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European Competitiveness Report 2013 :
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ANNEX 1
ABBREVIATIONS

ECR	Enforcing Contract Time
EPC	Employment Protection Legislation for collective dismissals.
EPL	Overall Employment Protection Legislation
EPR	Employment Protection Legislation for regular contracts
EPT	Employment Protection Legislation for temporary contracts
EU-15	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom.
EU-27	Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Lithuania, Luxembourg, Latvia, Malta, Netherlands, Poland, Portugal, Romania, Spain, Sweden, Slovenia, Slovakia, UK.
EU-8	Austria, Belgium, France, Netherlands, Spain, Germany, Italy, UK.
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GPT	General Purpose Technology
ICT	Information and Communications Technologies
IPR	Intellectual Property Rights
JP	Japan
LC	Labour Composition
LP	Labour Productivity
NACE	National Classicisation of Economic Activities
NMW	National Minimum Wage
NUTS	The Nomenclature of Territorial Units for Statistics
OECD	Organisation for Economic Cooperation and Development
OLS	Ordinary Least Squares
PMR	Product Market Regulation
R&D	Research and Development
RI	Regulation Impact
SFA	Stochastic Frontier Analysis
SME	Small and Medium-sized Enterprise
TE	Technical Efficiency
TFP	Total Factor Productivity
US	United States

ANNEX 2
METHODOLOGIES

2.A. METHODOLOGY TO AGGREGATE PRODUCTIVITY DATA

The Conference Board Total Economy Database (TED) and the EUKLEMS database contain a wide range of economic performance measures on a country-by-country basis. This information is however of limited use if one wants to establish meaningful comparisons of growth and productivity trends between the whole of the EU and other world economies. In this study, the methodology set out in Timmer et al, 2007 is followed to construct EU aggregate (e.g. the EU-27 or EU-15) measures of output, input and productivity.

This methodology is based in the use of a Törnqvist quantity index, which is a discrete time approximation to a Divisia index. A Divisia index defined as a continuous-time weighted sum of the growth rates of various components, where the weights are the component's shares in total value; in the Törnqvist index, the growth rates are defined as the difference in the natural logarithm of consecutive observations of the components, and the weights are equal to the mean of the factor shares of the components in the corresponding pair of time periods (e.g. years).

Aggregation over countries

The derivation of an aggregate measure of labour productivity for the EU-27 is outlined in practical terms here. First of all, annual growth rates of labour productivity for each of the EU-27 countries are computed for the time period under consideration (as the differences in the natural logarithms). Secondly, the annual shares of each country in EU nominal output are calculated using PPP-converted values, which adjust for purchasing power parities price differentials across countries [1] (Inklaar and Timmer, 2008).

The calculation of nominal output shares for each of the EU countries is given by the following expression:

$$V_{c,j,t} = \frac{\left[\frac{PY_{c,j,t}}{PPP_{c,j,t}}\right]}{PY_{EU,j,t}}$$

[1] Purchasing Power Parities (PPP), which are available for economy level and for detailed industries, are usually given for a benchmark year. Here the PPPs are given for 1997 (See Inklaar and Timmer, 2008).

where VV denotes PPP-adjusted nominal output; *PY* denotes nominal output; *c* denotes country, *j* denotes industry, and *t* denotes year.

The overall labour productivity for the EU-27 is then calculated as a weighted average of country productivity growth rates, as set out below:

$$\Delta lnLP_{EU,j,t} = \sum_{c}^{n} \bar{V}_{c,j,t}\, \Delta LnLP_{c,j,t}$$

Where $\bar{V}_{c,j,t}$ $\bar{V}_{c,j,t}$ denotes the two-year average shares of each country in total nominal output. Once the annual growth rates for the EU country grouping are obtained, it is feasible to construct an aggregate index of labour productivity in relation to a base year (for example, assuming that labour productivity is equal to 100 in year 1995).

Aggregation over industries

A similar procedure to the one outlined above can be applied to calculate aggregate performance for a specific group of industries. For instance, to measure productivity growth in the high-technology manufacturing sector of a particular country. Moreover, if productivity in the high-technology manufacturing sector of the EU as a whole wants to be computed, a double aggregation procedure has to be followed. First an aggregation is performed over countries, and then, over industries, following recommendations in Timmer et al (2007).

$$\Delta lnLP_{EU,t} = \sum_{j}^{n} \bar{V}_{EU,j,t}\, \Delta LnLPY_{EU,j,t}$$

2.B. GROWTH ACCOUNTING METHODOLOGY

The growth accounting methodology (Jorgenson and Griliches, 1967; Jorgenson et al, 1987) has been widely used to assess the contribution of the different factors of production to aggregate economic growth. According to this methodology, which is rooted in neoclassical theory, the part of output growth that is not accounted by the growth in inputs, usually capital and labour can be attributed to TFP, a proxy measure for technological progress. Assuming a Cobb-Douglas production function, output YY (i.e. value added) is a function of capital (K), labour (L), and technology (A) in the following terms:

$$Y = AL^{\alpha}K^{\beta}$$

Assuming that factor markets are competitive, full input utilisation and constant returns to scale, the growth of output can be expressed as the cost-share weighted growth of inputs and technological change (A), using the translog functional form common in such analyses:

$$\alpha + \beta = 1$$

$$\Delta \,\mathrm{LN}\, y_t = \bar{\alpha}\Delta l_t + \bar{\beta}\Delta k_t + \Delta A_t$$

where $\bar{\alpha}$ are the and $\bar{\beta}$ is the two-period average share of labour and capital input in nominal output.

With the use of this empirical approach It is s possible to identify and quantify the role of labour and capital in aggregate growth. More recent contributions extended the framework to allow for the separate analysis of ICT assets (computers, software and communications) and non-ICT capital assets (machinery, transport equipment, residential buildings, infrastructure), as well as changes in workforce composition, in terms of labour characteristics such as educational attainment, age or gender (Jorgenson et al, 2005). Growth in output can be decomposed into the following elements:

$$\Delta y_t = \alpha\Delta l_t + \bar{\beta}_{ict}\Delta ictk_t + \beta_{nict}\Delta nictk_t + \Delta TFP_t$$

$$\Delta y_t = \alpha\Delta l_t + \bar{\beta}_{ict}\Delta ictk_t + \beta_{nict}\Delta nictk_t + \Delta TFP_t$$

where the contribution of each factor input is given by the product of its share in total costs and its growth rate;

$\bar{\beta}_{ict}$ $\bar{\beta}_{ict}$is the two-period average share of ICT assets in total capital compensation; and $\bar{\beta}_{nict}\bar{\beta}_{nict}$ is the two-period average share of non-ICT assets in total capital compensation.

The growth in labour input can be split into growth of hours worked and changes in labour composition. Labour composition in EUKLEMS is derived by dividing labour into types and multiplying growth in each type by wage bill shares.

$$\Delta l_t = \Delta h + \Delta LC \; \Delta l_t = \Delta h + \Delta LC$$

To analyse productivity it is useful to divide output and inputs by the number of hours.The following expression can be derived for labour productivity growth:

$$\Delta\left(\frac{y}{l}\right) = \bar{\beta}_{ict}\Delta\left(\frac{ictk}{l}\right) + \bar{\beta}_{nict}\Delta\left(\frac{nictk}{l}\right) + \bar{\alpha}\Delta\left(\frac{LC}{l}\right) + \Delta TFP$$

Based on the above formulae, the EUKLEMS and The Conference Board Total Economy Database provide a full decomposition of output and labour productivity growth into the contributions of the various factor inputs and TFP growth.

2.C. THRESHOLD REGRESSIONS

Threshold models have in recent times received a great deal of attention as a means of modelling parameter heterogeneity and non-linearities. In a series of papers Hansen (1996, 1999 and 2000) develops a technique that allows the sample data to jointly determine both the regression coefficients and the threshold value for OLS and (non-dynamic) fixed effects panel models.

The threshold model for a single threshold can be written as:

$$y_i = \alpha_0 + \delta_1 x_i 1(q_i \le \lambda_1) + \delta_2 x_i 1(q_i > \lambda_1) + \varepsilon_i$$

where 1 is the indicator function and q_i is the threshold variable. Here the observations are divided into two regimes depending on whether the threshold variable is smaller or larger than λ_1. The two regimes are distinguished by different regression slopes, δ_1 and δ_2. Chan (1993) and Hansen (1999) recommend estimation of λ_1 by least squares. This involves finding the value of λ_1 that minimises the concentrated sum of squared errors. In practice this involves searching over distinct values of q_i for the value of λ_1 at which the sum of squared errors is smallest, which is then our estimate of the threshold. Once we have an estimate for the threshold it is straightforward to estimate the model. Hansen (2000) extends this method to the case of non-dynamic fixed-effects panel models.

Having found a threshold it is important to determine whether it is statistically significant or not, that is, to test the null hypothesis; $H_0{:}\,\delta_1 = \delta_2$.

Given that the threshold λ_1 is not identified under the null, this test has a non-standard distribution and critical values cannot be read off standard distribution tables. Hansen (1996) suggests bootstrapping to simulate the asymptotic distribution of the likelihood ratio test allowing one to obtain a p-value for this test. Firstly, one estimates the model under the null (i.e. linearity) and alternative (i.e. threshold occurring at λ_1). This allows one to construct the actual value of the likelihood ratio test (F_1):

$$F_1 = \frac{S_0 - S_1(\lambda)_1)}{\Sigma^2}$$ where

$$\Sigma^2 = \frac{1}{N(T-1)} S_1(\lambda_1)$$

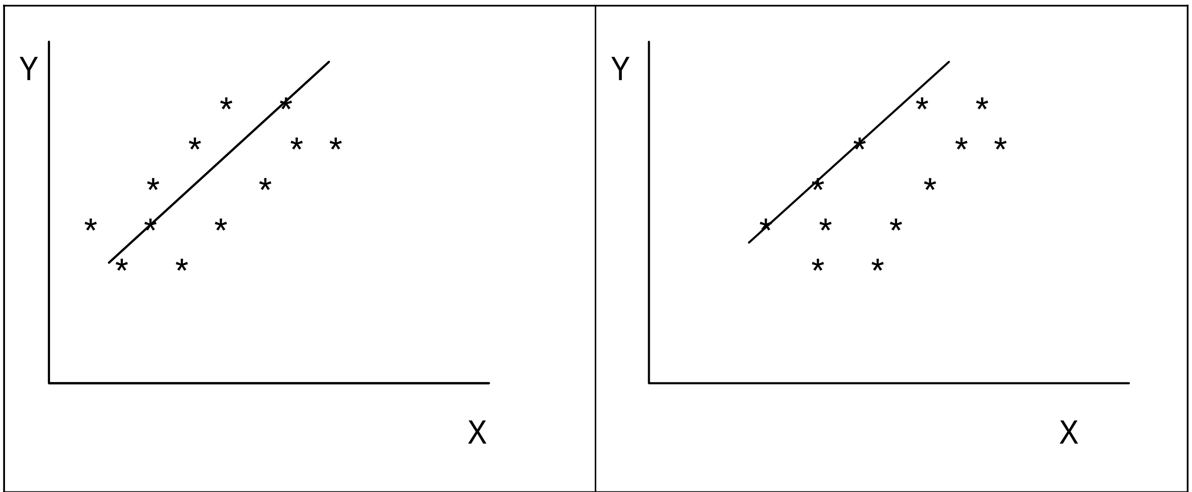
Here S_0 and S_1 are the residual sum of squares from the linear and threshold models respectively. Using a parametric bootstrap (see Cameron and Trivedi, 2005) the model is then estimated under the null and alternative and the likelihood ratio F_1 is calculated. This process is repeated a large number of times.

The bootstrap estimate of the p-value for F_1 under the null is given by the percentage of draws for which the simulated statistic F_1 exceeds the actual one.

The approach is also easily extended to consider more than one threshold. While it is straightforward to search for multiple thresholds, it can be computationally time-consuming. Bai (1997) has shown, however, that sequential estimation is consistent, thus avoiding this computation problem. In the case of a two-threshold model, this involves fixing the first threshold and searching for a second threshold. The estimate of the second threshold is then asymptotically efficient, but not the first threshold because it was estimated from a sum of squared errors function that was contaminated by the presence of a neglected regime. Bai (1997) suggests estimating a refined estimator for the first threshold, which involved re-estimating the first threshold, assuming that the second threshold is fixed. The test of significance of the second threshold proceeds along the same lines as described above, with the null and alternative hypotheses being of a one and two threshold model respectively.

2.D. STOCHASTIC FRONTIER ANALYSIS (SFA)

Frontier Analysis, initially developed in Farrell (1957) and successively extended by Aigner et al. (1977), Kumbhakar and Lovell (2000) and Greene (2005) among others, aims to identify the production frontier, i.e. the maximum level of output that can be achieved by using the available inputs. Compared to regression analysis, the estimation of the frontier production function implies fitting a regression line over the units (industries in our case) that produce the most output. The difference between the two techniques can be easily seen in the following figure, where Y indicates output and X denotes a generic input:



A: Regression analysis | B: Frontier analysis

Countries/industries at the frontier are those that are making the most efficient use of their resources. Those below the frontier have some level of inefficiency, which can be directly estimated by the distance between each industry and the frontier industry.

It is possible to distinguish between two frontier methods, Deterministic Frontier (DEA) and Stochastic Frontier (SFA). DEA (Farrell 1957, Charnes, Cooper and Rhodes 1978) provides a non-parametric approach for estimating production technologies and measuring inefficiencies in production. It relies on the assumption that all deviations from the frontier are caused by technical inefficiency, without making allowanced for measurement errors and/or random components. This implies that not only the method is very sensitive to the presence of outliers, but also lacks the necessary diagnostic to help the user determine whether or not the chosen model is appropriate, which variables are significant and which are not. These shortcomings are overcome by using the SFA.

Here the identification of the frontier technology is based on the econometric estimation of a production function, usually a Cobb-Douglas or a semi-translog function. Differently from standard regression analysis, frontier analysis allows for the presence of a composite error term, which includes a random component and an inefficiency term. The random component allows for the presence of measurement errors and other effects not captured by the model. The inefficiency term measures technical inefficiencies, i.e. the distance of each country/industry from the frontier. This ranges between 0 and 1, with higher values identifying more efficient units. Technical efficiency scores derived for each unit/industry can then be analysed across different dimensions to pinpoint areas characterised by low/high inefficiencies.

The performance of an industry depends not only on the inputs used in the production process but also on other external or environmental factors that can affect the efficient use of resources. These are usually factors that are outside the control of an industry, even though it is possible that some factors play a dual role, i.e. they affect both frontier output and inefficiency (Kneller and Stevens 2006). The SFA framework can easily account for this by modelling the mean level of the inefficiency term as a function of these additional factors. Production frontier and determinants of inefficiency are estimated simultaneously by maximum likelihood (ML) (Battese and Coelli 1995).

2.E. PAVITT TAXONOMY (1984)

Using industry-specific characteristics of innovative UK firms Pavitt (1984) identifies some major technological trajectories in manufacturing, on the basis of which it is possible to identify some specific patterns of sectoral innovation. The Pavitt (1984) taxonomy maps industries according to the source of innovation activities made by the firms (internal vs external), the nature of innovation (informal vs formal, or learning vs R&D), firm size (small, medium, or large), appropriability of innovation (low vs high returns to innovation), method of protection (secrecy vs patents) etc. Industries or firms can be grouped into the following categories:

Scale-intensive: They are large firms exploiting increasing returns to scale and learning-by-doing associated with the size of the reference market, or of their own plant. The source of innovation may be both external and internal. In the former case, these firms acquire production technologies from specialised suppliers. In the latter case, in-house R&D activities are performed to develop new types of products; in this case, patenting is effective to protect innovation. The main economic activities of such firms are basic metals or the production of durable goods.

Science based: They are mainly large firms using internal sources of knowledge to produce innovations (R&D). Their knowledge base is complex and relies upon scientific advances. Sometimes, innovations are developed between private firms and universities and other research institutes. Patents are the major, but not exclusive, tools to protect innovations. Small firms may be very competitive in certain technologically advanced niches. The main economic activities of such firms are pharmaceuticals, electronics, etc.

