industrial output in these countries (Figure 8). The reason was slower productivity growth in other sectors of the economy: construction, mining, agriculture and public services. These countries have succeeded in shaping an institutional order that sufficiently supports the natural convergence of productivity and the growth of production volumes in the industrial sector, but does not fully tap the economic potential of the service industries, the agricultural sector or construction. In Latvia the process was reversed; relatively slow industrialisation was compensated for by the rapid increase in service efficiency. Obstacles could in both cases be structural: low urbanisation and fragmented structures of land ownership and agricultural production in Poland, the small scale of the Latvian economy and traditional structure of its industry and, in both cases, deficits in human capital.

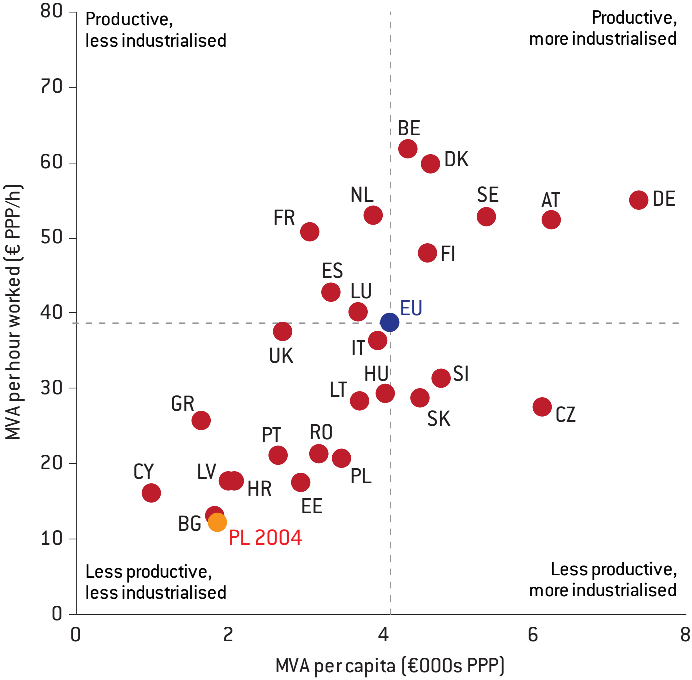
6.2 Manufacturing today in central and eastern Europe

6.2.1 Scale and internationalisation

The rapid industrialisation of central and eastern Europe between 1990 and 2015 had four main features. First, the expansion of production capacity increased the volume of manufactured goods. Second, investment in new machines and equipment, organisational improvements and transfer of industrial know-how from the west gradually increased labour productivity in the manufacturing sector. Third, quantitative changes were accompanied by qualitative improvements in the form of rising complexity and diversity of products. Fourth, the regions that benefited from the post-1990 industrialisation were largely the same as those that industrialised first in the nineteenth century and retained their industrial character during socialism.

These phenomena are well illustrated by the automotive sector. Towards the end of socialism, the automotive sector was dominated by a few plants located in the present day Czech Republic and Poland, which produced a total of about 600,000 vehicles per year. This production was poor quality and its technical sophistication was several decades behind western standards (Bukowski *et al*, 2015). After ten years this picture had changed. The number of cars leaving central European factories doubled and their production expanded to Slovakia, Hungary and Slovenia. This was thanks to international automobile producers that settled in central Europe, reallocating there the most labour-intensive elements of their value chains. After the accession of central and eastern European countries to the European Union, this process was reinforced by Asian and American companies. Currently factories located in central and eastern Europe produce about 3.6 million passenger cars per year, about 25 percent more than plants located in Italy and France combined. Moreover – in contrast to the final assembly model that dominated in the late 1990s – central and eastern European car plants are technologically no different to their western counterparts. Their presence has attracted to the region major investment in other sectors. In particular central Europe has become a major producer of automotive components and spare parts that are manufactured by smaller local companies as well as multinationals.

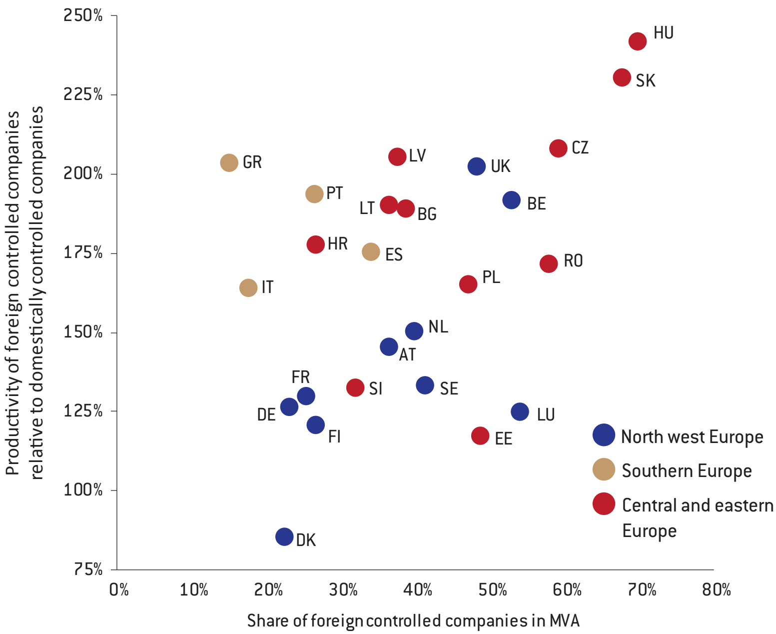
Figure 9: Manufacturing value added per capita and per hour worked in the EU 2015



Source: Bukowski and Śniegocki (2017).

The automotive industry was not the only branch of central and eastern European industry to significantly expand its manufacturing capabilities. A similar boom touched, among others, the production of household appliances, consumer electronics, lighting, furniture, medicines, chemical and metal products, and industrial and construction machinery and equipment. In all cases, the role of foreign investment for the development of manufacturing capacity was crucial. Foreign owned companies account for more than 70 percent of manufacturing value added in Slovakia and Hungary, about 60-65 percent in Romania and the Czech Republic and about 40-55 percent in Poland, Bulgaria and the Baltic states (Figures 9 and 10). The smallest share of foreign capital in industrial production is found in the countries of the former Yugoslavia – Slovenia and Croatia – which already during socialism had companies capable of exporting medium-tech goods to western markets.

Figure 10: Relative productivity of foreign-controlled manufacturing companies and their share *of manufacturing value added*



Source: Bukowski and Śniegocki (2017).

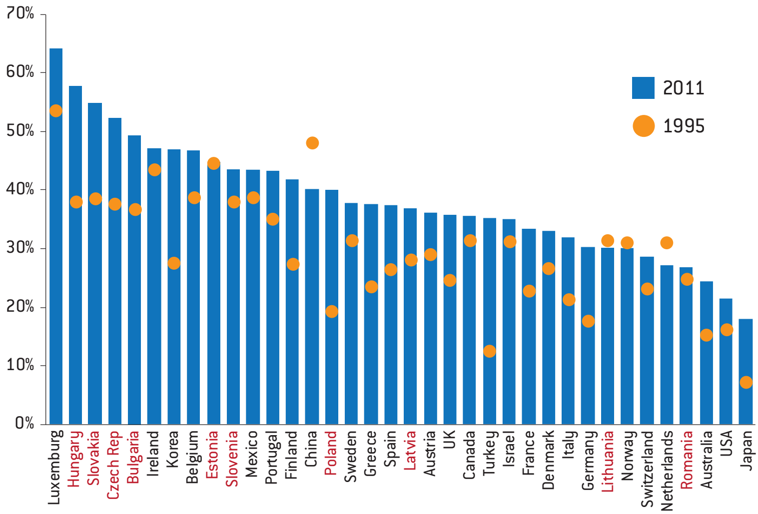
The importance of foreign investment for the industrialisation of central and eastern Europe after the 1990s is even more visible in the area of labour productivity. In most countries, foreign manufacturing companies are two to 2.5 times more productive than domestic firms. Only Estonia and Slovenia, which are already industrialised along western lines (with lower levels of total production per capita), and to a lesser extent Poland and Romania, do not reflect this pattern. In Romania, the gradual convergence of labour productivity between domestic and foreign-owned companies is visible, although exports are still dominated by large (250-999 employees) and very large (more than 1000 employees) foreign companies. Domestic manufacturing is more oriented towards the internal market and its contribution to the export boom after Romania's accession to the European Union was limited to medium-sized enterprises.

6.2.2 Economic complexity

In the last 30 years, the rollout of global value chains has significantly contributed to the international division of labour, changing the employment structure of high and middle income countries, including those of central and eastern Europe. The countries of central and eastern Europe joined the global economy exactly at the point that globalisation accelerated.

From the point of view of an industrialising country, the most important consequence of globalisation is the need to adapt its production profile to the closest industrial centre – the main source of final demand, investment capital and component supply. For central and eastern Europe, this means the European Union and in particular its industrial core stretching from northern Italy, through Austria, Switzerland and the French-German border to Belgium and the Netherlands. From this perspective it is worth looking at the structural changes in central and eastern European industry after the collapse of communism in 1989. In the centrally planned economy, employment in manufacturing per unit of production was clearly higher than in the west (Figure 1). In the first years of transformation this led to large-scale restructuring of the overbuilt production capacity in mining and steel production and low-tech branches that like textiles or leather manufacturing migrated to Asia. Today the share of low-tech manufacturing in central and eastern European employment is much lower than in some of the southern European middle-income countries, such as Portugal and Greece. This is related not to the retention of a large number of workers in low-tech sectors in southern Europe, but rather to its inability to build a large industrial base in mid- and high-tech branches of manufacturing, and thus to reallocate employment to them.

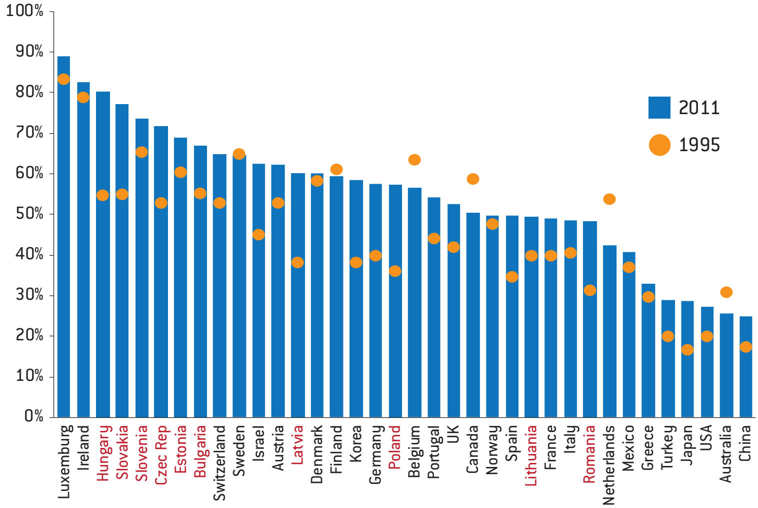
Figure 11: Share of imported components in the manufacturing export value



Source: Bukowski and Śniegocki (2017).

The employment structure in central Europe today resembles those of Italy or Spain, rather than those of Greece or Portugal. However, medium and high-tech sectors such as electronics, optical equipment and pharmaceuticals are on average under-represented in the region, compared to Germany and other highly industrialised economies such as Austria, Sweden and Switzerland. The revealed comparative advantage of central Europe is in the industries that were already present there before 1990 but which are complementary with the western European manufacturing base. Poland illustrates this. After joining the EU, Poland recorded a rapid increase in the production of machinery (16 percent per annum), metal (13 percent per annum) and transport equipment (9 percent). The major source of this boom was the functional integration with the single market and the rapid development of trade with the industrial centre of Europe. In fact after 2004 the hallmark of central and eastern European manufacturing was its internationalisation. Currently, almost 60 percent of the value added created by Polish industry is generated by foreign demand (Figures 11 and 12). This value is typical for large export-oriented economies such as Germany and South Korea. For smaller countries such as Estonia, Slovakia, Slovenia, Bulgaria and the Czech Republic, this ratio exceeds 70 percent, and in some cases, such as Ireland, Hungary and Luxembourg, even 80 percent.

Figure 12: Manufacturing value added dependent on foreign demand



Source: Bukowski and Śniegocki (2017).

The Hausmann and Hidalgo (2014) economic complexity index synthesised these changes. The index combines the average complexity of goods produced in different countries with the degree of their diffusion to international markets. Countries that produce a variety of technologically advanced and rare goods, and that have networks of trade links with other equally advanced countries, score high. At the opposite extreme are economies that focus on production of relatively simple goods and that trade with partners that also produce easily accessible products with a low degree of technical complexity. The changing Hausman and Hidalgo index for the period between 1990 and 2015 shows that the complexity of the central European economies gradually increased throughout the period of economic transition. Companies located in central and eastern Europe gradually built up trade relationships with much more industrialised western Europe and through that increased their technological sophistication. Poland managed to close the complexity gap from 60 percent in the early 1990s to 30-40 percent today. Even more progress was made in other central European economies such as Hungary, Czech Republic and Slovakia which – thanks to greater exposure to foreign investment – have visibly higher levels of economic complexity than Poland. On the other hand Poland is the only country in the region that, over the last two decades, managed to nurture a few globally competitive domestic manufacturers. Most of these businesses were started in the early 1990s and, through cooperation or competition with much larger multinationals, have been able to achieve significant presence in their industrial niches, at least in Europe.

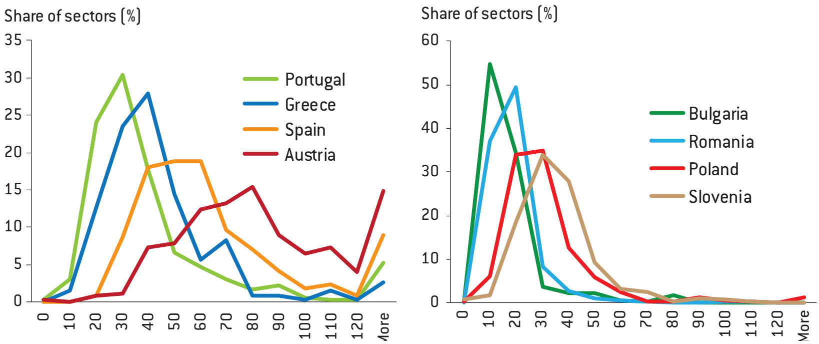
6.2.3 Productivity and wages

Despite structural similarity, the economic efficiency of central and eastern European industry is still below that of southern Europe. Particularly noteworthy is an almost complete absence of sectors with labour productivity exceeding €60,000. In Spain about one third of the manufacturing sector exceeds this level. As a result, from the perspective of foreign investors, manufacturing labour costs in central and eastern Europe have been and still are very low compared to Europe's industrial core. This promotes 'near-shoring' within the EU and encourages Asian and American producers to invest in the region. When choosing to invest in fully automated assemblage in the west or in semi-automated processes in central Europe, multinational companies often chose the latter.

Central European industrialisation after 1990 was primarily based on labour-intensive technologies. One reason for this might be the relatively slow convergence of price levels within the EU and the visibly undervalued currencies of those central and eastern European states that haven't joined the euro area. In addition, the region as a whole has not had enough time to create many medium-sized and large productive companies, either in industry or services. The presence in the economic structure of a large number of high-performing enterprises looking for the best staff has increased the wage pressure in the economy, forcing low-performing firms to seek productivity improvements. If the number of high-performing companies is limited, median wage levels are shaped by smaller establishments with modest economic quality. The observed concentration of manufacturing productivity around €24,000 (compared to €53,000 in Spain) even in the most industrialised central and eastern European countries might be a decisive factor behind the wage compression in the region, which results in a relatively low average personnel cost in manufacturing of about €13,000 (varying from €6,000-7,000 in Bulgaria and Romania to €13,000-16,000 in Poland, Hungary, Slovakia, Czech Republic and the Baltic States to €24,000 in Slovenia) per employee per annum (compared to €37,000 in Spain). The difference in productivity between central and eastern Europe and Spain or Italy is therefore smaller than the pay gap (Figures 13 and 14).

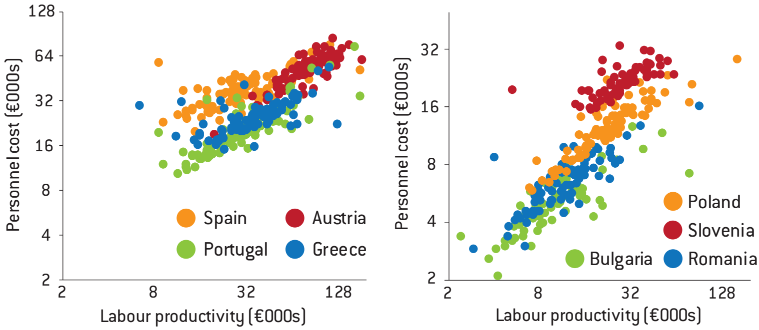
This might be due to the weaker market power of central and eastern European producers, which suffer from a shortage of well-known international brands and lack well-developed pan-European sales and distribution channels. On the other hand central and eastern European entrepreneurs can, thanks to the favourable terms-of-trade and relatively low cost of labour, accumulate capital and acquire industrial know-how without having to undertake rapid technological leaps. This allows them to gradually invest in better equipment, expand their sale networks, develop better marketing and brand promotion and even to innovate. These processes are delayed in comparison to the western part of the continent or to the production capacity development in the region. As a consequence, full convergence of European manufacturing, with respect to both the volume and efficiency of industrial production, might take about 15-30 years longer than the convergence of industrial output only. The Czech Republic is a good illustration of this phenomenon. It has already reached the average European level of industrialisation, despite its manufacturing sector being half as productive as that of northern Europe. Nevertheless the change since 1990 has been substantial. Value added per worker in Czech manufacturing increased between 1990 and 2015 from 20 percent to 46 percent of the EU28 average. Even faster change was observed in Slovakia (18 percent in 1990 and 47 percent in 2015) and Poland (15 percent and 38 percent respectively).

Figure 13: Manufacturing productivity distribution in selected countries, western Europe (left panel) and eastern Europe (right panel)



Source: Bruegel based on Eurostat. Note: In the right panel, one point represents one NACE 4-digit industry sector; in terms of productivity distribution, manufacturing in the Czech Republic, Hungary and Slovakia, which are not shown, are very similar to Poland, which is related to the similar stage of development of these countries.

Figure 14: Manufacturing productivity and personnel costs in selected countries, western Europe (left panel) and eastern Europe (right panel)



Source: see Figure 13.

6.3 Lessons for the future

The rapid pace of industrialisation in central and eastern Europe after 1990 was rooted in general structural and institutional change, which followed the pattern of countries in the south of Europe. Industrial development has been driven by the strong inflow of foreign investment and exports stimulated by integration with Europe's industrial core. Poland, Hungary, the Czech Republic and Slovakia, and later Romania, Bulgaria and the Baltic states, adopted the principle of openness to foreign trade and capital flows and made a number of institutional reforms that opened their economies to domestic and foreign competition. This accelerated the transfer of market know-how, and helped initially vulnerable domestic producers to integrate into global value chains.

Countries of the former Soviet Union (Ukraine, Russia and Belarus) acted differently. They created native oligarchies, which, after taking over most of the assets of privatised companies, only grudgingly promoted institutions that enhance market competition and transparency of economic processes. As a result, for a long time they have been unable to increase their manufacturing capacity over the capital inherited from the USSR, and their economic growth has had to rely on the exploitation of natural resources and the global raw materials boom.

Most of the non-Soviet central and eastern European states have exploited three main advantages they already had at their disposal: (i) relatively well-educated and young populations, (ii) geographical proximity to the European industrial centre, and (iii) already existing though nascent industrial cultures. The central European political class perceived accession to the EU as an opportunity for development and also as a genuine guarantor of independence from Russian influence. EU accession has led to many economically advantageous reforms that essentially fit into the Washington Consensus but are much broader and deeper. It can be assumed that without this external stimulus it would have been much harder to carry out so many large-scale reforms in such a short time. The strategy of Serbia and those parts of former Yugoslavia that chose an alternative path of economic and institutional development has not produced equally good results. Their economies were initially at a similar level of development to Poland and Slovakia but are today much poorer. The gap between the former Yugoslavia (except Slovenia and Croatia) and the central and eastern European average is both qualitative and quantitative.

The period of economic transition in central and eastern Europe, and with it a set of specific challenges resulting from the complex heritage of the centrally planned economy, is already closed. However, the east-west industrialisation gap is still there, although central and eastern European manufacturing has managed to move beyond the low-tech profile that dominated the socialist period. The productivity differences between the east and the west of the EU now result more from the smaller size of median producers and continuing shortfalls in human capital and organisational know-how, rather than from the disadvantageous sectoral structure of industry. The first stage of industrialization – a 'big push,' creating a relatively large, yet diversified manufacturing base capable of competing in the global economy – is therefore completed. This clearly distinguishes central and eastern Europe from other emerging markets and makes today's challenges in the region more like the problems of the industrialised world than those of developing countries. The main development challenge today is not to implant new types of industrial activity into the region but rather to increase the scale of the most productive industries and companies that are already present. This requires maintaining the current trend of development for the next 20-30 years and retaining the readiness to implement gradual reforms that constantly encourage domestic and foreign capital to invest in central and eastern European countries.

Based on international experience, it can be argued that such policies (Aghion *et al*, 2011; Núñez and Primi, 2009) should be horizontal and should include:

- Restructuring of declining industries;
- Providing regulatory support to competitive financial and capital markets;
- Building R&D infrastructure in enterprises and universities and reinforcing research in research institutions and private companies;
- Supporting the emergence and identification of talents through higher education;
- Facilitating the mutual cooperation between companies and between business and the scientific world;
- Attracting high-tech foreign companies and supporting their integration with national sub-contractors;
- Developing the training and dissemination institutions that can supply SMEs with information on export markets and key technologies.

Any public initiatives that target industrial development should always be responsive to market needs and, therefore, must not arise without close cooperation with industry itself. The main emphasis in the design of industrial policy instruments in central Europe should be on the competition with, and further integration into, the rest of the continent. This means leaving plenty of room for potential support not only by incumbent beneficiaries but also by the new players, as well as promoting the strong presence of the region within the EU and euro area.

References

Aghion, P., J. Boulanger and E. Cohen (2011) 'Rethinking industrial policy', *Policy Brief* 2011/04, Bruegel

Bałtowski M. (2009) *Gospodarka socjalistyczna w Polsce: geneza – rozwój – upadek*, Warsaw: Wydawnictwo Naukowe PWN

Broadberry, S., R. Fremdling and P.M. Solar (2008) 'European Industry 1700-1870', *Jahrbuch für Wirtschaftsgeschichte/ Economic History Yearbook* vol 49(2): 141–172

Bukowski, M., J. Gąska and P. Koryś (2015) 'Poland industrialised anew', in M. Bukowski (ed) *Employment in Poland 2014. Labour in the age of innovation*, WiseEuropa, Warsaw

Bukowski, M. and A. Śniegocki (2017) *Made in Europe: polityka przemysłowa wobec wyzwań XXI wieku*, WiseEuropa, Warsaw

Edvinsson, R. (2005) *Growth, Accumulation, Crisis: With New Macroeconomic Data for Sweden 1800-2000*, Almqvist & Wiksell International

Eichengreen, B. (1995) *Europe's postwar recovery*, Cambridge University Press

Hausmann, R. and C.A. Hidalgo (2014) *The atlas of economic complexity: Mapping paths to prosperity*, MIT Press

Koryś, P. (2015) 'The state as an entrepreneur: reorientation of the economic policy of the Republic of Poland in late 1930s and the development of state capitalism', *Ekonomia* 42

Kuklo, C., J. Łukasiewicz, and C. Leszczyńska (2014) *The History of Poland in Numbers*, Central Statistical Office, Warsaw

Leszczyński, A. (2013) *Skok w nowoczesność. Polityka wzrostu w krajach peryferyjnych 1943–1980*, Warsaw: Krytyka Polityczna

Peres Núñez, W. and A. Primi (2009) *Theory and practice of industrial policy: evidence from the Latin American experience*, United Nations Environment Programme

7 Europe's comparative advantage in low-carbon technology

Georg Zachmann and Robert Kalcik[33]

7.1 Introduction

Given the global decarbonisation push, the wide array of low-carbon technologies now available offers significant growth potential for manufacturing in the European Union. Some EU countries have already been able to develop a comparative advantage in wind turbines and electric vehicles, though the EU has been less able to develop a comparative advantage when it comes to exporting solar panels and batteries. Based on an analysis of patenting activity, we find the potential in some EU countries and regions to further specialise in all of these four low-carbon technologies. A regional overview is valuable because it can help in targeting public investment (eg in infrastructure, research and education) to enable development in the most promising sectors and regions.

