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International Fragmentation of Production, Trade and Growth: Impacts and Prospects for EU Member States

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Abstract

There has been an ongoing trend towards increasing internationalisation of production over the past two decades or so. This implies that countries become more dependent on demand from foreign countries but also that countries and industries are able to source intermediates from different countries, an activity referred to as 'offshoring'. Whereas the former aspect means an increasing dependency on foreign markets, the second aspect implies that countries and industries source at lower costs making them more productive and competitive. Using the World Input-Output Database (WIOD) we first provide an overview of these trends over the period 1995-2011 for 40 advanced and emerging countries with a specific focus on the EU as a whole and the individual EU member states. In the second part of the paper we show results from an econometric analysis to explain growth performance, focusing on the impacts of the increasing internationalisation of production.

Keywords: *international fragmentation of production, growth, employment, trade*

JEL classification: *E20, F15, F43, F62*

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1 Introduction

There is an ongoing longer-term trend of increasing integration at the regional and global level which is mostly seen via increased trade flows across economies both in terms of final and intermediate goods trade and increased fragmentation of production, FDI activities and also labour migration (not mentioning the internationalisation of financial flows). The EU is very much a part of this phenomenon. On the one hand, the EU has become more strongly integrated into the world economy, and on the other, within-EU integration has become more important over the past decades. This latter aspect in particular gained momentum with the integration of the Eastern European economies from the mid-1990s onwards. Whether this trend has stopped, been interrupted only or has even reversed following the economic and financial crisis which hit the global economy in 2008 remains an open question.

The aim of this paper is to focus on an important part of the international integration dynamics, namely the increasing internationalisation of production. By this we mean the increasing probability that a particular product is no longer produced in a single economy and then exported as a final product to other countries, but that the production process itself is characterised by an increasing share of inputs from other countries and by offshoring parts of production to other countries. Analogously, a country's income is more and more dependent on demand from other countries in the form of demand for intermediates or as final demand. This implies a permanent shift towards new markets, with the most important aspect being the growing importance of emerging economies not only as a potential target of offshoring activities, thus exploiting low costs of production, but also as important markets to sell a country's products. This increasing internationalisation therefore has important implications for a country's growth strategies, employment and performance in general which has to be considered both from the supply and the demand side.

Section 2 of this paper provides an overview of these ongoing trends for the EU as a whole but also from the perspective of each individual member state over the period 1995 to the onset of the crisis, and also looks at the respective developments over the crisis period until 2011. For this we employ several indicators commonly used in the literature to show the role of the EU in the global economy and point towards similarities and differences across EU member states in this respect. Here, the question arises as to whether the internationalisation of production for individual member states was important largely due to being part of stronger within-EU integration or to the increasing exposure of each member state to the world economy, i.e. whether there was increased 'regionalisation of production' (strong EU integration) or whether the 'globalisation' of production was more important. Though these two trends could go in parallel their relative importance will be considered.

In Section 3 an econometric strategy is followed which pins down the relative importance of these aspects for a country's performance with respect to income, employment and productivity growth, which is of particular importance after the painful experiences of the crisis period. This section starts by showing results from regressing the growth rate of gross output, value added and employment on standard growth variables including openness and internationalisation of production indicators. Whereas this focuses on the overall growth performance of countries and industries, the next subsection discusses the effects of openness and the upstreamness of production on (labour) productivity. The third subsection investigates the extent to which the characteristics of produced goods are a driver of growth. Following Hausmann et al. (2007) a sophistication index is calculated and its relationship to growth examined.

Section 4 draws some conclusions from the results with respect to the international dimension of the EU economy and a comparison of the performance of the individual member states in this respect. In particular it highlights lessons learnt from developments and performance before the crisis which might be indicative for policy in this critical period and the period when the crisis has come to an end.

2 EU and Member State performance in the global production system

2.1 Indicators showing a country's exposure to the world

In a globalised world, international trade allows consumption levels and patterns that could not be achieved in a single closed economy. The reason is that consumption no longer has to coincide with a country's production possibilities, with specialisation and international exchange allowing for production and consumption patterns to differ. This in most cases implies overall welfare gains, though there might be undesired distributional effects which are often a matter of debate when countries start to integrate. The additional possibility to not only trade final goods but also to engage in production sharing, i.e. moving production to locations where this can be done more efficiently or at lower costs, allows countries to further specialise in activities for which they have a comparative advantage (either caused by relative technology differences or factor endowments).

The past decades have seen an increase in the internationalisation of countries in terms of final goods trade but also in terms of international fragmentation of production, normally referred to as 'offshoring'. This was particularly the case for the European countries which additionally to the international integration at the global level engaged in an intensive and rapid phase of internal integration due to the European Single Market. An additional impact was the integration of East European countries after the fall of the iron curtain, which resulted in an enlarged European Union now comprising 27 countries and – for some of them – the emergence of a common currency system.

This has changed the economic landscape and the role of economic policies both at the level of the EU as well as the individual member states. Over the past decades however these new challenges and opportunities have been tackled differently across countries, potentially leading to differences in performance and outcomes which became most obvious during the course of the crisis which hit the world economy, but particularly the EU, over the past few years.

The aim of this section is to document these ongoing changes from the perspective of the EU as a whole but also for the individual member states. The focus is on the opportunities and challenges of these patterns of economic integration at the world level as well as internal integration patterns. This requires looking at this phenomenon from both the demand and supply side of the economies. The former implies that as a result of more international integration a country can sell its products to a larger set of – maybe themselves growing – markets while also being able to source final goods from a larger set of countries. The first means that a larger proportion of a country's production, i.e. its value added created in the economy, may depend to a larger extent on demand from abroad. The second aspect means that more income is spent on goods produced in other countries. Both aspects lead to a change in a country's net trade balance, which – in essence – reflects a country's overall savings (as is clear from national accounting identities). Furthermore, the fact that a country can sell its products to a larger set of markets is also true for all other economies, meaning that competition in these markets might become fiercer.

From the latter perspective, the supply side, increased internationalisation of production might also imply that a country which exploits potential comparative advantages due to sourcing from other countries – having a comparative advantage in other stages of production or producing intermediate inputs cheaper than compared to domestic production – might gain in competitiveness in some sectors leading to better growth performance in terms of output or value added. Whether this is also the case for employment is a trickier question, as offshoring often has a similar effect as labour saving technical progress though the overall increase in output might compensate for that.

In this section we construct and describe particular indicators (explained below) to pin down these aspects. We do so first for the EU as a whole which has to face the global challenges, and then for individual member states which have additionally integrated in the internal market. For this we use the World Input-Output Database (WIOD)[1] which allows one to calculate the most relevant indicators from a value added perspective. Value added created in an economy, i.e. the country's GDP, is the most important indicator of economic performance, as it indicates people's income and thus consumption possibilities.