Specialised suppliers: They are small- and medium-sized firms manufacturing sophisticated equipment and/or precision machinery. They strongly rely upon internal sources of innovation (engineering and design capabilities are pivotal), developing new products by continuously interacting with their customers, i.e. downstream firms using in their production the equipment developed by this category. The nature of innovation of this type of firms is therefore informal and based on learning.

Supplier dominated: They are traditional firms, representing the least technologically advanced branch of the manufacturing sector. Their main source of innovation is external and consists in introducing cost-saving process innovations, or implementing advanced technologies, equipment and materials, developed in other sectors. The only internal source of innovation is the learning associated with the usage of acquired inputs. Given the low level of appropriability of internal innovation, patenting is not very developed. The main economic activities of such firms are food, textile, footwear, etc.

Chapter 4.
A 'MANUFACTURING IMPERATIVE' IN THE EU: THE ROLE OF INDUSTRIAL POLICY

The economic crisis changed the perceptions of the role of the manufacturing sector in the economy. Manufacturing has redeemed its reputation in the sense that a comparatively large manufacturing sector is no longer considered to reflect an outdated economic structure, inadequate for a post-industrial, services-dominated economy like the EU. Rather, nurtured by the observation that within the EU, countries which have maintained a larger manufacturing base fared better during and after the crisis (Reiner, 2012; Fürst, 2013), a dynamic manufacturing sector is again considered a prerequisite for an innovative and fast-growing economy. In a recent Communication, the European Commission, emphasises that a 'vibrant and highly competitive EU manufacturing sector' is a key element for solving societal changes ahead and a 'more sustainable, inclusive and resource-efficient economy' (European Commission, 2010a).

This altered perception of manufacturing raised concerns that manufacturing production had declined too much (Warwick, 2013) in some Member States leading to a loss of knowledge, capabilities and supplier networks which have been referred to as the 'manufacturing commons' (Pisano and Shih, 2009)[2]. Earlier arguments for a 'manufacturing imperative' (Rodrik, 2012) were re-discovered and the current structural shift out of manufacturing in advanced economies, including most EU Member States, started to look less advantageous. The urge felt by policy makers and the business community to maintain a broad manufacturing base in Europe also led to a renewed interest in industrial policy in Europe and elsewhere (including the United States).

The importance of industrial structures is widely accepted. The potential for economic policy to shape that structure, however, remains highly disputed, particularly in Europe where the track record of interventionist industrial policy experiments in the 1960s and 1970s was rather disappointing (Crafts, 2010; Owen, 2012). Industrial policy, understood as selective government interventions seeking to alter the structure of production towards industries that are expected to offer higher growth prospects (Pack and Saggi, 2006), can in principle try to foster structural change towards any sector or industry that government authorities consider to be 'strategic' or potential carrier of growth. Viewed through the lenses of a 'manufacturing imperative', the particular characteristics of manufacturing industries (such as externalities and increasing returns to scale[3]) call for industrial policies that re-direct the European economy towards manufacturing activities and aim at strengthening or restoring the industrial commons.

Despite this renewed debate about the objectives and instruments of EU industrial policy, it remains deeply rooted in the principles of competition, favouring general framework policies (such as the proper functioning of the Internal Market and competition rules) and 'horizontal' policies over sector-specific interventions[4]. Nevertheless, in the aftermath of the economic crisis the European Commission's focus on framework policies has been supplemented with more sector-specific policy objectives such as the definition of key priority areas which include inter alia the development of clean vehicles and vessels and smart grids (European Commission, 2012a). Sector-specific action may indeed be warranted in cases where the market is not able to bring about a resource allocation that is efficient and conducive to solving societal challenges. A potential reason for that is the existence of path dependency in technological trajectories as documented for example in an under-provision of clean technologies (Aghion et al., 2010). A corollary of this is that the state has an important coordination role, helping to remove lock-in effects in technological developments.

Against this background, this chapter revisits some of the main arguments in favour of a manufacturing imperative and discusses them in a European context. It also shows the limitations and caveats of these arguments in a world of strong inter-linkages between

[2] The industrial commons are a reference to the commons which is the land belonging to a (village) community as a whole and which could also be used by each member of the community (typically for grazing of animals). They can be described as the general stock of knowledge, competences and skills (often embodied in the workforce) and institutions (including supplier networks) relevant for modern manufacturing activities that can be shared and accessed by the manufacturing sector as a whole (Pisano and Shih, 2009).

[3] Increasing returns to scale can also arise from network externalities which play a role in a number of sectors that can be referred to as utilities such as water, gas and electricity, telecommunication or rail services.

[4] Among economists it is highly disputed whether horizontal measures are necessarily less distortive than sectoral interventions. De facto, horizontal policies are hardly neutral with regards to structure and sectors. Therefore, the dichotomy between horizontal measures and vertical measures may be blurred or even meaningless (Pelkmans, 2006; Cohen, 2006; Midelfart and Overman, 2002; Chang, 2006).

the production of manufactures and the services which enter the production process (Sections: 4.1-4.6). Sections: 4.7-4.10, identify the main challenges ahead for European manufacturing given the structural changes that occurred in the EU over the period 1995 to 2011. Sections: 4.11-4.15 analyse a number of industrial policy measures that are related to these structural challenges. Given the still prevalent use of State aid by EU Member States and the unique institutional framework which empowers the Commission to restrict the use of State aid, a quantitative analysis of State aid and its relationship with competitiveness and value added is undertaken. Due to the great importance that the European Commission attaches to innovation-related industrial policy, the study of public support measures continues with a firm-level study of the impact of public R&D support for firms on innovativeness and innovation output. The section 4.16 discusses policy implications of the use of State aid and R&D support measures in the context of the structural challenges.

4.1. THE MANUFACTURING IMPERATIVE IN A EUROPEAN CONTEXT

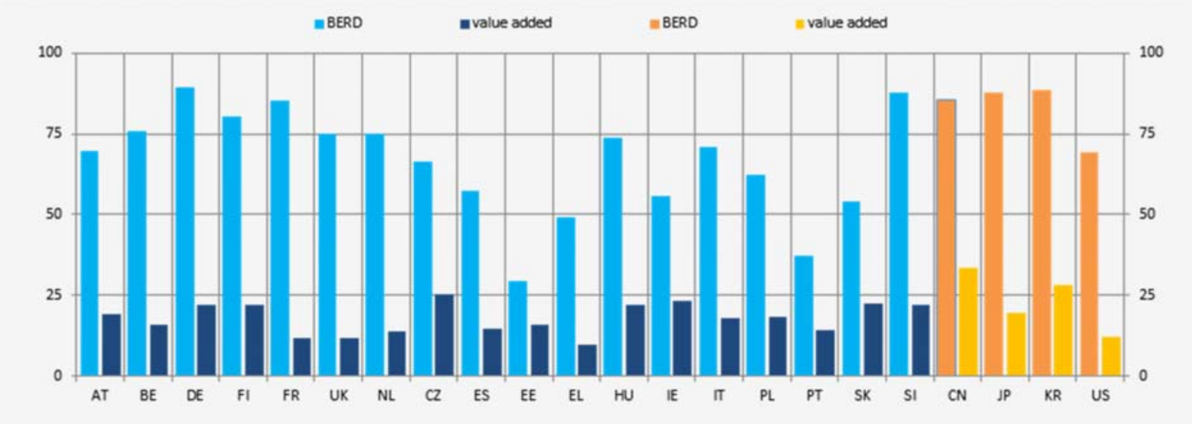
This section lays the ground for the analysis of the structural shifts in the European manufacturing sector and the challenges ahead. In particular, it revisits some of the main arguments in favour of maintaining, re-building or creating – as the case may be – a strong manufacturing base in EU Member States while bearing in mind that modern manufacturing production is increasingly dependent on innovations and specialised services inputs. The latter have gained importance for product differentiation and quality improvements of manufactures which allow firms to charge higher prices and increase the value-added of their activities. Therefore the discussion of the particular role of manufacturing for the economy has to be considered in the context of increasing inter-linkages between manufacturing and services.

Many arguments have been brought forward for why a thriving manufacturing sector is a prerequisite for any economy aiming for high growth and employment rates.

4.2. THE MAIN SOURCE OF INNOVATION AND TECHNOLOGICAL PROGRESS

One principle in favour of a strong manufacturing base is that the manufacturing sector is the major source of technological progress (e.g. Baumol, 1967; Kaldor, 1968; UNIDO, 2002; Aiginger and Sieber, 2006; Helper et al., 2012). Inspection of firms' business expenditure on research and development (BERD) in the EU and other countries clearly supports this claim (Figure 4.1). Manufacturing firms are more inclined to undertake R&D than firms in the rest of the economy, resulting in higher shares of the sector compared to its share of value- added. On average the share of the manufacturing sector in business R&D exceeds that of the value-added share by a factor close to four in the EU Member States; the same holds for the United States, Japan and South Korea. Despite marked variations in the business R&D share of manufacturing firms, ranging from almost 90% in Germany to 29% in Estonia[5], it exceeds the value added share of manufacturing in all Member States. Consequently the R&D expenditures of firms indicate that the overwhelming majority of R&D activities take place in the manufacturing sector which can therefore be identified as the main source of innovation and technological progress.

Figure 4.1 Share of manufacturing in value added and in business expenditure on R&D (BERD), 2005-2009



Note: Business Expenditure on R&D includes R&D by foreign enterprises. Averages over the period 2005-2009 of available data. Source: WIOD, WIPO, OECD ANBERD, wiiw calculations.

While the essential role of manufacturing firms for innovation and technological progress is generally accepted, an important question is whether a thriving European manufacturing sector requires innovative

[5] The median value of the business R&D share of manufacturing firms is 70.5% for the EU Member States.

European firms to keep their production facilities in the EU. For Member States at the technological frontier it would, in principle, suffice if firms kept headquarter functions and in particular R&D activities in the domestic economy but move manufacturing production to low-wage locations in order to reduce costs and increase productivity. Such a vertical specialisation strategy could lead to a 'high-powered' manufacturing sector in Europe characterised by highly productive domestically innovating but internationally producing manufacturing firms.

While a successful vertical specialisation strategy supports firms' competitiveness and offshoring may also be seen as a necessity to survive international competition, a potential risk in this high-powered manufacturing strategy is a continuous 'leakage' of more complex activities to offshore destinations. The stepwise offshoring of more sophisticated production and engineering activities is the result of the building-up of capabilities in offshore destinations as well as communication and co-ordination failures. From a European perspective, the fact that offshoring is mainly taking place between EU Member States could be an advantage, as in this context, and in this case competences would not risk being shifted out of the region.

4.3. INCREASED LINKAGES BETWEEN MANUFACTURING AND SERVICES

R&D and innovation are not the sole ingredients for a highly productive and internationally competitive manufacturing sector. In order to differentiate products and charge higher price-cost mark-ups manufacturing firms depend increasingly on sophisticated services inputs. The mirror-image of this is that the manufacturing sector is an important source of demand for many services. Both aspects highlight the fact that goods and services often complement each other (Nordås and Kim, 2013). Moreover, evidence of the strong interdependences between manufacturing and services in the European economy is provided by the fact that manufacturing firms generate a growing amount of their sales from services. This 'servicisation' of manufacturing seems to be more developed among producers of complex manufactures (Dachs et al. 2013).

On returning to the issue of supply linkages between services and manufacturing sector, an interesting indicator is the service intensity of the manufacturing sector, measured as the cost share of services in manufacturing gross output. During the period 1995-2011 the service intensity of the European manufacturing sector increased from 22% in 1995 to 24% in 2011 with an interim high in 2009 (Figure 4.2).

Figure 4.2. Service inputs into the manufacturing sector relative to manufacturing gross output for the EU-27, 1995-2011

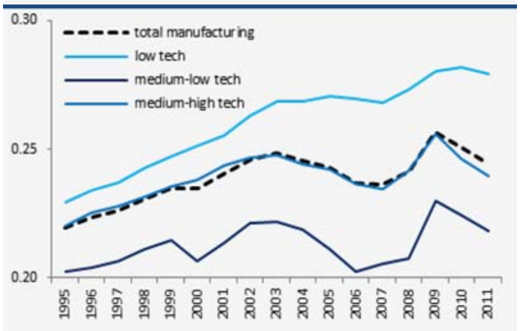
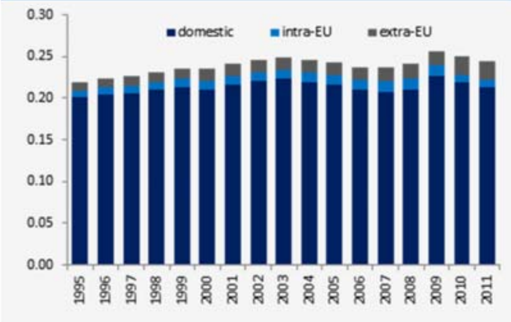


Figure 4.3. Service inputs into manufacturing (relative to manufacturing gross output) sourced from domestic economy, intra-EU and extra-EU, 1995-2011



Note: Calculations based on EU Member States and aggregated to the EU-27. Intra-EU includes the services sourced from EU Member States other than the Member States in question.
Source: WIOD, wiiw calculations

This increase, which is discernible in low-tech, medium-low-tech as well as medium-high-tech industries, reflects the intensified linkages between manufacturing and services. It is noticeable that, in contrast to R&D efforts and innovation which tend to be concentrated in advanced industries such as pharmaceuticals, the electronic industry, machinery and transport equipment industries (particularly the aircraft industry), there is no systematic relationship between services intensity and the technology intensity of industries (see also Nordås and Kim, 2013). The reason for this is that transport and sales services are more intensively used by low-tech industries. It is true, however, that business services are most intensively used by the medium-high-technology industries, although the differences across the three groups of industries are not very large. This could mean that precisely because innovation plays a less important role or international competition is fiercer, low-tech industries must strongly rely on business services (such as marketing) in order to differentiate their products from competitors. An important feature of the inter-linkages between manufacturing and services is that EU manufacturing firms source intermediate services almost exclusively nationally. On average, the share of domestically sourced services amounted to 87% in 2011 (Figure 4.3). Another 4% were sourced from other EU Member States and 9% from third countries.

4.4. THE 'CARRIER FUNCTION' OF MANUFACTURES

Another important structural feature is that manufactures are highly tradable whereas this is only true for a subset of services. The higher tradability of manufactures combined with the increasing services intensity of manufactures imply that manufactures assume an important 'carrier function' for services. Just as many chemical processes require carrier substances, many services require manufactures to be 'carried' to foreign customers. This carrier function stems from the fact that many services by themselves are not easily tradable as evidenced by the relatively small (though growing) share of intermediate services sourced from abroad. The high tradability of manufactures and the carrier function this provides for services are of course highly relevant for the EU's external balance of payments.

While the share of services in the EU's gross exports to third countries has grown considerably over the past decades to about a third, it still falls far short of the (equally growing) share of services in both GDP[6] and value-added exports[7]. This can be seen by comparing the share of services in gross exports, i.e. 33%, to the share of services in extra-EU value added exports which amounted to 57%. Hence, in terms of value-added exports the share of services exceeded that of manufactures which amounted to 37% in 2011. The rising importance of services in terms of value-added exports results from the fact that more services are embodied in exports of the manufacturing sector than vice-versa[8]. Hence, for non-tradable services an internationally competitive manufacturing sector is needed in order to make services exportable and to create comparative advantages in services[9]. At the same time, services have become an essential factor in underpinning the competitiveness of manufactures.

6 Typically, the share of services account for about 60-70% of GDP in advanced economies.

7 Value added exports are a measure based on input-output methodology that reflects the value-added created domestically in an industry or sector in order to satisfy foreign demand (see also Box 4.1).

8 Another factor is that vertical specialisation and trade in intermediates in general is more developed in manufacturing which 'inflates' the gross amounts of exports.