The low-carbon technology sector is going through a period of disruptive innovation (Figure 1) and strongly increased investment (Figure 2), which is likely to continue (Figure 3). In addition, the share of low-carbon exports in all EU exports is increasing (Figure 4). The share of electric vehicle technology patents in all patents has increased fourfold since 2000, while it has doubled for wind turbines and has grown by half for photovoltaics. In the same period, the share of exports of wind turbines and electric vehicles in global gross exports increased sixfold, while exports of

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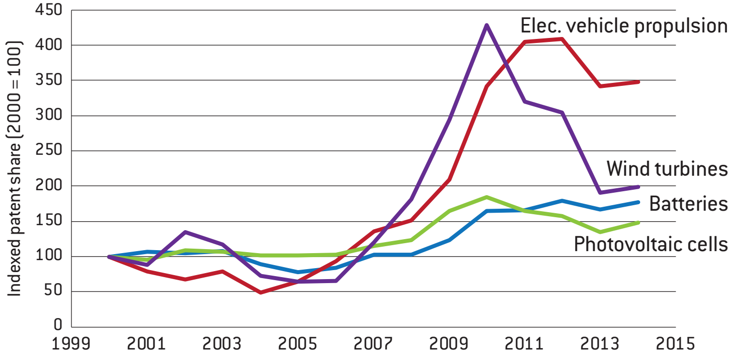
33 The research underlying this chapter was financially supported by the European Climate Foundation's Industrial Innovation for Competitiveness initiative (i24c).

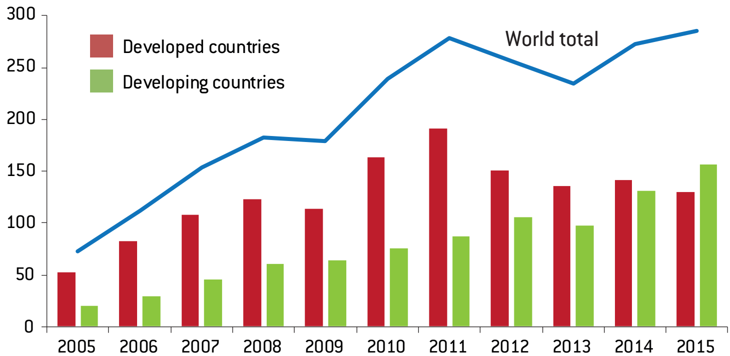
photovoltaic cells increased threefold, despite massively falling prices.

Figure 1: Share of certain low-carbon patents in total patents worldwide (index: 2000=100)



Source: Bruegel based on Patstat. Note: to keep it manageable we use throughout this chapter one International Patent Classification (IPC) code per technology: for electric vehicles we use B60L Propulsion of electrically propelled vehicles; for wind turbines we use F03D Wind motors; for batteries we use H01M Processes or means, eg batteries, for the direct conversion of chemical energy into electrical energy and for photovoltaics we use H01L Semiconductor devices; electric solid state devices not otherwise provided for.

Figure 2: Global new investment in renewable power and fuels ($ billions)



Source: Bruegel based on REN21 (2016).

On the demand side, global investment in renewable power and fuels has quadrupled over the last decade. And this development is only starting. Global investment in renewable power and fuels reached a new record of $286 billion in 2015 (Figure 2)[34]. While wind and solar power needed big subsidies everywhere 10 years ago, they have started to be competitive under specific conditions that are mainly defined by the climatic conditions, the structure of the incumbent system and local fuel and emissions costs. By 2015, wind and solar had become a mainstream option for power generation investment, accounting for more than 60 percent of investment in generation capacity globally[35]. This trend will continue as long as technology cost keep falling (which they have massively in the past decade) and/or as long as countries continue to support renewables to reduce the negative effects of fossil fuels, including greenhouse gas emissions.

The political momentum to combat climate change was reconfirmed and reinforced in 2015, when for the first time all countries agreed in the Paris Agreement to limit carbon emissions and to aim for carbon neutrality in the second half of the century. According to most current projections, deep decarbonisation will coincide with massive investment in renewable electricity generation and the parallel electrification of transport and heating. Together with growing electricity demand in emerging countries, the market for low-carbon energy will continue to increase[36]. But low-carbon technology investment

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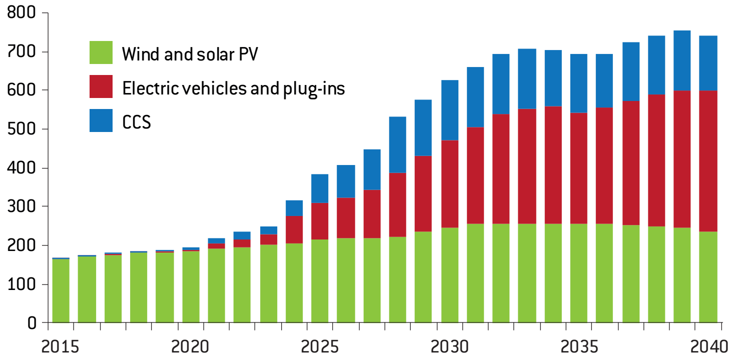
34 Between 2005 and 2015, renewable energy investment in developing countries grew steadily – especially in China, Brazil and India –overtaking for the first time in 2015 the total investment in renewables of OECD countries. Starting from $3 billion of investment in 2004, China overtook the US as largest investor in renewable energy in 2012 and accounted for more than a third of global commitments in 2015 (FS-UNEP/BNEF, 2016).

35 According to REN21 (2016, footnote 80), 63 gigawatts of wind power, 50 GW of PV, 28 GW of hydro and 3.8 GW of other renewable generation were installed in 2015, compared to 42 GW of coal, 40 GW of natural gas and 6.5 GW of nuclear.

36 Low-carbon technologies typically refer to very different types of technology that all compete with high-carbon alternatives. Examples are energy generation technologies such as renewables, but also nuclear, energy consumption technologies such as clean fuel vehicles, and technologies to make more efficient use of energy, such as smart meters.

will not be limited to power generation. Goldman Sachs (Kooroshy *et al*, 2015) estimates the market opportunity for electric vehicles and plug-in hybrids to be in the order of $240 billion by 2025. On top of that, there will be investment in other areas, such as $200 billion per year in energy efficiency of buildings. The International Energy Agency in its 450 ppm scenario – keeping the concentration of greenhouse gases in the atmosphere below 450 parts per million of CO2 equivalent, and hence global warming below 2°C above preindustrial levels – forecasts a need to ramp up annual investment in wind, solar, electric vehicles and carbon sequestration to about $750 billion after 2030 (Figure 3)[37].

Figure 3: Global investment in variable renewables, carbon sequestration (CCS) and electric vehicles in the 450 scenario ($ billions, 2013)



Source: IEA (2015).

We picked four technologies deemed essential for the low-carbon transition: electric vehicles, batteries, wind turbines and photovoltaic (PV) cells. All four are tradable; trade in them (apart from batteries) has grown faster than total international trade (Figure 4) and patenting

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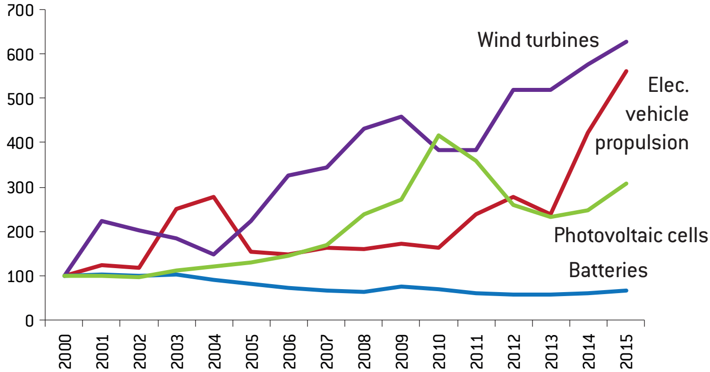
37 While globally the increase in demand for low-carbon technologies is clear, European markets for wind and PV might expand less fast because of over-capacity and past investment in these technologies. However, the EU might still be a competitive producer of these technologies despite stagnant domestic markets, because the markets are global.

activity has also outpaced activity in other areas (Figure 1). While the four categories do not perfectly fit into past trade and patenting statistics, existing statistical categories provide good proxies[38].

Figure 4: Share of certain low-carbon exports in total global gross exports (index: 2000=100)



Source: Bruegel based on Comtrade. Note: to keep it manageable we use throughout the chapter one Harmonised System (HS) code per export category: for Electric vehicles we use 870390 Automobiles including gas turbine powered; for Wind turbines we use 850231 Wind-powered generating; for Batteries we use 8506 Primary cells and primary batteries; for Photovoltaic we use 854140 Photosensitive/photovoltaic/LED semiconductor devices

38 The four technologies are at different states of maturity, while wind-power is (close) to a mature technology with the share in patenting declining, batteries seem to be at an earlier stage.

7.2 In which low-carbon technologies are EU countries competitive?

Countries that specialise in the production and export of goods associated with higher productivity levels perform better in terms of economic growth. If a country manages to export a wide range of goods that are typically exported by highly-productive countries, it is more likely to grow (Hausmann *et al*, 2005). Moreover, open market economies would not focus on exporting goods that they are not relatively good at producing. Hence, we assess the competitiveness of EU countries in low-carbon technologies using export specialisation as an indicator.

To control for the size of the countries and the size of the market segments we use the Revealed Comparative Advantage (RCA) to make the strength of countries in different products comparable[39]. The RCA is defined as the share of a good in a country's overall exports, divided by the share in all global exports of global exports of this good. The RCA is greater than 1 if a country exports more of this good than one would expect relative to the volume of its overall exports. For example, between 2004 and 2009, Germany, Denmark and Spain exported more than twice as many wind turbines (RCA>2) as one would expect from the volume of each country's total exports. By contrast, France, Poland, Italy and the United Kingdom exported less than half (RCA<0.5) as many wind turbines as one would expect from the volumes of each country's exports.

When moving into new sectors, countries tend to move to those that are related or 'nearby' the goods in which they already have a comparative advantage, in order to take advantage of their current productive structure strengths. This should give an important indication to policymakers by showing that the current productive structure of a country is a fundamental factor to take into consideration when deciding on support for the production of new technologies (Barabási *et al*, 2007).

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39 Note that a comparative advantage in a good does not necessarily mean that a country exports more of this good than other countries. It only means that relative to all other goods exported by a country, it is better at exporting this good.

In the past decade, developments within and outside the EU have changed the comparative advantage of EU countries in the four low-carbon products of interest:

- No change was observed for **wind turbines**: the comparative advantage enjoyed by Denmark, Germany and Spain has been maintained[40].

- Poland had a comparative advantage in **electric vehicles**, which was a very narrow niche market in 2004-09[41]. Then the west European car-making countries – primarily Germany, France, Belgium and Spain, but also the UK, the Netherlands and Finland – gained a competitive edge in the emerging segment. Poland's comparative advantage vanished when the market grew. Slovakia is an interesting case. Slovakia's electric car exports grew fast: from $12 million in 2012 to $68 million in 2015. And with Volkswagen, PSA and Kia having major operations in Slovakia, the country is by far the global leader in car production per 1000 inhabitants (178 compared to 68 in Germany). In 2013, the Volkswagen plant in Bratislava began to produce the group's first fully electric-powered vehicle – the Volkswagen e-up! – making Slovakia one of the main European producers of electric vehicles.

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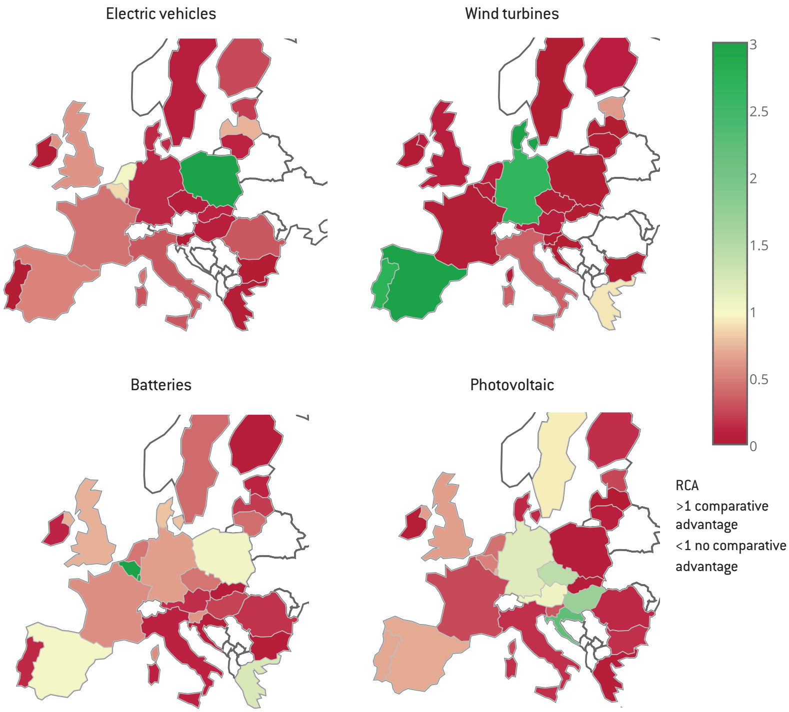
40 Some small countries have highly volatile wind turbine exports: Bulgaria had virtually no exports up to 2010, but $190 million in 2011, $14 million 2012 and $500,000 in 2014. Greece's wind turbine exports stood at $10-20 million up to 2010, then $55 million in 2011 and $32 million in 2012.

41 Melex has been producing electric vehicles for niche applications (golf courses, hotels) in Poland since 1971. Poland's exports in this category were $240 million before 2010, but dropped to $1.4 million in 2011 and thereafter, indicating an apparent data issue.

Figure 5a: EU revealed comparative advantage (RCA) in four product categories, 2004-09



Source: Bruegel based on UN Comtrade

- The picture is very different for **photovoltaic cells**. Despite significant support for solar PV deployment in many EU countries (most notably the feed-in tariffs in Germany, Italy and Spain), none has been able to defend its comparative advantage in this technology. The early comparative advantages enjoyed by Germany and the Czech Republic vanished after 2010, when Asian suppliers managed to undercut EU production costs. Croatia's comparative advantage has arguably also vanished, with only one remaining manufacturer reported in 2015[42].

- For **batteries** the EU as a whole has no comparative advantage. Only Belgium – with a global chemical industry cluster (including Umicore and Solvay) – has remained a main battery exporter (2005: $750 million; 2010: $720 million; 2015: $640 million)[43]. Luxembourg seems to have lost its battery exporting business (2005: $46 million, 2010: $3 million). The largest Luxembourgish battery producer we found, ACCUMALUX, had by 2010 outsourced battery production to the Czech Republic and Bulgaria. Battery exports are currently concentrated in a few Asian countries which are relatively specialised but also dominant in terms of absolute export market shares. Among them are Indonesia (RCA = 5.0), Singapore (4.0), Hong Kong (2.6) and China (2.2)[44].

We assess the potential of countries to develop an export specialisation in one of the four low-carbon technologies by examining whether they are specialised in similar products. We also look at the export patterns of similar countries. Hausmann *et al* (2014) show that a country's future comparative advantage in a product category can be estimated from its comparative advantage in technologically related products, even if the country does not yet export these products. This has been shown to be highly predictive of long-term industry growth.

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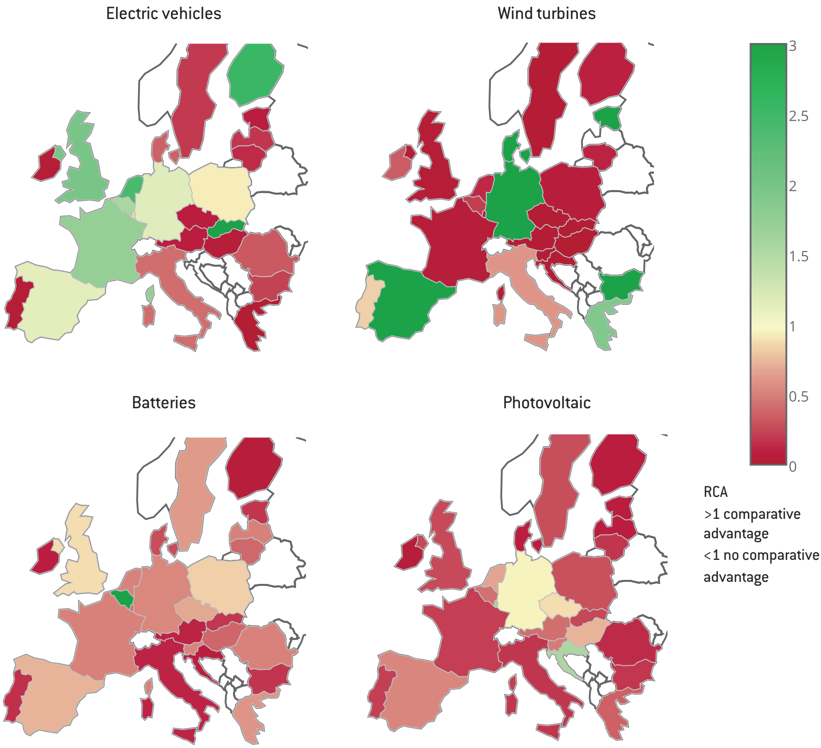
42 http://www.enfsolar.com/directory/panel/other_europe only reports SOLVIS. Other companies previously reported (http://www.cres.gr/biocogen/pdf/coutries/Croatia.pdf), such as Solar Cells LTD and SOLARIS, seem to have left the market.

43 Also hidden champions such as Prayon – a €700 million turnover phosphate-chemicals company – moved into battery technology.

44 China hosts the largest lithium ion manufacturer globally, Tianqi Lithium. This follows its acquisition of Talison Lithium in 2012 and Galaxy's Jiangsu processing facility in 2015 (IEEFA, 2017).

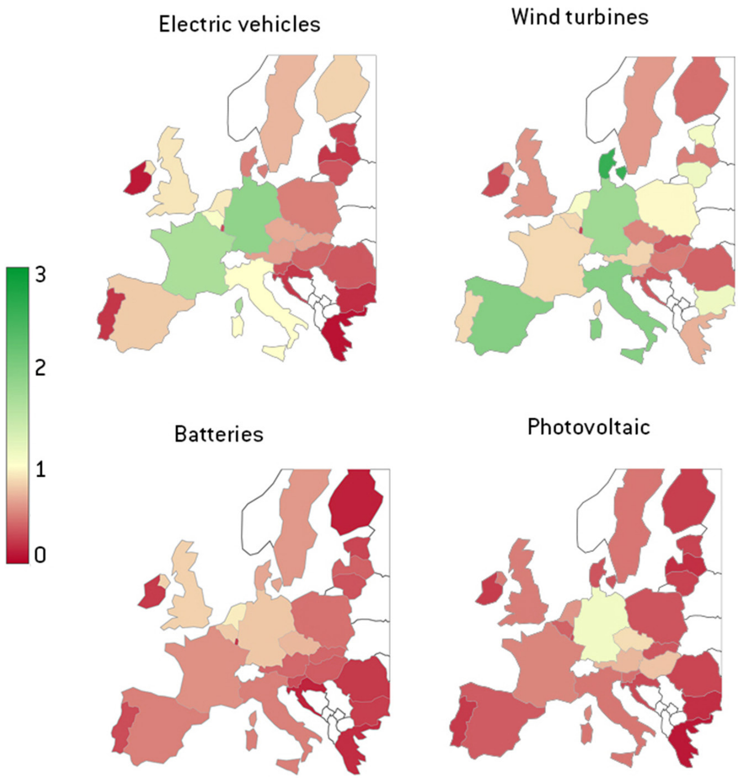
Figure 5b: EU revealed comparative advantage (RCA) in four product categories, 2010-15



Source: Bruegel based on UN Comtrade.

The similarity measure is based on the RCA of country-industry pairs. Two products are assumed to be similar if the correlation of RCAs in these categories across countries is high. For example, export specialisation in photovoltaic devices often appears together with the export of transistors (r = 0.86) or diodes (r = 0.85). Analogously, two countries are similar if the RCAs correlate across industries. Geographically proximate countries often exhibit similar export specialisation, such as Japan and South Korea (r = 0.74) or Lithuania and Latvia (r = 0.73). A weighted sum of RCA indicators in similar export sectors and similar countries is used to determine the potential RCA.

Figure 6: Export specialisation in related product categories and similar countries, 2010-15



- Between 2009 and 2014, several car manufacturing countries were able to develop a revealed comparative advantage in exporting **electric vehicles**. Italy is an exception because it has not specialised in exporting electric vehicles. However, given its exports in related products, and the patterns seen in similar countries, such as Germany or France, Italy has the potential to develop an export specialisation in electric vehicles.

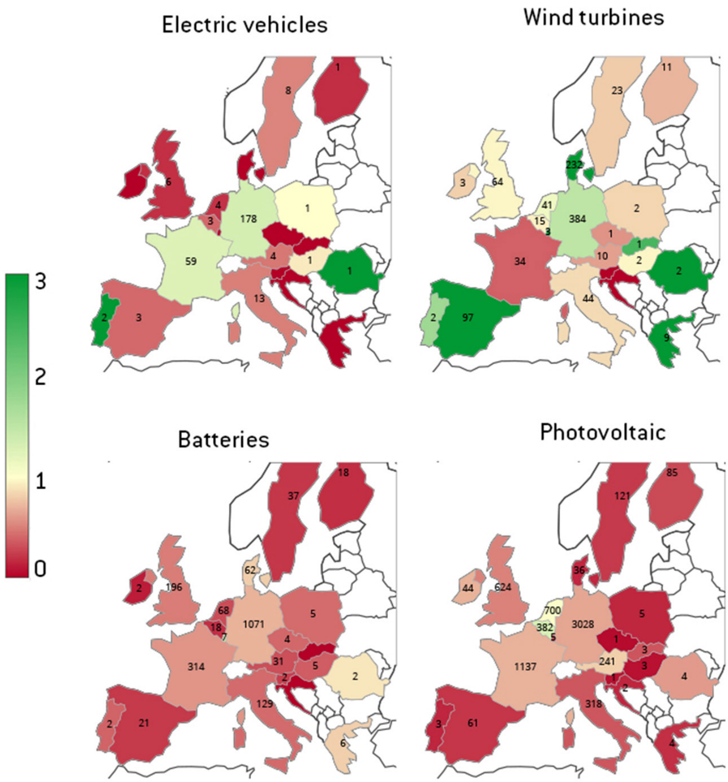
- Although **wind turbine** exports are dominated by Spain, Germany and Denmark, an examination of the export patterns of similar countries and industries indicates that several central and eastern European countries might develop specialisations in the future. In particular, Poland's and Lithuania's exports of related products reveal greater potential for specialisation than has so far been realised.

- For **batteries** and **photovoltaic cells,** the analysis shows that export patterns in Europe and similar countries do not suggest that any EU country has the potential to specialise in these technologies.

7.3 In which low-carbon technologies might EU countries become competitive?

In a market economy, current strength is a good predictor of future strength in producing and exporting certain products. Current strength indicates that crucial factors are available and their prices are appropriate, that knowledge and a network of suppliers are established and that the regulatory environment is conducive. But the absence of a revealed comparative advantage does not imply that a country is unable to develop new strengths in the future. One of the building blocks of future comparative advantage – especially in new technologies – is innovation. Thus, countries that focus their innovation activity on specific technologies are more likely to develop/strengthen a comparative advantage in exporting the corresponding products.

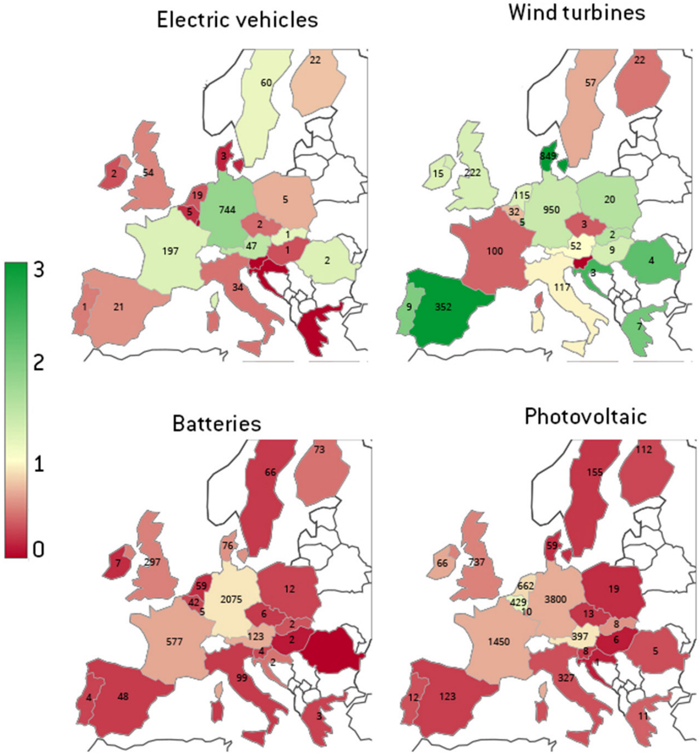
Figure 7a: Technology specialisation (RTA) and number of patents in four technologies 2003-08



Source: Bruegel based on Patstat. Note: Colour depicts RTA, numbers show patent counts. Only countries with at least 300 patents in the period of observation are included.

In line with this, we expect that some countries that specialise in innovation in certain technologies might manage to build comparative advantages in these areas. Thereby, the revealed technology advantage (RTA) is the equivalent to the revealed comparative advantage in terms of patenting. The RTA is defined as the share of a technology in a country's overall patents, divided by the global share of this technology in all patents. Hence, the RTA is greater than one if a country is patenting more in this technology than would be expected from the total number of patents from the country[45].