[1] See Timmer et al. (2012).

2.2 The EU in the global economy

2.2.1 The role of foreign demand for EU income

As discussed above, increasing internationalisation might imply that a country's income level and growth rely to a greater extent on foreign demand. This could be due to the fact that some emerging and large economies such as China, India and Brazil have experienced an exceptional growth performance which has triggered demand for other countries' products. This can either be because of an increase in foreign demand for final products or an increase in demand for intermediate products which are inputs into the production process of foreign countries. Of course, this depends not only on the growth performance of other countries but also on the extent to which a country remains competitive compared to other economies also providing such products.

The value added created in an economy due to demand for final products in other economies, or the 'value added exports (VAX)' as described in Johnson and Noguera (2012), can be easily calculated using the WIOD database. Koopman et al. (2010) provide a further decomposition and Stehrer (2012 and 2013) discusses how this relates to other concepts. In Table 2.2.1 the value added created in the EU as a whole due to demand in other countries as a % of GDP is presented over the period 1995 to 2011.[2]

Whereas in 1995 about 10% of GDP in the EU-27 was produced to satisfy – directly and indirectly – foreign demand abroad, this share has increased to almost 15% in 2011. Conversely, domestic final demand contributed only 85% of EU-27 income in 2011. While this share declined slightly during the crisis in 2009 it became larger in 2010 and 2011, which is explained by the better growth performance of the emerging economies. On top of this trend there have been significant changes with respect to the relative importance of the absorbing countries. Columns (4)-(17) in Table 2.2.1 present the composition of GDP due to foreign demand. The most striking trend is the rising share of China, which increased from 3.3% in 1995 to more than 11% in 2011 at the expense of Japan (8.1% in 1995 and 3.4% in 2011) and the US (24.5% in 1995 compared to 18.4% in 2011). Though trends for other countries are also significant in relative terms, these are less relevant with respect to their importance. Thus, it is not only that advanced economies such as the EU are challenged by low-cost competition from emerging markets but that these countries themselves become increasingly important as markets for EU products. Consequently, the EU not only has to struggle with remaining competitive in advanced third markets, but also increasingly so in remaining competitive in emerging third markets.[3] The second part of Table 2.2.1 indicates that the same holds for employment. More than 10% of employed persons (in terms of total employed) are directly and indirectly employed to satisfy foreign demand.

[2] Johnson and Noguera (2012) express value added exports in terms of gross exports (VAX ratio). Value added exports can be split into 'direct absorption', 'indirect absorption' and 'absorption in third countries' following Koopman et al. (2010). Steher (2012b) shows these indicators for the set of WIOD countries.

[3] It should be noted here that the volume of sales grow, though the share might be lower.

The trends with respect to employment are similar though somewhat less pronounced when compared to value added.

Table 2.2.1

Value added and employment due to foreign demand, 1995-2011

Value added

	EU VA due to domestic demand in % of GDP	EU VA due to foreign demand in % of GDP	EU VA due to foreign demand by partner (in % of EU VAX due to foreign demand)													
			AUS	BRA	CAN	CHN	IDN	IND	JPN	KOR	MEX	RUS	TUR	TWN	USA	ROW
1995	90.1	9.9	2.5	2.6	2.9	3.3	1.5	1.6	8.1	2.7	1.0	3.8	2.0	2.1	24.5	41.5
1996	89.9	10.1	2.5	2.4	2.9	3.0	1.7	1.6	7.5	3.0	1.1	3.7	2.5	2.0	25.3	40.7
1997	89.1	10.9	2.6	2.7	3.0	3.1	1.6	1.6	6.9	2.5	1.4	4.1	2.7	2.0	27.3	38.5
1998	89.6	10.4	2.4	2.8	3.2	3.4	0.9	1.8	6.3	1.4	1.6	3.6	2.7	2.1	29.1	38.8
1999	89.6	10.4	2.6	2.3	3.5	3.9	0.9	1.5	6.6	1.8	1.8	2.0	2.4	2.0	31.4	37.3
2000	88.4	11.6	2.2	2.4	3.4	4.3	0.8	1.4	6.7	2.3	2.0	2.2	2.8	2.0	33.3	34.4
2001	88.3	11.7	2.0	2.3	3.2	5.1	0.8	1.3	6.4	2.1	2.0	2.6	1.8	1.7	32.6	36.1
2002	88.2	11.8	2.1	1.8	3.0	5.6	0.7	1.4	5.4	2.1	2.0	3.0	1.9	1.4	32.2	37.4
2003	88.8	11.2	2.3	1.6	3.2	6.7	0.6	1.3	5.6	2.1	1.8	3.1	2.3	1.3	30.1	38.1
2004	88.5	11.5	2.4	1.6	3.1	7.1	0.7	1.5	5.6	2.0	1.7	3.3	2.7	1.3	27.8	39.1
2005	88.0	12.0	2.4	1.7	3.1	6.5	0.8	1.8	5.1	2.1	1.8	3.6	2.7	1.3	26.5	40.6
2006	87.6	12.4	2.1	1.9	3.1	7.1	0.7	2.4	4.7	2.2	1.7	4.2	2.7	1.1	25.2	40.7
2007	87.2	12.8	2.3	2.1	2.8	7.4	0.8	2.4	4.2	2.2	1.7	4.7	2.7	1.0	22.1	43.6
2008	86.7	13.3	2.1	2.3	3.0	7.8	0.9	2.2	3.9	2.3	1.6	5.5	3.1	1.0	20.1	44.2
2009	87.7	12.3	2.2	2.5	3.0	9.2	0.8	2.1	3.7	1.9	1.4	4.5	2.6	0.9	19.2	45.8
2010	85.7	14.3	2.1	2.8	2.9	10.1	0.8	2.0	3.3	1.8	1.4	4.5	2.7	1.0	19.5	45.0
2011	85.1	14.9	2.2	3.1	2.9	11.1	0.8	1.9	3.4	1.9	1.4	5.1	3.1	1.0	18.4	43.8