9 An alternative way to sell services internationally is by establishing a foreign subsidiary (Mode 3 of cross-border services trade in WTO terminology).

4.5. PRODUCTIVITY GROWTH

Another common argument for the special role of manufacturing – which is strongly related to the innovation argument but distinct from it – is that productivity growth is higher in manufacturing than in the rest of the economy. The productivity argument is related to the innovation argument because R&D and innovation feed into technological progress and productivity growth. It is distinct because the sector of origin of technological progress need not necessarily be the sector that benefits most strongly from new technologies[10].

Irrespective of this distinction, it turns out that total factor productivity (TFP) growth in the manufacturing sector outperforms TFP growth in the total economy as well as that of business services across a sample of EU Member States and also the US (Figure 4.4). Within the EU, the TFP growth differential between the manufacturing sector and the total economy is particularly large in Austria and in Germany, but is also present in the service-oriented British economy. The sole exceptions to this EU-wide pattern are Spain and Italy which actually did not experience any TFP growth between 1995 and 2007. The result remains unchanged if TFP growth in manufacturing is compared to TFP growth in the market services sector instead of the total economy. Hence, the superior TFP growth trajectory in the manufacturing sector between 1995 and 2007 is not due to low productivity performance in typically low productivity services such as health care or personal services.

TFP growth in the manufacturing sector also exceeds that of the total economy in the United States[11].

The reason for higher productivity growth in the manufacturing sector is partly related to technological aspects of manufacturing (increasing returns to scale, externalities, learning effects)[12]. An additional reason is that manufactures, being more tradable compared than services, are exposed to fiercer international competition which sets further incentives to increase productivity. This does not exclude the possibility of high productivity pockets within the services sector

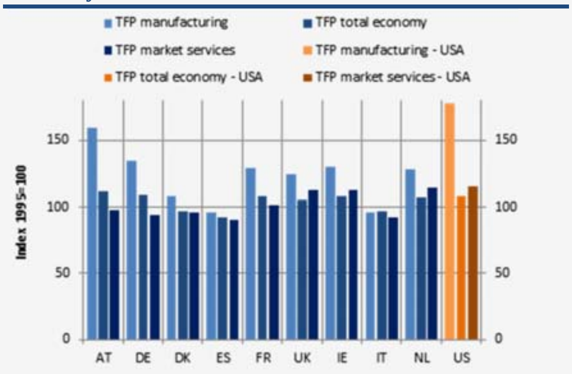
10 The relationship between innovation and productivity at the industry or sectoral level is blurred by the fact that in the case of product innovations the productivity gains (depending on market structures) may not accrue to the innovating industry but to downstream industries sourcing cheaper inputs or inputs of higher quality. By contrast, productivity gains from process innovation typically accrue in the innovating sector though they may spread to other sectors later on.

11 In the case of the United States, however, real productivity growth of manufacturing may be overstated due to strongly decreasing price deflators in the electronic equipment industry.

12 Another issue is the problem of measuring and comparing TFP across industries, but lacking alternatives this analysis relies on the best data source available which is the EU KLEMS database.

which is of course a very heterogeneous sector, comprising a number of high productivity industries like telecommunications.

Figure 4.4. Comparison of total factor productivity (TFP) growth in the manufacturing sector, the total economy and market services, 1995-2007



Source: EU KLEMS, wiiw calculations.

An implication of these differentiated patterns of TFP developments is – in accordance with Baumol's arguments of structural change (see Baumol, 1967) outlined in more detail below - that in the longer term prices of manufactures will decline relative to services which – ceteris paribus - is leading to a lower share of manufactures in value added in nominal terms. Therefore a declining value added share of the manufacturing sector per se is not a reason for concern but the logical consequence of a European manufacturing sector that is constantly becoming more efficient.

To sum up, the comparison of TFP growth rates supports the view that the manufacturing sector is not only the most important source of innovation and technological progress but also the sector where innovations and new technologies are primarily implemented and turned into total factor productivity growth.

4.6. DOES MANUFACTURING OFFER HIGHER WAGES IN EUROPE?

A final argument in the context of a manufacturing imperative is that the manufacturing sector is capable of providing a large amount of well-paid jobs (Rodrik, 2012). This claim is typically put forward in the context of emerging economies but it could also be relevant for the cohesion countries among the EU Member States.

From a theoretical perspective, the argument that the manufacturing sector offers higher wages typically states that the production of manufactures is characterised by imperfect competition (e.g. due to learning effects or static economies of scale in production), combined with imperfect inter-industry labour mobility within a country[13]. For the EU-27, however, there is no evidence of higher wages in manufacturing compared to the services sector – neither at the general wage level, nor for wages set by educational attainment. Considering the EU as a whole, hourly wages have been lower in the manufacturing sector (EUR 13.39) than in the services sector (EUR 14.34)[14]. At the level of EU Member States the results are mixed, with manufacturing wages being higher in some EU-15 countries. But wages in the services sector are higher in all central and eastern European Member States as well as Malta and Cyprus (EU-12). The same comparison but taking the educational attainments of workers into account, suggests that in general wage differentials between the services and the manufacturing sector are small. The finding is in line with the results found for other countries, such as the United States (McKinsey Global Institute, 2012). According to economic theory, factor rewards should in the long run reflect factor intensities.[15] Simple correlations between wages in different sectors could therefore be misleading.

4.7. STRUCTURAL CHANGE IN THE EU ECONOMY

A general feature of the European economy (and advanced economies in general) is the structural shift to the services sector. This shift is observable for both value-added and employment and has been discussed in Chapter 2 of this report. The mirror image of the 'move into services' in Europe is a decline in the relative importance of manufacturing industries (Table 4.1.) for which there is a whole series of explanations.

As shown above, productivity growth in the European manufacturing sector outpaces productivity growth in services and the economy in general.

This is a major reason why relative prices of manufactures decline relative to those of services. As a consequence, the nominal value added share of manufacturing declined by 4.2 percentage points between 1995 and 2011 (and by 5.3 percentage points between 1995 and 2009) as shown in Table 4.1. The relative decline in real terms was more moderate, amounting to 2.6 percentage points between 1995 and

[13] From a theoretical perspective differences in wages between industries will always depend on some limitations to inter-industry labour mobility. Differences in wages can be motivated by a number of economic models, e.g. a specific-factor model of trade. The differences in wages between industries depend on a number of factors including the capital intensity or whether one looks at the short or the long run.

[14] This result is based on 2010 Eurostat data of hourly gross earnings of employees working in companies with ten or more employees.

[15] Norman, V, D. & Orvedal, L. (2010).

2009 (see for example also Aiginger, 2007). In real terms, the value added share of the EU manufacturing sector is higher than in nominal terms amounting to 17.5% in 2009. The share of the manufacturing sector in terms of employment declined to a similar extent as the nominal value added share (4.3 percentage points between 1995 and 2009).

This suggests that technological progress which lies behind the changes in relative prices is mainly labour-saving.

A second factor for the observable structural trend is rigid demand structures characterised by low price elasticities of demand and high income elasticities for some services, e.g. education, tourism, health, cultural activities (see Baumol, 1967). This factor helps to explain why the relative importance of manufacturing in value added terms has declined over time. Besides, outsourcing processes and vertical disintegration (with more service activities provided by external firms rather than produced internally) might be an additional cause for declining industry shares.

The structural shift out of manufacturing (both in the EU and globally) encompasses basically all manufacturing industries, implying that the aggregate decline of the manufacturing value-added share is the result of widespread trends across industries rather than driven by only a part of them.

Against the background of these general structural trends at the global and European level, important changes in the global economy such as the emergence of new players in international production and trade and the growing importance of ideas, skills and technology for international competitiveness, poses major challenges for European manufacturing.

To offset the effects of cyclical consumption patterns and sectoral relative productivity growth rates on

Table 4.1. Nominal and real valued added shares and employment shares in the EU and the global economy 2009 and 2011 (in %); changes 1995-2009 and 1995-2011 in percentage points

	EU-27						World					
	Nominal value added		Real value added		Employment		Nominal value added		Real value added		Employment	
Industry	2011	change 1995-2011	2009	change 1995-2009	2009	change 1995-2009	2011	change 1995-2011	2009	change 1995-2009	2009	change 1995-2009
Primary Industries	2.7	-1.21	3.1	-0.79	5.9	-3.73	9.6	3.29	4.9	0.22	32.2	-8.76
Manufacturing	15.8	-4.24	17.5	-2.55	15.6	-4.33	17.2	-2.43	18.3	-1.53	15.2	0.20
Food	1.9	-0.54	2.0	-0.45	2.2	-0.46	2.4	-0.20	2.1	-0.40	1.9	-0.20
Textiles	0.5	-0.55	0.6	-0.43	1.1	-1.04	0.8	-0.27	0.8	-0.25	2.6	0.29
Leather	0.1	-0.09	0.1	-0.11	0.2	-0.20	0.1	-0.02	0.1	-0.04	0.5	0.15
Wood	0.3	-0.15	0.4	-0.11	0.6	-0.21	0.4	-0.13	0.3	-0.15	1.0	0.27
Pulp & Paper	1.2	-0.64	1.5	-0.38	1.1	-0.42	1.1	-0.53	1.3	-0.37	1.0	0.22
Ref. Petroleum	0.3	0.00	0.3	-0.04	0.1	-0.06	0.9	0.27	0.7	0.04	0.1	-0.02
Chemicals	1.7	-0.39	2.2	0.12	0.8	-0.30	1.8	-0.17	2.0	0.06	0.8	-0.11
Plastics	0.7	-0.20	0.9	0.00	0.8	-0.04	0.7	-0.15	0.7	-0.11	0.9	0.28
NM Minerals	0.6	-0.34	0.7	-0.24	0.7	-0.23	0.7	-0.15	0.7	-0.19	0.9	-0.37
Metals	2.4	-0.29	2.2	-0.53	2.3	-0.40	2.4	-0.23	2.2	-0.48	1.3	-0.24
Machinery	2.0	-0.14	1.9	-0.30	1.7	-0.42	1.5	-0.20	1.7	-0.14	1.1	-0.19
Electrical Eq.	1.7	-0.56	2.6	0.27	1.7	-0.30	2.3	-0.18	3.3	0.78	1.4	0.22
Transport Eq.	1.7	-0.18	1.8	-0.16	1.4	-0.13	1.6	-0.36	1.9	-0.16	0.9	-0.01
Manufacturing n.e.s.	0.6	-0.17	0.6	-0.20	1.0	-0.12	0.5	-0.11	0.5	-0.12	1.0	-0.09
Electricity, gas, water	2.4	-0.29	2.2	-0.48	0.8	-0.25	2.1	-0.20	2.2	-0.28	0.5	-0.02
Construction	5.9	-0.10	4.8	-1.19	7.2	0.16	5.5	-0.38	4.4	-1.48	6.9	1.36
Services	73.2	5.84	72.4	5.01	70.5	8.15	65.6	-0.29	70.1	3.07	45.1	7.22

Note: Industry classification based on NACE Rev. 1.1. Food=15t16; Textiles=17t18; Leather=19; Wood=20; Pulp & Paper=21t22; Refined Petroleum=23; Chemicals=24; Plastics=25; Non-Mineral Metals=26; Metals=27t28; machinery=29; Electrical equipment=30t33; Transport equipment=34; Manufactures n.e.s.=36t37. World includes EU-27.
Source: WIOD, wiiw calculations.

manufacturing shares of GDP and total employment, manufacturing firms and industries in the EU need to become more competitive on the world markets. Given the importance of service inputs in manufacturing production, the completion of the single market for services is expected to advance the level of services tradability. By raising their market shares, the production and employment in EU manufacturing can increase.[16]

Industrial policy also has a role to play here, by providing the rules and instruments necessary to increase the competitiveness of EU manufacturing industries.

manufacturing is the increase in productivity that – as mentioned before – tends to be labour-saving[18]. In addition the structural shifts within the manufacturing sector are going in the direction of a mild but persistent shift towards more technology-intensive industries (chemicals, machinery, electrical equipment and transport equipment) which also tend to be less labour-intensive. These 'advanced industries' also registered negative employment trends between 1995 and 2009 (with the exception of transport equipment) but job losses were more pronounced in the low-tech industries (3.5 million) which accounted for 70% of total losses in manufacturing employment (Table 4.2).

Table 4.2. Employment developments within the manufacturing sector, EU-27, 1995-2009

	1995		**2009**		**changes 1995-2009**	
industry	**number of jobs (in '000)**	**share**	**number of jobs (in '000)**	**share**	**number of jobs (in '000)**	**percentage points**
low-tech	17,257	43.1	13,795	39.3	-3,462	-3.78
medium-low tech	3,778	9.4	3,493	10.0	-285	0.52
metals	5,419	13.5	5,155	14.7	-264	1.16
chemicals	2,258	5.6	1,864	5.3	-394	-0.33
machinery	4,227	10.6	3,786	10.8	-441	0.23
electrical eq.	3,958	9.9	3,758	10.7	-200	0.83
transportation eq.	3,142	7.8	3,235	9.2	93	1.37
manufacturing	40,038	100.0	35,084	100.0	-4,954	

Note: Value added price deflators for the electrical equipment industry of Finland, France, Sweden, Japan, South Korea and the US replaced by respective German deflation in each year. Industry classification based on NACE Rev. 1.1. Low-tech: Food=15t16, Textiles=17t18, Leather=19, Wood=20, Pulp & Paper=21t22, Manufactures n.e.s.=36t37; medium-low-tech: Refined Petroleum=23, Plastics=25, Non-metallic mineral products=26; Metals=27t28; Chemicals=24; Machinery=29; Electrical equipment=30t33; Transport equipment=34;
Source: WIOD, wiiw calculations.

4.8. Trends within EU manufacturing

Over the period 1995-2009 almost 5 million jobs were lost. From 2009 to 2011 manufacturing employment in the EU-27 fell by another 1 million jobs[17].

To some extent the loss of manufacturing jobs may be offset by new jobs created in services sectors providing intermediate services to manufacturing.

An important explanation for the negative employment developments in European

This trend towards advanced manufacturing industries reflects international specialisation patterns of EU Member States because in general technology-intensive industries offer more possibilities for building comparative advantages by product differentiation and quality aspects. At the same time low-technology-intensive industries still accounted for almost 40% of manufacturing employment in 2009. Overall, the EU manufacturing sector is well diversified. In order to maintain diversity, the structural upgrading should proceed at a moderate pace in order to ensure that the manufacturing base in the EU remains broad, encompassing all industries. In low-tech and medium-low-tech industries this will

[16] The effects on employment could however be negative if the main way to become more competitive is to increase productivity growth.

[17] Development 2009-2011 based on Eurostat data.

[18] This has to be considered in conjunction with the structures of price and income elasticities of demand which tend to work against compensating demand shifts towards relatively cheaper manufactures.

require a high degree of specialisation within these industries and the occupation of niche markets. Existing evidence suggests that many European firms follow such a 'premium strategy' within their respective industry. Within industries and product categories featuring a low degree of complexity, European firms typically operate in the top quality segments (Reinstaller et al., 2012)[19].

Maintaining a broad and well-diversified manufacturing base in Europe is important in order to preserve manufacturing capabilities which, once lost are hard to develop again. Manufacturing capabilities specific to particular industries may at a later stage turn out to be important inputs for fast growing new products. It is argued that the United States has made this experience in several industries such as shoe production where the entire supply chain has been lost (Helper et al., 2012).[20]

Having stressed the diversification of the EU manufacturing sector and the specialisation into the premium segments within industries it is also important to note the high degree of heterogeneity across Member States. Figure 4.5 illustrates this with respect to the value added share of manufacturing and changes thereto between 1995 and 2011. While this is an imperfect indicator of the role of the manufacturing sector for the economy, the cross-country comparison still indicates which countries may have reason to be worried about their industrial commons. There is cause for concern either because the value added share of manufacturing is declining very strongly – as in the United Kingdom or Latvia – or because it was very low initially (i.e. in 1995) as in the case of France or Greece.