Figure 7b: Technology specialisation (RTA) and number of patents in four technologies 2009-14



Source: Bruegel based on Patstat. Note: Colour depicts RTA, numbers show patent counts.

45 The number of patents attributed to a country is based on the location of the inventor of patents applied for from the European Patent Offices or international patents under the Patent Cooperation Treaty. The patent holder might be in a different country from the inventor. The earliest application of individual patent families is used and attributed in fractions to all inventor countries and technology codes. Only countries with at least 300 patents during the analysed periods are included.

For example, Greece's patenting related to wind turbines (RTA>2 in 2003-08) was accompanied by the development of a comparative advantage (RCA < 1.0 in 2004-09 versus RCA > 1.1 in 2010-15). We cannot establish causality because many factors influence the development of competitiveness (eg deployment and presence of similar technologies – see Huberty and Zachmann, 2011) and companies that produce/export a certain product are also more likely to generate patents in this area. However, RCA and RTA are complementary indicators for the potential of future competitiveness.

In some low-carbon technology areas such as batteries and photovoltaics, the number of patents is high, because they are types of technology for which there is more patenting, commercial interest in the technologies is high and the categories are broadly defined. Much less patenting occurs in relation to electric vehicles and wind turbines, though EU member states have embarked more on specialisation in the latter two fields. Patenting data is no perfect measure for innovative activity. It only measures a specific step in the innovation process and, because patents are a legal instrument to enforce intellectual property, they are only applied for if an inventor requires this protection. Not all innovation is patented. However, companies might also decide to patent very minor technological improvements in order to enjoy protection for their intellectual property. Thus the quality of patents can be quite variable[46].

As expected, countries that are good at exporting certain products are often also good at patenting in related technologies.

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46 The use of additional data sources and patent quality indicators (such as citations or patent family size) is warranted in order to increase the reliability of the analysis. This, however, often implies working very far from real time – because the quality of a patent is only revealed over time. This calls for improved innovation statistics at EU level, for example through a European energy information service, which would collect and administer energy innovation statistics.

- For **electric vehicles,** we find that almost all EU countries have significantly increased the number of patents in electric propulsion technology. This has helped France and Germany keep pace with the growing patenting field and develop a comparative advantage in exporting electric vehicles. Austria and Sweden are also responsible for relatively more patents in electric propulsion than in other technology fields but are yet to develop a comparative advantage in exporting electric vehicles[47].

- With a few notable exemptions, most EU countries have a technology advantage in **wind turbines**. This is even true for countries such as the UK, which were not strong exporters of wind turbines. Many central and eastern European countries also patent relatively more in wind turbine technology than their small number of total patents would suggest. Then there are the global wind powerhouses Denmark, Germany and Spain, which together accounted for 43 percent of worldwide wind turbine patents from 2000-14. The most notable exception is France, which has only filed about half as many patents as the average country in wind turbines, relative to its overall patenting activity. Belgium, Sweden, Finland and the Czech Republic also do not focus on wind turbines.

- The picture is completely different for **battery technology**. No EU country has a revealed technology advantage – not even Belgium, which has done relatively better at exporting batteries. The reason is the dominance of South Korea (RTA = 2.54) and Japan (RTA = 2.28), which both have more than twice as many

47 This is also true for Romania. However, given the small number of patents produced by Romania, these numbers have to be interpreted with caution. A relative technology advantage (RTA>1) is already driven by a small number of patents during the analysed period.

batteries patents as one would expect from their overall patenting activity[48]. Furthermore, thanks to their patenting legislation and sectoral focus[49] Japan and South Korea are among the strongest patent producers in the world. Japan has 43 percent and Korea 14 percent of all patents considered (by comparison France accounts for 3 percent). However, if these two battery patent powerhouses are excluded from the analysis, several EU countries have an above-average share of battery patents in total patents such as Germany (RTA = 1.56), Austria (RTA = 1.19) or France (1.14).

- **Photovoltaic** technology patents illustrate well that our RTA measure does not capture absolute patent numbers, but countries' relative specialisations. Germany and France generate many photovoltaic patents – many more than for wind turbines – but that is largely because the patent category is much wider. The photovoltaic patents category accounts for almost 4 percent of global patents, while wind turbines accounts for only 0.4 percent. So although between 2009 and 2014 France produced 1,450 patents and Germany 3,800, the only EU country with a small revealed technology advantage in this technology class is Belgium (RTA = 1.16). The most specialised countries are Japan (RTA = 1.74), South Korea (RTA = 1.69) and Singapore (RTA = 1.59), while interestingly China is under-specialised in this category (RTA = 0.90). If the top-three Asian countries are dropped from the sample, only Belgium (RTA = 1.52), Austria (RTA =

48 South Korea and Japan, however, do not exhibit a revealed comparative advantage in exporting batteries, mostly driven by the concentration of the export market in other Asian countries.

49 Japan's patent figures are likely to be inflated by the greater tendency to patent incremental innovations, as well as the concentration in Japan of patenting-intensive sectors, such as manufacturing and, in particular, electronics. See 'Mother of invention – Why is Japan the source of so many bright ideas?' *The Economist*, 3 August 2007.

1.18) and the Netherlands (RTA = 1.11) have an advantage in the photovoltaics technology category. The strong Dutch position is partly explained by the strong position of Philips, which applied for at least a fifth of the patents in this category[50]. Despite massive solar subsidies, Germany has not strongly specialised in photovoltaic technology innovation (RTA = 0.67). Interestingly, China is also responsible for fewer patents in solar PV than would be expected for a country with China's total number of patent applications.

Almost all EU countries are, in global terms, disproportionally innovative in either electric vehicles and/or wind turbines, while almost no EU country has a technology advantage in battery and photovoltaic technology. But this picture could change because countries can alter the focus of their innovative activity[51]. We want to determine which countries might have some of the prerequisites for developing an advantage in the four technologies of interest.

We build on the fact that countries find it easier to innovate in technologies that are related to technologies they are already good at, or those that are developed in countries with similar patenting patterns. Using an analogous method to the assessment of potential RCA in the previous section, we estimate potential technological specialisation from a weighted sum of RTAs in similar technologies and similar countries[52]. Although many indicators of technology proximity exist, we

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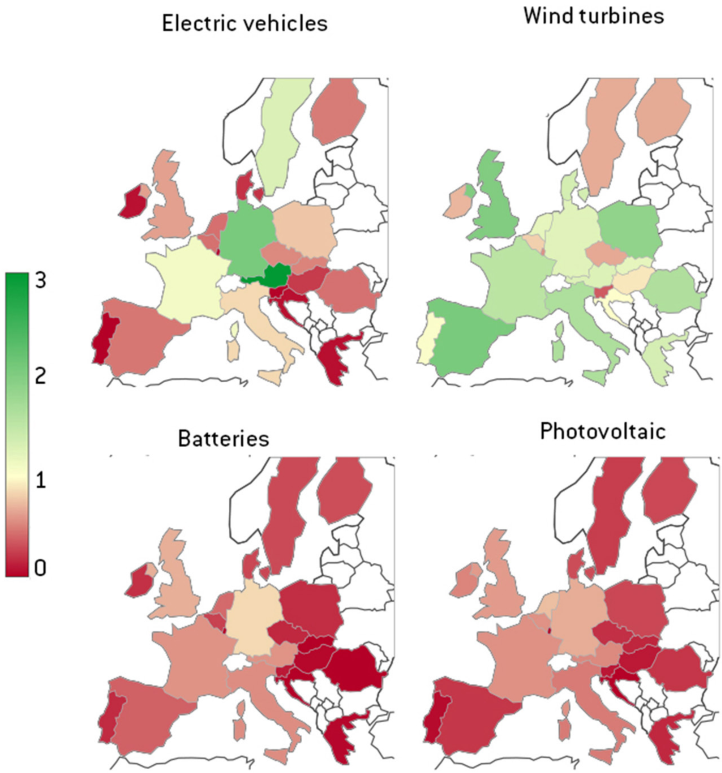
50 Includes lighting technology because the PV category H01L also includes LEDs. A quick inspection of the only partly-cleaned data shows that Philips applied for about 300 of about 1,500 patents that included the H01L technology code in the Netherlands between 2000 and 2014.

51 For example, Austria developed a technology advantage in electric propulsion and Ireland in wind turbines between 2003-08 and 2009-14.

52 The top 4 percent related technology codes are used, resulting in 26 technologies. The relationship between technology codes leads to weights that are not country specific.

use the relative frequency with which two technology classes (in fact technology codes) are developed within individual countries[53].

Figure 8: Technology specialisation in related technologies and similar countries 2009 - 14



Source: Bruegel based on Patstat.

To give one example, to establish Poland's potential for wind turbine innovation, we look at related technologies, such as 'machines or engines for liquids' and 'dynamo-electric machines', and related

53 For a recent discussion on different measures of technology proximity see Alstott *et al* (2016).

countries, such as Romania. We find that the potential RTA of Poland for wind turbines is rather high, because it is already specialised in the two nearby technologies. In fact, Poland is also already specialised in wind turbines.

In general we find that countries that specialise in nearby technologies are already also specialised in the low-carbon technology of interest – somewhat validating our approach. The interesting cases are, however, those countries that are good at innovating in nearby technologies, but which have not yet developed a specialisation in the technology of interest.

- The EU's innovative activity and export specialisation in **electric vehicles** both increased between the early 2000s and 2015. However, only France and Germany have consistently demonstrated comparative advantages in export and patenting activity. Austria and Sweden also have the potential to increase their comparative advantage. Italy, among the big car manufacturing countries, lags in terms of developing export or innovation specialisations in electric propulsion. Although the analysis of exports in related products and similar countries showed that Italy has the potential to increase its export specialisation, this was not found to be the case for its technological specialisation.

- For **wind turbines,** Denmark, Germany and Spain (but also Greece) have revealed comparative advantages, revealed technology advantages, and also the potential to increase their technology advantages based on specialisation in related technologies and similar countries. Portugal, the UK, the Netherlands, Poland, Slovakia and Romania have both a revealed technology advantage in wind turbines and a revealed technology advantage in related technologies. France so far has not excelled in patenting or exporting wind turbines – but the specialisation in innovation in nearby technologies and similar countries suggests that some of the technological prerequisites for strengthening innovation in wind technology are present.

- For **batteries,** the initial finding – that EU countries are neither good at exporting nor at patenting batteries – is largely confirmed. Only Germany appears to be slightly stronger than its EU partners at patenting technologies that are close to battery technologies.

- For **photovoltaic cells** the picture is even less encouraging – no EU country is strong in patenting photovoltaic cells technology or in closely related technologies.

7.4 Clusters matter

Innovative activity is not evenly distributed within countries. It largely follows the concentration of industrial activity. Consequently, patent data is helpful in identifying regional industrial strengths (clusters). The advantage of patent data over other types of data is that patent data is available for concrete locations (the address of the inventor), with a narrowly categorised technology description (the IPC code). The data is also rather consistent over many years. To properly analyse patent data we applied a machine-learning algorithm (Peruzzi *et al*, 2014) to attribute individual patents to companies, to categorise the inventors into different types (companies, individuals, universities) and to locate the inventors. This was done by combining the sometimes sketchy patent data with the comprehensive up-to-date company database Orbis. The algorithm in general works very well in attributing 2.6 million patents to about 150,000 inventors and fixing a location for 1.5 million of the patents.

When we plot the location of patents in our four technology categories, significant regional clusters emerge. For **electric vehicles** in

France, for example, the automotive clusters around Lyon (Renault), Paris (PSA and Renault) and Lille (Renault) stand out. These innovative clusters feature large companies and also smaller competitors and an ecosystem of suppliers. In Germany, the entire south-west (Daimler, Porsche, Bosch), the Ruhr (Opel, Mercedes, Ford) and the area around Munich (Audi, BMW, Siemens) are clusters of electric propulsion innovation.

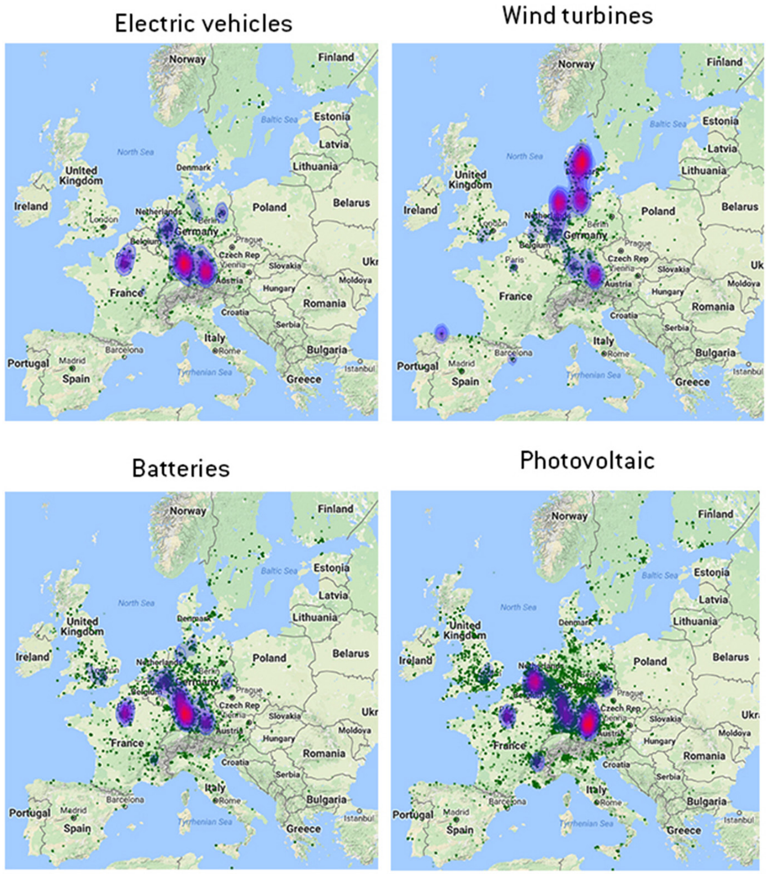
For **wind turbines** the three largest innovation cluster are Midtjylland (Denmark: Vestas, Siemens), Hamburg (Germany: Nordex, Senvion) and Oviedo (Spain: EDP Renováveis). But we also observe numerous smaller clusters of wind turbine innovation in other parts of Germany and Spain, and in the UK, Belgium and the Netherlands.

Not completely unexpectedly, the clustering of innovative activity related to **batteries** matches the innovation clusters for electric propulsion, with the addition of a cluster south of Berlin (the Daimler subsidiary Li-Tec Batteries in Kamenz[54]) and around London. In contrast to the country view there appear to be several smaller innovation hubs on a regional level that might develop further.

Among our four technologies, **photovoltaic** innovation appears least densely clustered, with a large number of small clusters across western Europe. This might partly be because the photovoltaic technology category is broadly defined – but could also be a consequence of the industry structure, which consists of more smaller-scale companies than the car or the wind industries.

54 https://de.wikipedia.org/wiki/Li-Tec_Battery. But Li-Tec might also serve as a warning. Despite public support and strong initial investment, production was stopped in 2015. Because of its location, Li-Tec was unable to build on a cluster in similar or nearby technologies or a strong academic research centre focusing on corresponding technologies.

Figure 9: Regional clusters of innovation 2000-13



Source: Bruegel based on PATSTAT. Note: In the map that plots absolute numbers of patents, the concentration of low-carbon research activity in particular countries/regions appears even stronger than in the RTA maps (Figure 7). This is mainly because we previously plotted the specialisations (RTA) of countries, which imply that a country can be good at a certain low-carbon technology even if it does not produce many patents in this technology class just because it produces few patents overall (so its specialisation in this low-carbon technology is nevertheless high).

Regional clusters of patenting activity in certain technologies are not just a result of clustered industrial activity. They also point to innovation spillovers – the most fascinating example being Silicon Valley[55].

To understand the importance of geographic spillovers for our four technologies, we analysed the distance between inventors and other inventors that they cite in their patents. Such citations, which identify significant previous patents on which the new patent builds, are part of patent filings. Our findings are in line with the literature[56], indicating a strong concentration of spillovers within clusters. For all four technologies, between a quarter and a half of the cited patents are applied for by person or company whose address is less than 50 kilometres away from the address given in cited relevant patents[57]. Innovators tend to climb on the shoulders of nearby giants.

The four technologies benefit from different types of knowledge spillovers. We can observe more significant technological clusters for batteries and solar panels, while this is less evident for electric vehicles and wind turbines. Solar panels are the technology with the greatest geographical concentration of citations. Solar PV and electric vehicles are more reliant on related technologies, while batteries and wind turbines mostly cite patents within the same technology class.

It is too early to make specific policy recommendations such as *"focus policy support for electric vehicles to regions that already excel in related technologies because regional spillovers matter"* or *"support national champions in photovoltaics as the within company*

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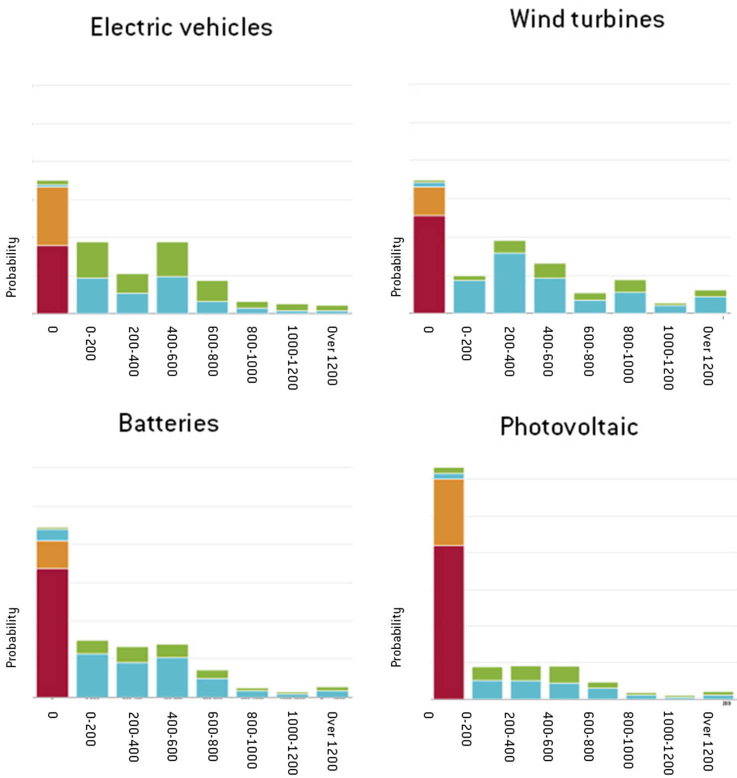
55 http://www.grips.ac.jp/r-center/wp-content/uploads/12-18.pdf.

56 For a summary of the literature see Carlino and Kerr (2014).

57 Compared to the academic literature, such as Jaffe *et al* (1993), Carlino *et al* (2012) and Murata *et al* (2014), we do not control for self-citation and other characteristics, and thus potentially overestimate the spillover effects, which those papers also found.

spillovers are so large" based on our limited analysis. But our results indicate that geographic knowledge spillovers matter and that these spillovers differ markedly between technologies. Therefore, cluster policies should be differentiated depending on the technology.

Figure 10: Histogram of geographic distance to other patents cited in patent applications



Source: Bruegel based on Patstat.

7.5 Conclusion

Europe's business model of selling more of the same in new markets is reaching its limits as the pace at which new markets emerge slows, while new competitors that sell the same products emerge quickly. One strategy to restore economic growth in Europe would be to export new products that promise higher value added and growing markets. One such area could be low-carbon technologies. In the framework of global decarbonisation and the desire to reduce resource consumption, the market for low-carbon technologies has been growing fast – and is likely to continue to do so.

In terms of Europe's potential, we assessed different criteria:

1. **Strength of current exports:** Strong exports are a powerful signal that a country is (relatively) better at producing certain goods or services. Different EU countries already have comparative advantages in a number of low-carbon technologies. For example Denmark, Germany and Spain are major exporters of wind turbines.
2. **Export strength in nearby products and similar countries:** Exports strength tends to be systematically correlated between countries and industries. Given current production patterns, several central and east European countries could have the potential to specialise in electric vehicle and wind turbine exports.
3. **Strength of current innovation:** Other EU countries might have the potential to develop comparative advantages based on their specialisation in innovation in these new fields. For example, Germany is already strong in patenting electric vehicle technology and might turn this into a comparative advantage.
4. **Innovation strength in nearby technologies and similar countries:** France has so far neither excelled in patenting nor in exporting wind turbines – but France's specialisation in innovation in nearby technologies suggests that some of the technological prerequisites for strengthening innovation in wind technology and ultimately boosting exports are present. Although modest in

absolute terms, some central and east European countries exhibit specialisation in technologies related to electric vehicles and wind turbines.

5. **Regional clusters:** Finally we find that – while only Belgium is good at exporting batteries and no EU country is good at inventing batteries – several regional clusters exist that produce significant battery technology patents. These clusters might be the nuclei of future growth.

We can therefore conclude that the EU has potential, but that one-size-fits-all policies would ignore the complexity of the task of supporting the EU economy to gain a competitive edge in new products and services that will form the basis for future growth and jobs.

References

Alstott, J., G. Triulzi, B. Yan and J. Luo (2016) 'Mapping Technology Space by Normalizing Patent Networks', available at http://arxiv.org/pdf/1509.07285.pdf

Barabási, A. L., R. Hausmann, C. A. Hidalgo and B. Klinger (2007) 'The Product Space Conditions the Development of Nations', *Science* 317 (5837): 482-487

Carlino, G., J. Carr, R. Hunt and T. Smith (2012) 'The agglomeration of R&D labs', *Working Paper* 12-22, Federal Reserve Bank of Philadelphia

Carlino, G. and W. R. Kerr (2014) 'Agglomeration and Innovation', *Working Paper* No. 20367, National Bureau of Economic Research

David, P., D. Foray and B. H. Hall (2009) *Measuring Smart Specialisation: The Concept and the Need for Indicators*, Knowledge for Growth Expert Group

FS-UNEP/BNEF (2016) *Global Trends in Renewable Energy Investment 2016*, Frankfurt School-UNEP Centre/BNEF Report

Gordon, R. J. (2012) 'Is U.S. Economic Growth Over? Faltering Innovation Confronts the Six Headwinds', *Working Paper* No. 18315, National Bureau of Economic Research

Hausmann, R., J. Hwang and D. Rodrik (2005) 'What you Export Matters', *Working Paper* No. 11905, National Bureau of Economic Research

Hausmann, R., Hidalgo, C., Stock, D., Yildirim, M. (2014) 'Implied Comparative Advantage', *Working Paper* No. 276, Center for International Development at Harvard University i24c (2016) *Scaling Up innovation in the Energy union to meet climate, competitiveness and societal goals*, Industrial Innovation for Competitiveness i24c

IEEFA (2017) *China's Global Renewable Energy Expansion*, Institute for Energy Economics and Financial Analysis Report

International Energy Agency (2015) *Energy and Climate Change*, World Energy Outlook Special Report

Jaffe, A., M. Trajtenberg and R. Henderson (1993) 'Geographic localization of knowledge spillovers as evidenced by patent citations', *Quarterly Journal of Economics*, 108 (3): 577-598

Kooroshy, J., A. Ibbotson, B. Lee, D. R. Bingham and W. Simons (2015) *The Low Carbon Economy: GS SUSTAIN equity investor's guide to a low carbon world, 2015-25*, Goldman Sachs, available at http://www.goldmansachs.com/our-thinking/pages/new-energy-landscape-folder/report-the-low-carbon-economy/report.pdf

McCann, P. and R. Ortega-Argilés (2015) 'Smart specialization, regional growth and applications to European Union cohesion policy', *Regional Studies* 49 (8): 1291-1302.

Murata, Y., R. Nakajima, R. Okamoto and R. Tamura (2014) 'Localized knowledge spillovers and patent citations: a distance-based approach', *Review of Economics and Statistics*, 96 (5): 967-985

Murata, Y., R. Nakajima, R. Okamoto and R. Tamura (2013) 'Localized knowledge spillovers and patent citations: A distance-based approach (revised version)', GRIPS *Discussion Paper* 12-18, National Graduate Institute for Policy Studies

Ortega-Argilé, R. (2012) 'The transatlantic productivity gap: a survey of the main causes', *Journal of Economic Surveys* 26 (3): 395–419

Peruzzi, M., G. Zachmann and R. Veugelers (2014) 'Remerge: regression-based record linkage with an application to PATSTAT', *Working Paper* 2014/10iii, Bruegel

REN21 (2016) *Renewables Global Status Report*, available at http://www.ren21.net/wp-content/uploads/2016/05/GSR_2016_Full_Report_lowres.pdf

The Economist (2007) 'Mother of invention – Why is Japan the source of so many bright ideas?', 3 August

Zachmann, G. (2012) 'Smart choices for growth', *Policy Contribution* 2012/21, Bruegel

8 From big oil to big data? Perspectives on the European energy industry of the future

Simone Tagliapietra and Georg Zachmann[58]

8.1 Introduction

Energy is a cornerstone of the European Union's economic architecture. In 2015, the EU spent €1.6 trillion on energy, or 11 percent of its GDP[59]. This represents about €3,000 per person. Energy system costs are expected to increase up to 2020 as large investments are undertaken driven by current decarbonisation policies. Overall, energy system costs are estimated to rise by 2020 to 12.3 percent of EU GDP. Between 2020 and 2030 this share is expected to remain stable, and to only decrease thereafter as the system reaps benefits from the investments undertaken in the previous decade, notably in the form of fuel savings. Between 2030 and 2050, the share of GDP of energy system costs is forecast to gradually reduce, reaching levels close to those in 2005 by 2050 (Figure 1).