Employment

	EU em-ployment due to domestic demand in % of total employ-ment	EU employ-ment due to foreign demand in % of total employ-ment	EU EMP due to foreign demand by partner													
			AUS	BRA	CAN	CHN	IDN	IND	JPN	KOR	MEX	RUS	TWN	TWN	USA	ROW
1995	90.7	9.3	2.4	2.5	2.9	3.4	1.5	1.5	8.4	2.8	0.9	4.4	2.0	2.1	23.5	41.8
1996	90.4	9.6	2.4	2.3	2.9	3.1	1.6	1.5	7.9	3.2	1.1	4.2	2.5	2.1	24.3	41.0
1997	90.0	10.0	2.5	2.6	3.1	3.1	1.5	1.5	7.3	2.6	1.3	4.7	2.7	2.1	26.7	38.1
1998	90.4	9.6	2.4	2.7	3.2	3.4	0.9	1.7	6.7	1.5	1.6	4.1	2.7	2.1	28.5	38.7
1999	90.5	9.5	2.5	2.2	3.5	4.0	0.8	1.5	7.0	1.8	1.7	2.3	2.4	2.0	30.8	37.4
2000	89.5	10.5	2.1	2.3	3.4	4.3	0.7	1.4	7.1	2.3	1.9	2.5	2.7	2.0	32.5	34.7
2001	89.3	10.7	1.9	2.2	3.2	5.2	0.8	1.3	6.7	2.1	2.0	3.0	1.8	1.7	31.9	36.3
2002	89.2	10.8	2.1	1.7	3.0	5.6	0.7	1.4	5.9	2.1	1.9	3.5	2.0	1.5	31.5	37.2
2003	89.7	10.3	2.3	1.5	3.2	6.6	0.6	1.3	6.0	2.1	1.7	3.4	2.3	1.3	29.5	38.0
2004	89.5	10.5	2.4	1.5	3.1	7.1	0.7	1.5	6.0	2.1	1.7	3.7	2.7	1.4	27.4	38.8
2005	89.1	10.9	2.4	1.6	3.2	6.5	0.7	1.8	5.4	2.1	1.7	4.0	2.7	1.3	26.1	40.3
2006	88.7	11.3	2.1	1.9	3.1	7.1	0.7	2.4	5.0	2.3	1.7	4.7	2.7	1.2	24.6	40.6
2007	88.4	11.6	2.3	2.1	2.9	7.3	0.8	2.5	4.4	2.3	1.6	5.2	2.7	1.1	21.5	43.4
2008	87.8	12.2	2.1	2.3	3.0	7.8	0.8	2.2	4.0	2.3	1.6	6.0	3.5	1.0	19.4	44.0
2009	88.4	11.6	2.2	2.4	3.0	9.3	0.7	2.1	3.9	2.0	1.4	5.1	3.0	0.9	18.5	45.6

Source: WIOD, own calculations.

A different, though related, view is to look at how much value added has to be created abroad for producing final consumption – either from domestic production or imported – of the EU economy. Table 2.2.2 shows the share of these 'value added imports' again expressed as a % of GDP. The first column equals the first column in Table 2.2.1 as this shows value added created in the EU due to EU final demand. The second column shows value added imports of the EU, i.e. the value added created abroad which is needed to satisfy EU final demand as a % of GDP. This share was also increasing over the period of interest, rising from 7.4% in 1995 to almost 13% in 2011. Thus, it is not only that foreign economies absorb more and more of value added created in the EU, but also that the EU absorbs more and more of value added created outside the EU, i.e. EU consumption depends increasingly on production abroad. Both trends are in line with the increasing internationalisation of production as is well known from studies pointing towards increasing vertical specialisation (e.g. Hummels et al., 2001). By partner country, the trends are similar to those for value added exports, i.e. the strong increases of China are mirrored by the strong declines of the shares of advanced economies such as Japan and the US.

Table 2.2.2

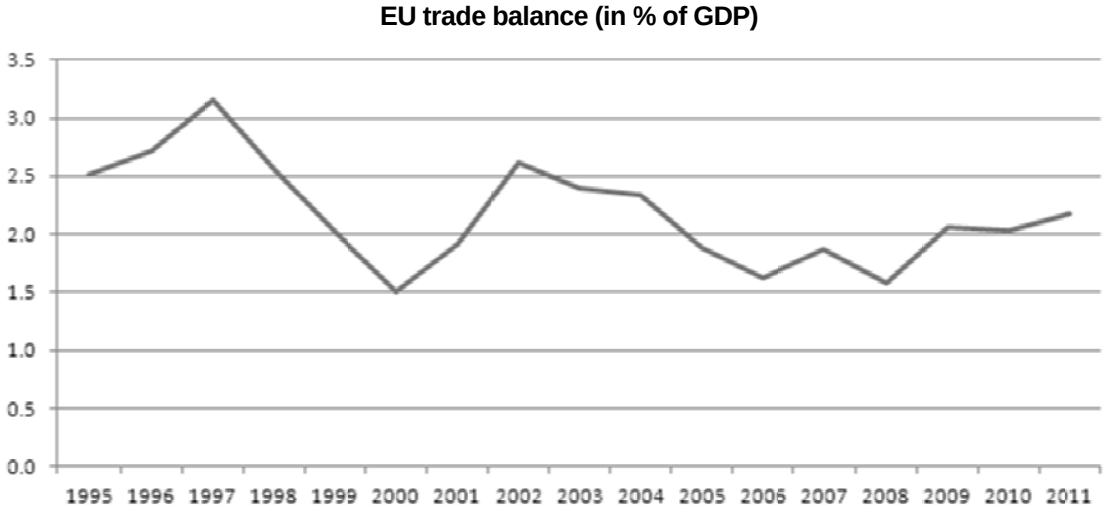
Value added imports, 1995-2011

	EU VA due to domestic demand in % of GDP	EU VA imports due to domestic demand in % of GDP	EU VA imports due to domestic demand by partner													
			AUS	BRA	CAN	CHN	IDN	IND	JPN	KOR	MEX	RUS	TWN	TWN	USA	ROW
1995	90.1	7.4	1.7	2.7	3.1	5.1	1.6	2.0	12.0	3.1	1.4	7.3	2.3	2.2	25.3	30.2
1996	89.8	7.4	1.7	2.4	3.1	4.9	1.6	2.1	10.3	3.0	1.3	7.0	2.6	2.2	25.6	31.9
1997	89.1	7.7	1.8	2.8	3.2	5.7	1.8	2.2	10.7	3.2	1.4	7.6	3.3	2.4	28.6	25.5
1998	89.6	7.8	1.6	2.6	3.2	6.2	1.3	2.3	10.9	2.9	1.6	6.8	3.3	2.4	28.2	26.5
1999	89.6	8.4	1.6	2.2	3.4	6.3	1.1	2.0	10.7	3.0	1.6	5.0	2.9	2.5	27.3	30.4
2000	88.4	10.1	1.5	2.2	3.2	6.3	1.3	2.1	10.1	3.0	2.1	6.1	2.5	2.4	25.0	32.2
2001	88.3	9.8	1.4	2.3	3.0	6.9	1.3	2.0	8.6	2.7	2.0	5.5	2.4	2.0	25.8	34.1
2002	88.2	9.2	1.5	2.3	3.1	7.6	1.4	2.0	8.3	2.9	1.8	5.5	2.2	2.0	26.1	33.4
2003	88.8	8.8	1.5	2.3	2.9	8.7	1.3	2.0	8.7	3.1	1.7	6.2	2.5	2.0	23.6	33.5
2004	88.5	9.2	1.7	2.5	3.3	9.4	1.2	2.7	8.6	3.4	1.6	7.2	2.7	1.8	20.6	33.3
2005	88.0	10.1	1.8	2.5	3.2	9.9	1.2	2.8	7.3	3.4	1.9	7.9	2.6	1.7	19.1	34.8
2006	87.6	10.8	1.6	2.6	3.2	11.3	1.3	3.1	6.6	3.3	1.7	7.8	2.5	1.5	18.7	34.9
2007	87.2	10.9	1.5	2.7	3.1	12.8	1.2	3.2	6.3	3.1	1.7	8.3	2.6	1.6	18.1	33.8
2008	86.7	11.8	1.4	2.7	2.8	13.2	1.2	3.1	5.6	2.8	1.5	8.8	2.8	1.3	16.5	36.3
2009	87.7	10.3	1.5	2.8	2.8	14.8	1.4	3.2	5.2	3.0	1.3	6.9	3.1	1.3	18.7	34.0
2010	85.7	12.3	1.7	3.1	2.7	15.3	1.4	3.5	4.8	3.1	1.2	7.4	2.6	1.4	19.2	32.6
2011	85.1	12.7	1.7	3.4	2.8	15.9	1.5	3.5	4.5	2.9	1.3	8.4	2.8	1.3	18.3	31.7