In principle, a declining share of manufacturing in the economy's value-added may be of little concern in Member States whose manufacturing industries produce sophisticated products with a high premium on world markets. Such Member States, e.g. Finland (despite some problems faced recently in the high-tech manufacturing sector) or the United Kingdom are potentially left with a high-powered manufacturing sector. The developments could be of more concern in countries such as Cyprus, Greece, Latvia or Malta where industries produce less sophisticated products and are therefore more vulnerable to competition from low-cost producers. (see Reinstaller et al., 2012). In contrast, there is a set of countries including Germany, Austria and a number of central and eastern European countries that have maintained a rather high-value added share of manufacturing. This shows that there is considerable dispersion among Member States.

4.9. External competitiveness

Figure 4.6 not only shows the competitive positions of the EU-27 as measured by shares in global value-added exports compared to major competitors among advanced economies – the US, Japan and South Korea – but also compared to large emerging economies like Brazil, China and India. Technological leadership and quality upgrading have become increasingly important to ward off competition from emerging economies.

Given the structural upgrading in emerging economies, competitive pressures from these countries are not limited to low-technology-intensive industries but are also felt in advanced manufacturing industries where emerging economies have also gained a foothold. Brazil, India and China all considerably increased their market shares in global value-added exports of manufactures. However, it is the outstanding performance of China, whose market share quadrupled between 1995 and 2011, which basically drives the reshuffling of competitive positions in the global economy.

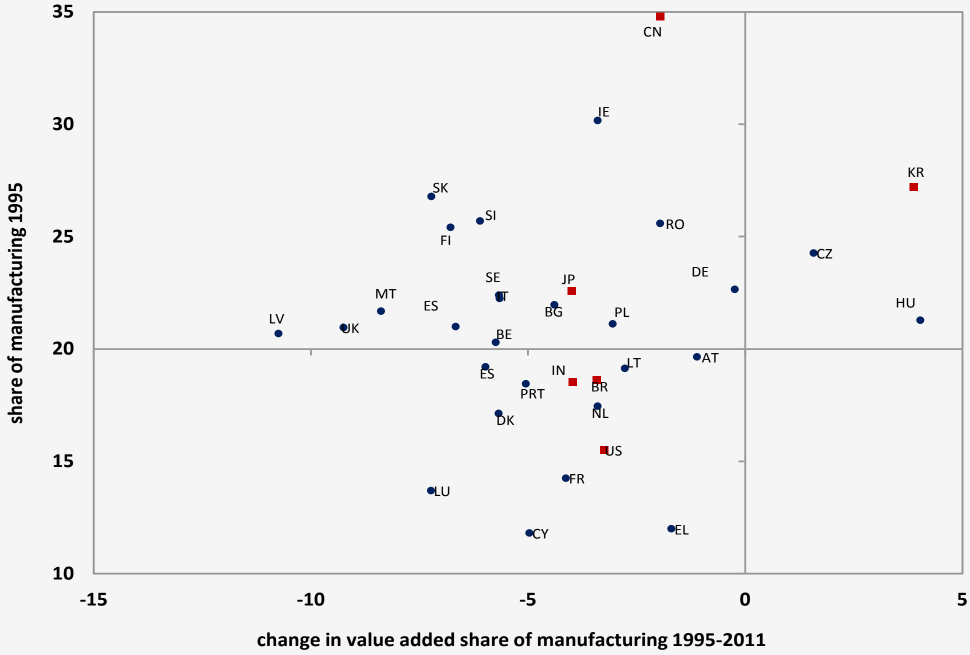
By 2011 China had almost caught up with the EU-27 in terms of value added exports of manufactures, with both economies having a market share of about 20%. China's rise to a first-class exporter of manufactures can be seen in the way it gained export market shares across all industries, with extremely strong positions in the export of textiles and leather as well as in the electrical equipment industry. While China is still specialised in the relatively more labour-intensive stages of production within the electrical equipment industry, the impressive gains in market shares also reflect a remarkable upgrading of industrial structures. The same holds true for other industries and also other emerging economies, e.g. the Indian pharmaceutical and automotive industries.

A factor that facilitated structural upgrading in emerging economies is the relative ease of international technology transfer in a global economy (through trade, FDI, labour mobility in the high-skill segment of the labour force and knowledge diffusion). This is particularly true for the manufacturing sector because the required technology and industrial know-how are to a large extent embodied in physical products which makes them more prone to imitation.

[19] See also Chapter 2 of this Report.

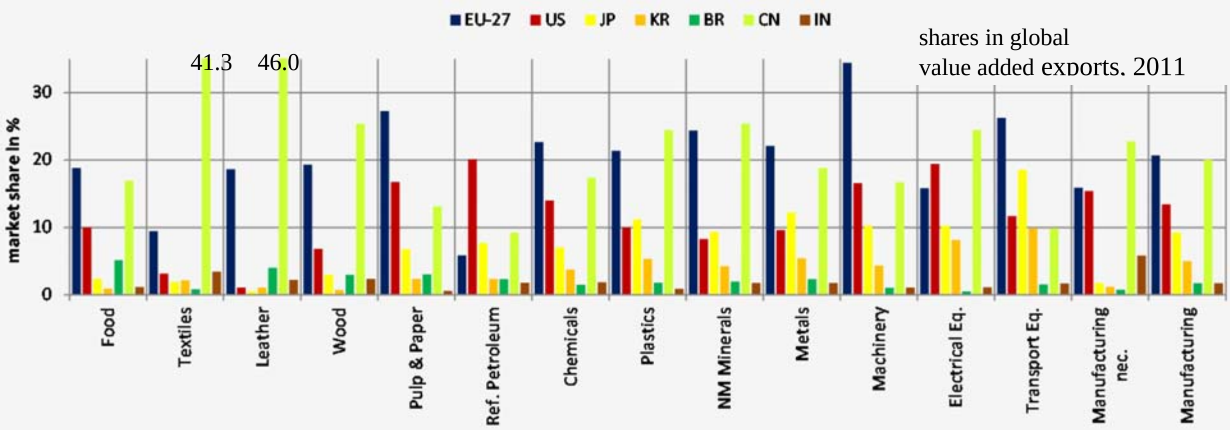
[20] Maybe more important is the case of thin-film-deposition which has moved from the US to South East Asia together with semiconductor production which turned out to be important for producing solar panels.

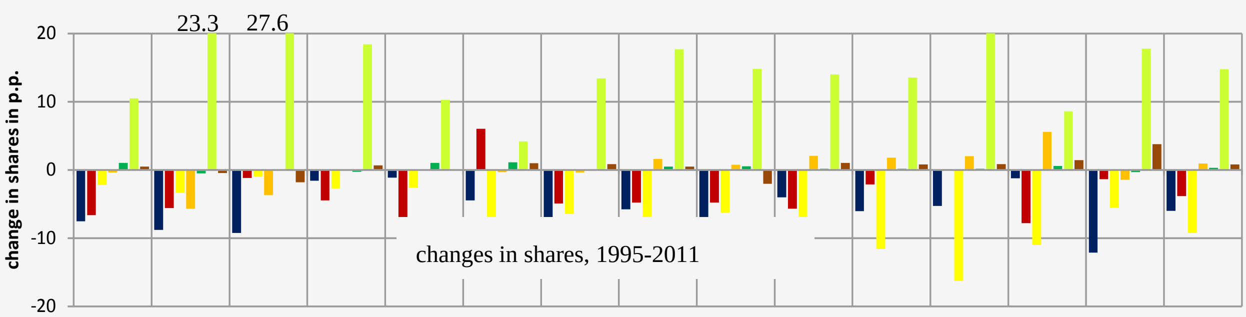
Figure 4.5. Developments of the value-added share of manufacturing (nominal) across EU Member States and selected competitor countries, 1995-2011



Source: WIOD, wiiw calculations.

Figure 4.6. Shares in global value added exports of manufactures (in %), 2011 (upper panel) and changes thereto (in p.p.), 1995-2011 (lower panel), extra-EU exports





Note: Industry classification based on NACE Rev. 1.1. Food=15t16; Textiles=17t18; Leather=19; Wood=20; Pulp & Paper=21t22; Refined Petroleum=23; Chemicals=24; Plastics=25; Non-metallic mineral products=26; Metals=27t28; Machinery=29; Electrical equipment=30t33; Transport equipment=34; Manufactures n.e.s.=36t37. Global market shares in value-added exports and changes thereto exclude intra-EU value-added exports. Source: WIOD, wiiw calculations

Box 4.1. Why is it important to look at value-added exports?

International trade has not only expanded spectacularly over the past 25 years, it has also become increasingly complex. One important dimension in this complexity is the fact that the specialisation patterns have become more granular. Supported by declining trade costs, the ever finer specialisation on individual components of a product or steps in the production process – also referred to as fragmentation of production – makes the analysis of trade flows more demanding. International fragmentation of production heightens the importance of trade in intermediate goods. This in turn poses some difficulties for traditional trade statistics which record trade flows according to a gross concept thereby inflating trade figures.

One possibility to adjust gross export flows for imported intermediates is provided by global input-output statistics. The present Report relies on the World Input-Output Database (WIOD) which provides such statistics for a set of 40 countries including EU Member States. The WIOD is used to calculate the value-added exports at industry level for each country or country groups. These value added exports capture only the value added that is generated domestically in the production of goods that are destined for export (see Johnson and Noguera, 2012; Stehrer, 2012) but exclude foreign value-added associated with imported intermediates.

The figures above illustrate how the differences between gross exports and value-added exports can be quite significant, particularly in industries characterised by intensive intra-industry trade such as electrical equipment. According to gross exports, China's market share in the electrical equipment industry for example rose from 5.27% in 1995 to 33.6% in 2011. Looking at value added exports, China's market share still rose but reached only 24.5% in 2011. While this is still a spectacular development, the resulting difference between China's market share in gross exports and value added exports is equal to about 33.6% and 24.5% in 2011, respectively.

For the EU and the United States the opposite is true. The EU's share in global value added exports in the electrical equipment industry is 2.2 percentage points higher than in terms of gross exports in 2011 and in the US the difference even reaches 9 percentage points. The figures above also indicate that the difference between gross exports and value added exports has increased between 1995 and 2011 due to the emergence of international production networks and more fragmented global production.

In the presence of international production sharing the value added exports probably give a more accurate picture of export market shares of the trading partners involved

As a result emerging economies like China not only have large export market shares in low-tech and medium-low-tech industries (where they can be expected to possess comparative advantages due to lower labour costs) but also increasingly in more technology-intensive industries.

The mirror image of the entry of China and other emerging economies into the global trade arena is a decline in market shares of the EU, the US– both lost about a fifth of their export market shares between 1995 and 2011 – and Japan, whose market share was halved. Even if the gains in market shares of China levels off in coming years as wages rise and the technology gap narrows[21], these industries in China will remain major competitors. Arguably, competition may become fiercer as the catch-up process of major emerging economies such as China, India and Brazil continues and these countries expand their skills and capabilities in the manufacturing domain.

In any case, the shifts in competitive positions discernible in Figure 4.8 suggest that the EU's losses of export market shares in manufacturing were primarily due to the integration of emerging countries into the global economy and to a lesser extent to competition from other advanced economies with the exception of South Korea, which made substantial inroads into the production and export of transport equipment (mainly the automotive industry).

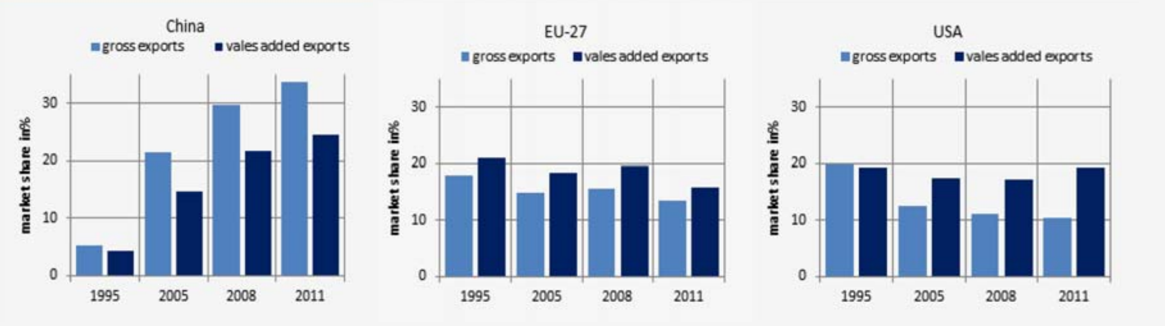
Given these trends in market shares in global value added exports, further shifts towards these emerging economies can be expected.

From a European perspective, however, the rise of China and other emerging economies not only constitutes a formidable competitive challenge but

[21] Gains in market shares in Chinese value added exports in manufactures seems to have levelled off somewhat since the mid-2000s although they continued to increase (by 4.2 percentage points between 2007 and 2011 compared to 5.3 percentage points between 2002 and 2006).

also means new and enlarged markets. Equally important is the fact that the benefits from new export opportunities and the potential costs of a deteriorating international competitiveness are not distributed evenly across EU Member States. This leads to another main challenge for European manufacturing which consists of the agglomeration of manufacturing activities.

Figure 4.7. Differences between market shares in gross exports and value added exports in the electrical equipment industry, 1995-2011

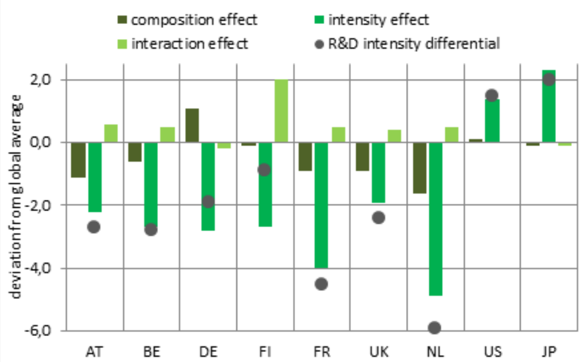


Source: WIOD, wiiw calculations.

4.10. R&D AS MEANS TO MEET COMPETITION

The gap between the innovation activities of firms in the EU and the United States has been a concern for European policymakers for decades. Indeed, the comparison of R&D intensity in manufacturing as an indicator of the intensity of innovative activity, measured as the business expenditure of manufacturing firms on R&D relative to manufacturing value-added, suggests that European manufacturing is characterised by lower R&D intensity in comparison to US and Japan.

Figure 4.8. Decomposition of differences in manufacturing R&D intensity in EU Member States, the US and Japan, average 2007-2008



Note: R&D intensity is Business expenditure on Research and Development in per cent of value added. Global average is the average of the nine countries. R&D intensity differential is the difference of the manufacturing-level R&D intensity to the mean of the nine countries. Methodology following Eaton et al. (1998). Industry classification based on NACE Rev. 1.1. For industry groupings and decomposition see Appendix
Source: WIOD, OECD ANBERD, wiiw calculations

These differences in R&D intensity at the manufacturing level can be split into a composition effect which reflects differences across countries in industry structure, and an intensity effect which reflects differences in the R&D intensity at the level of manufacturing industries, as well as an interaction effect (see Eaton et al., 1998 and European Commission (2011)). This decomposition shows that the differences in the R&D intensity of firms across EU Member States, the US and Japan at the manufacturing level are mainly driven by the intensity effect. The industry structure (composition effect) plays a role in some Member States but is never the primary factor[22].

However, there are also research findings-based on BERD territorial official statistics and also company data that conclude on the lower overall corporate R&D intensity for the EU as a result of sector specialisation (structural effect). In these cases, the US seems to have a stronger sectoral specialisation in the high R&D intensity (especially ICT-related) sectors than the EU does, and also has a much larger population of R&D investing firms within these sectors[23]. This issue, call for policy makers to pay further attention to the industrial structures differences and the need for Europe to favour the growth and emergence of new world leading innovative companies[24].