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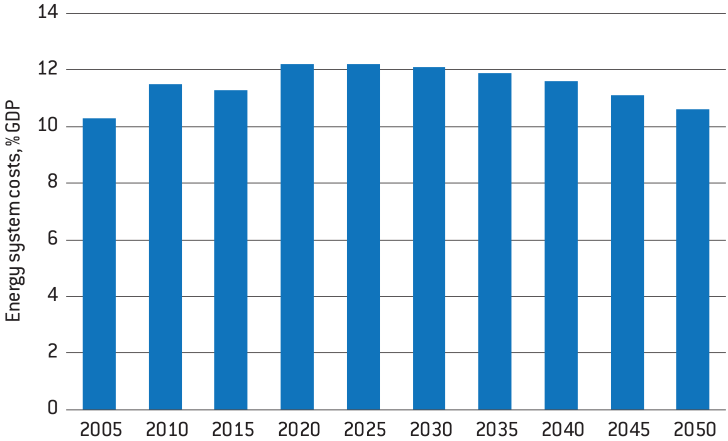
58 The authors are grateful to Enrico Nano for excellent research assistance.

59 The PRIMES model reports on costs from the perspective of final energy consumers; the sum of these costs gives the total energy system cost. It includes: i) capital cost (ie annuity payment for capital or energy saving investment); ii) variable costs for operation and maintenance; iii) fuel/electricity/steam purchase costs (including taxes, carbon costs, etc.); iv) renewable energy subsidy; v) disutility costs (< decrease in useful energy demand). Energy system costs exclude ETS auction payments, given that they result in corresponding auction revenues.

Figure 1: Evolution of energy system costs relative to GDP (%)



Source: PRIMES (2016).

The profound transformation of the EU energy system over the next few years will be shaped by two trends: decarbonisation and digitalisation. Based on strong public policies, decarbonisation is changing the European energy mix, while innovation in digital technologies is enabling disruptive change in the way energy systems are operated. Digitalisation should lead to the European energy system becoming more decentralised, with an increasing interaction of services (electricity, heat, transport, data) that used to be largely separated[60].

In this context, the European energy industry must quickly rethink its long-lasting business models in order to adapt to, and make the best of, the new reality. We first outline the two trends and then explore possible future scenarios for the EU energy industry, with a particular focus on oil and gas companies and utilities. We then

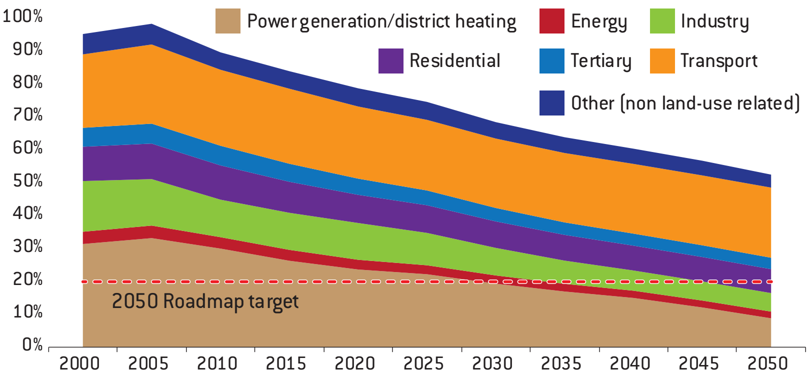
60 For a wider discussion of the decentralisation and convergence trends, see Tagliapietra and Zachmann (2016).

consider what EU policies needed to govern the transformation, and to ensure the stability needed by investors to deliver the annual €379 billion in investment required between 2020 and 2030 to turn the EU 2030 energy and climate targets into reality[61].

8.2 Decarbonisation and digitalisation are reshaping the EU energy system

The European Union's energy and climate policy architecture has at its core the aim to deliver decarbonisation. On the basis of a long-term objective to reduce greenhouse gas emissions by 80-95 percent by 2050 compared to 1990 (Figure 2), the EU adopted a binding 40 percent emissions reduction target to be achieved by 2030 compared to 1990. This target is also the basis of the EU's international commitment to the United Nations Framework Convention on Climate Change Paris Agreement[62].

Figure 2: EU greenhouse gas emissions reduction scenario under current policies: not yet in line with the 2050 target (1990=100%)



Source: Bruegel based on European Commission (2016).

61 European Commission (2016h).

62 See Latvian Presidency of the Council of the European Union (2015).

Turning these targets into reality is challenging. It requires radical changes to Europe's power, heating and cooling, industry and transport sectors.

The task can become even more challenging if the global effort against global warming is further strengthened[63]. The current EU 2050 decarbonisation trajectory is calibrated against the target of keeping the global temperature rise this century below 2 degrees Celsius compared to pre-industrial levels. This is also the central aim of the Paris Agreement. But the Paris Agreement also pledges to pursue efforts to limit the temperature increase to 1.5 degrees Celsius (a significantly safer defence line against the worst impacts of a changing climate) (United Nations, 2015).

Digitalisation, by making the overall energy system smarter and more efficient, can be an important catalyst for decarbonisation. Digital technologies give consumers more control over their energy use and offer benefits from additional services. At the same time, suppliers can optimise their operations and develop new offers, and system operators can benefit from new tools to manage their grids more efficiently and to integrate an increasing amount of variable renewables into the system. Interaction between intelligent appliances, smart grids and home platforms – mediated by or on behalf of consumers – can usher in a new era with radically different consumption patterns centred on automation and remote controls.

From a technological perspective, energy is already going digital. The share of patents in which energy and IT appear on the same patent application has boomed since 2006, largely outpacing traditional patents in IT and energy taken individually (Figure 3).

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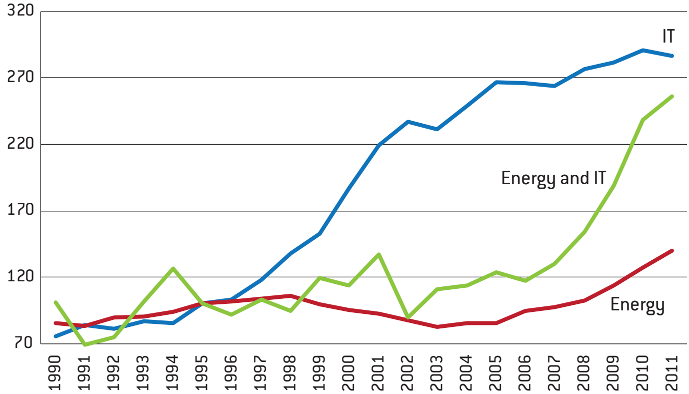
63 Carbon Market Watch (2016),

Figure 3: Share of IT and energy tech in total patents, EU28, index=1995



Source: Bruegel based on PATSTAT (2014). Note: The graph shows the share of patents related to specific IPC codes among all PCT patents with at least one European inventor in a given year indexed in 1995. Share of patents in total patents, first priority application under the Patent Cooperation Treaty (PCT), classified with IPC codes H02 or G06 with at least one inventor from the EU28. The graph is based on international patent applications under the PCT retrieved from the PATSTAT database. Counts are derived using the priority date (first date of filing of a patent application) and the inventors' country of residence, where at least one inventor came from the EU28. The International Patent Classification system (IPC) is used to distinguish patents relevant to energy generation technology and IT. In particular, the classification codes H02 – 'Generation, Conversion, or Distribution of Electric Power' – and G06 – 'Computing; Calculating; Counting' – were taken into consideration. All inventions in the database are classified with at least one IPC code but classifications in multiple groups is common. In the latter case, the patent is counted in equal fractions towards each technology.

This rapid technological evolution means digitalisation is set to be a key enabler for the transformation of the European energy system, from the traditional static and centralised model, into a more dynamic and decentralised eco-system within which a wide range of players interact in a flexible system.

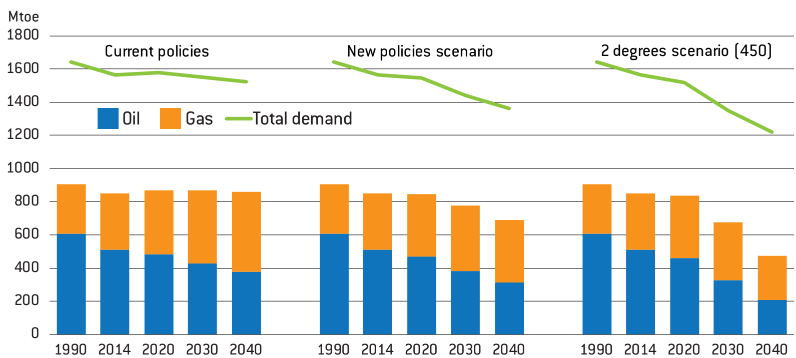
8.3 Oil and gas companies

Oil and gas companies are the biggest part of the European energy industry by market capitalisation (eg around 60 percent, vis-à-vis the 40 percent of utilities) and also represent the sector with traditional business models put most at risk by decarbonisation.

The International Energy Agency sets out every year three scenarios for global energy: i) the current policies scenario, which assumes no changes in policies; ii) the new policies scenario, which assumes that national pledges to reduce greenhouse-gas emissions will be translated into national policies; iii) the 450 scenario, which sets out an energy pathway consistent with the goal of limiting the global increase in temperature to two degrees Celsius (with 450 referring to the parts per million of carbon dioxide in the atmosphere).

As Figure 4 shows, over the next three decades EU demand for oil is projected to decrease in all scenarios, though at different rates (by 26 percent in the current policies scenario between 2014 and 2040, compared to 60 percent in the 450 scenario). Meanwhile, gas demand is projected to grow (in the current policies and new policies scenarios) or to maintain (in the 450 scenario) its role. As a result, European oil and gas companies, which in the past enjoyed almost uninterrupted growth in oil and gas demand, will need to transform in all scenarios.

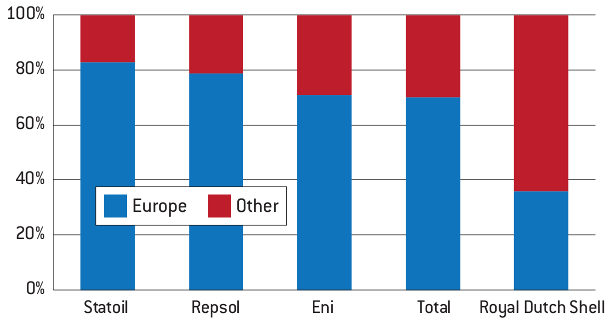
Figure 4: EU total primary energy demand, with oil and gas highlighted: scenarios to 2040



Source: Bruegel based on International Energy Agency (2016).

These three scenarios illustrate the key role of EU energy and climate policy in shaping the future of the oil and gas industry. This point is further emphasised by the fact that European oil and gas companies generate a major share of their revenues in Europe (Figure 5).

Figure 5: Selected European oil and gas companies' revenues by geographical area

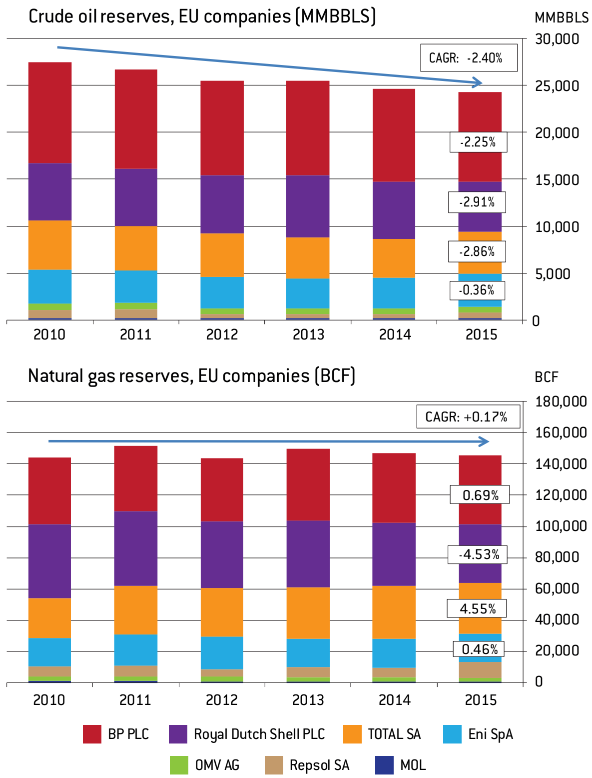


Source: Bruegel based on Bloomberg, accessed in November 2016.

Policy signals: the key to the future strategies of oil and gas companies
Clear public policy signals are needed to incentivise EU oil and gas companies to transform their traditional business models in light of decarbonisation. Without strong policy signals – such as sensible carbon pricing – EU oil and gas companies are likely to avoid a structural transformation of their business models. EU energy and climate policy thus has a key role to play in shaping the future industrial choices of oil and gas companies in Europe. In the absence of such signals, some oil and gas companies might bet against deep decarbonisation, instead of embracing it.

i) Betting against deep decarbonisation and refocusing only on gas
In the absence of strong policy signals on decarbonisation, and particularly in absence of meaningful carbon pricing, oil and gas companies might decide to continue in a business-as-usual mode, and to progressively refocus their activities on gas.

Figure 6: Oil and gas reserves possessed by leading European companies (2010-2015)



Source: Bruegel based on Bloomberg, accessed in November 2016.

This switch might respond to the general expectations, also illustrated by previous scenarios, of declining demand for oil and of rising (or stable) demand for gas. In the absence of strong signals of a deep commitment to decarbonisation, oil and gas companies might well base their strategies on: i) the assumption of a rising role for gas in the energy mix, as a substitute for more-polluting coal and as a back-up for variable renewables; ii) the assumption of a more difficult outlook for oil, particularly because of the expected progressive electrification of transportation.

The most recent developments of reserves possessed by Europe's leading oil and gas companies might provide a first indication of this oil-to-gas switch. As Figure 6 shows, oil reserves possessed by EU companies decreased by 2.4 percent per year between 2010 and 2015, while gas reserves maintained their level.

As reserves are mainly a function of investment in exploratory activities[64], it is possible to assume that European oil and gas companies already invest more in gas and less in oil. This trend preceded the fall in oil prices that started in June 2014 indicating a longer-term strategy being adopted by European oil and gas companies to promote gas as a transition fuel in the decarbonisation process.

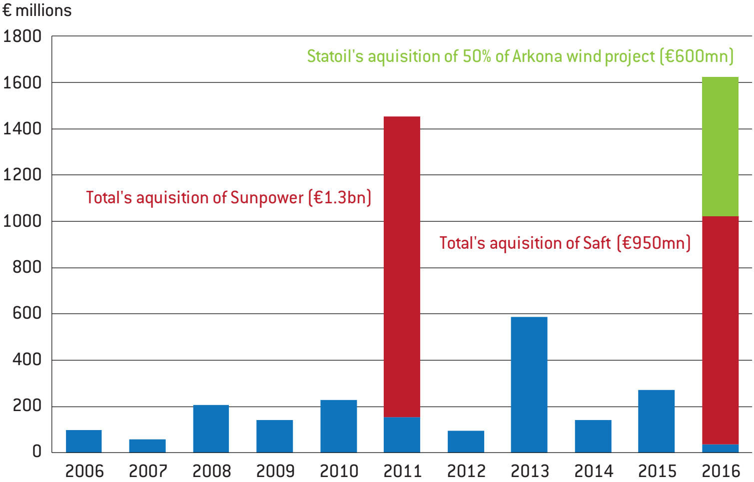
ii) Embracing deep decarbonisation and transforming from oil and gas to energy company

But European oil and gas companies could also adopt proactive strategies, embrace deep decarbonisation and embark on a transformational process of diversification to new clean energy businesses. In particular, oil and gas companies could accompany their oil-to-gas switch with the opening up of new areas of activity on renewable energy.

Over the last few years, leading European oil and gas companies have often pledged to commit to new energy solutions. However, as Figure 7 illustrates, these companies have yet to translate declarations into action. Only Total and Statoil have made significant investments in new energy solutions. In 2011, Total acquired 60 percent of SunPower, a global leader in solar panel manufacturing, and acquired in 2016 Saft, a French battery manufacturer. Statoil in 2016 acquired 50 percent of the Arkona offshore wind farm in Germany.

64 Statistical re-calculations also influence reserves levels.

Figure 7: European oil and gas companies' investments in new energy solutions



Source: Bruegel based on Bloomberg, accessed in November 2016. Note: the following Bloomberg categories are included: M&A, Investment, Joint Venture, Spin-off, Buyback. Acquirer are companies categorised as: oil&gas, oil&gas Services, Pipelines. Target or seller: Energy-Alternate Sources, Batteries/Battery Systems.

The EU oil&gas companies' pledge to new energy solutions further strengthen in the run-up to the 2015 Paris climate conference. In that moment leading EU and international oil&gas companies tried to coordinate a common response to climate change, also by establishing the Oil and Gas Climate Initiative[65]. In that context, four EU oil and gas companies established in 2015 'New Energy' divisions, and two also consecutively committed to investments in both new energy projects and research (Table 1).

65 Oil and Gas Climate Initiative (2015).

Table 1: Leading European oil and gas companies' new renewable energy initiatives

Eni	2015 2016	Establishment of 'Energy Solutions' division Commitment to invest EUR 1 billion in projects and research (2017-19)
Repsol	2015	Establishment of 'New Energy' division
Shell	2015	Establishment of 'New Energies' division
Statoil	2015 2016	Establishment of 'New Energy Solutions' division Launch of USD 200 million 'Energy Ventures' fund

Source: Bruegel based on companies' reports, accessed in November 2016.

However, these diversification strategies appear to be still timid, particularly if put into the perspective of overall capital expenditures. For instance, Total's acquisition of Saft represented about 3 percent of the company's annual capital expenditure[66]. An annual expenditure on renewables of €500 million represents for Eni also about 3 percent of its total capital expenditure[67], while $200 million represents for Statoil 1.4 percent of its capital expenditure[68].

Carbon capture and storage (CCS) is a technology that could make a considerable contribution to the decarbonisation of industry (in particular of the production of iron and steel, chemicals and cement) and, to a certain extent, also of fossil fuel-based power generation. According to IEA scenarios, CCS is critical to achieve the 2 degree target, and becomes even more important in a more ambitious 1.5 degree scenario. Oil and gas companies might play an important role in the development of CCS, particularly considering their technical expertise in terms of operating underground. However, European oil and gas companies do not seem to bet on the future of CCS. In

66 Total's capital expenditure amounted to USD 24 billion in 2015. Data source: www.total.com

67 Eni's capital expenditure amounted to EUR 11.5 billion in 2015. Data source: www.eni.com

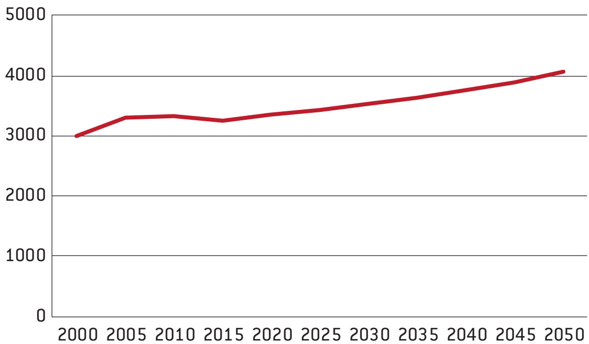
68 Statoil's capital expenditure amounted to USD 14.7 billion in 2015. Data source: www.statoil.com

November 2016, ten of the world's largest oil and gas companies pledged to invest $1 billion over the next 10 years in climate investments, with a specific focus on CCS[69]. This represents less than 1 percent of the companies' total annual capital expenditure, and this pledge thus casts doubts on companies' actual commitment to the development of CCS.

8.4 Electricity utilities

Most scenarios[70] assume that low-carbon electricity supply will be a major contributor to economy wide decarbonisation. This entails three parallel developments: i) a significant reduction in electricity consumption of appliances (eg lighting); ii) replacement of fossil fuels in power generation by mainly renewable electricity sources; iii) a shift in transport and heating fuels from oil and gas towards electricity (electric vehicles and heat pumps) – all of which will increase electricity demand in the longer term. On the basis of these assumptions, under current policies EU electricity demand is projected to grow by 25 percent between 2015 and 2050 (Figure 10).

Figure 8: EU reference scenario 2016: the outlook for electricity



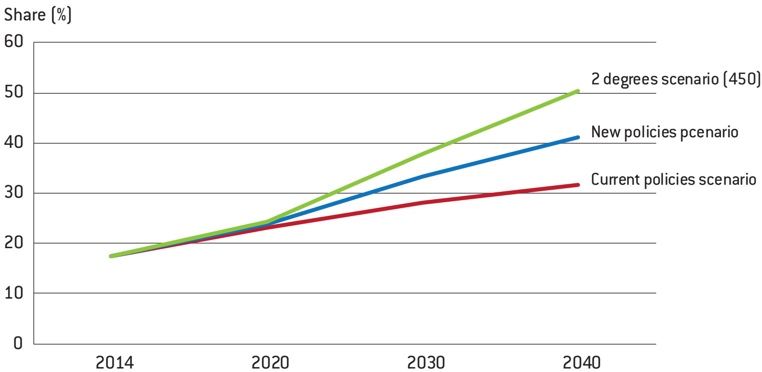
Source: European Commission (2016).

69 http://www.oilandgasclimateinitiative.com/

70 For example International Energy Agency, European Commission, European Climate Foundation.

Over the same period, the share of renewables is expected to increase from 18 percent to 45 percent. Scenarios that model more ambitious policies necessary to meet the 2°C target foresee an even more rapid shift towards renewable electricity (Figure 9).

Figure 9: Scenarios for share of EU electricity produced by renewables (excl. hydro)



Source: Bruegel based on International Energy Agency (2016).

This expected increase in electricity consumption (notably from renewables) sounds like great news for electricity utilities that dominated the electricity sector for many decades. However, the market capitalisation of the EU's largest electricity utilities[71] declined by more than €286 billion (or 72 percent of their value) from 2007 to 2016[72] (Figure 10).

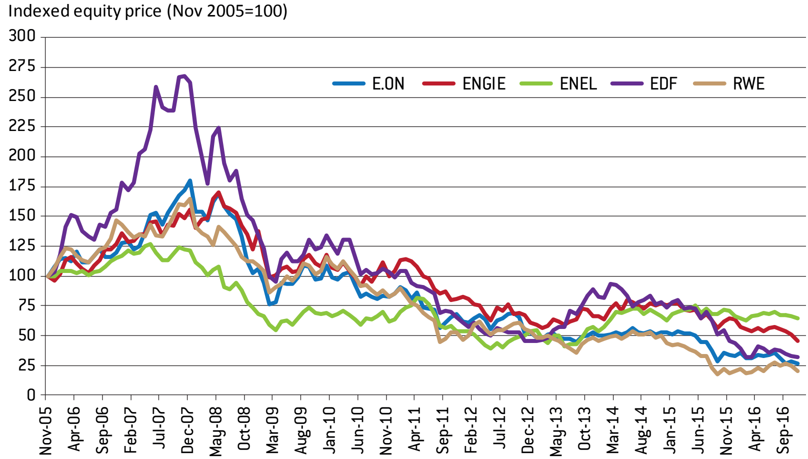
This downward trend is the result of the economic crisis, but also of the rapid emergence of new market and policy conditions that have created unprecedented pressure on European electricity utilities' traditional business models. The emergence of strong decarbonisation policies, the rise of renewable energy and improved energy efficiency favoured by technological development, the rise of distributed

71 EDF, Engie, Enel, E.ON and RWE.

72 Data source: Bloomberg, accessed in December 2016.

generation and new developments in demand response and storage capacities, all put pressure on conventional generation assets.

Figure 10: Market valuation of leading European electricity utilities



Source: Bruegel based on Bloomberg, accessed in December 2016.

As Gray (2015) outlines, a crucial role here has been played by the utility 'death spiral' underpinned by the development of solar PV. In a nutshell, the more electricity generated by distributed solar PV (eg rooftop solar panels), the fewer customers there are to share grid maintenance and transmission costs, which in turn pushes the retail price of electricity higher and thus further incentivises the uptake of distributed solar PV, demand reduction and distributed residential storage applications.

As a result, total impairments of generation assets between 2010 and 2014 amounted to $44 billion[73]. In such a complex situation, each company has developed its own response. Two contrasting strategies have emerged so far: i) Defending the existing business model; ii) Becoming a driver of the transition.

73 Catoire, G. and Coneybeare, D. (2015).

i) Defending the existing business model

A number of European electricity utilities understand that their coal and gas units might be needed for several decades to come. In the EU reference scenario (Figure 10), more than a third of electricity in 2040 will still come from coal and gas – and this electricity will cost to the consumer an above-average price because it will only be produced when wind and sun are insufficient to meet demand. It remains unclear what technology could replace fossil fuels during a week-long low-wind period in winter, when demand is high and solar irradiation low.