Source: WIOD, own calculations.

It can easily be seen that the first two columns of Table 2.2.2 do not add up to 100. The reason for this is that the EU is running a trade surplus. Though this is expressed here in terms of value added trade it can be shown that this also equals a country's net trade in gross terms (see Stehrer, 2012). The difference between the second columns in Tables 2.2.1 and 2.2.2 therefore provides EU net trade as a per cent of GDP, and is shown in Figure 2.2.1.

Figure 2.2.1



Source: WIOD, own calculations.

This share was around 2% on average, with the highest value of more than 3% reached in 1997 and the lowest level of 1.5% in 2000 (with similar levels in 2006 and 2008).

Similarly one can ask which sectors are and which have become more dependent on extra-EU demand. Thus we calculate the above measure, i.e. value added created in the EU due to final demand in non-EU countries, but split the measure by individual industries. Table 2.2.3 presents the results as a percentage of sectoral value added (analogous to Table 2.2.1 above which shows the same indicator for the total economy) on the left side and the relative importance of the industrial GDP created due to extra-EU final demand on the right side.

Let us present the most important stylised facts in a graphical way. Figure 2.2.2 shows value added and jobs created due to foreign final demand in a particular sector as a percentage of this sector's GDP in 1995 and the change between 1995 and 2011.

From Table 2.2.1 we know that the respective share for the EU total was 10% in 1995. There are a couple of industries – mostly manufacturing – showing shares well above this average, with shares being in the range 25-30% in Machinery (NACE 29), Electrical engineering (NACE 30t33), Chemicals (NACE 24), Transport equipment (NACE 34t35), and Basic metals (NACE 27t28). The other manufacturing industries (except Leather, NACE 19) show shares between 10 and 20% with Food and beverages (NACE 15t16) ranking lowest with about 9%. With respect to the service industries the transport equipment industries, particularly Water transport (NACE 61) and Air transport (NACE 62), have rather large shares. For Renting and other business activities (NACE 71t74) the share is

about 15% in 1995. As expected, the other service industries and public services and construction in particular, do not depend very much on foreign demand.

Table 2.2.3

Sectoral value added exports, 1995-2011

Ind		EU VAX due to foreign demand in % of sectoral GDP				EU VAX due to foreign demand (in % of total GDP due to foreign demand)			
		1995	2000	2007	2011	1995	2000	2007	2011
AtB	Agriculture, Hunting, Forestry and Fishing	8.9	10.0	11.3	12.1	3.0	2.4	1.9	1.7
C	Mining and Quarrying	21.5	22.6	22.5	25.5	0.8	0.8	0.8	0.6
15t16	Food, Beverages and Tobacco	9.5	10.3	12.1	12.6	2.5	2.4	2.2	2.1
17t18	Textiles and Textile Products	18.7	20.9	27.6	27.6	1.0	0.8	0.5	0.5
19	Leather, Leather and Footwear	24.6	30.0	31.2	31.2	0.2	0.2	0.1	0.1
20	Wood and Products of Wood and Cork	13.9	17.1	20.2	20.2	0.4	0.4	0.4	0.3
21t22	Pulp, Paper, Paper , Printing and Publishing	15.9	18.6	21.5	21.6	1.8	1.7	1.3	1.1
23	Coke, Refined Petroleum and Nuclear Fuel	13.8	16.2	25.6	24.1	0.5	0.5	0.5	0.4
24	Chemicals and Chemical Products	27.3	32.9	37.0	39.0	1.8	1.6	1.4	1.2
25	Rubber and Plastics	21.3	24.1	28.4	28.9	0.8	0.8	0.7	0.6
26	Other Non-Metallic Mineral	15.1	17.4	17.8	17.9	0.9	0.8	0.8	0.6
27t28	Basic Metals and Fabricated Metal	25.1	26.8	32.8	33.6	2.3	2.1	2.0	1.6
29	Machinery, Nec	31.8	32.9	37.8	38.7	1.7	1.6	1.5	1.3
30t33	Electrical and Optical Equipment	29.7	35.3	36.8	39.0	1.8	1.9	1.5	1.2
34t35	Transport Equipment	25.5	28.3	31.2	31.2	1.7	1.8	1.7	1.4
36t37	Manufacturing, Nec; Recycling	17.0	19.2	21.7	20.4	0.7	0.7	0.6	0.6
E	Electricity, Gas and Water Supply	7.5	9.4	11.0	10.8	2.9	2.1	2.4	2.6
F	Construction	1.9	2.2	2.4	2.8	6.6	6.3	7.2	7.0
50	Sale, Maintenance and Repair of Motor Vehicles and Motorcycles	6.1	7.4	8.7	8.7	1.8	1.9	1.9	1.8
51	Wholesale Trade and Commission Trade	10.6	12.8	14.6	15.0	5.1	5.1	4.9	4.8
52	Retail Trade, Except of Motor Vehicles and Motorcycles	8.0	9.1	10.9	11.0	4.7	4.7	4.4	4.3
H	Hotels and Restaurants	2.4	2.9	3.9	3.7	2.8	3.2	3.2	3.3
60	Inland Transport	12.5	15.8	16.6	17.0	2.5	2.4	2.3	2.3
61	Water Transport	64.6	69.1	71.9	73.4	0.1	0.1	0.1	0.1
62	Air Transport	29.8	32.2	27.8	30.6	0.4	0.4	0.3	0.3
63	Other Supporting and Auxiliary Transport Activities	17.9	20.0	21.8	22.6	1.3	1.4	1.5	1.5
64	Post and Telecommunications	7.7	9.4	10.1	10.5	2.3	2.4	2.3	2.2
J	Financial Intermediation	9.6	12.5	16.5	16.4	5.0	4.9	5.3	5.5
70	Real Estate Activities	2.7	3.2	3.8	3.6	10.4	10.6	11.4	11.8
71t74	Renting of M&Eq and Other Business Activities	14.1	17.2	18.3	18.5	8.6	10.1	11.0	11.1
L	Public Admin and Defence; Compulsory Social Security	1.7	1.1	1.5	1.4	7.2	6.9	6.7	7.2
M	Education	0.9	1.5	1.9	1.7	5.3	5.4	5.3	5.6
N	Health and Social Work	0.3	0.4	0.4	0.4	6.7	7.0	7.6	8.3
O	Other Community, Social and Personal Services	4.0	5.4	5.7	5.3	3.9	4.2	4.2	4.4
P	Private Households with Employed Persons	0.1	0.1	0.1	0.1	0.4	0.4	0.5	0.5