This gap in R&D activities of the manufacturing sector in the seven EU Member States, characterised by the largest R&D intensities across Member States for which data are available, is partly compensated by higher public R&D expenditure in these countries. R&D intensity in the seven EU Member States with the relatively highest R&D intensities across the EU (Figure 4.8) is only 62% that of the United States.

At the same time, it seems that the concern about a deterioration of relative positions in advanced manufacturing industries vis-à-vis the US and other economies at the technological frontier; should be limited to the electrical components industry. In all, other advanced manufacturing sectors, the market shares in global value-added exports of the EU are still much higher than those of the US. The EU is still the world's largest exporter of chemicals, machinery and transport equipment, with the latter two constituting the major strongholds of European manufacturing. Despite a 6 percentage points decline in its market share of global value added exports between 1995 and 2011[25], the EU still accounts for more than a third of global machinery valued-added that is exported, putting it far ahead of the United States[26] (for the concept of value-added exports see Box 4.1). The EU-27 also has considerable export market shares in low-technology industries such as the food industry or the pulp and paper industry which supports the claim that EU firms often occupy premium segments within industries to remain internationally competitive. An example for such high-quality specialisation in low-technology sectors is the production of protective textiles or extra-long hardened rail tracks. Figure 4.8 suggests that EU firms are more successful in this type of specialisation than their US rivals.

Offshoring implies that part of the value-added created by EU firms is generated in low-cost locations. The offshoring activities of EU multinationals were predominantly regional in scope, meaning that labour-intensive parts of the production process were re-located to central and eastern European Member States, which also still have relatively low labour costs by EU standards. It is worth mentioning that offshoring does not predominantly affect labour-intensive industries (as opposed to advanced manufacturing industries). The dividing line is rather the skill level of employees with low-skill (though often medium-paid) jobs in manufacturing being more prone to offshoring. This points towards a major role for education and training of the labour force, in particular in high-wage countries, in order to remain an attractive location for manufacturing activity.

The next section will investigate the effects of industrial policies in the form of State aid and innovation support.

4.11. INDUSTRIAL POLICY MEASURES IN THE EUROPEAN UNION

Few people will doubt that the main responsibility for mastering the challenges facing the European manufacturing sector rests with firms. However, a recent survey of the top 1000 EU R&D investing companies has shown that public policies may constitute an important stimulus for company

[22] The relative importance of the composition effect and the intensity effect in such a decomposition exercise depends on the level of aggregation of the industries. A more detailed industry break-down would assign greater importance to the composition effect. The EU R&D Scoreboard 2012 also identifies an R&D intensity gap which is particularly strong in the high-tech industries when using ANBERD data which are territory based. When using a more elaborate analysis based on company-level data, it is argued that industry composition becomes an important agent (see http://iri.jrc.ec.europa.eu/scoreboard12.html for details, particularly Chapter 7).

[23] See Moncada-Paternò-Castello; Ciupagea, C.; P., Smith, K; Tübke, A. and Tubbs, M.: "Does Europe perform too little corporate R&D? A comparison of EU and non-EU corporate R&D performance", Research Policy 39 (2010) pp. 523–536

[24] See Cincera, M. and Veugelers, R.: Young Leading Innovators and EU's R&D intensity gap. JRC-IPTS Working Papers on Corporate R&D and Innovation, nº11/2010.

[25] These figures exclude intra-EU value added exports.

[26] These figures exclude intra-EU value added exports.

innovation[27]. According to that survey, national public support in terms of fiscal incentives and public grants had a positive effect on company innovation, as well as EU policies in terms of direct public aid and public private partnerships. In this sense, another question is whether the EU and its Member States have fully exploited the potential of industrial policies to support firms in mastering these challenges and ensuring a strong manufacturing base in Europe.

After a brief overview of industrial policies at the Union level and by Member States, this section provides a quantitative analysis of State aid by EU Member States which constitutes an important industrial policy tool. Since R&D is a key aspect in EU's industrial policy mix and it is directly linked to the challenges of European manufacturing, this section also investigates the impact of public funding for R&D on innovation activity and innovation output at firm level. Finally, it takes a look at the role of initial vocational training, which is a 'soft' industrial policy and an important element of the industrial commons for the competitiveness of the European manufacturing sector.

4.12. Industrial policies at the Union level and by Member States

With the Maastricht Treaty, the EU enshrined its industrial policy approach in primary law, stipulating that the 'Union and the Member States shall ensure that the conditions necessary for the competitiveness of the Union's industry exist'[28]. However, by defining industrial policy in a very broad sense including flanking measures, the EU had set a major industrial policy objective well before Maastricht. The creation of the European single market embedded the EU's competition rules, which were previously part of the earlier common market. The particularity of EU competition rules is that besides controlling the anti-competitive behaviour of firms (abuse of a dominant position, market and price rigging and later merger control), the European Commission was also empowered to control the State aid provided to firms by EU governments. Still today this is a quite unique feature in competition rules.[29] The control of State aid of sovereign governments is obviously a delicate issue and the Commission has exercised a large degree of pragmatism in this respect (Doleys, 2012). The Commission has tried to shift State aid by Member States from sector-based schemes to horizontal objectives such as aid to SMEs or support for R&D, or aid for employment and worker training.

The European Commission's preference for horizontal State aid stems from the belief that horizontal aid distorts competition less than sectoral aid (Friederiszick et al. 2006), and that it contributes to the Commission's own market-correcting or redistributive policy goals which links it to an objective of 'common interest' (Blauberger, 2008)[30].

The latest revision of State aid policy (State Aid Modernization) favours a shift towards block-exempted aid. This aid is less likely to distort competition, due to lower levels of aid intensities and it is in line with the most prominent EU initiatives.

While at the Union level, the focus remained on general framework conditions, there were also early attempts to implement a kind of technology policy (Owen, 2012). Over time, the support for R&D, innovation and technology funded from the EU budget has become quite substantial, leading prominent economists to conclude that at the EU level industrial policy is essentially R&D policy (Van Pottelsberghe, 2007).

The EU's ambitions in the field of industrial policy (European Commission 2010a) have intensified in the aftermath of the economic crisis of 2008 with the focus largely remaining on framework measures and innovation. Hence, in the EU's new growth strategy, the Europe 2020 strategy adopted in 2010 (European Commission, 2010b), the 'Innovation Union' (European Commission, 2011c) figures prominently among the flagship initiatives. Moreover, the 2020 strategy also confirms the EU's horizontal industrial policy approach. This policy communication also proposes a fresh approach to industrial policy that complements its market-oriented horizontal approach with sector-specific elements. The Commission characterises its approach as 'bringing together a horizontal basis and sectoral applications' (European Commission, 2010a, p. 4). The mention of sectoral application of horizontal measures seems to take into account the claim that infrastructure and other public inputs tend to be highly context-specific, calling for a sector-specific definition of industrial policy (Hausmann and Rodrik, 2006). In the specification of the sectoral dimension of industrial policy, the European Commission identifies the development of

[27] See Tübke, A.; Hervás, F. and Zimmermann, J.: "The 2012 EU Survey on R&D Investment Business Trends", European Commission, Joint Research Centre, EUR 25424 EN, www.jrc.es, pp.22.

[28] Article 173(1) of the Treaty on the Functioning of the European Union (TFEU).

[29] Only EFTA has a comparable competition authority.

[30] For the various types of horizontal state aid there exist so-called block exemptions. These block exemptions specify a number of criteria that aid programmes must fulfil (e.g. maximum subsidy amount typically expressed in percentage of eligible costs). If the criteria are fulfilled the aid programme is considered to be compatible with state aid rules. The block exemptions constitute a major simplification of the state aid procedure as they exempt eligible aid programmes from the requirement of prior notification and Commission approval. For Member States this means that they are able to grant aid that meets the conditions laid down in these regulations without the formal notification procedure. However, ex post information sheets on the implemented aid have to be submitted.

clean and energy-efficient vehicle technologies as a priority area for industrial policy. The Commission's update of the industrial policy communication from October 2012 (European Commission, 2012a) contains six priority action lines which aim at improving the competitiveness of European manufacturing.

These priority lines highlight once more the importance of new technologies for a thriving manufacturing sector. At the same time these action lines are directly or indirectly related to the protection of the environment and the mitigation of climate change.

The priority action lines are accompanied by a number of additional objectives, such as the establishment of a European patent, and new elements such as the 'green public procurement', a demand-side policy instrument which has not previously featured among the main concerns of industrial policy.

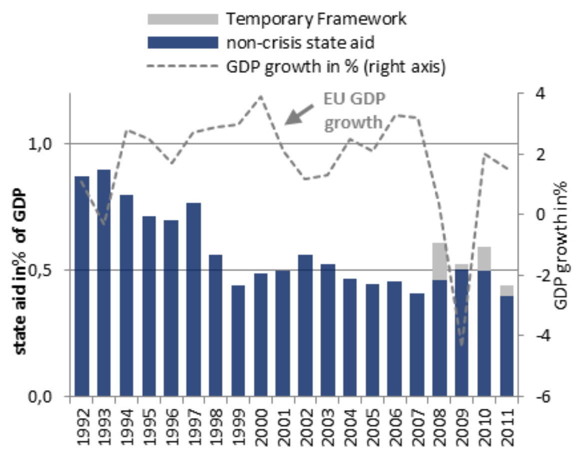
The industrial policy approach at Union level is highly relevant for the industrial policies applied by Member States. The interdependence between policies at EU level and Member State level is most obvious in the field of competition policy including State aid where the Commission is responsible for controlling the activities of Member States. But the two layers are also linked by the fact that most of the projects paid from EU funds have to be co-financed by Member States.

During the 1980s, State aid to industry and services provided by EU Member States amounted to approximately 2% of EU GDP and went down to about 1% in the following decade (European Commission, 2011b). The general downward trend in State aid in the EU continued until 2007 where it reached an all-time low of 0.4% of GDP.

State aid also has a counter-cyclical component, i.e. the amount of state aid spent increases in times of recessions. This was the case in the economic crisis of 2008. As shown in Figure Figure 4.9, state aid increased to 0.6% in 2008, which is still a very low amount by historical standards but represented a 50% increase from the year before. These figures include state aid granted under the Temporary Framework which allowed a temporary adjustment of state aid rules and was intended to encourage investment and ease the access to finance for firms facing tightening credit conditions. It was targeted at the real economy.[31]

The Temporary Framework provided new measures specifically targeted to facilitate companies' access to finance[32].

Figure 4.9. State aid to industry and services in the EU-27, 1992-2011, in % of GDP



Note: Figures exclude crisis-related aid to the financial sector. The value for France in 1997 excludes the EUR 18 billion state aid to Crédit Lyonnais. Amounts refer to the aid element (or gross grant equivalent in the case of guarantees and loans) contained in the state aid measure.
Source: European Commission State Aid Scoreboard, Eurostat, wiiw calculations.

Due to the crisis, state aid by Member States rose to 0.5%-0.6% of GDP in the years 2008-2010 but in 2011 the amount dropped to 0.44% of EU GDP, which equals the pre-crisis levels of aid intensity.[33] Setting aside the crisis-related state aid, the amount of state aid in 2011 was back at the 2007 level. These very low figures are interesting for a number of reasons. First of all, they show that the amount of state aid provided by Member States has become relatively small. Secondly, the renewed interest in industrial policy both at the Member State and the EU level has not so far resulted in a substantial increase in state aid figures[34]. Thirdly, the impact of even small amounts of state aid is potentially very large. The total of state aid measures under the Temporary

[31] Crisis-related aid measures to the financial sector were subject to a different set of rules and the amounts involved were much higher, reaching 1.9% of EU GDP in 2008 and 2.9% of GDP in 2009. These amounts are not included in Figure 4.9.

[32] The measures of the Temporary Framework included the possibility to grant direct subsidies to individual firms up to an amount of EUR 500 000; the provision of state guarantees at reduced premia; additional interest-rate support for loans financing investments in green products; and the possibility for official export credit agencies (ECAs) to provide cover for short-term transactions which were previously considered to be 'marketable risk'.

[33] The Temporary Framework expired by the end of December 2011. In the period 2008-2011 about EUR 4.8 billion of state aid (0.04% of EU GDP) was paid out under the Temporary Framework, mainly in the form of subsidies and direct grants (European Commission, 2012b). The Temporary Framework was open to all industries and sectors but de facto the majority of the aid was allocated to car producers which were hit hard by the crisis due to the crisis-related slump in car sales.

[34] The priority for a fiscal consolidation affected considerably State aid measures in several Member States.

Framework by the 27 Member States sums up to EUR 4.8 billion over the period 2008-2010 but it consists of a large number of measures, including multi-billion loans to car producers. The aid elements implicit in such measures seem low but they can nevertheless have a great impact on individual companies (in particular when the state aid comes in the form of a rescue operation) but also at market level for the industry[35]. So the leverage of state aid measures may be quite high. EU governments have a great potential to affect market outcomes and also the position of EU companies in global competition without large fiscal implications. The next sections analyses use of state aid by EU Member States in more detail by investigating the relationship between various types of state aid on the one hand and competitiveness and value added of the manufacturing sector on the other hand.

4.13. QUANTITATIVE ASSESSMENT OF STATE AID AND EXPORT ORIENTATED MANUFACTURING

Three different specifications have been implemented with the objective to quantitatively assess in what way different types of state aid provided by EU Member States, impact on the export-oriented manufacturing sector in the EU. The state aid variables used are explained below in Box 4.2. The strategy follows recent empirical literature on the development of the internationally competitive manufacturing sector, this proxied with three different indicators. The three base specifications (see annex for details) deal with the explanation of extra-EU export shares (following Aghion et al., 2011), value-added per capita in export-orientated manufacturing

[35] Note that so-called *de minimis* aid provided by Member States is not included in the state aid figures because *de minimis* aid need not be notified to the Commission. *De minimis* aid represents all aid measures with an aid amount below EUR 200 000 (this threshold applies since December 2006 when it was raised from EUR 100 000).

Table 4.3. Internationalisation measures and competitiveness
Dependent variable: Member States' share in total extra-EU exports

Specification	(1)		(2)		(3)		(4)	
internationalisation measures	0.024	***	0.020	***	0.025	***	0.022	***
	(0.005)		(0.006)		(0.008)		(0.006)	
internationalisation measures²	-0.001		-0.001		0.000		-0.001	
	(0.001)		(0.002)		(0.001)		(0.001)	
loans to GDP	0.071							
	(0.072)							
loans to GDP²	-0.269	***						
	(0.033)							
loans to GDP * internationalisation measures	-0.009							
	(0.007)							
governance			0.437					
			(0.356)					
governance²			-0.105					
			(0.981)					
governance * internationalisation measures			0.142	***				
			(0.017)					
wage share					0.179			
					(0.422)			
wage share²					2.224			
					(1.957)			
wage share * internationalisation measures					0.108	**		
					(0.045)			
tariff rate							0.071	*
							(0.040)	
tariff rate²							-0.026	
							(0.030)	
tariff rate * internationalisation measures							0.066	***
							(0.012)	
R^2	0.993		0.990		0.989		0.990	
adjusted R^2	0.992		0.988		0.987		0.989	
Observations	373		380		341		391	

*Note: Standard errors appear in parentheses. ***, **, * indicate statistical significance at the 1%; 5% and 10% level respectively. Regressions include country and year fixed effects as well as a constant term which are not reported. The standard errors are robust. All the data was logarithmised (observations of the value zero were changed to 0.01 in order to make the taking of logarithms possible) and centred in order to make the estimated coefficients interpretable.*
Source: WIOD, European Union State Aid Scoreboard, Eurostat, UNCTAD-TRAINS, World Bank's Worldwide Governance Indicators (WGI) database.

(following Haraguchi and Rezonja, 2011) as well as real value added growth of export-oriented manufacturing industries (following Rajan and Subramanian, 2011). The three approaches are used in order to cover different aspects of the export-oriented manufacturing sector (value added export share, per capita level and real growth). Here we present selected results of the first two approaches. The full set of results is available in background study of this chapter.

Box 4.2. Categories of state aid in the European Union

Non-crisis state aid granted by the Member States to industry and services broadly splits into two types: horizontal and sectoral.