Consequently, these utilities seek to convince governments that they require continued cash-flows for their fossil fuel plant fleets in order to keep the lights on. Corresponding capacity mechanisms – that pay power plants for being available (instead of for the actual electricity they produce) – have been implemented in several EU countries and are now about to be somewhat harmonised at EU level.

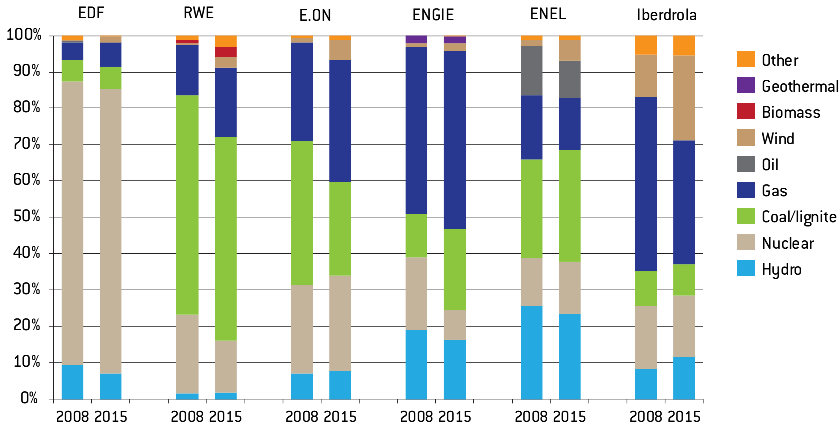
Other electricity utilities see that under the current set of rules they are still more competitive than renewables. In particular, some incumbent utilities from central and eastern Europe hope that their strong position in their home countries can help them to prevent too intrusive decarbonisation policies – be they a high emissions trading price, emission performance standards or renewables subsidies.

ii) Becoming a driver of the transition

Some electricity utilities have built-up a significant portfolio of wind and photovoltaic generation capacities, invested in networks and divested from fossil fuels.

They clearly trust that European energy policy will continue to be highly favourable to the fast deployment of wind and solar capacities. Iberdrola is leading this trend in Europe, followed by Enel and E.on (Figure 11).

Figure 11: Leading European electricity utilities' generation portfolios (2008 and 2015)



Source: Bruegel based on Bloomberg, accessed in December 2016.

Returns from the network business and renewables are largely policy driven. Regulators explicitly decide on the rate of return for electricity networks and policymakers decide on the remuneration schemes for renewables. A change in regulations can cost regulated businesses billions of euros. Therefore, understanding and managing the political environment is probably more important for the success of renewables and network electricity companies than good internal management or efficient supply chains. The split-up of, both, E.on and RWE in a fossil-fuel generation company (called UNIPER and RWE) and a renewables and electricity grids company (called E.on and Innogy) is partly justified by the difficulty of the traditional full-portfolio energy companies to deliver consistent policy messages.

But new players might also emerge in the electricity business, as decarbonisation and digitalisation drive convergence of services (electricity, heat, transport, data) that used to be largely separated[74]. In this new context, new industrial players might establish themselves in the market, breaking through traditional sectoral boundaries and integrating energy, transport and telecom businesses. Tesla is one example of this emerging trend. Started in 2008 as an electric luxury car maker, the US company rapidly expanded its business into battery and electric drivetrain technologies, auto-driving technology, supercharger networks and 'solar roof' technology. This has been done on the basis of the vision of providing an integrated clean energy service package to future customers, entailing renewable electricity production, domestic electricity storage and electric mobility.

The emergence of this kind of new player in Europe should be incentivised, because this could represent a considerable opportunity to re-launch European industry at global scale, particularly if first-mover advantage can be secured. In order to facilitate – and not hamper – this transformation, a structural rethinking of the design of the EU energy market is needed. This should also involve a rethinking of EU competition, regulatory and fiscal policies.

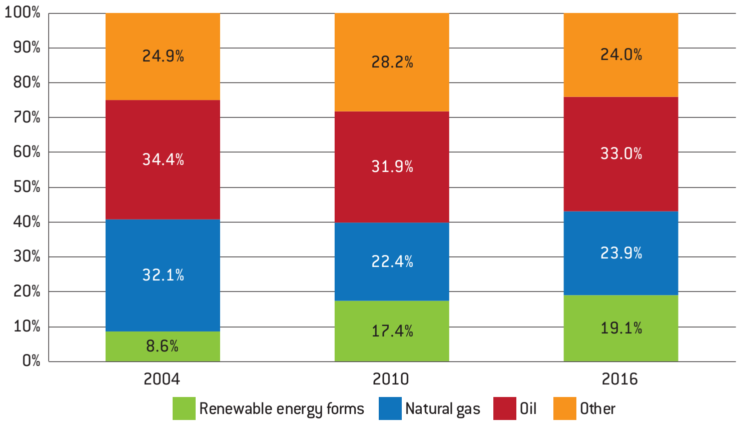
8.5 Conclusions

Policy-driven decarbonisation and market-driven technological innovation are profoundly and rapidly reshaping the European energy system. In this context, the European energy industry is under great pressure, because it needs to quickly rethink its long-lasting business models to adapt to, and ideally make the best of, the new reality. The cases of oil and gas companies and electricity utilities illustrate the need for strong and consistent public policy frameworks. These represent a fundamental prerequisite to provide long-term signals to investors. Without clear and credible policy guidance investors are unlikely to take the action required to achieve the EU decarbonisation targets. These signals are important to enable long-term investment

74 For a wider discussion of these trends, see Tagliapietra, S. and Zachmann, G (2016).

(which energy projects are) in a highly uncertain environment. This uncertainty can, for example, be illustrated by the strikingly different projections for renewables and gas in the EU energy mix of 2030 made by the European Commission in 2004, 2010 and 2016 (Figure 12).

Figure 12: EU energy scenarios to 2030: different visions on renewables and gas



Source: Bruegel based on European Commission (2004, 2010 and 2016c).

Considering the number and the order of magnitude of the challenges ahead, we consider that providing just partial fixes to the current European energy regulatory system (eg through the reform of the ETS or the reform of electricity market design) is not sufficient to provide the appropriate policy guidance to the energy industry.

Instead, Europe urgently needs a high-powered platform – representing all major stakeholders – to discuss a broader vision for the design of its future energy sector. This should go beyond the existing working-level discussion forums.

The ongoing structural transformation of the European energy system requires a parallel structural transformation of the policy framework within which the system develops. This should become a priority of the EU Energy Union initiative.

To involve all major stakeholders and ensure a transparent and well-resourced discussion the European Council should ask the European Commission to produce a new green paper on the organisation of the (digitalised) European energy sector in the twenty-first century.

Like the 1995 green paper 'For a European Union Energy Policy', it should be a consistent basis for upcoming legislation in different policy areas. This should not necessarily imply more EU oversight in all areas, but could also allow EU countries to experiment with new regulatory approaches when they follow some general principles (eg non-discrimination against foreign firms).

This is urgently needed. With the current level of policy uncertainty investors are unlikely to deliver the annual €379 billion of investments required between 2020 and 2030 to turn the EU's commitment to the Paris Agreement into reality.

References

Carbon Market Watch (2016), *The impact of the Paris agreement on the EU's climate policies*, Brussels.

Catoire, G. and Coneybeare, D. (2015), *Benchmarking European power and utility asset impairments. Testing times ahead*, EY, Paris.

European Commission (1995), *For a European Union Energy Policy,'* Green Paper, Brussels.

European Commission (2004), *European Energy and Transport. Scenarios and Key Trends*, Brussels.

European Commission (2010), *EU Energy Trends to 2030*, Brussels.

European Commission (2011), *A Roadmap for moving to a competitive low carbon economy in 2050*, COM(2011) 112 final.

European Commission (2016a), *An EU Strategy on Heating and Cooling*, COM(2016) 51 final.

European Commission (2016b), *Review of available information, Accompanying the document EU Strategy for Heating and Cooling*, SWD(2016) 24 final.

European Commission (2016c), *EU Reference Scenario 2016, Energy, transport and GHG emissions, Trends to 2050*.

European Commission (2016d), *A European Strategy for Low-Emission Mobility,* SWD(2016) 244 final.

European Commission (2016e), *Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system,* SEC(2011) 391 final.

European Commission (2016f), *Impact Assessment for the Amendment of the Energy Efficiency Directive,* SWD(2016) 405 final.

European Commission (2016g), *4th EEAG Working Group on Capacity Mechanisms*, Working Group with Member States, 15 June 2016, Brussels.

European Commission (2016h), *Clean Energy for All Europeans*, COM(2016) 860 final.

Gray, M. (2015), *Coal: Caught in the EU Utility Death Spiral*, Carbon Tracker Initiative, London.

International Energy Agency (2010), *Opportunities To Transform The Electricity Sector In Major Economies*, IEA Report for the Clean Energy Ministerial.

International Energy Agency (2015), *Energy Technology Perspectives 2015* Report OECD/IEA 2015.

International Energy Agency (2016), *World Energy Outlook 2016*, OECD/IEA 2016.

Oil and Gas Climate Initiative (2015), *More energy, lower emissions. Catalyzing practical action on climate change,* October 2015.

Tagliapietra, S. and Zachmann, G. (2016), *Going local: Empowering Cities to Lead EU Decarbonisation*, Policy Contribution, Issue 2016/22, Bruegel, Brussels.

9 Fintech in Europe: challenges and opportunities.

Silvia Merler

9.1 Introduction

In recent years, ‘fintech’ has become a buzzword that indicates a broad range of technology-enabled and innovative financial activities. The rise of fintech has also caught the attention of policymakers, concerned in particular about the uncertain impact that this new disruptive business model will have on traditional banking and about the potential financial stability risks in a situation in which there are so far internationally agreed fintech regulatory standards. We look at the current fintech landscape in Europe and the regulatory initiatives that have been undertaken – mostly at national level. Europe appears to be unique in terms of the prevalence of competitive – as opposed to collaborative – fintech activities. However, there seem to be substantial differences in views in different European countries, with different national regulatory approaches. In the absence of internationally agreed regulatory standards for fintech, the distinction is between those national authorities that have acted within already existing frameworks, and those that have introduced new rules.

9.2 Fintech: an overview

The term fintech is often used to describe digital innovation and technology-enabled finance, but it covers a very diversified range of corporate structures, activities, business models and technologies. We can group them into four broad categories: activities related to payment systems, financial intermediation of different kinds, ancillary services such as insurance and regulatory compliance, and the function of currency. Examples include[75]:

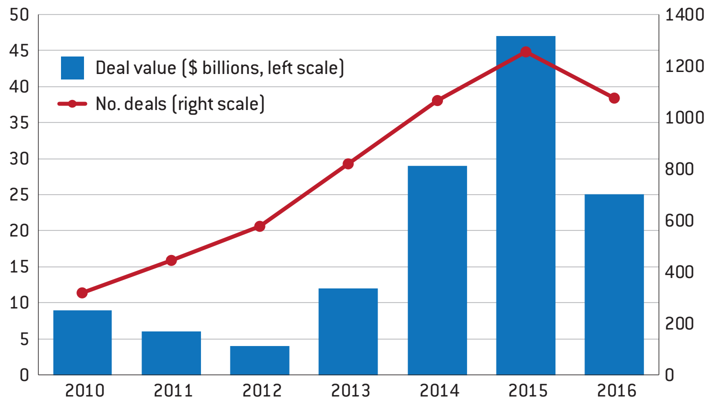
- **Payment systems:**
  - *Payment and billing tech* (facilitate payments processing, subscription billing software tools);
  - *Money transfer and remittance* (peer-to-peer platforms to transfer money between individuals across countries);
- **Financial intermediation**:
  - *Lending tech* (eg peer-to-peer lending platforms, platforms using machine learning and algorithms to assess creditworthiness);
  - *Personal finance and wealth management* (tech companies that help individuals manage personal bills, accounts and/or credit, personal assets and investments);
  - *Equity crowdfunding* (platforms allowing individuals to provide monetary contributions to support specific projects or companies in exchange for equity);
  - *Institutional and capital markets tech* (providing tools to financial institutions or other institutional investors);
- **Ancillary services**:
  - *InsurTech* (companies creating new underwriting, claims, distribution and brokerage platforms, or software-as-a-service to help insurers with IT issues);
  - *RegTech* (application of digital technology to regulatory compliance);
- **Currency functions:** blockchain/bitcoin (key software/technology firms in the distributed ledger area).

Figure 1 shows total global investment, including venture capital and mergers and acquisitions, in fintech companies. Total investment

75 See also CBI (2016).

in fintech declined globally in 2016, after a steady rise over previous years. Global investment in fintech companies was about $25bn in 2016, spread across 1076 deals (KPMG, 2016). The slowdown in 2016 might be a reflection of generalised uncertainty prevailing in the major fintech markets, because of political or economic events (Brexit in the United Kingdom, the presidential elections in the United States and the economic slowdown in China). When disaggregating the total investment figure, the decline seems attributable mostly to a slowdown of M&A activity[76]. Interest in InsurTech seemed to grow substantially during 2016, while investment in blockchain technologies saw some deceleration, as corporate investors shifted from direct investment in blockchain providers towards investing in blockchain-based projects.

Figure 1: Total global investment in fintech companies (2010-16)

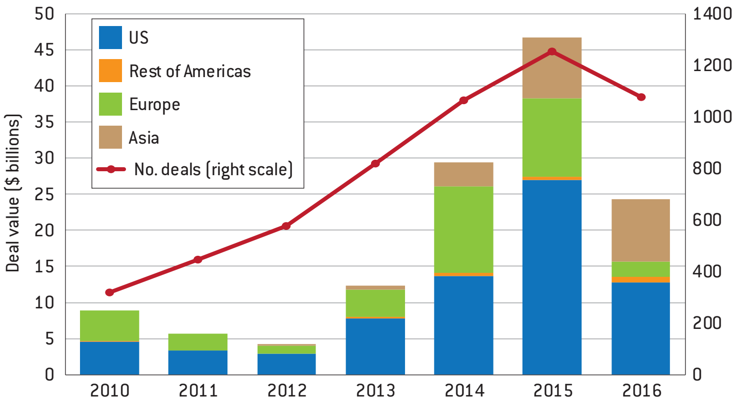


Source: KPMG (2017). Note: this figure includes both venture capital investment and M&A activity.

76 Data from KPMG *Pulse of Fintech* showed that M&A deals in 2016 fell from $34 billion to $11 billion compared to 2015, but 2015 was an outlier in terms of M&A value attributable to fintech. Total venture capital investment in 2016 instead increased from $12.7 billion to $13.6 billion, although deal activity dropped from 940 to 840 deals over the same period.

Activity has evolved differently in different fintech geographical markets. The total number of fintech deals on the American continent dropped in 2016, and the value of fintech deals in the region fell more than 50 percent year-on-year. Investment in the US remains dominant, but funding is also increasingly reaching fintech in Brazil, Argentina and Mexico, while Canada experienced record growth in terms of both deal activity and value. In Europe, total fintech investment declined significantly in 2016, although the decline in the number of deals appears very small. As a consequence, Asia surpassed Europe as the second largest market in 2016. The total investment in Asian fintech reached a high of $8.6 billion, despite a slight decline in the number of deals. Most of this activity was driven by investment in China, which is dominant in online lending and is the biggest market for digital payments (*The Economist*, 2017).

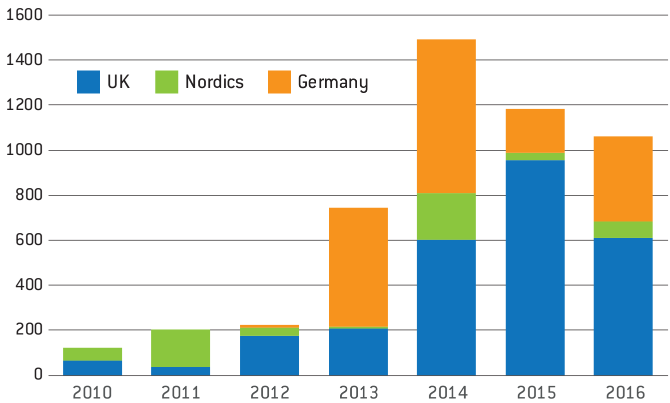
Figure 2: Total global investment in Fintech companies, selected (2010-16)



Source: KPMG (2017). Note: this figure includes both venture capital investment and M&A activity.

Investment in fintech companies in Europe was $2.2 billion in 2016, down from $10.9 billion in 2015. Most of the 2016 investment was venture capital (VC). The UK remained the dominant market, despite experiencing a decrease in VC investment compared to the record levels reached in 2015. The second European market is Germany, which in 2016 recorded $376 million of VC investment. The Nordic market appears more volatile, with peaks of investment recorded in 2011 and 2014 and $76 million invested in 2016. Europe also accounts for four private fintech start-ups valued at $1 billion or more. There are 22 such companies in the world (CBI, 2016). In Europe, two of them are located in the UK (Funding Circle and TransferWise), one in Sweden (Klarna) and one in the Netherlands (Adyen).

Figure 3: Fintech venture investment, major European markets ($ millions)



Source: KPMG (2017).

9.3 Policy challenges

The 'fintech revolution' raises a series of policy concerns. One question is how fintech will impact the traditional banking business model, and in particular how traditional banks will position themselves in the face of this new challenge. A second question is whether digital and technology-enabled financial activities require adaptations of the current regulatory framework. To date, in the European context regulatory action on fintech has been limited, and has been pursued at national rather than EU level. Regulatory work on fintech will prove challenging, because it will need to provide for appropriate oversight while maintaining the conditions that make for a particularly dynamic and innovative environment. Third, there is the question of if and how this new sector could create financial stability risks.

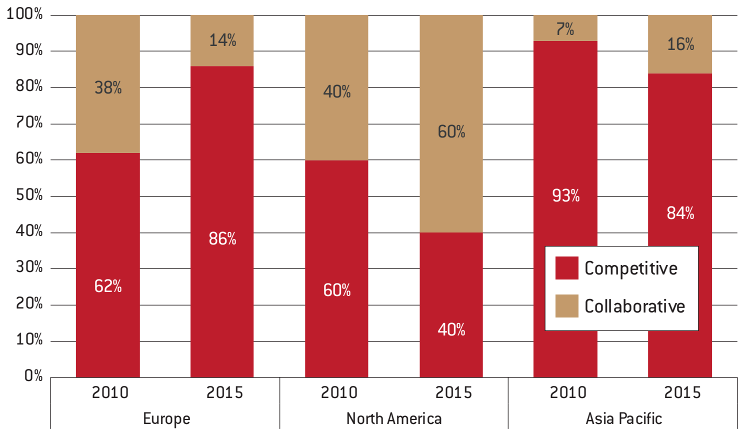
9.3.1 Fintech and traditional banking

Fintech is a disruptive technology, often introduced by new firms (start-ups) which, at least in the early phase of their development, can be expected to compete with the business model of the traditional banking sector. *Competitive* fintech essentially offers services that have the potential to disrupt and replace incumbents. Incumbents can respond in different ways, for example by trying to be at the forefront of the technological innovations or at least by being fast adopters. This might entail buying the products of fintech start-ups or buying the start-ups themselves. In this case, fintech becomes *collaborative,* leveraging technology to offer products that can enhance traditional business models[77]. A recent report by Accenture (2016) shows that the balance between investment in competitive versus collaborative fintech companies remained steady from 2010 to 2015, with 62 percent of deals going to competitive companies. The situation however varies in different markets (Figure 4). The North American market saw a shift towards more investment in collaborative fintech from 2010 to 2015. A similar trend was also visible in the Asian-Pacific region, where investment

77 OnDeck is an example of company that has gone from a disruptive to a more collaborative approach. In 2011, when it was founded, OnDeck filled a gap with software that was able to underwrite small loans at a lower cost in a market from which banks were retreating (lending to SMEs). Since going public in 2014, it now partners with several large global retail banks, enabling them to offer small business borrowers the speed of an alternative lender. An example of a competitive company is Betterment, launched in 2010 as a low-fee, digital alternative to traditional investing. It has continued to grow and offers a traditional banking product that is more adapted to today's customers' needs (Accenture, 2016).

in collaborative fintech increased from 7 percent to 16 percent of the total from 2010 to 2015. In Europe, on the other hand, investment in collaborative fintech declined from 38 percent of the total to 14 percent. In the UK, more than 90 percent of investment has been directed to competitive fintech.

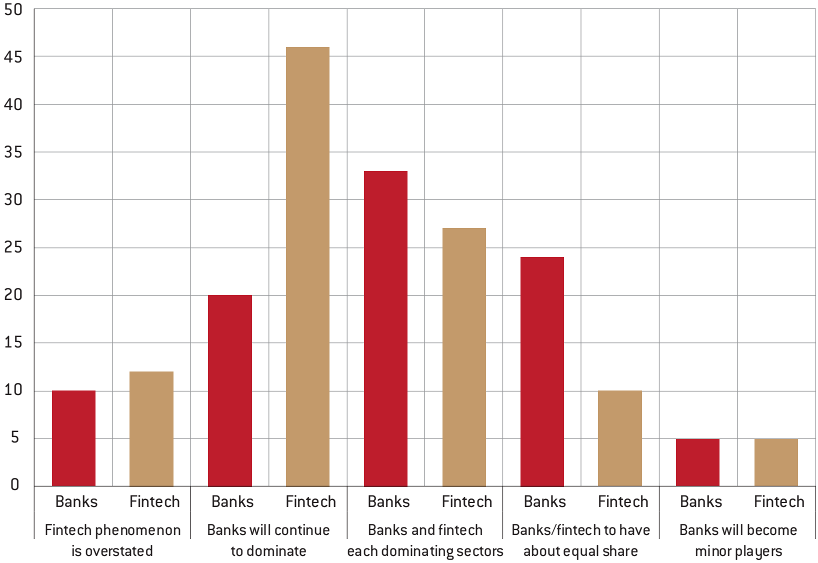
Figure 4: Collaborative versus competitive fintech investment, major markets



Source: Accenture (2016).

Fintech companies do not seem to think that fintech will become dominant in the future. In 2015, the Economist Intelligence Unit (EIU) conducted parallel surveys of more than 100 senior bankers and 100 fintech executives, to understand market participants' views on the impact of fintech, including expectations for the evolution of the retail banking industry. The results show that 33 percent of respondents see the future as a mix of banks and fintech, with dominating in some sectors. For 46 percent of the responding fintech companies, however, banks are more likely to continue dominating (Figure 5).

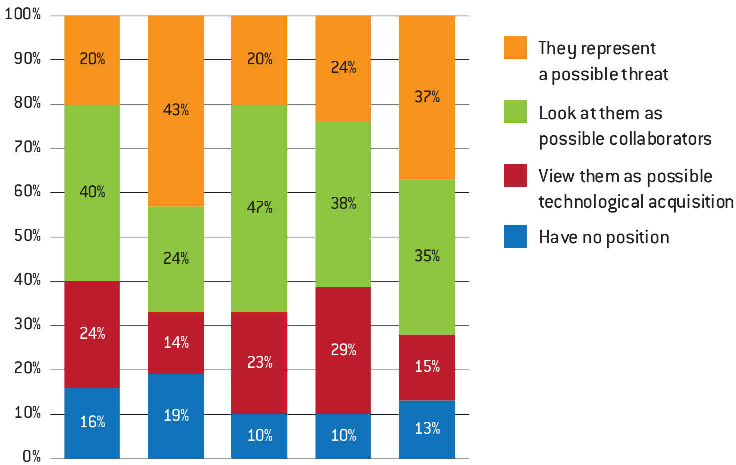
Figure 5: Views on the future of banking, % of respondents



Source: EIU (2016).

Not all areas are perceived as equally threatened by the rise of fintech. PWC (2016) conducted a global survey of 544 respondents from top financial institutions in 46 countries. The majority of participants saw consumer banking and fund transfer and payments as areas most likely to be disrupted by 2020, because they are more vulnerable to the kind of disintermediation emerging through online platforms and technology-driven payments processes. Sixty-seven percent of respondents saw threats from fintech coming mostly in the form of *"pressure on margins"* and 59 percent from *"loss of market share"*. However, not everybody sees fintech as a threat. A 2016 survey run by Business Insider showed significant differences in views in different European countries. In France, 43 percent of interviewed banks appear to see fintech companies mostly as a threat; German banks are split, with 37 percent seeing fintech companies as a threat and 35 percent seeing them as possible collaborators; while 47 percent of Italian banks see fintech companies as possible collaborators. About 20 per-cent of the banks said that they would consider fintech firms as targets for possible acquisition.

Figure 6: How European banks see fintech, % of respondents



Source: Business Insider (2016).

Overall, no immediate conclusion can be drawn about how the entry of new fintech players will impact the incumbent sector. Much will depend on how incumbents react and adapt their business models. Fintech certainly offers an opportunity for new start-ups to compete with incumbents, without having to bear the costs of their legacy IT systems and compliance-oriented business cultures. On the other hand, a strength of traditional banks is their economies of scale, which may be unavailable to start-ups unless they team up with incumbents (Coeuré, 2016). So fintech could be a positive shock for a sector that needs to restructure after the crisis. However, an important point for policymakers to consider is how to ensure a level playing field between entities providing similar financial services, to avoid market fragmentation, which might create challenges for a single EU market.