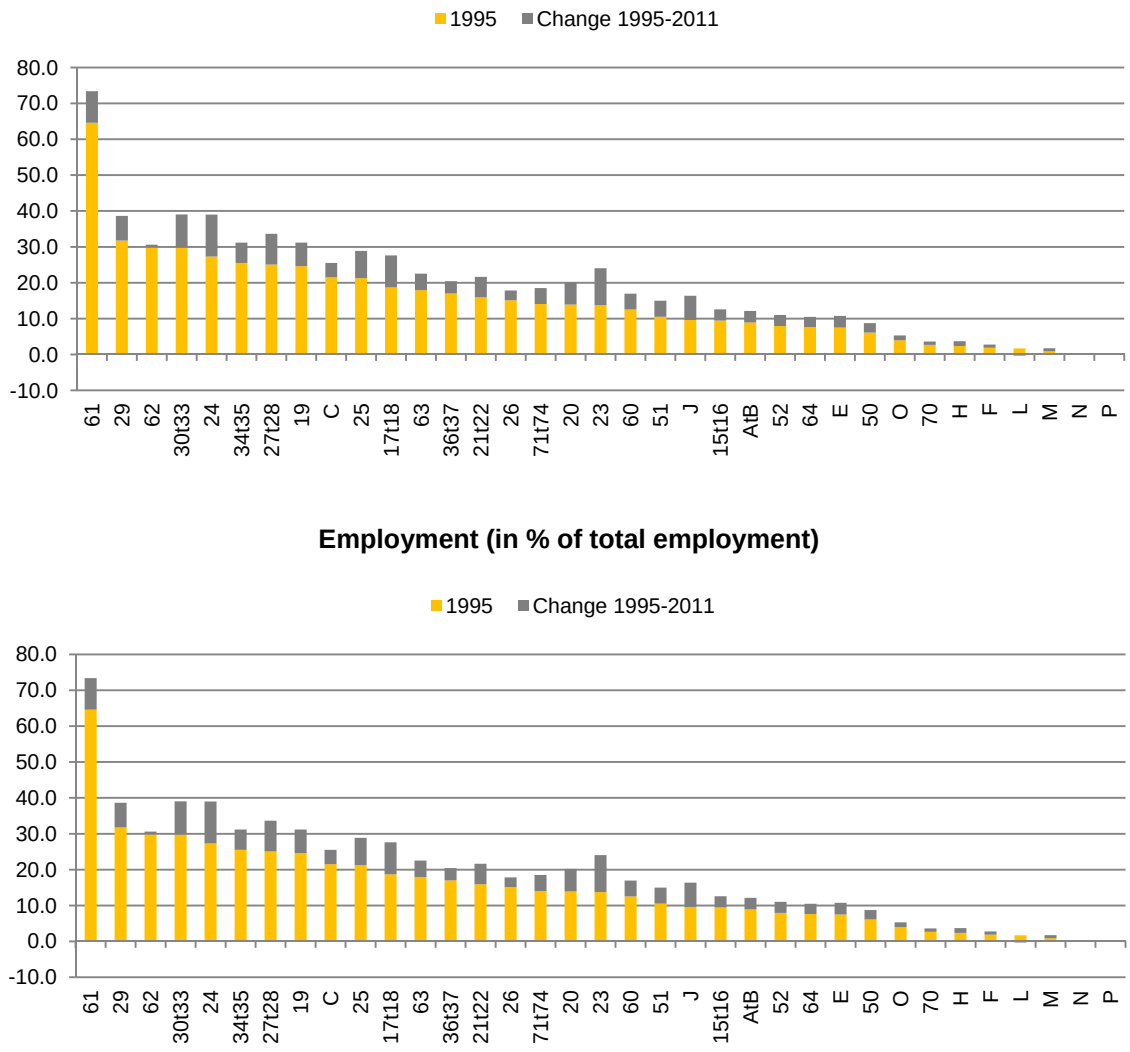
Source: WIOD, own calculations.

As is also obvious from Figure 2.2.2, the dependency on foreign demand has increased in all industries (with the exception of Public administration only, NACE L) though to a varying extent. This can be better seen when plotting the shares in 1995 against those in 2011 as presented in Figure 2.2.3. It is striking to see that those industries which were initially more dependent on external demand have become even more so over time. These industries tend to be medium-high- and high-tech manufacturing industries, and in particular: Chemicals (NACE 24), Electrical engineering (NACE 30t33), Machinery (NACE 29) and to a lesser extent Basic metals (NACE 27t28), Transport equipment (NACE 34t35), Leather

(NACE 19) and Coke and petroleum industry (NACE 23). In services industries, Financial intermediation (NACE J) and Business services (NACE 71t74) also show significant increases.