The concept of horizontal aid, which is aid that is not granted to specific sectors of the economy, derives from the EU Treaty. It leaves room for the Commission to make policy judgements whereby state aid can be considered compatible with the internal market if it provides effective support for common policy objectives. Most prominent here is aid earmarked for research, development and innovation, safeguarding the environment, fostering energy saving and promoting the use of renewable energy sources; Those categories are followed by regional development, aid to SMEs, job creation and the promotion of training (European Commission, 2012b).

Research, development and innovation: R&D&I lies at the heart of the Europe 2020 strategy as one of its flagship initiatives because of its potential to contribute to strengthening the competitiveness of the EU economy and to ensure sustainable growth, with a target of spending 3% of EU GDP on R&D by 2020.

Environmental protection: State aid here can include aid measures to support energy saving and waste management or to improve production processes, which have a direct benefit to the environment.

Regional development and cohesion: The aim of regional aid is to develop the economic, social and territorial cohesion of a Member State and of the EU as a whole. The Commission encourages Member States to grant regional aid on the basis of multi-sectoral schemes which form part of a national regional policy.

Commerce, export and internationalisation: This is a less used measure that however showed some importance in the quantitative analysis. It consists of a number of different aid measures such as the promotion of brand image or sales networks but also officially supported export credits to the extent that they contain an aid element.

State aid earmarked for specific sectors, or sectoral aid includes a number of measures targeting for instance: rescue and restructuring of firms in difficulty; Sectors covered include shipbuilding; steel; coal; land, sea and air transport; agriculture; fisheries and aquaculture.

The other positive and significant result in this specification is the interaction term between internationalisation measures and the governance effectiveness rank. More internationalisation measures is correlated to even bigger export shares in countries with a higher level of domestic competition (i.e. a higher wage share or, in other words, a smaller profit share, such as in the Nordic and core EU countries), as can be seen from specification (3). Finally, countries with both more internationalisation measures and more tariff protection have on average higher extra-EU export shares (see specification (4)). Ceteris paribus a higher tariff protection might support the development of domestic manufacturing capacity and induce additional exports. In fact, the positive coefficient is in line with the classical infant industry argument (which is based on the existence of externalities) if such tariff protection were assumed to be temporary.[36] The effects of sectoral state aid that directly targets the manufacturing sector were also analysed. In none of the estimated specificat ions did the conditional main effect of manufacturing aid appear to be significantly different from zero (see Table A.7 in the annex).

[36] It should be noted however, that Member States do not set tariffs themselves because trade policy is a competence of the European Commission. Any differences in the tariff rate across Member States are therefore due to differences in their export structures.

4.13.1. Value-added per capita

In a second attempt the methodology put forward in Haraguchi and Rezonja (2011) is applied to the provision of state aid by EU Member States. The aim here is to specify better the relationship by adding more control variables and to test for the determinants of the single manufacturing industry's importance separately, using a model that tries to explain the real value-added per-capita of the respective manufacturing sector.

Explanatory variables are the per capita gross domestic product, population density and natural resource endowment as well as different types of state aid per capita. The control variables which feature prominently in the growth literature account for developmental impact on manufacturing while other variables control for demographic and geographic conditions. In order to check the robustness of the estimated results, additional variables such as the private loans to GDP indicator have been included but the main results do not change very much. Moreover in the regression approach the individual manufacturing industries have been aggregated in two groups – export-oriented industries and industries focusing on the domestic market, based on an exportability measure.

The main findings are reported in Table 4.4. The level of export-oriented manufacturing value-added per capita is not affected by sectoral specific manufacturing aid. It is rather a few horizontal aid spending items which show signs of correlation, Regional aid is found to be positively correlated with the value-added level. Somewhat surprisingly, risk capital aid tends to target economies with lower levels of per capita export-oriented value added. One explanation may be that regional aid is more likely to be absorbed by large, internationally operating firms, while environment and energy saving aid can more easily be absorbed by domestically operating smaller firms.[37] However, the negative sign found for risk-capital aid is not straight forward to be explained. A possibility might also be that firms in manufacturing-orientated countries such as Germany or Austria rely more on banks to finance their needs, and consequently risk capital and risk capital aid is less important. In contrast, risk capital is more important in countries were the manufacturing sector development was less dynamic over the past one and a half decades (e.g. the United Kingdom). This sign possibly illustrates a correlation pattern existing restrictively in the specific sample for this exercise.

Table 4.4. State aid and value-added per capita – export orientated industries
Dependent variable: manufacturing value added per capita of export industries

Specification	(1)		(2)		(3)		(4)	
per capita GDP	1.537	***	1.455	***	1.343	***	1.615	***
	(0.206)		(0.191)		(0.199)		(0.182)	
per capita GDP²	0.443	***	0.483	***	0.458	***	0.491	***
	(0.086)		(0.090)		(0.083)		(0.087)	
population density	-4.376	***	-4.305	***	-5.095	***	-4.416	***
	(1.026)		(1.030)		(0.949)		(0.981)	
resource endowment	-0.006		0.008		-0.035		0.003	***
	(0.046)		(0.047)		(0.041)		(0.047)	
energy saving aid	0.009							
	(0.008)							
regional aid			0.023	***				
			(0.007)					
risk capital aid					-0.027	***		
					(0.005)			
training aid							0.008	*
							(0.004)	
R²	0.969		0.969		0.972		0.969	
adjusted R²	0.964		0.964		0.968		0.964	
Observations	286		286		286		286	

*Note: Standard errors appear in parentheses. ***, **, * indicate statistical significance at the 1%; 5% and 10% level respectively. Regressions include country and year fixed effects as well as a constant term which are not reported. The standard errors are robust.*
Source: European Union State Aid Scoreboard, Eurostat, UN Comtrade

4.14. COMPANY-LEVEL ANALYSIS OF COMMERCIALISATION PERFORMANCE

Innovation has been placed at the heart of the Europe 2020 agenda as one of the main drivers of economic growth. In a globalised world, innovative ideas and products stimulate exports and sales in general, thereby securing growth and future jobs (Harrison et al., 2008). As the EU-27 is still behind other major economies when looking at simple innovation indicators such as overall R&D expenditures, the impact of innovation policies on firms' innovative behaviour has been a major concern of policy-makers.

Instruments to address shortage of funding for firms still differ greatly in the EU. Venture capitalists are more active in Scandinavian and Anglo-Saxon countries and public funding is on average more pronounced in EU-15 countries compared to the

37 As shown in the background study, regional aid and risk capital aid has no impact on value added for domestically oriented firms while coefficients for energy saving aid and training aid are significantly positive.

EU-12 countries. When looking at the different settings, an essential question that arises is about the effectiveness of public innovation support. In this section, the effects of public innovation support on the commercialisation of R&D effort will be evaluated.

To that end, the effect of public funding on private R&D intensity and innovation output is estimated, using data from the Community Innovation Survey (CIS)[38]. Focusing on the commercialisation of R&D efforts, innovation output will be measured in terms of innovative sales.

The EU is usually perceived as less effective at bringing research to the market compared to its main competitors such as the US, Japan, and South Korea. The relative underperformance in research commercialisation in the EU has been attributed to a number of factors including the absence of an entrepreneurial culture and a less developed venture capital sector[39]. The discussion about the main factors explaining the European innovation gap dates back to the Dosi et al. (2006) much-cited criticism on the concept of the European paradox, a widely accepted opinion that Europe does not lag behind the US in terms of scientific excellence, but lacks the entrepreneurial capacity of the US to effectively commercialise inventions and step thereby on an innovation-driven growth path. In the literature there are a number of publications that investigate whether Europe's weak commercialization performance can explain the paradox and whether other explanatory factors are identified (examples of recent overviews can be found in Conti and Gaule (2011) and Carlsson et al. (2009)).

This section focuses on which specific innovation-related factors and which types of public funding can be identified as relevant for commercialization performance. By doing so, a firm-level analysis is provided with a particular focus on the commercialisation of R&D efforts. Among the activities examined are the actual R&D performed internally and/or acquired from external sources, the research collaboration activities with different players (such as customers, suppliers, public research institutions and other firms), and the firm's use of particular types of public funding for innovation.

The analysis of the market uptake of innovation at the firm-level is based on the Community Innovation Survey (CIS) micro-data. The CIS survey is a European-wide, harmonized data collection on innovation according to the guidelines of the Oslo Manual (Eurostat/OECD, 2005). The CIS survey is organized bi-annually and collects information on enterprise's innovation activities. For consistency and timing reasons, the anonymized CIS2008 and CIS2006 surveys were used which cover the time span 2006-2008 and 2004-2006 respectively.

The CIS2006 covers three countries from the EU-15, namely Greece, Spain and Portugal and 9 countries from the EU-12. The CIS2008 covers 15 countries. Germany, Spain, Italy, Ireland and Portugal are EU-15 countries. The other 10 countries represented in the CIS2008 are EU-12 countries which joined the EU after 2004. Additionally to differences in country coverage the two waves also differ with respect to sectoral classifications as the CIS2006 is based on the NACE Rev. 1.1 whereas the CIS2008 on the NACE Rev. 2 classification. Results reported below distinguish broader industry aggregates by broad technology intensity when considering manufacturing firms only.[40]

As a key variable for assessing a firm's commercialization performance, this analysis uses the firm's answers on the innovation commercialization question in the CIS survey; firms were asked about "the percentage of total turnover from new or significantly improved goods and services introduced that were new to your market".

The theoretical rationale of the contextual variable choices comes from to firm-level innovation analysis literature which also uses the CIS data. The importance of collaborative R&D for innovation and general firm performance is illustrated by among others Laursen and Salter (2006) and Belderbos et al. (2004). Cassiman and Veugelers (2006) confirm the importance of innovation activities. More specifically, they show that internal knowledge production as well as external knowledge acquisition is important for a firm to introduce products new to the market. The combination of internal and external R&D activities is often referred to in the literature as absorptive capacity (Cohen and Levinthal (1990)).

[38] Following to the Community Innovation Survey, public funding or public innovation support is defined as credits or deductions, grants, subsidised loans, and loan guarantees for innovative activities. The support may come from three authorities: the EU, national governments and regional authorities.

[39] In this report 'research commercialisation' is defined as a sub-set of the innovation trajectory. Similarly, the 'commercialisation gap' is understood as a sub-part of the 'innovation gap', focusing here on the latest stages of the innovation trajectory.

[40] The industry class dummies have been defined based on the post-anonymization NACE codes. These codes differ between the CIS2006 (derived from NACE Rev. 1) and CIS2008 (derived from NACE Rev. 2) waves of the survey. For the CIS2006 data the following industry class definitions were used: low-tech (nace_pro codes DA, DB, DC, 20_21, 22, DN), medium-tech (nace_pro DF_DG, DH, DI, 27, 28), high-tech (nace_pro DK, DL, DM). For the CIS2008 wave: low-tech (nace_pro C10_C12, C13_C15, C16_C18, C31_C33), medium-tech (nace_pro C19_C23, C24_C25), high-tech (nace_pro C26_C30).

The literature concerning the introduction of new products into the market illustrates that it is important to take into account the firm's marketing efforts (market introduction activities) in the commercialisation model. As such, public funding plays a role not only in stimulating the R&D efforts of firms, but also in promoting successful commercialisation of research results (Griffith et al. (2006).

model the R&D expenditures is the dependent variable which is influenced by its own set of factors (R&D equation)[41]. Finally, the commercialisation performance - expressed as turnover from products new to the market - is estimated on a set of factors including (estimated) R&D efforts measure. Thus, the commercialisation and the R&D equations are connected as the estimated values of the (log of) R&D expenditure from the latter serve as the input in the former equation. This procedure avoids the potential and well-known endogeneity problems. The details of the model applied together with results from the first and second stages are reported in the Annex.

Table 4.5. Results of the commercialisation output regressions with CIS2006

	All firms	EU-15	EU-12	Small firms	Medium and large firms	All manuf. firms	Low-tech	Medium-low tech	Medium-high and high tech
Commercialisation performance equation									
extramural R&D	0.278***	0.285***	0.261***	0.431***	0.166***	0.231***	0.252***	0.196***	0.242***
	(28.26)	(20.59)	(18.39)	(9.30)	(7.22)	(19.01)	(10.70)	(9.67)	(12.50)
log R&D expenditures	0.0521***	0.0446***	0.0615***	-0.279	0.170***	0.0874***	0.176***	0.0788***	0.0151
	(6.80)	(3.41)	(6.58)	(-1.74)	(3.53)	(8.67)	(8.32)	(4.67)	(0.96)
log 2004 sales	0.00578***	0.00650***	0.00480**	0.00247	0.0229***	0.00545***	0.00689**	0.00257	0.00652**
	(5.40)	(4.27)	(3.16)	(1.86)	(9.69)	(4.17)	(2.84)	(1.25)	(2.86)
vertical cooperation	0.316***	0.223***	0.389***	0.549***	0.182***	0.279***	0.314***	0.231***	0.273***
	(27.63)	(13.13)	(24.78)	(7.60)	(7.83)	(20.28)	(11.93)	(10.21)	(12.21)
horizontal cooperation	0.0640***	0.0822***	0.0165	0.193***	-0.00319	0.0273	0.0206	0.0296	0.0335
	(4.62)	(3.42)	(0.98)	(4.37)	(-0.15)	(1.56)	(0.59)	(1.02)	(1.23)
intra-group cooperation	0.0162	0.0600**	-0.0173	0.173***	-0.0287	0.0421*	-0.0901*	0.0146	-0.0328
	(1.15)	(2.61)	(-1.00)	(3.35)	(-1.22)	(2.48)	(-2.37)	(0.53)	(-1.17)
local public funding	0.178***	0.199***	0.181***	0.384***	0.0678**	0.150***	0.206***	0.137***	0.124***
	(13.90)	(13.14)	(4.99)	(4.98)	(3.04)	(9.78)	(7.10)	(5.62)	(4.84)
national public funding	0.108***	0.160***	0.038	0.506**	-0.0183	0.0421*	0.0148	-0.014	0.146***
	(7.78)	(7.91)	(1.91)	(2.91)	(-0.43)	(2.45)	(0.44)	(-0.49)	(5.29)
EU funding	0.0982***	0.0426	0.139***	0.295***	-0.00892	0.0741***	0.0445	0.118***	0.048
	(5.91)	(1.53)	(6.80)	(3.84)	(-0.23)	(3.58)	(1.17)	(3.44)	(1.38)
F-test for model's significance	11800.6***	5333.3***	6695.5***	6288.1***	5176.9***	5353***	2039.0***	1439.3***	1401.1***
observations	85238	38127	47111	53915	31323	43897	21677	13080	9140

*Note: t statistics appear in parentheses. ***, **, *indicate statistical significance at the 0,1%; 1% and 5% level respectively. Regressions include country and industry fixed effects as well as a constant term which are not reported.*
Source: Community Innovation Survey (CIS)

The model on which the analysis is based represents a slightly modified version of the CDM model introduced in Crepon et al. (1998). A firms' choice to conduct/report R&D is estimated in the first stage (R&D selection equation). At the second stage of the

41 Ideally, one should include employment additional to turnover to control for size of firms. As this analysis is based on the anonymized CD-ROM version of the CIS data this variable is not available. Instead we used the two employment size classes available for all countries: small (<50) and medium and large (>50) for the estimation of the R&D levels.