9.3.2 Fintech and regulation

A second issue is that of regulation, in particular of whether fintech creates a need to adapt the current regulatory framework. The challenge in regulating fintech is how to allow innovation to develop without hindering financial stability. There are currently no internationally-agreed regulatory standards for fintech activities, while there is a distinction between those national authorities that have acted within already existing frameworks, and those that have introduced new rules specifically for fintech.

In the US, fintech companies looking to offer bank-like products or services across state lines have traditionally been required to apply for multiple state licenses. In December 2016, the Office of the Comptroller of the Currency (OCC) issued a white paper proposing to create a special-purpose national bank charter available to fintech companies that provide non-deposit banking products and services (Deloitte, 2017). Fintech firms are not directly supervised, examined or regulated by a federal banking regulatory agency, although they are subject to some federal regulations, particularly in the field of consumer protection. The OCC's proposal goes beyond consumer protection and focuses on prudential supervision, baseline safety, soundness and compliance, for fintech companies seeking a national charter (Clifford Chance, 2017).

In Europe, several national authorities, the European Commission, the European Parliament, the European Central Bank and the European Securities and Markets Authority, have started regulatory initiatives related to fintech. Table A in the Appendix to this chapter lists some of the actions taken at national level. The UK is unsurprisingly advanced on this issue, and the UK Financial Conduct Authority (FCA) has been the first regulator to launch a regulatory sandbox[78]

78 The sandbox is described by the UK FCA as *"a supervised space, open to both authorised and unauthorised firms, that provides firms with reduced time-to-market at potentially lower cost, appropriate consumer protection safeguards built in to new products and services better access to finance"*. See https://www.fca.org.uk/firms/regulatory-sandbox.

initiative, allowing businesses to test innovative financial services without incurring all the normal regulatory consequences associated with those activities (Denmark is considering a similar option). In the context of Brexit, it is at the time of writing uncertain what the impact will be on London as a financial centre, and continental countries could seize the opportunity to attract fintech companies. France has already taken steps in this direction, introducing a '2WeekTicket' licensing procedure for fintech companies in 2016. Similarly, the French Prudential Supervision and Resolution Authority (ACPR) said in September 2016 that the authorisation process would be enhanced and simplified for, among others, UK credit institutions, payment institutions and insurance companies. Other countries – including Germany, Italy, Ireland and Spain – do not currently envisage 'light' regulation for fintech companies. The European regulatory landscape currently shows significant fragmentation and national idiosyncrasies, so there is a strong rationale for an EU initiative. The European Commission acknowledged this diversity in a public consultation it published in March 2017, on the impact of technology on the European financial services sector. The Commission's stance on fintech relies on three principles:

- **Technology neutrality**: ensure that the same activity is subject to the same regulation irrespective of the way the service is delivered, so that innovation is enabled and the level-playing field preserved;

- **Proportionality**: reflecting the business model, size, systemic significance, complexity and cross-border activities of regulated entities;

- **Integrity enhancement:** application of technologies to financial services should promote more market transparency to the benefit of consumers and businesses without creating unwarranted risks (eg market abuse, mis-selling, cyber security issues, systemic risks).

Results from the Commission's consultation were published in June 2017, showing that most respondents agreed with the three principles proposed by the Commission and highlighting the perception of a need for further EU action. Seventy-four percent of respondents seemed to favour active involvement of regulators and/or supervisors to foster competition or collaboration, as appropriate, between different market players and new entrants. The Commission argued that the different approaches in EU countries are costly and could reduce the incentives for innovation. The Commission said it would investigate the need for new licensing regimes for the relevant activities at EU level. More than half of respondents (53 percent) said that the EU should introduce new licensing categories for fintech activities, with harmonised regulatory and supervisory requirements, including passporting of such activities across the EU single market. Fifty-two percent of respondents highlighted a need for guidelines or regulation at EU level to harmonise regulatory sandbox approaches in EU countries and 49 percent saw merits in developing a European regulatory sandbox targeted specifically at fintech companies that want to operate cross-border. Speaking at a European Central Bank fintech workshop earlier in 2017, the Vice-Chair of the Single Supervisory Mechanism board said that the ECB is also working on fintech, including on a joint policy approach to bank licensing with national supervisors, to ensure that applications are treated in the same manner throughout the euro area, and that risks specific to fintech will be assessed appropriately and proportionately.

9.3.3 Fintech and financial stability

Fintech could have significant implications for payments, settlement and financial stability. At present, the small size of fintech credit relative to traditional banks credit limits the direct impact of fintech on financial stability. However, if the share of fintech credit were to increase, it could bring both benefits and risks for financial stability. BIS (2017) identified as potential benefits the potential increase in financial inclusion, more diversity in credit provision and efficiency pressures on incumbents. Among the risks, there is a potential deterioration of lending standards, possibly increased pro-cyclicality of credit provision and the uncertain impact on the traditional banks.

Fintech credit might create challenges for regulators in their task of monitoring. Regulatory and supervisory authorities rely heavily on the information contained in financial institutions' balance sheets, and the concept of the bank balance sheet is central to current regulatory frameworks. In the case of non-bank peer-to-peer (P2P) lending firms, however, it is difficult to obtain sufficient information on financial intermediation from their balance sheets, and imposing constraints on those balance sheets might not be very effective in terms of influencing these firms' lending activities (Nakaso, 2016). Reliable and timely data might not be available because of the absence of regulatory reporting requirements and supervisory processes, and increasing the share of lending that occurs outside the prudential net might limit the effectiveness of macro-prudential policy measures (BIS, 2017). On the other hand, BIS (2017) argues that most P2P lending platforms are not leveraged like banks, their lending models do not entail bank-like liquidity risks because investments and loans are typically duration-matched, and investors are unable to liquidate their investments before loan expiration.

Fintech also raises stability issues for the traditional banks, as highlighted by Single Supervisory Mechanism Vice-Chair Sabine Lautenschläger in a March 2017 speech (Lautenschläger, 2017). There is a risk that the squeeze on profits in the traditional sector under increased competition could induce banks to cut costs in areas such as risk management. On the other hand, the emergence of fintech could make bank funding less stable, as new products, tools and services enable depositors to be more easily mobile across banks. As a consequence, deposits might become a less reliable and costlier source of funding for regular banks. As far as lending is concerned, the increasing dis-intermediation could make risks associated with traditional banking emerge, eg maturity and liquidity transformation risks. Lastly, some fintech companies also use new models to score the quality of loans, based on vast amounts of data and supposedly more precise than traditional approaches. BIS (2017) highlights that some banks have begun to use proprietary fintech credit risk models for their own lending, but there is no firm evidence so far of actual improvements in the performance of credit risk models, and they have not been tested in a severe recession or a crisis.

More generally, digitalisation could change our understanding of what is needed to ensure financial stability. Financial networks are becoming increasingly accessible through open gateways such as the internet and smartphones, and this makes financial stability prone to cyber threats, the number of which is increasing. A related issue is fintech and big data. By being decentralised and personalised, the new digital finance will rely on massive amounts of personal data which may allow the alignment of individual loan terms and risk factors, thus improving risk management and pricing (BIS, 2016). However, this might also raise issues of data protection.

Lastly, an additional area for further research has to do with how decentralised financial activities, such as blockchain and distributed ledgers technology, could affect currencies and the tasks of central banks. The prevailing view seems to be that virtual currencies are unlikely to overwhelm sovereign currencies, because of the 'trust' which is indispensable to underpin a currency (Nakaso, 2016). BIS (2016) research however highlights several areas in which fintech could have an impact on central banks, their role in the payment system, the extent to which they have supervisory responsibilities for institutions in the network of digital currency or clearing services, their conduct of monetary policy, the issuance of physical currency and their role in maintaining financial stability. Broadbent (2016) also looks at these issues, focusing in particular on the challenging idea of central bank digital currency.

9.4 Conclusion

The rise of technology-enabled finance (fintech) has spurred significant interest from financial markets and policymakers, accompanied by concerns about the impact fintech could have on the established traditional banking business. Fintech activity slowed down in 2016, but this appears to be a consequence of political risks in 2016, and not to a general slowdown of the innovative trend. So there is good reason to believe that fintech will be central to the policy discussion in the coming years.

Globally, the balance between competitive and collaborative fintech is in favour of the latter. In Europe, competitive fintech activity seems to prevail currently. Much of the impact of fintech on traditional banking will depend on the responses of incumbents. National attitudes towards fintech vary significantly in Europe, with the perception of fintech ranging between a 'threat' and an 'opportunity'. It is unsurprising to see different regulatory approaches in different EU countries. In the absence of internationally agreed regulatory standards for fintech activities, some national authorities have acted within already existing frameworks, while others have introduced new rules specifically for fintech. In the EU, France has been very active, explicitly trying to seize the opportunity of Brexit to attract fintech players.

However, regulatory initiatives in EU countries are fragmented and with national idiosyncrasies, which the European Commission has rightly acknowledged to be costly, and potentially dis-incentivising for innovation. EU institutions have started working on this issue and this is a welcome development. The European Commission has set up a Financial Technology Task Force to formulate policy-oriented recommendations during 2017. Ultimately, the goal will be to strike a balance between incentivising innovation and ensuring financial stability. To prevent regulatory developments in this new area resulting in a fragmented market, initiatives such as uniform EU licensing, passporting and EU-wide regulatory sandboxes for cross-border fintech appear to be positive developments. Dealing with fintech at EU- level would help to prevent fragmentation and to ensure that regulatory requirements are harmonised across countries. This is important because fintech activities do potentially raise financial stability concerns at the macro level.

Appendix

Table A: National measures on fintech

Country	Actions taken
Denmark	The Danish FSA has set up a fintech task force to ensure that fintech initiatives receive appropriate guidance as to the type of licence necessary to carry out the contemplated business. The Danish FSA is also considering the potential introduction of a regulatory sandbox inspired by the UK and Singapore models.
France	The AMF and ACPR have created a taskforce to offer a single point of entry for fintech start-ups and facilitate a simplified licensing process with the French authorities. The ACPR has created the "ACPR-FinTech Innovation Pole", a team dedicated to fintech that intends to ease the filing and approval process for fintechs. The AMF and ACPR have also created an advisory body called the "Forum FinTech" to provide support to the fintech industry. Following the result of the UK's EU referendum, a "2WeekTicket" licensing procedure has been introduced by the AMF for fintech companies. This new programme called "AGiLITY", is based on a quick pre-authorisation regime. Once the pre-authorisation has been obtained, the AMF commits to deliver a full authorisation within two months. Similarly, the ACPR said in September 2016 stating that the authorisation process would be enhanced and simplified for, among others, English credit institutions, payment institutions and insurance companies. In December 2016 the Banque de France announced that it has launched a blockchain initiative and experiment with a group of banks and institutions.

Germany	BaFin provides general regulatory guidance for fintech companies and has created an internal task force. BaFin however has not started any initiatives to ease regulatory requirements for fintech companies, and has made it clear that fintech companies are expected to meet applicable legal requirements – i.e. if a business activity requires a banking financial service licence, the same would apply for a new market entrant.
Ireland	Fintech is an important component of the Irish government's strategy for Ireland's international financial services sector for 2015 – 2020. The Central Bank of Ireland, however, has not introduced specifically light regulatory initiatives for fintech companies, and has made it clear that fintech companies are expected to meet all applicable legal requirements. Like in Germany, if a certain business activity requires a regulatory licence, the same requirements would apply for a new market entrant.
Italy	The Italian Government has adopted legislation including incentives to support innovative start-up companies. Fintech companies with an exclusive or prevalent goal of developing, producing or selling innovative products and services with high technological value would typically qualify. The legislation does not impact licensing requirements, but provides for a number of incentives and derogations from the standard company law framework, including simplified procedures for incorporation and enhanced access to Italy's State Guarantee Fund for SMEs. The Bank of Italy and Consob have also held round-tables and seminars with a number of Italian institutions to discuss fintech.
Luxembourg	The CSSF - which was the first European supervisory authority to take a clear stand in favour of virtual currencies and their regulation - has established a dedicated division for financial innovation and technology. In order to foster innovation, several initiatives have been implemented at a national level by the CSSF and the Luxembourg legislator over the last year.
Netherlands	The AFM and the DNB have set up an "InnovationHub" to support companies that seek to market innovative financial services or products but are uncertain about the rules to encourage innovation in the financial sector. From 1 January 2017, fintech companies are also able to apply to the AFM and DNB to request the application of a regulatory sandbox (decided case-by-case by the supervisor). Other measures to encourage innovation in the financial services industry comprise partial authorisations (where certain licensing requirements are relaxed and activities of the licence holder may be limited), authorisations with requirements and restrictions (where the licence is tailored to allow for bespoke arrangements) and an opt-in banking licence (where the licence is limited to certain activities).

Poland	The Ministry of Development, Ministry of Digital Affairs, Ministry of Finance and Ministry of Health are developing a programme "From a paper to a digital Poland" to set the agenda for development of an e-state and digitisation of the economy. There are 13 streams operating within the programme, including the Blockchain and Cryptocurrency Stream, which is to focus on the implementation of distributed ledgers and promoting their application in business. In addition, a working group composed of, among others, representatives of the Ministry of Finance, Ministry of Development and the PFSA is to perform a review of existing law and supervisory regulations in order to identify any possible regulatory barriers to the development of innovative technological offerings in the field of financial services.
Spain	In December 2016 the CNMV launched a new fintech and innovation portal on its website for the purpose of assisting sponsors and financial companies on issues related to securities markets regulations and creating an informal forum for exchanging information on fintech initiatives.
UK	In October 2014 the FCA launched Project Innovate, which provides direct support to innovative firms through an Innovation Hub and also targets policy and process improvement activities. These include the execution of international cooperation agreements for development of the fintech industry with the Australian Securities and Investments Commission, the Monetary Authority of Singapore and the Korean Financial Services Commission. In May 2016 the FCA was the first regulator to launch a regulatory sandbox initiative, allowing businesses to test out new, innovative financial services without incurring all the normal regulatory consequences of engaging in those activities. The Bank of England launched a fintech accelerator in June 2016 to help it harness fintech innovations for central banking by working with successful applicants on areas such as cyber resilience, desensitisation of personal data and the capability of distributed ledger technology. Fintech has also received backing from the UK government, including HM Treasury's appointment of a fintech envoy and fintech roundtables being organised with relevant ministers and fintech firms. In April 2017, HM Treasury published a regulatory innovation plan for financial services. The plan covers the work of the FCA, the Prudential Regulation Authority, the Payment Systems Regulator and the Bank of England and outlines how the approach of each to regulation will support and promote innovation and breaking down barriers to entry.

Source: Clifford Chance (2017).

References

Accenture (2016) *Fintech's Golden Age*, FinTech Innovation Lab

BIS (2016) 'The Financial Sector, time to move on', chapter in *86th Annual Report, 2015/16*, Bank for International Settlements, Basel

BIS (2017) *FinTech credit. Market structure, business models and financial stability implications*, report prepared by a Working Group established by the Committee on the Global Financial System and the Financial Stability Board, Bank for International Settlements, Basel

BIS Committee on Payments and Market Infrastructure (2015) *Digital Currencies*, Bank for International Settlements, Basel

Broadbent, B. (2016) 'Central Banks and Digital Currencies', speech to the London School of Economics, 2 March, available at http://www.bis.org/review/r160303e.pdf

Caruana, J. (2016) 'Financial inclusion and the Fintech revolution: implications for supervision and oversight', speech to Third GPFI-FSI Conference on Standard-Setting Bodies and Innovative Financial Inclusion, 26 October, available at http://www.bis.org/speeches/sp161026.pdf

CBI Insights (2017) *The global fintech Report: 2016 in review*, available at https://www.cbinsights.com/reports/CB-Insights_Fintech-Trends-Report-2016.pdf

Clifford Chance (2017) *European fintech regulation – an overview*, Clifford Chance, London

Coeuré, B. (2016) 'From challenges to opportunities: rebooting the European financial sector', speech at to the Süddeutsche Zeitung Finance Day 2016, Frankfurt am Main, Germany

Deloitte (2015) 'RegTech is the new Fintech', *Performance* issue 20, Deloitte

Deloitte (2017) *The evolving fintech regulatory environment. Preparing for the inevitable*, Center for Regulatory Strategy Americas, Deloitte

Demirguc-Kunt, A., L. Klapper, D. Singer and P. Van Oudheusden (2015) 'The Global Findex Database 2014 - Measuring Financial Inclusion around the World', *Policy Research Working Paper* 7255, World Bank, Washington DC

EIU (2016) *The disruption of banking*, The Economist Intelligence Unit

EY (2016) *UK Fintech on the cutting edge*, report commissioned by HM Treasury

KPMG (2017) 'The pulse of Fintech Q42016: Global analysis of investment in Fintech', quarterly global report on fintech investment trends

Lautenschläger, S. (2017) 'Digital na(t)ive? Fintechs and the future of banking', statement at an ECB Fintech Workshop, Frankfurt am Main, Germany

Nakaso, H. (2016) ‘Fintech - its impacts on finance, economies and central banking’, speech to the University of Tokyo - Bank of Japan Joint Conference on FinTech and the Future of Money Remarks, 18 November, Bank for International Settlements, Basel

Philippon, T. (2016) ‘The Fintech Opportunity’, mimeo, Bank for International Settlements, Basel, available at https://www.bis.org/events/conf160624/philippon_paper.pdf

PWC (2016) *Blurred lines: How FinTech is shaping Financial Services*, Global FinTech Report

The Economist (2017) ‘In fintech, China shows the way’, 25 February

WEF (2016) ‘The Complex Regulatory Landscape for Fintech: An Uncertain Future for Small and Medium-Sized Enterprise Lending’, *White Paper*, World Economic Forum

10 Strengthening cross-border e-commerce in the European Union

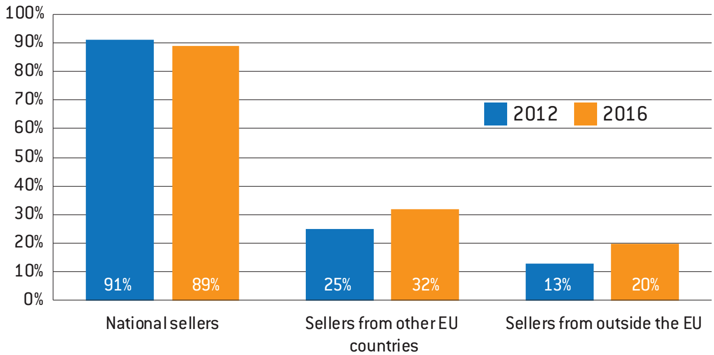
J. Scott Marcus, John Morales and Georgios Petropoulos

10.1 Introduction

Online purchasing is growing rapidly within the European Union, generating benefits for the broader European society. Europe lags other regions in many aspects of digital technology, and is by no means the front-runner in the *technology* of e-commerce; however, the EU is doing reasonably well in terms of *use* of e-commerce: *"e-Commerce [sale of goods] is growing rapidly in the EU at an average annual growth rate of 22 percent, surpassing €200 billion in 2014 and reaching a share of 7 percent of total retail sales"* (European Commission, 2015).

Domestic e-commerce is doing well. Cross-border purchasing is also growing in terms of the revenues generated and the number of consumers who order across borders, but lags significantly behind domestic online purchasing (Figure 1).

Figure 1: National and cross-border purchases by e-shoppers, EU, 2012 and 2016, % individuals



Source: Eurostat (2017). Note: % of individuals who bought or ordered goods or services over the internet for private use in the previous 12 months.

The imperfect integration of the European market in regard to digital services and online sales represents a substantial lost opportunity for Europe. With that in mind, this chapter asks three key questions:

- How great is the lost opportunity?
- What are the causes of lagging cross-border sales?
- What can be done to strengthen the cross-border component of e-commerce?

10.1.1 The foregone benefits of cross-border e-commerce in the EU

The costs of these challenges to cross-border e-commerce within the EU have caught the attention of policymakers.

The focus of the European institutions to date has been on impediments *within the EU/EEA*, since these impediments clearly run counter to the established goals of the European single market. Impediments to online trade *beyond the borders of the EU* are clearly also an issue, to the extent that they imply (1) less ability for European producers to export, and (2) higher prices for European consumers arising from gains in trade that could have been achieved, but were not. Since reducing these barriers would also tend to benefit the EU's trading partners and global competitors, the impacts on European societal welfare are less clear-cut. In any event, it is probably appropriate for the EU institutions to attempt to mitigate impediments to e-commerce within Europe first, since they have more and better tools to deal with the intra-EU challenges.

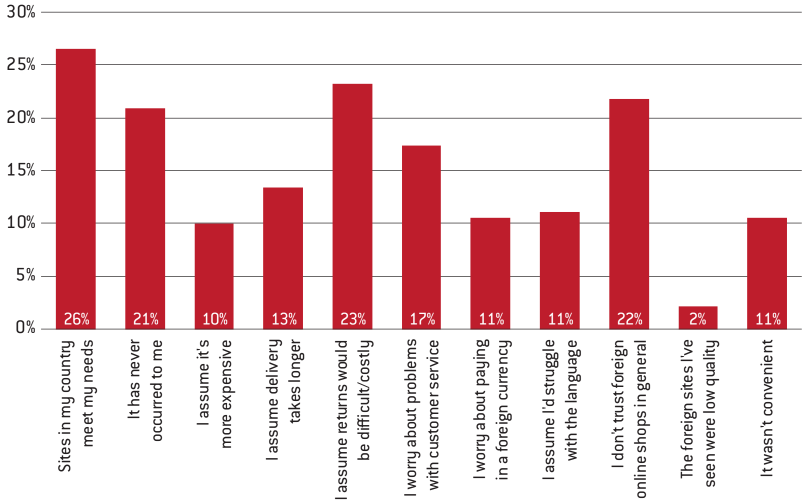
A noteworthy recent study using state-of-the-art analytic techniques found that if e-commerce sales within the European Union were as easy and cost-effective as domestic sales, retail prices would decrease across in all countries, both online (-1 percent on average) and offline (0.5 percent on average). Consumer surplus (CS) in the EU would increase by 1.2 percent, primarily based on the reduction of the price paid for goods and to a lesser degree on the ability of consumers to choose from a wider range of goods and services. The study also finds an increase of producer surplus (PS) of 1.4 percent, not only by reason of increased consumption resulting from price elasticity of demand, but also because of the reduced costs of supply – many purchases that are made from 'bricks and mortar' retailers today would instead be made online. The cost of producing the goods would be unchanged, but the cost of making the sale online would be less than the cost of making the equivalent sale offline (Duch-Brown and Martens, 2016).

10.1.2 Impediments to cross-border online sales in the EU

It is useful to distinguish between supply-side barriers to cross-border online sales in the European Union versus demand-side barriers. Some barriers are primarily on the supply side and impact consumers only indirectly. Barriers on the demand or consumption side, however, generally have direct impacts on suppliers as well.

On the demand side, consumer surveys on behalf of Google (Figure 2) show concerns about price (reported by 10 percent of respondents in a simple average across EU countries79), delivery costs (14 percent), customer service (17 percent), possible difficulty with returns (23 percent), payment arrangements (11 percent), the complexity of possibly having to deal with a foreign language (11 percent) and lack of trust in general (21 percent). These results are generally in line with surveys and consultations conducted on behalf of the European Commission. There are, however, significant differences between EU countries for all characteristics, including the important aspects of price, delivery time and perceived challenges in dealing with customer service (Figure 3).

Figure 2: Reasons for not purchasing a product online from abroad, averages across EU countries (2014-15)



Source: Bruegel based on the 'Consumer Barometer,' survey conducted on behalf of Google, at www.consumerbarometer.com, viewed 21 February 2017. Note: The question asked was: *"Why have you never purchased a product online from abroad?"* The data is based on a random survey conducted by telephone, and can be assumed to be reasonably representative and free of systematic bias.

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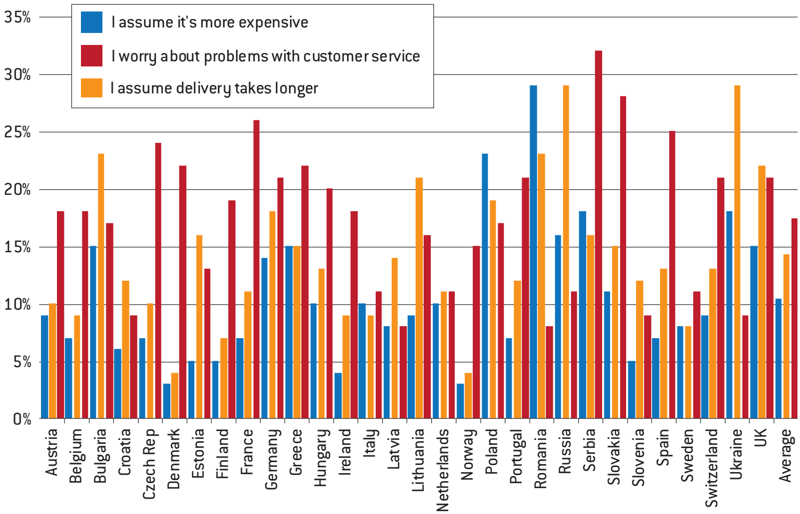
79 The data here covers the 28 EU member countries plus Switzerland and Ukraine.