Figure 2.2.2

Sectoral value added and employment due to foreign demand, 1995-2011

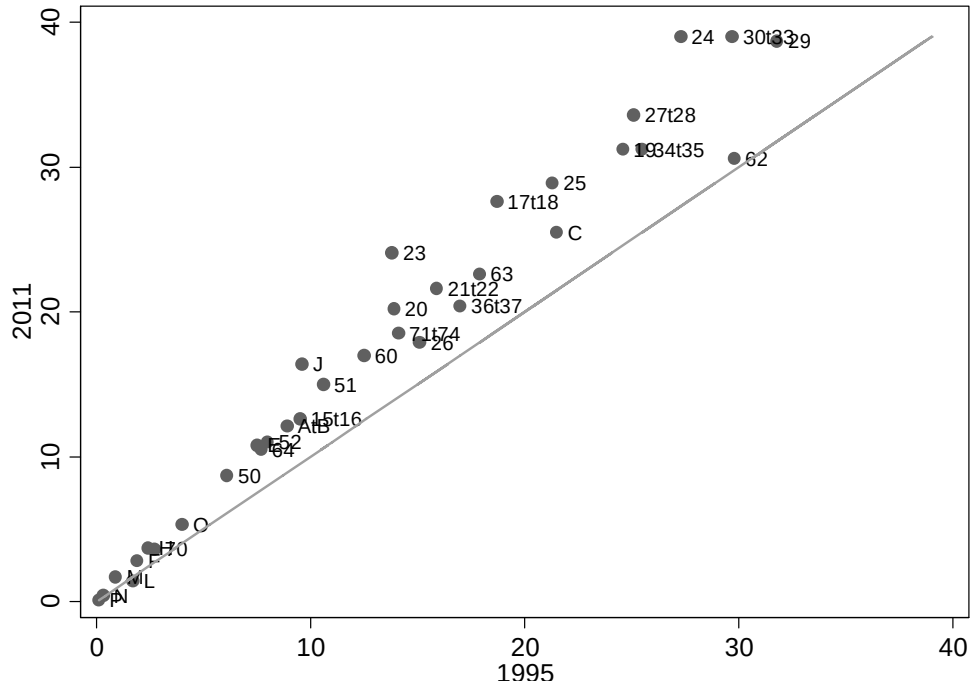


Source: WIOD, own calculations.

These shares and changes do not express the relative importance of the respective industries however, since this depends not only on the dependency on foreign demand but also on the relative sizes of the industries. The right part of Table 2.2.3 therefore shows the value added created due to foreign final demand in each industry as a percentage of the total value added created due to foreign final demand. The respective shares are presented graphically in Figure 2.2.4.

Figure 2.2.3

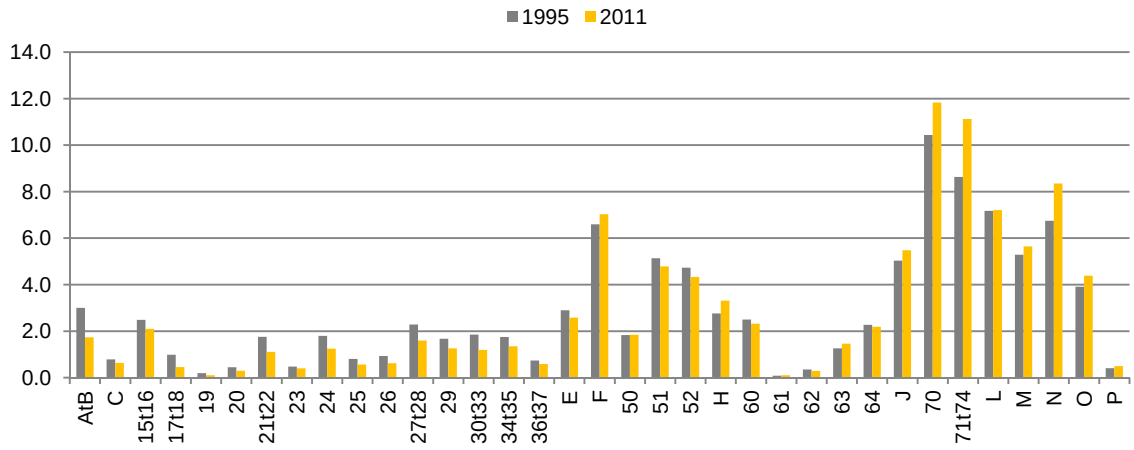
Changes in sectoral exposures to foreign demand (in % of sectoral GDP), 1995-2011



Source: WIOD, own calculations.

Figure 2.2.4

Sectoral importance in % of total value added created due to foreign demand, 1995-2011



Source: WIOD, own calculations.

Though the manufacturing industries show the highest dependency on foreign demand (see Figures 2.2.2 and 2.2.3) it is the service industries which contribute most to value added created due to foreign final demand. Here business activities such as Real estate activities (NACE 70) and Business services (NACE 71t74) again play the most important role, along with Public services and Financial intermediation (NACE J), Distribution industries (NACE 51 and 52) and Construction (NACE F). The manufacturing industries – though themselves highly dependent on foreign demand – play a less significant role.

When adding up over all manufacturing industries (NACE 15t16 to NACE 36t37) however, the share adds up to 18.2% in 1995.

A second striking aspect is that the relative importance of service activities, and business services in particular, has increased over time – particularly so for Business services (NACE 71t74) for which the share increased by 2.5 percentage points – while it decreased for manufacturing industries. For total manufacturing the share decreased from the above-mentioned 18.2% to 12.9%, thus by more than 5 percentage points.[4]

It was shown above that final demand becomes more intensive in foreign value added, referred to as 'value added imports' (see Table 2.2.2). Similarly, it is also the case that a country's production requires more inputs from foreign sources due to the ongoing process of offshoring of production stages. This is usually measured as the import content of exports (as in Hummels et al., 2001) or the foreign value added content of a country's exports as we do here.[5] Usually, exports include both intermediates and final goods exports.[6] In Table 2.2.4 we therefore show the share of foreign value added in EU exports.

Such a measure of vertical specialisation thus indicates the role of foreign sourcing in EU production and can therefore be considered as a supply-side indicator. It should be noted that, on the one hand, a higher share of foreign value added in a country's or industry's production (of final demand or exports) implies increased competitiveness as inputs are sourced cheaper. On the other hand, this might imply a scale effect in the way that more competitive industries or countries might grow faster (for a similar argument with respect to employment, see Foster et al., 2013). This will be investigated in Section 3 below. However, one has to bear in mind that a higher share of foreign value added in a country's or industry's production also – by definition – implies that its domestic share is declining.

2.2.2 Sourcing from abroad: changes in patterns of vertical specialisation

In addition to the increasing importance of final demand from outside the EU as a determinant of EU's GDP (see Table 2.2.1) and the increasing share of GDP absorbed from abroad (see Table 2.2.2), EU production has also become more intensive in inputs (here measured in value added terms) from abroad. As one can see from column 2 this share has increased from 8% in 1995 to almost 15% in 2011 with a dip to 12.1% in 2009 due to the crisis. There was also a significant change with respect to the sourcing structure of foreign inputs. While in 1995 the US with 26.1% and Japan with 10.9% (apart from the

[4] This resembles the output structure of advanced economies with a relatively small share of manufacturing. This should be clear as we multiply with total demand for each country thus including demand for services as well.

[5] One could also measure this as the foreign value added content of a country's production of final demand which includes exports of final goods.