Table 4.6. Results of the commercialisation output regressions with CIS2008

	All firms	EU-15	EU-12	Small firms	Medium and large firms	All manuf. firms	Low-tech	Medium-low tech	Medium-high and high tech
Commercialisation performance equation									
extramural R&D	0.231***	0.237***	0.227***	0.348***	0.330***	0.160***	0.170***	0.129***	0.183***
	(25.31)	(19.65)	(15.99)	(24.76)	(33.78)	(13.13)	(7.37)	(6.59)	(8.89)
log R&D expenditures	0.0416***	0.0262*	0.0526***	-0.00596	-0.237***	0.0796***	0.147***	0.0699***	0.00911
	(6.10)	(2.47)	(5.99)	(-0.91)	(-44.98)	(8.64)	(7.73)	(5.37)	(0.52)
log 2006 sales	0.00537***	0.00364***	0.00972***	0.00457***	0.00967***	0.00579***	0.00653**	0.00503*	0.00559*
	(5.85)	(3.35)	(5.60)	(3.80)	(5.46)	(4.75)	(3.09)	(2.55)	(2.44)
vertical cooperation	0.260***	0.218***	0.298***	0.376***	0.333***	0.227***	0.219***	0.223***	0.209***
	(26.18)	(16.62)	(19.38)	(24.17)	(29.57)	(18.48)	(8.67)	(11.61)	(9.62)
horizontal cooperation	0.0742***	0.0606***	0.0664***	0.0946***	0.0865***	0.0671***	0.0853**	0.0615*	0.0645*
	(6.40)	(3.60)	(4.09)	(4.62)	(6.71)	(4.35)	(3.01)	(2.43)	(2.42)
intra-group cooperation	0.0388***	0.0514**	0.0359*	0.141***	0.170***	-0.0311*	-0.0522	0.00386	0.0125
	(3.32)	(2.90)	(2.33)	(6.45)	(14.57)	(-2.02)	(-1.77)	(0.16)	(0.47)
local public funding	0.156***	0.167***	0.266***	0.205***	0.157***	0.120***	0.200***	0.0982***	0.0868***
	(14.87)	(14.43)	(8.12)	(12.65)	(11.68)	(9.19)	(8.45)	(4.55)	(3.83)
national public funding	0.138***	0.172***	0.105***	0.243***	0.383***	0.0665***	-0.0368	0.0850***	0.158***
	(11.57)	(10.67)	(5.58)	(14.12)	(31.76)	(4.40)	(-1.21)	(3.57)	(6.25)
EU funding	0.0815***	-0.0478*	0.167***	0.174***	0.258***	0.0831***	0.104**	0.034	0.105**
	(5.64)	(-2.02)	(9.26)	(6.84)	(17.11)	(4.65)	(3.27)	(1.13)	(3.25)
F-test for model's significance	14348.6***	7318.3***	7075.4***	7667.7***	6242.8***	6135.6***	2527.8***	1678.8***	1187.3***
observations	98070	48472	49598	60780	37290	47144	23615	15096	8433

*Note: t statistics appear in parentheses. ***, **, *indicate statistical significance at the 0,1%; 1% and 5% level respectively. Regressions include country and industry fixed effects as well as a constant term which are not reported.*
Source: Community Innovation Survey (CIS)

The variables used for the analysis have been chosen in a way to ensure the highest possible compatibility in definitions between the CIS2006 and CIS2008. One nonetheless has to be cautious when comparing the model's results from different waves of the CIS survey. Most of the conclusions below are therefore formulated based on the coefficients' signs and their statistical significance rather than their size.

In addition, to triangulate the obtained results and check the model's robustness, separate analyses were performed on different types of firms according to size (small and large)[42], geographic location (EU-15 and EU-12 countries) and for manufacturing firms according to their production technology intensity (low-tech, medium-low tech, and medium-high and high tech as described above).

The results from the first CDM equation (the R&D intensity estimations presented in Table A8 and A9 in the Annex) give us particular insights into the factors which influence firms' innovation efforts. The patterns are rather consistent, and show that acquiring the R&D services externally and benefitting from national and EU public funding stand out as consistent factors positively influencing the firms' R&D activities in two waves of CIS and across different firm types and classes. R&D collaborations with suppliers and customers as well as inside the enterprise group are also found to be important determinants of the firms' R&D efforts.

Concerning the specific question on determinants of R&D commercialisation at the firm level (see Table 4.5 and 4.6), the relationships between the commercialization performance expressed in terms of the share of turnover from products and services new to the market and the main characteristics of the firms' innovation activities present several distinctive patterns.

[42] Firms with less than 50 employees are classified as small and above 50 as medium and large. Due to differences in the size classification among different countries in CIS only these two classes can be consistently defined.

First, the impact of the R&D efforts on commercialization is positive and statistically significant when looking at all firms in the sample as well as manufacturing firms only. Investigating different subgroups, a positive, significant effect is observed in low- and medium-low tech manufacturing industries, and also when looking at firms from EU-15 and EU-12 in general. The relationship between the R&D input and the commercialisation results is mixed when looking at the performance of firms divided in groups by their size. The data from both 2006 and 2008 CIS waves show that for the small firms the relationship between the R&D expenditures and the share of turnover new to the market is not evident. For the large and medium enterprises CIS2006 indicates the statistically significant positive relationship between the R&D input and commercialisation, while in CIS2008 the opposite picture is observed.

It is observed that the firms which, in addition to their own R&D, also acquire R&D services externally tend to have higher share of turnover from innovative products. This external acquisition of R&D results can take place as a pure purchase of services, but also can be acquired in the framework of the inter-firm R&D cooperation.

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

The importance of customers and suppliers for the firm's innovation is further underlined by the finding that the R&D cooperation inside the group does not find broad and consistent support by the regression results. The R&D collaboration with other companies occupying the similar position in the value chain (horizontal cooperation) has been shown as a relevant positive factor by the CIS2008 data and partially by the CIS2006.

Finally, the effects of public funding on the commercialization performance of firms appear to be positive in most classes and groups of firms considered. The relationship between the use of local public R&D support and the commercialisation performance shows positive and statistically significant for both CIS waves and across all different technology intensity domains. The public R&D support at the national level is positively related to the share of innovative turnover in 2008 with results being somewhat more mixed for 2006. According to CIS2008, the firms appear to have higher commercialisation performance when making use of the EU-level public R&D support with the exceptions of the EU-15 and medium-tech subsamples. Results when using CIS2006 are more mixed though when significant these are always positive.

Across both CIS waves, a consistently strong and positive effect of public funding is found especially for firms in medium-high and high-tech industries and to a lesser degree for lower tech manufacturing firms. Regarding firm size, the results using CIS 2006 indicate a stronger effect of public funding on small firms.

Additional to the direct effect of public funding on the commercialization performance, there is also an indirect effect via the increase in R&D. As shown in the second stage, public funding positively affects R&D levels. In most cases, the increased R&D effort is estimated to have a positive effect on the commercialization performance.

Bringing the most important findings of the above analyses together allows one to formulate a number of conclusions regarding the general patterns of innovation and commercialisation performance of European firms. At the micro-economic level, when observing the behaviour of individual firms, the link between the R&D effort and the commercialisation performance is rather pronounced and a positive relationship has been observed in most cases.

But not only the R&D itself, also its origin and the patterns of R&D cooperation among firms play a role. It has been observed that acquiring results of external R&D and vertical cooperation with customers and suppliers is positively related to the firms' market uptake performance.

The above results provide especially pronounced evidence of the positive effect of the public R&D support at different levels. When looking at all firms as well as manufacturing firms only, a positive and significant effect of all types of R&D support on R&D levels as well as commercialisation performance is observed.

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

4.15. EFFECTS OF PUBLIC FUNDING FOR FIRMS' R&D

The previous results suggest there is generally a positive effect from public funding on R&D levels and commercialisation performance. Nevertheless, a major problem that the analysis faces is the possibility of selection bias. Neither the fact that a firm applies for funding nor the fact that it receives public support can be considered random. Firms receiving public support are, for example, more often exporting firms, which are likely to be more productive as well. Moreover, firms in higher-tech industries and those participating in joint R&D projects are more often supported, as are firms which are larger in terms of turnover. Thus, selection clearly has to be taken into account to be able to produce credible results.

In the analysis, matching techniques are applied to check for selection bias. According to a number of observable characteristics, each firm which receives public support is matched with a firm that does not. The two groups – the treatment group, those firms receiving public support, and the control group – should then be similar according to the considered observable characteristics.

One can then estimate the treatment effect on firms that receive public support. The complete procedure is an extended version of the one found in Czarnitzki and Lopes-Bento (2013) and is explained in Box 4.3. The results shown in Table 4.7 to 4.9 indicate that for the full sample, public funding has considerable effects on the R&D input as well as output. The average R&D intensity in the treatment group is 1.6% higher than in the control group (Table 4.7). The probability of firms to apply for a patent (patent application propensity) increases by 8.4% with public funding (Table 4.8) and the share of innovative sales are on average 3.1% higher for firms that received public funding (Table 4.9).

A more detailed look at geographic aspects reveals, that the R&D intensity as well as the patent application propensity of EU-15 firms is well above that of EU-12 firms. The difference in the patent application propensity is not a function of firm size distributions as firms in the matched sample are on average larger in the EU-12 and thus should have a higher patent application propensity. However, public funding has had a significantly positive effect in both country groups. The effects are quite different for the other innovation output measure – the share of innovative sales. Overall, this share is found to be larger in the EU-12 due to faster product upgrading, but the results indicate no effect of public funding on the commercialisation phase in this region. This finding is also rather stable over time when looking at different measurement waves (CIS4 and CIS5).

Interesting results also emerge from the investigation of effects along the dimension of firm size. Very pronounced effects of public support on R&D input as well as output can be found for small firms and medium-sized enterprises. SMEs often lack sufficient internal funds. Support is vital for them to become strong entrants in a competitive market able to fill world market niches and deliver innovative products. Effects on patent application rates are especially pronounced for larger firms. At the same time, no significant effect of public support on the share of innovative sales can be found for large firms. One reason for this finding is that large firms often split research and production facilities geographically and thus output affects may be generated in other subsidiaries.

The most striking results were obtained with respect to the industry affiliation of firms. On the one hand, the analysis shows that innovation projects in

Box 4.3. The four-step matching procedure

1. Restriction of the sample to the innovative firms of interest: either all innovative firms, or a subsample of firms with respect to size, country or industry affiliation

2. Estimation of probability of a firm to receive public funding depending on the following observable characteristics: size based on employment and turnover, country and industry affiliation, exporter status, a dummy for multinationals and domestic enterprise groups as well as information on R&D cooperation and preconditions for R&D (estimated at a previous stage)

3. Matching of firms receiving public support with firms which have a similar probability of getting public funds but do not receive them. Firms are only matched with other firms in the same country and employment size class (small: less than 50 employees, medium: between 50 and 250, large: more than 250). Firms with no similar counterpart are excluded from the sample using a threshold for the maximum allowed difference.

4. The average treatment effect can now be calculated as the mean difference of the matched samples.

Table 4.7. R&D intensity

R&D intensity	Treated	Control	Difference	T-stat	
All firms	0.033	0.017	0.016	13.46	***
EU-15 firms	0.035	0.018	0.017	13.23	***
EU-12 firms (CIS4)	0.024	0.013	0.011	3.81	***
EU-12 firms (CIS5)	0.024	0.012	0.013	4.48	***
Small	0.041	0.019	0.022	10.25	***
Medium	0.027	0.014	0.014	7.69	***
Large	0.029	0.019	0.010	4.66	***
High-tech	0.069	0.036	0.033	6.27	***
Medium-high-tech	0.041	0.025	0.016	5.97	***
Medium-low-tech	0.019	0.011	0.009	4.41	***
Low-tech	0.020	0.013	0.007	3.22	***
Food processing	0.015	0.006	0.008	2.23	**

Note: The stratified sample overall contains all CIS4 EU-27 countries; the number of treated firms in each sample is: full sample: 5152, EU-15: 4338, EU-12: 814 (CIS4), 954 (CIS5), Small: 2090, Medium: 1827, Large: 1235, Domestic enterprise groups: 1580, Foreign enterprise groups: 411, High-tech 633 firms, Medium-high-tech: 1447, Medium-low-tech: 1131, Low-tech: 902, Food processing: 441
****, ** and * denote tests being significant at a 1, 5 and 10% level, respectively.*
Source: Community Innovation Survey (CIS), waves 4 and 5, wiiw estimations

Table 4.8. Patent application propensity

Patent application propensity	Treated	Control	Difference	T-stat	
All firms	0.303	0.219	0.084	7.54	***
EU-15 firms	0.323	0.234	0.089	7.03	***
EU-12 firms (CIS4)	0.192	0.138	0.054	2.62	***
EU-12 firms (CIS5)	0.158	0.108	0.050	3.00	***
Small	0.193	0.128	0.066	4.59	***
Medium	0.284	0.201	0.082	4.62	***
Large	0.516	0.399	0.117	4.09	***
High-tech	0.404	0.288	0.117	3.38	***
Medium-high-tech	0.435	0.317	0.117	5.08	***
Medium-low-tech	0.249	0.195	0.055	2.55	**
Low-tech	0.121	0.127	-0.007	-0.35	
Food processing	0.163	0.091	0.073	2.51	**

Note: The stratified sample overall contains all CIS4 EU-27 countries; the number of treated firms in each sample is: full sample: 5152, EU-15: 4338, EU-12: 814 (CIS4), 954 (CIS5), Small: 2090, Medium: 1827, Large: 1235, Domestic enterprise groups: 1580, Foreign enterprise groups: 411, High-tech 633 firms, Medium-high-tech: 1447, Medium-low-tech: 1131, Low-tech: 902, Food processing: 441.
****, ** and * denote tests being significant at a 1, 5 and 10% level, respectively.*
Source: Community Innovation Survey (CIS), waves 4 and 5, wiiw estimations.

higher-tech industries (which basically comprise advanced manufacturing industries, see Annex Table A.2) benefit particularly from public funding. This can be seen from the significant and large effects on both the patent application propensity and the share of innovative sales.

Publicly funded firms in high- and medium-high-tech industries exhibit a higher increase in the share of innovative sales of 8.7 and 4.1 percentage points, respectively and an 11.7 percentage points higher application rate for patents.

On the other hand, the results indicate strong crowding out effects of public funding in lower-tech industries, especially with respect to innovation output measures. The finding is not an effect of lower-tech EU-12 firms, which overall exhibit no significant effects of public funds on the share of innovative sales, but can be found for lower-tech EU-15 firms as well. A possible explanation is that innovation projects in these industries take place in an environment which is changing less rapidly than that of high-tech industries. Thus, there is on average less risk and asymmetric information attached to

Table 4.9. Share of innovative sales

Share of innovative sales	Treated	Control	Difference	T-stat	
All firms	0.232	0.201	0.031	4.11	***
EU-15 firms	0.222	0.188	0.033	4.04	***
EU-12 firms (CIS4)	0.288	0.269	0.019	1.09	
EU-12 firms (CIS5)	0.285	0.277	0.009	0.57	
Small	0.225	0.198	0.027	2.19	**
Medium	0.233	0.190	0.042	3.55	***
Large	0.244	0.222	0.022	1.37	
High-tech	0.336	0.249	0.087	3.84	***
Medium-high-tech	0.261	0.220	0.041	3.04	***
Medium-low-tech	0.178	0.166	0.012	0.83	
Low-tech	0.200	0.190	0.010	0.60	
Food processing	0.173	0.149	0.024	0.92	

*Note: The stratified sample overall contains all CIS4 EU-27 countries; the number of treated firms in each sample is: full sample: 5152, EU-15: 4338, EU-12: 814 (CIS4), 954 (CIS5), Small: 2090, Medium: 1827, Large: 1235, Domestic enterprise groups: 1580, Foreign enterprise groups: 411, High-tech 633 firms, Medium-high-tech: 1447, Medium-low-tech: 1131, Low-tech: 902, Food processing: 441. ***, ** and * denote tests being significant at a 1, 5 and 10% level, respectively.*
Source: Community Innovation Survey (CIS), waves 4 and 5, wiiw estimations.

innovation projects in low-tech industries. Banks and other financial intermediaries can therefore better evaluate them. Innovation market failures can be expected to be less pronounced in traditional industries meaning here is also less need for public funding. This is especially true for larger firms, which can either rely on internal funding or have easier access to external sources such as banks. The finding also indicates that the increased innovation support via the Rural Development Policy, which is part of the European Common Agricultural Policy, has no or very small effects on innovation output.[43] It might thus be more desirable to reallocate these innovation funds to a broader support of competitiveness, as is planned in the budget for the period 2014-2020.