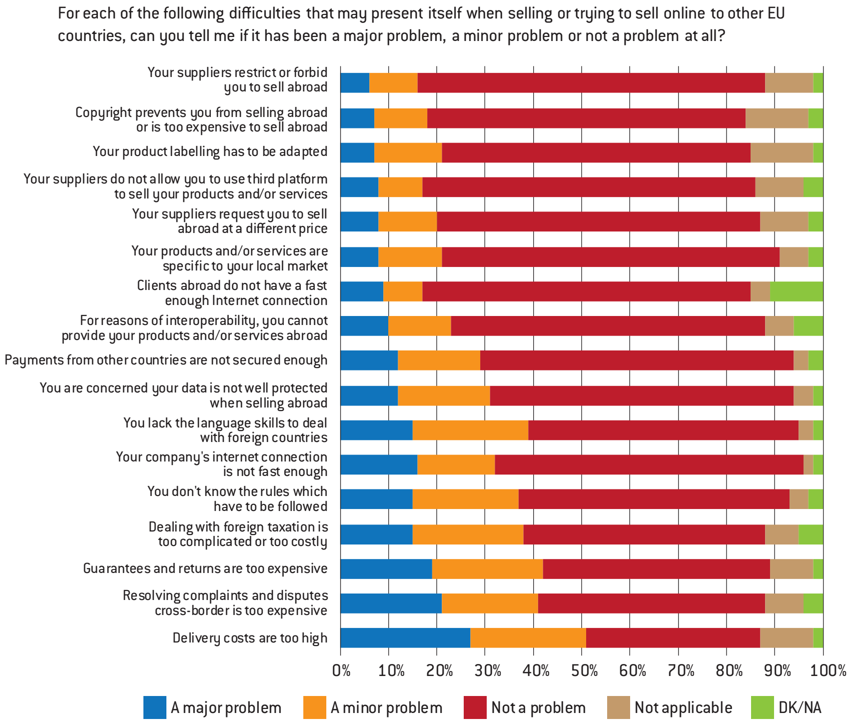
Figure 3: Reasons for not purchasing a product online from abroad (2014-15)



Source: Bruegel based on the 'Consumer Barometer,' survey conducted on behalf of Google, at www.consumerbarometer.com, viewed 21 February 2017. Note: The question asked was: *"Why have you never purchased a product online from abroad?"* See also the note to Figure 2.

Firms that sell cross-border (or that have sold cross-border in the recent past) identified a range of challenges. Particularly prominent are delivery costs that are too high, the complexity of dealing with foreign taxation, concerns about data protection when selling abroad and payments from other countries that are not sufficiently secure (Figure 3) (TNS, 2015). More generally, lack of language skills and differences in consumer protection also play a role. In sum, the concerns identified by businesses largely mirror those identified by European consumers, but the relative magnitude is not necessarily the same – for instance, suppliers appear to be more aware of delivery cost issues than consumers.

Figure 4: Problems impacting companies that sell cross-border (2014)



Source: TNS (2015).

10.1.3 Measures to address impediments to cross-border online sales

Given the wide range of issues that impact consumers and merchants, no single measure can hope to solve the 'problem' of cross-border delivery; rather, a range of measures will need to be employed in order to unlock the full potential of cross-border sales in the European Union.

With this in mind, we feel that the *Digital Single Market (DSM) Strategy* (European Commission, 2015) that the European Commission published in May 2015 is directionally right. There are synergies – the whole is greater than the sum of its parts. This does not necessarily mean that these good intentions will lead to constructive and coherent legislation. First, the details matter; merely being directionally right is not sufficient to assure good results. Second, the Commission has introduced separate legislative measures to deal with each of the problem areas that have been identified. As these measures proceed through the legislative process with little or no linkage to one another, there is a risk that well-intentioned but uncoordinated individual measures might undermine the effectiveness of the package as a whole, yielding a package that in the end achieves less than it might have. Recall that the Duch-Brown and Martens (2016) estimate of societal welfare gains (see section 10.1.1) is for fully effective and unrestricted online sales within the EU, but none of the DSM measures will in and of themselves produce this result, nor are all of them collectively likely to fully achieve it.

Assuming that the United Kingdom leaves the EU as a result of the Brexit referendum of 23 June 2016, each of the DSM measures is likely to generate less in the way of benefits than was initially foreseen. The proportional impact is however likely to be far greater on the UK than on the EU80. The details are difficult to predict because the DSM legislative measures are still being negotiated, and because of uncertainties in how the Article 50 Brexit process will play out in terms of the UK's 'Great Repeal Bill'81 and the negotiations between the EU and the UK. We discuss in section 5 the issue of data transfers between the EU and the UK, because serious problems in this respect can be predicted with a fair degree of confidence.

In the remainder of this chapter, we provide more detailed insights

80 Fullfact (2017) 'Everything you might want to know about the UK's trade with the EU': *"[A]bout 46% of the UK's exports go to other EU countries, while somewhere between 8-17% of exports from other EU countries go to the UK (depending on how you measure it). The value of that trade to the UK and other EU countries' economies – exports to the rest of the EU are worth about 13% of the UK's economy, and exports from other EU countries to the UK are worth about 3-4% of the value of those countries' economies taken as a whole"*. Available at https://fullfact.org/europe/uk-eu-trade/.

81 For a preliminary draft, see 'European Union (Withdrawal) Bill (HC Bill 5)' at https://publications.parliament.uk/pa/bills/cbill/2017-2019/0005/cbill_2017-20190005_en_2.htm viewed 25 July 2017.

into measures that have been proposed to address each of the challenges identified in section 10.1.1: high delivery costs (section 10.2), international tax complexity (section 10.3), consumer protection (section 10.4) and data protection and data transfers (section 10.5). We follow with an overall discussion of the problem of geo-blocking in general (section 10.6) before offering concluding thoughts (section 10.7).

10.2 Cross-border parcel delivery

Parcel delivery is a key issue for the online purchase of goods, to the extent that the goods need to be delivered to consumers. Of the €477 billion in e-commerce purchases in Europe in 2015, 53 percent was for the purchase of goods (E-commerce Europe, 2015). As we have noted, merchants have identified the cost of cross-border parcel delivery as the single most significant impediment to cross-border online sales. Consumers (who do not always experience the cost of cross-border delivery directly, since it is often bundled into the price of the goods sold) have also identified the cost of cross-border delivery as a significant concern.

10.2.1 Problems

The ability of Europe to fully capitalise on the opportunities offered by e-commerce appears to be limited by the high prices paid for the shipment of goods across national boundaries within the European Union. Our concern here is with basic cross-border delivery services, not with express or courier services; our primary focus is on business-to-consumer (B2C) shipments rather than business-to-business (B2B); and the concern is far greater for shipments by consumers, micro-enterprises and small and medium enterprises (SMEs) than for large shippers.

Our focus is on the national postal operators (NPOs), who continue to play a major role in these cross-border shipments, especially for SMEs. SMEs have been a core concern for European policy as regards cross-border e-commerce for some time. Based on Eurostat and other statistics, *"15 percent of SMEs sell online compared with 35 percent of large enterprises; 7 percent of SMEs sell across borders compared with*

*21 percent of large enterprises"*82.

Hard data on shipment modalities used by SMEs is quite limited, but a comprehensive study for the European Commission in 2011 found that:

"... market conditions are very different for large and small senders. Large senders operate in a competitive European cross-border parcels environment, and have much choice and bargaining power vis-a-vis suppliers. The prices they pay are negotiated. By contrast, many small senders tend to use the services of national postal operators, even in cases where they do have alternatives. As a result, they pay higher cross-border prices, as compared to domestic ones. These higher prices could be due to higher cross-border unit costs linked to the smaller scale of cross-border operations; and/or to insufficient competitive pressure, ie to the existence of market power" (FTI Consulting, 2011).

Inflated prices for cross-border delivery can negatively impact Europe in many ways:

- For B2C shipments, if the price of cross-border shipment is inflated, this price will ultimately be paid by the consumer one way or another and is likely to depress demand[83]. Purchases that might have been made but were not because of over-pricing[84] represent a welfare loss to European society.

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82 EurActiv and Digital Europe (2016) '*How Digital is the EU in 2015*?' available at http://www.digitaleurope.org/DesktopModules/Bring2mind/DMX/Download.aspx?Command=Core_Download&entryID=921&PortalId=0&TabId=353, viewed 9 April 2016. See also European Commission (2015): *"While 17% of SMEs in the EU sell online (which is already very low), only 7% sell cross-border to other EU countries."*

83 This effect would operate through the *price elasticity of demand*. It is sometimes argued that the price that the consumer pays to the retail shipper is irrelevant because retailers offer free or discounted delivery. It is indeed fair to assume that the explicit delivery charge that the consumer sees does not necessarily bear much of a relationship to the (unknown) price paid by the retailer to the delivery service (see for instance Okholm *et al* (2016), pages 21-24.). This is however rather beside the point. The retailer will consider the true costs of shipping goods when it determines the price of the goods sold.

84 To an economist, this can be understood as a deadweight loss, and can be analysed using Harberger's Triangle.

- Consumers may look only on domestic websites instead of checking websites in other member states because they (rightly or wrongly) fear high delivery charges. Analogously, small shippers might decline to offer services in other member states because they lack the knowledge or scale needed to offer services there. In both cases, potential gains in trade are foregone if a better or less expensive product that could have been purchased is not in fact purchased[85].

- European competitiveness is lost relative to the EU's global competitors. That SMEs are strongly impacted is particularly worrisome given that Europe is to some extent seeking to catch up with B2C providers elsewhere that were quicker than European firms to capitalise on e-commerce opportunities. European firms seeking to achieve market entry in the face of competition from global giants like Amazon should not be needlessly hobbled by Europe's own postal pricing arrangements.

- Shippers might be obliged to warehouse goods at more locations than would have been necessary if prices were more reflective of underlying costs[86]. This again represents a competitive disadvantage in comparison with other regions of the world.

For the most common postal (cross-border) services, payments

85 The desire to obtain these gains in trade is the reason why countries seek Free Trade Agreements (FTAs).

86 It is sometimes argued that goods are not necessarily shipped from the country associated with the website (see Okholm *et al* (2016), page 11: *"In fact, a large share of online transactions that are perceived as domestic by consumers involve a cross-border element."*). This is absolutely correct, and reflects a beneficial cost optimisation on the part of the shipper, but is somewhat irrelevant to the concern that fulfilment centres are not necessarily placed where they would be if the delivery were fully reflective of cost.

between national postal operators (NPOs) at wholesale level are referred to as terminal dues (TDs). Terminal dues are relevant not only for letters, but also for small parcels (less than 2 kilogrammes) delivered as letter post. Inward Land Rates (ILRs) are the wholesale payments between NPOs for heavier parcels of between 2kg and 20kg (up to 31kg in some countries).

Many studies have concluded that non-discounted retail prices for cross-border parcel delivery are greatly in excess of domestic prices, and also greatly in excess of real cost by any reasonable measure[87]. One might have expected that over-pricing of delivery services to other NPOs at wholesale level would drive this over-pricing, but this appears not to be the case; on the contrary, wholesale TDs appear if anything to be set below the incremental cost of delivery to the NPO in the country to which the parcel is sent. In other words, they are too low, not too high. The clear conclusion must be that NPOs take a huge mark-up over the fees that they pay to other NPOs for delivery in the country to which a parcel is sent (Marcus and Petropoulos, 2016).

The depressed wholesale prices, coupled with large mark-ups in published retail prices, cause a range of problems and distortions. Of greatest importance for our analysis here is that they discourage cross-border sales by small and medium enterprises (SMEs) within the EU. A related problem is that they enable countries outside the EU that have postal services that are content to take a smaller mark-up over wholesale TD payments[88] to use the resultant lower delivery prices to sell online to Europeans at lower prices than those achievable by European merchants, especially in comparison to smaller European merchants that have limited alternatives to the NPOs.

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87 See for instance FTI Consulting (2011), Claes and Vergote (2016) (but see also Borsenberger and Chever, 2016), Campbell (2014b) and Marcus and Petropoulos (2016).

88 Countries that are classified as 'developing', including China, may legitimately qualify for even lower TDs under the rules of the Universal Postal Union.

10.2.2 Possible solutions

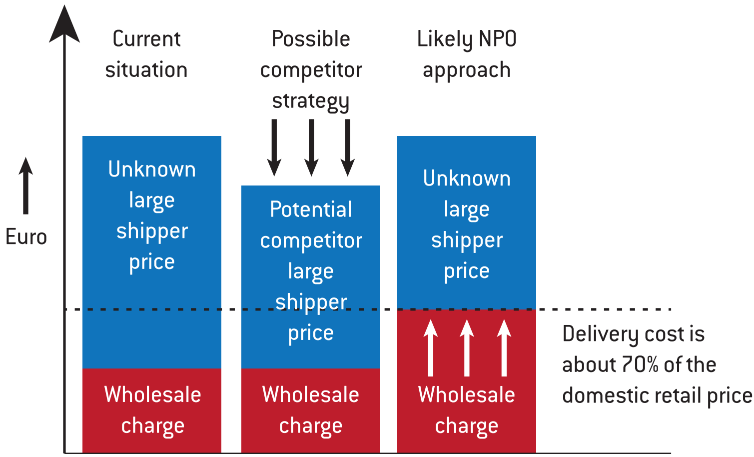
In its Digital Single Market (DSM) strategy, the European Commission rightly noted the importance of cutting the price paid for basic cross-border delivery by consumers and by small and medium sized retail shippers. Consumers and SMEs may have few alternatives to the National Postal Operators (NPOs), or may be unaware of the options that they have. These concerns led the Commission to put forward a legislative proposal in May 2016 (European Commission, 2016).

With its legislative proposal, the Commission sought (1) to strengthen the data gathering powers of member state postal regulatory authorities, and to oblige them to collect data at both retail and wholesale levels; (2) to increase transparency of pricing for those who use cross-border parcel delivery services; (3) to oblige member state postal regulatory authorities to assess annually the affordability of these services; and (4) to open cross-border Terminal Dues (TD) and Inward Land Rates (ILR) arrangements to competitors.

The first three of these seem to clearly be beneficial and appropriate. It is the fourth element (the opening up of these wholesale arrangements to true competitors), however, that is likely to have greatest effect, albeit at some risk.

As previously noted, TD rates appear to be too low in comparison with real costs to the NPOs. Opening these provisions up to domestic and cross-border competitors potentially enables the competitor to utilise the NPO's network at a cost below the true cost to the NPO itself. This would potentially enable competitors to beat the NPOs on price while using the NPO's own network. In Figure 5, the left column represents the current situation and the centre column shows how competitors could potentially take advantage of below-cost TDs if they were to remain at present levels. NPOs will not permit this to happen if they have any choice in the matter. Once the NPOs are forced to make their cross-border facilities and pricing available to true competitors, they will be under substantial economic pressure to raise their wholesale TD charges to levels approximating true cost (as shown in the right column of Figure 5), which has generally been assumed to be in the neighbourhood of 70 percent of the basic domestic tariff. The NPOs are subject to some limitations in their ability to adjust wholesale TD rates, but we assume that this will happen in the end, and that the adjustments are likely to lead to a better and less distorted parcel delivery environment throughout the European Union/European Economic Area.

Figure 5: Relationship between wholesale cost, wholesale charges, and published retail price for parcel delivery by a National Postal Operator (NPO) under proposed EU rules



Source: Marcus and Petropoulos (2016a).

10.3 Value added tax (VAT)

Lack of a fully harmonised, coherent system for the collection of value added tax (VAT) has been identified by merchants as a significant barrier to cross-border e-commerce. EU merchants ranked the cost and complexity of taxation fourth among impediments to cross-border sales in a 2014 Eurobarometer survey (TNS, 2015) (Figure 4), with 15 percent rating it a serious problem and an additional 23 percent rating it a minor problem.

10.3.1 Problems

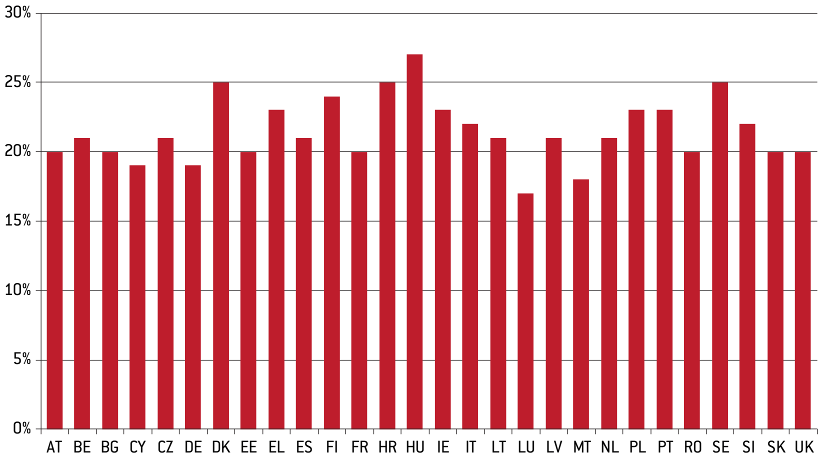
Merchants face numerous long-standing, well-known challenges.

- Every EU country sets its own VAT rates and rules;
- The shift in 2015 from country of origin to country of use was logical, but complicates matters greatly for cross-border online merchants since they are now subject to the rules of multiple member states;
- As a noteworthy example, virtual goods and physical goods are often subject to different VAT rates and rules;
- The Low Value Consignment Rule (LVCR) (which exempts small shipments from third countries from VAT) reduces the administrative burden on the member states, but also causes economic distortions, and disadvantages European e-merchants in comparison with foreign merchants.

Different VAT rates and rules in each member state

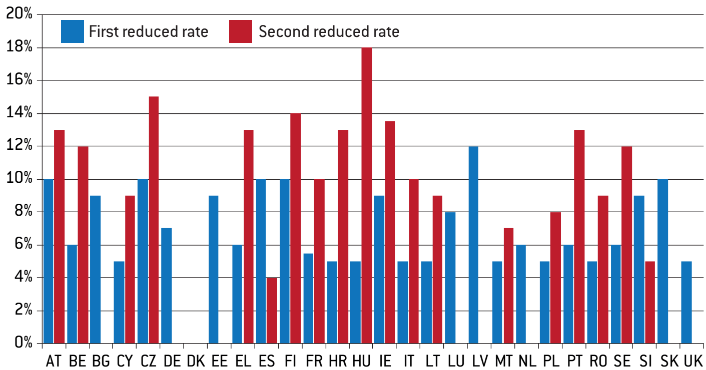
Under the EU treaties, each member state retains the prerogative to set its own VAT rates and rules. Under the EU VAT Regulation, each member state is allowed up to two different reduced rates that it can apply to a limited number of products and services of its choice. Each member state can set its own standard VAT rate and its own reduced rates.

Figure 6: Standard VAT rates among the EU member states



Source: Bruegel calculations based on European Commission (2016), '*VAT Rates*', at: http://europa.eu/youreurope/business/vat-customs/buy-sell/vat-rates/index_en.htm.

Figure 7: Reduced VAT rates among the EU member states



Source: Bruegel calculations based on European Commission (2016), 'VAT Rates', at: http://europa.eu/youreurope/business/vat-customs/buy-sell/vat-rates/index_en.htm.

In the past, these rate differentials encouraged a 'race to the bottom.' Firms might choose to locate in low VAT member states in a practice known as competitive sourcing. Member state complaints of losses in tax revenue led the Council of the EU in 2015 to adopt the destination principle – the policy that ecommerce merchants would pay VAT in the member state of consumption, rather than in the member state of establishment of the firm. This change eliminated the problems posed by competitive sourcing, but imposed new burdens on e-commerce merchants.

The shift in 2015 from country of origin to country of use VAT rules complicated matters for merchants

Under the destination principle, firms operating across member state borders must navigate a different VAT system in each member state in which they do business. Because each member state has its own VAT rate, firms must constantly adjust their prices depending on the customer's location.

In order to determine the correct VAT rate, the merchant must determine the consumer's location, a process that can be surprisingly difficult. In e-commerce involving the transfer of digital goods such as video or music files, the firm cannot use a customer's shipping address to determine which member state's VAT system applies to the transaction. In these instances, firms use the customer's IP address as a proxy for location. Unfortunately, IP addresses are relatively easy to falsify, and savvy customers could fake an IP address in a country with low VAT rates to decrease what they pay for a product. The shipping address (if the product is shipped) or the billing address might be of use, but no single indicator is perfect.

The costs associated with tracking the location of each customer present significant barriers to entry for SMEs. They limit the ability of SMEs to expand, and also are among the factors that contribute to significant tax evasion as firms seek to avoid navigating the complex web of different compliance regulations (Næss-Schmidt et al, 2012).

In an effort to reduce the burden on merchants, especially those that are SMEs, the European institutions put in place a Mini One-Stop-Shop (MOSS) to enable merchants to opt to make a single payment to tax authorities in their country of identification (establishment), rather than individual payments to each member state where VAT is due. Many businesses welcomed this simplification, but it imposes burdens of its own, and it does not entirely solve the problem – it applies only to electronic services (not to goods), and the merchant must still identify the member state from which the order has been placed in order to charge the correct VAT rate.

This problem runs deeper than a mere difference in rates. There are many differences in VAT practices among the member states. One example is the different thresholds of turnover that each member state applies in determining (1) whether the firm is required to pay VAT at all, and (2) whether the firm is subject to the destination principle – if the firm in question is below the threshold, it can choose to pay VAT according to the rules of its country of establishment (Næss-Schmidt *et al*, 2012).

Virtual goods are often subject to different VAT rates and rules than physical goods

One might reasonably expect that goods and services that compete with one another (ie economic substitutes) would be taxed at the same rate in order to avoid distorting consumption patterns. Unfortunately, this is not always the case.

A 2012 Deloitte study for the European Parliament (Næss-Schmidt *et al*, 2012) found:

"In many EU Member States the supply of hardcopy newspapers, periodicals, books, brochures and similar items edited on printed material are subject to a reduced VAT rate such as in Germany where a 19 per cent VAT rate is applied to e-books compared to a 7 per cent VAT on paper books. On the other hand, digital newspapers, periodicals, books, brochures and other similar items published on other physical means of support (e.g. CDROM) or digital means (e.g. e-books) are subject to the standard VAT rate ..."

The Low Value Consignment Rule (LVCR) introduces distortions, and disadvantages European merchants

The Low Value Consignment Rule (LVCR), which exempts small shipments from third countries from VAT, reduces administrative burden on the member states, but also causes economic distortions, and disadvantages European e-merchants in comparison with foreign merchants. The LVCR waives VAT for goods below a given threshold of value. It was put in place in the 1980s to relieve the member state of the administrative burden of collecting VAT from foreign firms importing into the EU, on the theory that the minimal revenues collected would not cover the cost of collection.

The LVCR predates both the birth of e-commerce and of the single market itself. Today, online merchants are able to ship cheap goods into the EU. The LVCR provides these foreign firms with an unfair advantage at the expense of their European competitors. To remain competitive, many European firms that produce low-value goods have moved their bases of operation outside of the EU.

An EY study conducted on behalf of the European Commission describes some of the bizarre distortions resulting from the LVCR. At one point, half of all Danish language magazines were printed in the Åland Islands (Finnish islands with a special status outside the EU VAT system) and shipped to Denmark in order to avoid paying VAT. Distortions such as these are estimated to have cost member state governments more than €600 million in lost revenue in 2013 alone (EY, 2015).

10.3.2 Possible solutions

The European Commission proposed new legislation on VAT on 1 December 2016 (European Commission, 2016a). Key elements of the Commission's legislative proposal are:

- A broadening of the Mini One-Stop-Shop (MOSS) to cover not only services, but also to goods, and to all cross-border services to end-consumers;

- Only businesses with cross border sales of more than €100,000 will be subject to the standard rules;

- Permission for member states to apply the same VAT rates to e-publications that they currently apply to printed publications. This helps to ensure the same rates and rules for physical and equivalent virtual goods;

- The LVCR will be eliminated, which is to say that foreign merchants will no longer benefit from a tax exemption that is unavailable to EU merchants[89];

- The new One-Stop Shop (OSS) will also be extended to imports. Non-EU sellers can declare the VAT using the OSS, but a second simplification mechanism will be available to imports where the OSS is not used.

These measures respond directly to the problems that have been identified, and appear to have significant chance of ameliorating them.

10.4 Consumer protection

European consumers are generally well protected in the online world; however, current arrangements (1) are subject to fragmentation, which imposes burdens on online merchants; and (2) are subject to some gaps in consumer protection. There are thus impediments both on the supply side and on the demand side. Recall that surveys on behalf of Google (see section 10.1.1) showed consumer concerns about customer service (reported by 17 percent of respondents in a simple average across the member states), possible difficulty with returns (23 percent), the complexity of possibly having to deal with a foreign language (11 percent) and lack of trust in general (21 percent).