[6] Here the issue of double counting arises. However, one should notice that from a national accounts perspective a country's exports include both intermediates and final goods. For a technical discussion see Stehrer (2012b); see Appendix Tables A.1 and A.2.

Rest-of-World with 30.4%) were the major sources of – directly and indirectly – inputs in value added terms there was a major shift towards sourcing from China, which increased its share from 3.7% to 13.5% between 1995 and 2011 accompanied by a strong decline for Japan (to 4.2%) and the US (to 18.4%). Russia with a share of 11.7% (compared to 9.2% in 1995 and 7% in 2001) is also a major source of inputs mostly due to natural resources for which price movements also play a role. Further, other emerging economies such as Brazil, India, and Turkey have also gained in relative importance.

Table 2.2.4

Vertical specialisation of EU, 1995-2011

			Sourcing structure													
	EU share	Foreign share (VS)	AUS	BRA	CAN	CHN	IDN	IND	JPN	KOR	MEX	RUS	TUR	TWN	USA	ROW
1995	92.0	8.0	1.9	2.8	4.0	3.7	1.3	1.3	10.9	3.0	1.7	9.2	1.3	2.2	26.1	30.4
1996	91.8	8.2	1.9	2.5	3.9	3.6	1.4	1.5	9.4	2.8	1.6	8.9	1.4	2.2	26.5	32.3
1997	91.5	8.5	2.0	2.7	4.0	4.5	1.6	1.6	9.9	2.9	1.6	9.7	1.9	2.4	29.6	25.7
1998	91.7	8.3	1.9	2.8	3.9	4.9	1.2	1.8	9.7	2.7	1.9	9.0	2.2	2.4	29.4	26.2
1999	91.1	8.9	1.8	2.3	3.7	5.3	1.0	1.5	9.3	2.7	1.9	6.8	1.7	2.4	28.8	30.7
2000	89.0	11.0	1.6	2.3	3.5	5.0	1.1	1.5	9.2	2.7	2.5	7.7	1.7	2.4	26.3	32.7
2001	89.3	10.7	1.5	2.3	3.3	5.5	1.1	1.4	7.9	2.2	2.3	7.0	1.6	1.9	27.6	34.3
2002	90.1	9.9	1.4	2.4	3.3	6.2	1.2	1.4	7.5	2.5	2.1	7.4	1.4	2.1	27.4	33.4
2003	90.2	9.8	1.5	2.4	3.1	7.1	1.2	1.4	7.9	2.5	2.0	8.6	1.5	2.1	24.4	34.2
2004	89.5	10.5	1.6	2.4	3.2	7.8	1.0	2.0	7.9	2.8	1.8	10.4	1.7	1.9	20.9	34.3
2005	88.2	11.8	1.7	2.6	3.1	7.7	1.1	2.0	6.6	3.0	2.1	11.5	1.5	1.6	19.0	36.5
2006	87.1	12.9	1.7	2.7	3.0	8.7	1.2	2.2	5.6	2.7	1.8	11.2	1.6	1.4	17.9	38.0
2007	86.9	13.1	1.7	2.9	3.1	10.0	1.1	2.3	5.7	2.7	1.9	12.1	1.7	1.6	17.5	35.6
2008	85.4	14.6	1.5	2.8	2.8	9.6	1.1	2.2	5.1	2.4	1.6	13.0	2.1	1.3	15.4	39.1
2009	87.9	12.1	1.5	2.9	2.9	11.7	1.3	2.3	5.1	2.6	1.4	10.1	2.4	1.4	19.1	35.2
2010	85.8	14.2	1.8	3.4	2.9	12.6	1.3	2.8	4.5	3.2	1.3	10.5	2.1	1.5	19.4	32.8
2011	85.3	14.7	1.8	3.7	3.0	13.5	1.4	2.8	4.2	3.1	1.4	11.7	2.4	1.4	18.4	31.3

Source: WIOD, own calculations.

Of course, vertical specialisation is quite differentiated across industries with manufacturing industries generally showing higher shares of foreign value added in their exports than services. Not considering the Coke and petroleum industry (NACE 23) these shares range from 11.1% in the Paper and pulp industry (NACE 21t22) to 19.5% in the Electrical engineering industry (NACE 30t33), with transport services (NACE 60 to 63) and Energy supply (NACE E) also showing high shares. Other business services (NACE 71t74) however only had a share of 5.8% in 2011.

The dynamics of this ongoing internationalisation of production are better seen in Figures 2.2.5 and 2.2.6 which plot the shares in 1995 against those in 2007 and those in 2007 against those in 2011, which allow us to gain insights into the impact of the crisis on the internationalisation of production. With respect to the period 1995-2007 there was a strong tendency for industries having had a large share of foreign value added in their exports in 1995 to increase their shares strongly up to 2007. With respect to manufacturing industries

this was particularly the case in medium- and higher-tech industries, notably Basic and fabricated metals (NACE 27t28), Electrical engineering (NACE 30t33), Transport equipment (NACE 34t35) and Chemicals (NACE 24). Amongst other industries with strong increases are most of the remaining manufacturing industries together with Energy (NACE E), and transport services (particularly Water transport, NACE 61, and Air transport, NACE 62). It is interesting to note that a similar pattern is found over the crisis period which is also characterised by an increasing share of foreign value added, which is again strongest in industries which have also faced the strongest increases over the period 1995-2007. This would suggest that the crisis has not caused a break in the trend of increasing internationalisation of production, but rather an interruption. The overall dip observed in 2009 (see Table 2.2.4) therefore seems to be mostly caused by strong sectoral differences in the impact of the crisis, which mostly hit those industries showing large shares of foreign value added in exports such as the Transport equipment industry (NACE 34t35).