4.16. Summary and policy implications

Despite of longer-term trends in advanced economies whereby the manufacturing sector accounts for a shrinking share of value-added of employment, there is a considerable case for preserving a 'critical size' of manufacturing activities in European economies.

The main arguments are the following: Firstly, manufacturing still accounts for a major part of innovation effort in advanced economies which translates into above-average contributions to overall productivity growth and thus to real income growth. Secondly, there are very important 'backward linkages' from manufacturing to services which provide important inputs for manufacturing (in particular business services). Thirdly, manufacturing has a 'carrier function for services which might otherwise be considered to have limited tradability. In the same direction goes the increased 'product bundling' of production and service activities in advanced manufacturing activities. This 'carrier function' – through international competitive pressure – has furthermore a stimulus effect for innovation and qualitative upgrading for service activities. Lastly, and related to the first argument, is the higher productivity growth in manufacturing which is important because the sector of origin of productivity growth be the sector that benefits most from the actual productivity gain.

The main findings of the analyses of state aid and export-oriented manufacturing are the following. Regarding extra-EU manufacturing export shares of Member States, internationalisation measures appear to be a support item that has a positive effect. Also, in the case of internationalisation measures, there is a positive interaction effect with governance effectiveness.

As for the per capita levels of the export-oriented manufacturing sector in the EU-27 countries, regional aid and training aid were positively associated with value-added per capita growth while risk capital aid has a significant negative effect.

The results from the analyses of public funding of R&D&I suggest that it can be better targeted in the EU-12 and make it more effective. Especially in the EU-12, and irrespective of the actual objectives of the support programmes, de facto governments end up providing innovation support more often to larger firms than to their smaller competitors (for detailed

[43] 'Food processing' was analysed separately, as firms in this industry exhibit by far the highest support rate with respect to EU funds.

evidence refer to the background study of the report).Given the substantial evidence that small firms in particular face considerable financial problems due to asymmetric information impacts, they should be the primary target of public funds.

In order to increase support to small firms, a special targeting of grants is one way to improve the allocation of public funds. Other initiatives could include information campaigns about credits, deductions and subsidised loans for new entrepreneurs. As problems lie mainly in the commercialisation phase, fostering venture capital investment would be another starting point.

Industrial policy is designed to improve the growth process (in its quantitative and qualitative aspects) through its impact upon economic structures (see also Pack and Saggi, 2006). This could be done by impacting economic structure in terms of the composition of activities or industries, or by influencing the directions in which technologies develop or within industries, by affecting the distribution of enterprises and plants according to different performance characteristics. There is also the influence on the distribution of economic activity over geographic area, so that industrial policy has an interface with regional policy. The impact of industrial policy on economic activity may take place directly (e.g. through direct support for particular types of industries, firms, technologies) or indirectly (through framework conditions such as the way financial markets operate or the legal and administrative system or the quality of educational and training institutions).

The second goal of industrial policy – apart growth – is external competitiveness, which means that would pay particular attention to the development of the tradable sector (in all the dimensions cited previously: composition of activities and industries; intra-industry composition; technologies and product quality).

Furthermore, industrial policy has to be attentive to the different needs of countries and regions at different levels of economic development.

The maintenance of a competitive and diversified industrial base is part of the Europe 2020 strategy. The policy challenge could be seen as providing the right framework conditions and public inputs so that gaps do not open up in the spectrum of industrial activities which could be deemed strategic in terms of the future development of industrial activity. ‘Strategic’ in this context means that such segments of industrial activity do or could (in future) exert important ‘spillover effects’ in terms of backward or forward learning processes in linked activities and/or could also provide important inputs for various activities.

Industrial policy at the EU level should ensure that Europe has a broad and diversified industrial structure which is well-equipped to be a major actor in the development of new areas of activity such as environmental technology. In this it is able to benefit from the diversified character of European industrial and demand structures and benefit from the pooling of resources. This encourages innovations in existing areas, in which Europe draws on its specific comparative advantages, to be based on traditions of production specialisation (fashion in France and Italy, high-quality mechanical engineering and transport equipment in Germany and in a number of the central European economies), or on a diversified pattern of private and public demand. The latter includes features of the ‘European model’ such as the strong position of public transport, of high-quality health services or linked medical devices and pharmaceuticals.

Furthermore, the preservation of the ‘industrial commons’ includes nurturing manufacturing-services inter-linkages and exploiting specialisation advantages of different European economies. State aid measures to support structural change and structural adjustment have so far been used predominantly at national level and did not rely much on the coordinated use of state aid tools. In a highly integrated European economy, the preservation and development of ‘industrial commons’ should be seen as a joint responsibility because of strong externalities across the European economy. Such joint responsibility for ‘industrial commons’ includes rules for quality assurance and recognition of qualifications, supporting the mobility of skilled staff, learning from successful cluster policies, support for necessary transport and communications infrastructure.

It is important that concept of industrial policy support the ‘structural change enhancing’ rather than the ‘structure preserving’ aspects. Industrial policy should play an active role in reducing entry barriers in four directions: supporting new firms, developing and marketing new products, moving into new markets or market niches.

Something well worth elaborating and increasing is demand-side industrial policy as an instrument to stimulate the commercial application of innovation. There is a broad consensus that the existing gap between European research excellence and the development of marketable products is a major weak spot in Member States’ innovation systems. The US defence-related public procurement policy may serve as an example of how to remedy this shortcoming. As pointed out above, public procurement can provide the necessary incentive to invest in the development of marketable products. Given the strong political commitment of the EU to environmental protection and the mitigation of climate change, a long-term industrial policy targeted at the development of 'clean' products and technologies could well form the base for a major industrial policy initiative. Importantly, such a strategy should not only include a long-term funding commitment for research but also needs a reliable source of demand that should be provided by public procurement of EU Member States and the EU itself.

The industrial policy strategy laid out in the European Commission's Industrial Policy Communication of October 2012 (European Commission, 2012a) goes in the same direction: Five of the six priority areas (priority action lines) defined in this Communication are related to meeting the challenge of climate change and the degradation of the environment. It remains to be seen whether public procurement will have any role to play in the EU's policy initiatives for stimulating the commercialisation of innovations and the development of green and more resource-efficient products.

This issue has been much researched and forms the backbone of many policy initiatives (most prominently the Lisbon Agenda, and subsequently in the Europe 2020 Agenda). In the face of technological competition, particularly with the United States and more recently with a range of Asian economies, innovation has increasingly become the focus of industrial policy at EU level.

Analyses in this chapter have contributed to the evaluation of innovation policy in the way it is conducted at national and EU levels. They come out in favour of further efforts towards increased harmonisation of 'innovation systems' and the use of innovation policies across the EU Member States. Attempts at EU level have already been made to create an 'internal market for research', supporting the 'free movement of knowledge, researchers and technology, with the aim of increasing cooperation, stimulating competition and achieving a better allocation of resources and an improved coordination of national research activities and policies' (FREE, 2010). The attempts have been further reinforced through the Article 179 of the Lisbon Treaty, creating an unified research area based on the internal market, in which researchers, scientific knowledge and technology circulate freely and through which the Union and its Member States strengthen their scientific and technological bases, their competitiveness and their capacity to collectively address grand challenges (COM(2012)392 final).

However, the empirical analysis conducted also shows that innovation policies conducted at EU, national and regional levels partly address different needs, such as support for large firms vs. SMEs, national enterprise groups vs. multinationals, activities where the technological spillovers are more local vs. those which are international. It was also found that there can be different instances of misallocation of resources in the way programmes are conceived at EU or national levels. The different focus is understandable as issues of asymmetric information and knowledge of spillover effects are perceived differently at local, national and EU levels. Hence a clear view of division of tasks and use of resources at these different levels is important in the area of innovation policy as in many other areas.

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ANNEX 1
INDUSTRY LISTS AND COUNTRY ABBREVIATIONS

Table A1. Country abbreviations

AT	Austria
BE	Belgium
BG	Bulgaria
CY	Cyprus
CZ	Czech Republic
DE	Germany
DK	Denmark
ES	Spain
EE	Estonia
FI	Finland
FR	France
UK	United Kingdom
EL	Greece
HU	Hungary
IE	Ireland
IT	Italy
LT	Lithuania
LU	Luxembourg
LV	Latvia
MT	Malta
NL	Netherlands
PL	Poland
PT	Portugal
RO	Romania
SK	Slovakia
SI	Slovenia
SE	Sweden
US	Unites States
JP	Japan
KR	South Korea
BR	Brazil
CN	China
IN	India

Table A2. Industry classification with detailed advanced manufacturing industries

15t16	Food, Beverages and Tobacco	Low technology
17t18	Textiles and Textile Products	Low technology
19	Leather, Leather and Footwear	Low technology
20	Wood and Products of Wood and Cork	Low technology
21t22	Pulp, Paper, Paper , Printing and Publishing	Low technology
23	Coke, Refined Petroleum and Nuclear Fuel	Medium-low technology
24	Chemicals and Chemical Products	Chemicals
25	Rubber and Plastics	Medium-low technology
26	Other Non-Metallic Mineral	Medium-low technology
27t28	Basic Metals and Fabricated Metal	Metals
29	Machinery, nec	Machinery
30t33	Electrical and Optical Equipment	Electrical equipment
34t35	Transport Equipment	Transport equipment
36t37	Manufacturing, nec; Recycling	Low technology

Note: Based on NACE Rev. 1 industry classification.

Table A3. Industry classification according to technology intensity

15t16	Food, Beverages and Tobacco	Low technology
17t18	Textiles and Textile Products	Low technology
19	Leather, Leather and Footwear	Low technology
20	Wood and Products of Wood and Cork	Low technology
21t22	Pulp, Paper, Paper , Printing and Publishing	Low technology
23	Coke, Refined Petroleum and Nuclear Fuel	Medium-low technology
24	Chemicals and Chemical Products	Medium-high and high technology
25	Rubber and Plastics	Medium-low technology
26	Other Non-Metallic Mineral	Medium-low technology
27t28	Basic Metals and Fabricated Metal	Medium-low technology
29	Machinery, nec	Medium-high and high technology
30t33	Electrical and Optical Equipment	Medium-high and high technology
34t35	Transport Equipment	Medium-high and high technology
36t37	Manufacturing, nec; Recycling	Low technology

Note: Based on NACE Rev. 1 industry classification.

Table A4. Industry classification according to Eaton et al. (1998)

15t16	Food, Beverages and Tobacco	Labour-intensive / Chemical-linked
17t18	Textiles and Textile Products	Labour-intensive / Chemical-linked
19	Leather, Leather and Footwear	Labour-intensive / Chemical-linked
20	Wood and Products of Wood and Cork	Resource-intensive / Earth-linked
21t22	Pulp, Paper, Paper , Printing and Publishing	Resource-intensive / Earth-linked
23	Coke, Refined Petroleum and Nuclear Fuel	Resource-intensive / Earth-linked
24	Chemicals and Chemical Products	Chemicals
25	Rubber and Plastics	Labour-intensive / Chemical-linked
26	Other Non-Metallic Mineral	Resource-intensive / Earth-linked
27t28	Basic Metals and Fabricated Metal	Metals
29	Machinery, nec	Machinery
30t33	Electrical and Optical Equipment	Electrical equipment
34t35	Transport Equipment	Transport equipment
36t37	Manufacturing, nec; Recycling	Resource-intensive / Earth-linked

Note: Based on NACE Rev. 1 industry classification.

ANNEX 2
ADDITIONAL RESULTS FROM THE QUANTITATIVE ANALYSIS OF STATE AID

Table A5. Percentile ranks of EU Member States' governance effectiveness, average 1995-2011

AT	93.4
BE	93.8
BG	56.4
CY	91.5
CZ	81.5
DE	91.9
DK	99.5
ES	82.0
EE	84.8
FI	100
FR	88.2
UK	92.4
EL	66.8
HU	73.0
IE	89.1
IT	66.4
LT	72.0
LU	94.8
LV	72.5
MT	82.9
NL	96.7
PL	71.6
PT	78.7
RO	47.4
SK	76.3
SI	79.6
SE	98.6

Note: Percentile range (globally) is from 0-100. Higher percentiles indicate higher governance effectiveness.
Source: World Bank’s Worldwide Governance Indicators (WGI) database.

Table A6. Aid to research, development and innovation and competitiveness[44]
Dependent variable: Member States' share in total extra-EU exports

Specification	(1)		(2)		(3)		(4)	
R&D aid	-0.004		0.001		0.011		-0.013	
	(0.018)		(0.022)		(0.026)		(0.020)	
R&D aid²	-0.001		0.000		0.001		-0.004	*
	(0.002)		(0.002)		(0.003)		(0.002)	
loans to GDP	0.035							
	(0.069)							
loans to GDP²	-0.253	***						
	(0.035)							
loans to GDP * R&D aid	-0.002							
	(0.011)							
governance			0.454					
			(0.342)					
governance²			0.658					
			(0.964)					
governance * R&D aid			-0.134	***				
			(0.033)					
wage share					-0.376			
					(0.401)			
wage share²					2.853			
					(2.276)			
wage share R&D aid					-0.248	***		
					(0.061)			
tariff rate							-0.046	
							(0.052)	
tariff rate²							-0.081	***
							(0.029)	
tariff rate * R&D aid							-0.020	*
							(0.012)	
R²	0.992		0.989		0.988		0.988	
adjusted R²	0.991		0.987		0.987		0.986	
Observations	373		380		341		391	

*Note: Standard errors appear in parentheses. ***, **, *indicate statistical significance at the 1%; 5% and 10% level respectively. Regressions include country and year fixed effects as well as a constant term which are not reported. The standard errors are robust. All the data was logarithmised (observations of the value zero were changed to 0.01 in order to make the taking of logarithms possible) and centred in order to make the estimated coefficients interpretable. R&D aid is aid to research, development and innovation.*
Source: WIOD, European Union State Aid Scoreboard, Eurostat, UNCTAD-TRAINS, World Bank's Worldwide Governance Indicators (WGI) database.

[44] It is important to note that this analysis is of a general nature and does not imply a specific link between a certain type of aid and the trade performance of any particular product or sector.

Table A7. Sectoral aid to manufacturing and competitiveness[45]
Dependent variable: Member States' share in total extra-EU exports

Specification	(1)	(2)	(3)	(4)
manufacturing aid	0.002	-0.008	0.000	-0.004
	(0.006)	(0.007)	(0.007)	(0.006)
manufacturing aid²	-0.001	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
loans to GDP	0.054			
	(0.070)			
loans to GDP²	-0.250***			
	(0.031)			
Loans * manufacturing aid	0.004			
	(0.008)			
governance		0.446		
		(0.362)		
governance²		0.889		
		(1.020)		
governance * manufacturing aid		0.071***		
		(0.023)		
wage share			-0.091	
			(0.399)	
wage share²			1.436	
			(1.983)	
wage share * manufacturing aid			-0.091**	
			(0.044)	
tariff rate				0.007
				(0.042)
tariff rate²				-0.090***
				(0.032)
tariff rate * manufacturing aid				0.004
				(0.007)
R^2	0.992	0.988	0.988	0.988
adjusted R^2	0.991	0.987	0.986	0.986
Observations	373	380	341	391

*Note: Standard errors appear in parentheses. ***, **, *indicate statistical significance at the 1%; 5% and 10% level respectively. Regressions include country and year fixed effects as well as a constant term which are not reported. The standard errors are robust. All the data was logarithmised (observations of the value zero were changed to 0.01 in order to make the taking of logarithms possible) and centred in order to make the estimated coefficients interpretable. Manufacturing aid is sectoral aid to manufacturing.*
Source: WIOD, European Union State Aid Scoreboard, Eurostat, UNCTAD-TRAINS, World Bank's Worldwide Governance Indicators (WGI) database.

[45] It is important to note that this analysis is of a general nature and does not imply a specific link between a certain type of aid and the trade performance of any particular product or sector.