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89 European micro-businesses tend to be exempt from VAT if their annual turn-over is sufficiently low.

EU merchants ranked the cost of resolving disputes cross-border second and *"not knowing the rules that have to be applied"* fifth among impediments to cross-border sales in a 2014 Eurobarometer survey (TNS, 2015) (Figure 4).

10.4.1 Problems

The *Consumer Rights Directive (CRD)*[90] (together with a broad range of complementary legislative instruments) has done a great deal to harmonise consumer protection arrangements across the member states and to ensure that all Europeans enjoy basic consumer rights.

Nonetheless, there are classic problems of fragmentation arising from minimum harmonisation of many aspects of the CRD. Member states can and do go beyond the provisions of the CRD, thus introducing challenging compliance issues for online merchants who seek to conduct business cross-border.

The Commission's Impact Assessment (European Commission, 2015a) expresses this complex concern as clearly as possible:

"The Consumer Rights Directive has fully harmonised certain rules for online sales of goods and supply of digital content (mainly pre-contractual information requirements and the right of withdrawal). However, there are no specific EU rules to protect consumers against non-conforming digital content. There are only minimum harmonisation rules on the notion of conformity with the contract and on remedies for non-conforming goods (under the Consumer Sales and Guarantees Directive) the implementation of which some Member States have chosen to extend to digital content. In addition, for both digital content and goods there are minimum requirements on unfair standard

90 Directive 2011/83/EU of the European Parliament and of the Council of 25 October 2011 on consumer rights, amending Council Directive 93/13/EEC and Directive 1999/44/EC of the European Parliament and of the Council and repealing Council Directive 85/577/EEC and Directive 97/7/EC of the European Parliament and of the Council, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX-:32011L0083.

contract terms (under the Unfair Contract Terms Directive). Since these are minimum standards, Member States have the possibility to go further and add requirements in favour of consumers. Many Member States have used this possibility on different points and to a different extent."

An odd corollary of this problem is that, despite generally good coverage overall, there are vexing gaps in coverage. Many of these flow once again from fragmentation in the legislative framework. Quoting again from the Commission's Impact Assessment:

"The Rome I Regulation[91] *allows contracting parties to choose which law applies to their contract and determines which law applies in the absence of choice. A trader who "directs his activities" to consumers in another country may either apply the consumer's national law or choose another law (in practice almost always the trader's national law). In this latter case, however, the trader must also respect the mandatory consumer contract law rules of the consumer's country to the extent that those rules provide a higher level of consumer protection. When the trader does not direct his activities to consumers in a specific Member State but agrees to enter into a contract at the consumer's own initiative, consumers do not benefit from the more protective rules of their national law"* (European Commission, 2015a).

10.4.2 Possible solutions

In its Impact Assessment (European Commission, 2015a) and in its legislative proposals, the Commission has reflected on various means of addressing these shortcomings in order both to ease the burdens on (small-scale) merchants, and to enhance consumer confidence in cross-border e-commerce.

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91 Regulation (EC) No 593/2008 of the European Parliament and of the Council of 17 June 2008 on the law applicable to contractual obligations (Rome I), at http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L:2008:177:TOC.

The Commission settled on the approach that is most comprehensive and probably best. Their proposed directive on supply of digital goods and contractual issues (which is at time of writing under discussion in the European Parliament) requires full harmonisation of consumer protection rules for all online sales (not just over the internet, but also for instance over the telephone). According to the proposed text, *"Member States shall not maintain or introduce provisions diverging from those laid down in this Directive including more or less stringent provisions to ensure a different level of consumer protection"*[92]. This serves not only to prevent, as much as possible, divergence among member states, but also to ensure that all offer basic guarantees of consumer protection.

The proposed directive attempts for instance to establish rules that are consistent across the member states as regards fitness for purpose (eg conformity with the contract), and as regards the consumer's rights in dealing with defective goods (eg repair or replacement).

This approach imposes transition costs on merchants, and especially on small-scale merchants, but in the long term it is likely to offer substantial net benefits on both the demand side and on the supply side. Online merchants that operate cross-border will need to master only the consumer protection laws of their country of establishment. Consumers will know that their rights are substantially the same, no matter in which member state they make their online purchases.

These measures have the effect of reducing deadweight loss associated with transaction costs for merchants and lack of confidence for consumers, thus enabling increased consumption. The Commission rightly predicts that this can be expected to increase societal welfare. We note, however, that the different measures being proposed (as discussed throughout this chapter) are mutually complementary, and that it is their combined effects that are most important.

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92 European Commission (2015) '*Proposal for a Directive of the European Parliament and of the Council on certain aspects concerning contracts for the online and other distance sales of goods*', COM(2015) 635 final.

10.5 Data transfers and data protection

As noted in section 10.1.1, concerns that data is not sufficiently well protected when selling abroad featured prominently among issues raised by merchants. In a survey of EU companies that sell cross-border within the EU, or that did so in the past, 12 percent identified this as a major problem, and an additional 19 percent as a minor problem (TNS, 2015).

Many different technical and policy aspects intersect in this area. These concerns partly reflect a concern over cybersecurity; partly, a broad concern over consumer privacy; and partly, a more focused concern over the legal permissibility of transferring data from one country to another.

Cybersecurity is a further, multi-faceted challenge that is likely to be prominent for decades to come. There is clearly an international dimension – forensically determining the country from which an attack comes can be difficult to impossible. Countries differ in regard to the quality of resources available at national level for cybersecurity and the effectiveness of their cooperation with their counterparts in other countries. At the same time, it is clear that all countries are vulnerable, both for domestic and cross-border online services. We have little more to say about it here, other than to acknowledge that it is a huge and vexing problem.

As regards data privacy, solutions need to balance consumer rights against business efficiency. The EU's General Data Protection Regulation (GDPR), which takes effect from 25 May 2018, has done a great deal to create a more uniform and future-oriented overall approach to data privacy[93]. As regards online aspects, the ongoing review of the e-Privacy Directive will hopefully play a complementary role.

Cross-border data transfers between organisations in EU member states are generally permitted, and thus unproblematic, under Article 23 of the GDPR.

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93 The current EU privacy framework law (at the time of writing), Directive 95/46/EC, will be repealed as of that date.

As an aside, we note that data transfers from the EU to the UK might become problematic in light of Brexit. If the UK is no longer an EU or EEA member state, it would raise issues that previously emerged in a legal case brought by Austrian privacy activist Maximilian Schrems. A European Court of Justice ruling on 6 October 2015[94] invalidated data transfers from the EU to the US under an agreement that had existed since July 2000. The finding was that the personal data of EU users is not adequately protected when it is transferred to the US from the EU because US firms potentially make the data available to the US National Security Agency, for which the protections set out in the EU-US data transfer agreement were either unavailable or irrelevant[95].

As long as the UK is an EU member state, transfers of personally identifiable data to the UK are governed by Article 23 of the GDPR, which permits member states to take liberties with data protection and data transfers when doing so *"respects the essence of the fundamental rights and freedoms and is a necessary and proportionate measure in a democratic society to safeguard … national security"*. If the UK were no longer an EU (or EEA) member state, it would become a third country relative to the GDPR, and transfers of personal data would instead be governed by Articles 45 through 49 of the GDPR. Article 45 of the GDPR is consistent with the Schrems judgement, but it establishes a much higher threshold for transfers

94 As the EU Court of Justice's press release notes: *"United States public authorities are not themselves subject to [the agreement]. Furthermore, national security, public interest and law enforcement requirements of the United States prevail over the safe harbour scheme, so that United States undertakings are bound to disregard, without limitation, the protective rules laid down by that scheme where they conflict with such requirements. … "*. An additional concern was that *"the persons concerned had no administrative or judicial means of redress enabling, in particular, the data relating to them to be accessed and … rectified or erased."* See http://curia.europa.eu/jcms/upload/docs/application/pdf/2015-10/cp150117en.pdf. The decision itself is available at http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:62014CJ0362.

95 See also Marcus and Petropoulos (2015).

of personal data. In order to establish an *adequacy decision* on the safeguards for transferred data, the European Commission would be obliged to take account of *"the rule of law, respect for human rights and fundamental freedoms, relevant legislation, both general and sectoral, including concerning public security, defence, national security and criminal law and the access of public authorities to personal data"*. In light of the activities of its intelligence and security services, the UK would be unlikely to get a free ride. It is highly probable that the UK would be obliged to enter into an agreement very similar to the Privacy Shield, which was agreed in 2016 between the EU and the United States (Marcus and Petropoulos, 2016b).

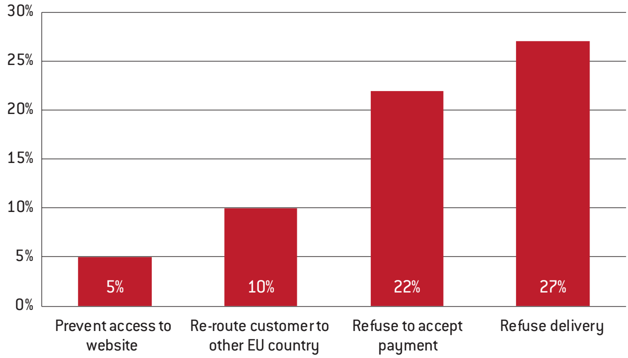
10.6 Geo-blocking and copyright

Geo-blocking occurs when a merchant declines to make online sales to prospective customers in another member state. Geo-blocking can occur at any of a number of points in the process of making an online purchase.

- The prospective customer might be prevented from accessing the e-commerce website;
- The prospective customer might be automatically re-routed to a website targeted at another member state;
- The prospective customer might not be permitted to pay for the goods or services;
- The prospective customer might be unable to arrange for delivery of the goods.

A survey conducted for the European Commission (2016b) found that the cumulative impact of these measures is enormous. About two-thirds of attempts to order cross-border fail (Figure 8).

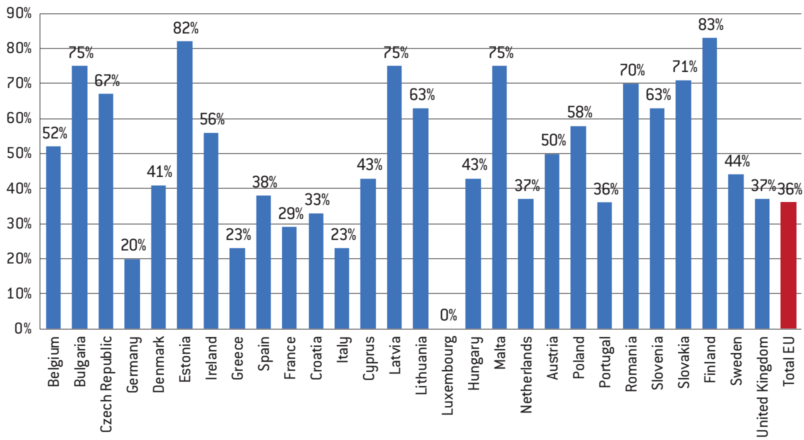
Figure 8: Prevalence of different forms of geo-blocking (EU)



Source: GfK Mystery Shopping Survey, JRC/IPTS calculations (forthcoming), as quoted in the Commission's Impact Assessment report.

Geo-blocking is widespread in Europe. The European Commission has determined that 36 percent of retailers in EU do not sell cross-border for at least one of the product categories they are selling (Figure 9) (European Commission, 2016b).

Figure 9: Respondents that do not sell cross-border in at least one product category for each of the member states



Source: European Commission (2016b).

10.6.1 Problems

The European institutions are greatly discomforted by geo-blocking, and there can be no question that geo-blocking runs directly counter to the spirit of the single market. However, there can be legitimate business reasons to geo-block. Notably, cross-border online sales may incur higher transaction costs than domestic sales, and these costs typically place a proportionately greater burden on SMEs than on large companies. Public policy must take factors such as these into account.

In terms of economic theory, geo-blocking constitutes a form of vertical restraint. In vertical agreements, restraints may also be associated with benefits. According to the Chicago School doctrine, territorial restrictions in sales may be associated with better vertical coordination, and can have a positive impact on the value of the final product (because of a better match between local demand and the products and services offered). Moreover, part of the value can be appropriated by the local distributors and have a positive impact on the real economic activity at local level. As the post-Chicago school of thought has pointed out, however, vertical restraints may also reflect strategic exploitation of market power, possibly to the point of market foreclosure. In order to assess whether geo-blocking is justified or not, case-by-case analysis is required.

In practical terms, there are many different factors that might justify geo-blocking under specific circumstances. The decision to decline to serve consumers in certain countries might legitimately reflect, for instance:

- The regulatory and administrative burden of doing business in that country;
- Tax considerations;
- Lack of affordable, high-quality delivery services;
- Different technical specifications (eg labelling requirements) in different member states;
- Challenges in terms of fraud prevention;
- Specific obligations regarding advertising, tobacco, alcohol or gambling.

10.6.2 Possible solutions

The European Commission in May 2016[96] proposed a regulation that seeks to prohibit geo-blocking. The regulation addresses three main aspects of the problem:

- Article 3 would prohibit traders from preventing access to their online interface (eg their website), or from involuntarily rerouting the customer to a different website, on the basis of the customer's residence;

- Article 4 would prohibit certain traders from applying *"different general conditions of access to their goods or services, for reasons related to the nationality, place of residence or place of establishment of the customer"*;

- Article 5 would prohibit traders from applying *"different conditions of payment for any sales of goods or provision of services"*;

The scope of goods and services to which the proposed regulation would apply is quite narrow. To begin with, copyrighted digital content services (such as films, TV series, broadcasts of sport events, software, eBooks, online games and music) are excluded overall.

Furthermore, the non-discrimination obligations of Article 4 are restricted so as to cover only goods or services for which no physical delivery is required:

- In the case of selling of physical goods when they are not delivered cross-border to the member state of the customer by the trader or on his or her behalf;

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96 European Commission (2016) '*Proposal for a Regulation of the European Parliament and of the Council on addressing geo-blocking and other forms of discrimination based on customers' nationality, place of residence or place of establishment within the internal market and amending Regulation (EC) No 2006/2004 and Directive 2009/22/EC*', COM (2016) 289 final.

- In the provision of electronically supplied services, other than services whose main feature is the provision of access and use of copyright-protected works;

- In services (other than those covered by the second situation), which are supplied to the customer at the premises of the trader or in a physical location where the trader operates (for example, hotel accommodation, leisure activities, car hire, festivals and so on)[97].

Finally, the proposed regulation governs conduct relative to end-users of the goods or services; thus, it does not govern arrangements between firms.

The regulation appears to be directionally appropriate. It addresses real concerns, based both on the mystery shopping tour (Figure 8), and also on the observation that 11 percent of consumers report concerns with payment arrangements in consumer surveys on behalf of Google (see section 10.1.1).

The exclusions are unfortunate, but the exclusion of goods requiring shipment and of copyrighted audiovisual content services reflects valid concerns.

- In the case of goods, excluding those that require shipment avoids imposing non-discrimination obligations in cases where cross-border shipment costs are truly too large to ignore (see section 10.2.1). It is clear that prices to the end-user cannot be the same as in the case of domestic delivery[98].

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97 This non-discrimination principle is in line with Article 20(2) of the Services Directive, which prohibits discrimination based on nationality or place of residence except where those differences are directly justified by objective criteria. The provisions attempt to strike a balance between, pursuing the Single Market objective and addressing the potentially harmful effects of price and other discrimination. However, as the Commission admits in the geo-blocking regulatory proposal, the Directive was not an effective intervention to achieve the pursued objectives.

98 Whether this price appears as a separate charge, or is included in the price of the goods or services, is not relevant here. What is relevant is the total effective price.

- In the case of copyrighted audiovisual services, a substantial literature suggests that the current system of territorial restrictions plays an important role in enabling the financing the creation of new audiovisual content, and that a prohibition on territorial restrictions might therefore reduce the volume of new content produced[99].

It might perhaps be possible to mitigate these gaps and shortcomings in the proposed Regulation by means of narrowly and carefully crafted rules (Marcus and Petropoulos, 2017).

In the case of goods that require shipment (Marcus and Petropoulos, 2017a), one could consider including them within the scope of the non-discrimination obligations, but allowing the merchant to charge a justifiably higher price. Specifically, the merchant might have to ensure that the price charged to cross-border customers would not be permitted to exceed the price charged to domestic customers by a sum greater than that by which the NPO's published price for shipment of goods with the characteristics of the shipment in question (eg weight and volume) from the merchant's member state of establishment to the member state to which shipment is requested exceeds the NPO's published price for shipment of the same goods within the merchant's member state of establishment.

There is an active debate about geo-blocking of copyrighted material, but it is not really a debate about copyright. There are complexities with the copyright procedure and with collecting necessary rights across the member states, but the problem that is relevant to geo-blocking is for the most part not with the copyright procedure itself. In the context that we are discussing here, copyright is in most cases used as a means of enforcing geographic or temporal partitioning that has been decided for commercial reasons. The real questions are (1) whether those restrictions enhance or decrease societal welfare

99 See CRA (2014), Oxera (2016) and Marcus and Petropoulos (2017).

in the broadest sense, and (2) whether they are compatible with EU single market principles. The material in question might be subject to copyright, but these questions have very little to do with the copyright as such.

In the case of copyrighted audiovisual content, it might be possible to include within scope only works for which sufficient time has passed from the date of first theatrical release to enable most of the revenue to be extracted (perhaps two years). Alternatively, including only Transactional Video on Demand (TVoD) services might have only minimal adverse effect on the pre-financing model.

For other copyrighted digital content (music, e-books and games), inclusion within the scope of the proposed regulation is not likely to introduce serious problems; however, case by case analysis would be required. In the case of e-books, for example, it would be necessary to permit merchants to comply with member state laws that mandate fixed prices, as is already proposed by the Commission in the case of printed books (Marcus and Petropoulos, 2017).

10.7 Conclusions

As noted in section 10.1.3, we feel that the DSM strategy (European Commission, 2015) put forward by the European Commission is directionally right. Strengthening e-commerce with an interrelated barrage of measures is generally appropriate. There are synergies – the whole is greater than the sum of its parts.

This does not necessarily mean that these good intentions will lead to constructive and coherent legislation. For each of the proposed measures, the devil is in the detail, and these details are still, at the time of writing, being sorted out by the European Parliament and the Council of the EU.

The measures can also be distinguished in terms of (1) their relative importance, (2) the sequence in which they are enacted, and (3) the speed with which their effects are felt. Multiple surveys of merchants suggest that high cross-border parcel delivery prices from the NPOs, divergent consumer protection rules, and divergent VAT regimes are their most serious problems (Figure 4). Imposition of a prohibition on geo-blocking for any class of goods or services should not take effect until the relevant parcel delivery, consumer protection, and VAT measures have taken effect. In other words, the sequence in which measures take effect could be important.

Carrying this thought a bit further, this initial set of measures might set the stage for a second round of legislation in the future. For example, an extension of the prohibition on geo-blocking to include goods that require shipment would be ill-advised today, because too little is known about the wholesale and retail pricing arrangements among the NPOs, and between the NPOs and merchants. Such a measure might however be considered in a few years once data has been collected, and possibly in concert with complementary legislative measures.

Beyond this, we see a serious risk that the lack of coordination among the various legislative measures might lead to conflicts and problems. Well-intentioned changes to individual measures (for instance, attempts to retain member state consumer protection measures that go far beyond the requirements of EU directives) might well undermine the effectiveness of the package as a whole. If the legislative package ultimately results in obligations for fairly small-scale merchants to make online cross-border sales, but fails to properly address the high transaction costs associated with cross-border sales, the net effect might be to reduce European societal welfare rather than to enhance it[100]. In other words, there is substantial risk that well-intentioned but uncoordinated individual measures might undermine the effectiveness of the package as a whole, yielding a package that in the end achieves less than it might have.

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100 Restricting such an obligation to passive sales does little to solve this problem.

References

Borsenberger, C. and L. Chever (2016) *The Drivers of Cross-Border Parcel Delivery Prices: An Econometric Study at the EU Level*, report for Le Group La Poste

Campbell, J.I. Jr. (2014) 'Estimating the Effects of UPU Terminal Dues, 2014-2017', 8th Bi-annual Postal Economics Conference on E-commerce, Digital Economy and Delivery Services, Toulouse

Claes, A. and W. Vergote (2016) *Econometric study on parcel list prices*, Université Saint-Louis Bruxelles prepared for the European Commission, available at http://ec.europa.eu/DocsRoom/documents/14647

CRA (2014) *Economic Analysis of the Territoriality of the Making Available Right in the EU*, study for the European Commission

Duch-Brown, N. and B. Martens (2016) 'The economic impact of lifting geoblocking restrictions in the EU Digital single Market', *Digital Economy Working Paper* 2016/02, Institute for Prospective Technological Studies, European Commission

E-commerce Europe (2015) *2014 Key B2C E-commerce Data of Goods & Services at a Glance*

European Commission (2015) 'A Digital Single Market Strategy for Europe', SWD (2015) 100 final

European Commission (2015a), Impact Assessment accompanying the document 'Proposals for Directives of the European Parliament and of the Council (1) on certain aspects concerning contracts for the supply of digital content and (2) on certain aspects concerning contracts for the online and other distance sales of goods', SWD(2015) 274 final/2

European Commission (2016) 'Proposal for a Regulation of the European Parliament and of the Council on cross-border parcel delivery services', COM(2016) 285 final

European Commission (2016a) 'Modernising VAT for cross-border B2C e-commerce', COM(2016) 757 final

European Commission (2016b) 'Preliminary Report on the E-commerce Sector Inquiry', SWD (2016) 312 final

Eurostat (2017) 'E-commerce statistics for individuals', available at http://ec.europa.eu/eurostat/statistics-explained/index.php/E-commerce_statistics_for_individuals

EY (2015) *Assessment of the application and impact of the VAT exemption for importation of small consignments*, study for the European Commission, available at https://ec.europa.eu/taxation_customs/sites/taxation/files/docs/body/lvcr-study.pdf

FTI Consulting (2011) *Intra-community cross-border parcel delivery*, study for the European Commission, available at http://ec.europa.eu/docsroom/documents/14205/attachments/1/translations/en/renditions/native

Marcus J.S. and G. Petropoulos (2015) ‘Data transfers under the threat of terrorist attacks’, *Bruegel Blog*, 15 December

Marcus J.S. and G. Petropoulos (2016a) ‘E-commerce in Europe: Parcel delivery prices in a Digital Single Market’, *Policy Contribution* 2016/09, Bruegel

Marcus J.S. and G. Petropoulos (2016b) ‘Brexit and its potential impact on international data transfers’, *Bruegel Blog*, 4 August

Marcus J.S. and G. Petropoulos (2017), *Extending the scope of the geo-blocking prohibition: An economic assessment*, study for the IMCO Committee, European Parliament

Marcus J.S. and G. Petropoulos (2017a) ‘Geo-blocking of goods that require cross-border delivery: A preliminary view on EU policy considerations’, presentation to the FSR/Rutgers Postal Economics Conference, Barcelona, May

Næss-Schmidt, H.S., D. Mekonnen Ali and M. Nieto Arias (2012) *Simplifying and Modernising VAT in the Digital Single Market for e-Commerce*, study for the European Parliament, available at http://www.europarl.europa.eu/RegData/etudes/etudes/join/2012/492432/IPOL-IMCO_ET(2012)492432_EN.pdf

Okholm, H., A. Möller Boivie, J. Sabine Wahl, K. Jensen, A. Nygard and B. Basalisco (2016) *Principles of E-Commerce Parcel Prices*, Copenhagen Economics, prepared for PostEurop, available at: https://www.copenhageneconomics.com/publications/publication/principles-of-e-commerce-delivery-prices

Oxera (2016) *The impact of cross-border access to audiovisual content on EU consumers*, available at https://www.oxera.com/getmedia/5c575114-e2de-4387-a2de-1ca64d793b19/Cross-border-report-(final).pdf.aspx

TNS (2015) ‘Companies Engaged In Online Activities’, *Flash Eurobarometer* 413

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REMAKING EUROPE: THE NEW MANUFACTURING AS AN ENGINE FOR GROWTH

Reinhilde Veugelers

Manufacturing once provided Europe with many jobs that did not require high skills. The idea that such jobs can be revived is a central issue for many politicians and is behind the demand that products should be 'made in' the countries that consume them. But such rhetoric has as its reference point an old version of manufacturing, which has been supplanted by complex value chains and is highly automated and data driven. This new version of manufacturing also needs attention from politicians, but for different reasons than the provision of millions of old-style production-line jobs.

The policy discussion on the future of manufacturing requires an understanding of the changing role of manufacturing in Europe's growth agenda. Europe needs to know how it can realise the potential for industrial rejuvenation. How well are European firms responding to the new opportunities for growth, and in which global value chains are they developing these new activities? Does Europe have the right conditions for its economies to create and capture value from the activities that contribute most strongly and sustainably to Europe's growth and external competitiveness? This Blueprint helps to provide some of the answers. The evidence in this volume shows that the challenge for European policymakers is how to promote and attract those high-value added activities within global chains that are the basis for sustainable growth and competitiveness. Such activities are not necessarily production related, but will increasingly have service-like characteristics and do not necessarily require all the activities of the whole value chain to be located at home.

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