Table 2.2.5

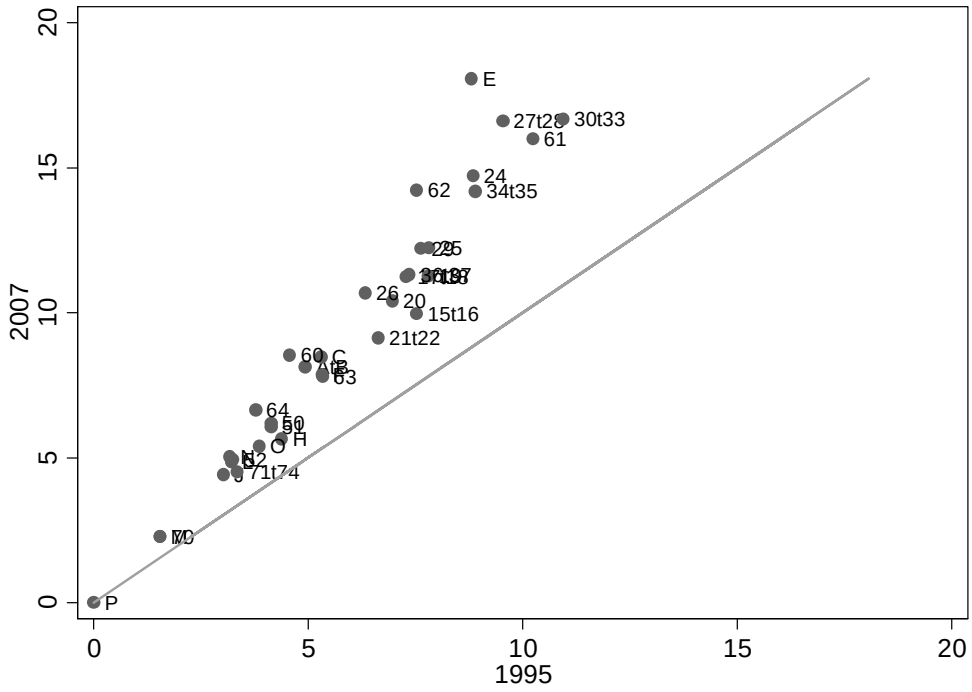
Vertical specialisation of EU by industry, 1995-2011

		1995	2000	2007	2011
AtB	Agriculture, Hunting, Forestry and Fishing	4.9	6.6	8.1	10.3
C	Mining and Quarrying	5.3	6.1	8.5	9.7
15t16	Food, Beverages and Tobacco	7.5	8.9	10.0	12.7
17t18	Textiles and Textile Products	7.3	9.8	11.2	14.5
19	Leather, Leather and Footwear	7.8	10.0	11.3	12.9
20	Wood and Products of Wood and Cork	7.0	9.4	10.4	12.0
21t22	Pulp, Paper, Paper , Printing and Publishing	6.6	8.5	9.1	11.5
23	Coke, Refined Petroleum and Nuclear Fuel	32.1	42.9	50.1	47.4
24	Chemicals and Chemical Products	8.9	12.7	14.7	18.0
25	Rubber and Plastics	7.8	10.3	12.2	15.0
26	Other Non-Metallic Mineral	6.3	9.2	10.7	12.7
27t28	Basic Metals and Fabricated Metal	9.5	12.3	16.6	17.6
29	Machinery, Nec	7.6	10.3	12.2	13.9
30t33	Electrical and Optical Equipment	10.9	14.9	16.7	19.5
34t35	Transport Equipment	8.9	12.4	14.2	16.8
36t37	Manufacturing, Nec; Recycling	7.4	9.6	11.3	12.8
E	Electricity, Gas and Water Supply	8.8	13.5	18.1	20.1
F	Construction	5.3	7.4	7.9	9.2
50	Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel	4.1	5.7	6.2	7.4
51	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	4.1	5.7	6.1	7.8
52	Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods	3.2	4.3	4.9	6.0
H	Hotels and Restaurants	4.4	5.2	5.7	7.0
60	Inland Transport	4.6	7.0	8.5	10.5
61	Water Transport	10.2	15.3	16.0	18.8
62	Air Transport	7.5	12.4	14.2	18.6
63	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	5.3	7.5	7.8	10.5
64	Post and Telecommunications	3.8	6.8	6.6	8.3
J	Financial Intermediation	3.0	4.5	4.4	6.5
70	Real Estate Activities	1.6	2.1	2.3	2.9
71t74	Renting of M&Eq and Other Business Activities	3.3	4.5	4.5	5.8
L	Public Admin and Defence; Compulsory Social Security	3.2	4.7	4.8	5.8
M	Education	1.5	2.0	2.3	2.7
N	Health and Social Work	3.2	4.1	5.0	5.9
O	Other Community, Social and Personal Services	3.9	5.0	5.4	6.5
P	Private Households with Employed Persons	0.0	0.0	0.0	0.0

Source: WIOD, own calculations.

Figure 2.2.5

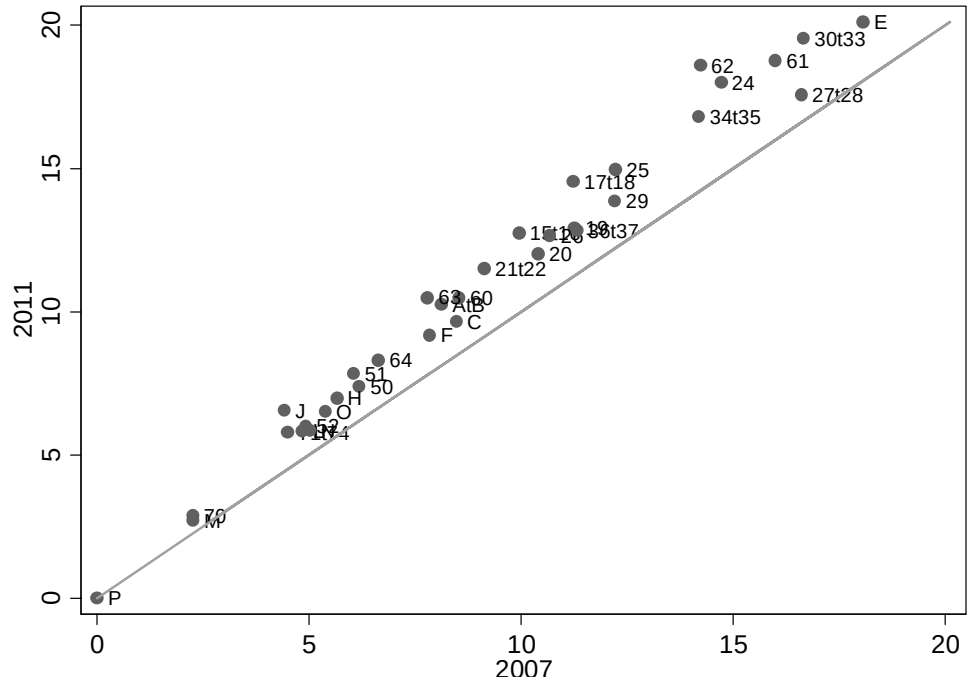
Vertical specialisation by industry, 1995 and 2007



Source: WIOD, own calculations.

Figure 2.2.6

Vertical specialisation by industry, 2007 and 2011



Source: WIOD, own calculations.

2.3 Relative positioning of individual member states in global demand and supply

2.3.1 Increasing importance of foreign demand

It is interesting to look at these trends not only from a total EU perspective but also from the perspective of each individual member state. Table 2.3.1 replicates Table 2.2.1 but for each individual member state. Additionally, it splits each country's value added exports, i.e. value added created in the respective country due to foreign final demand, into value added exports to extra-EU and intra-EU countries.

Table 2.3.1

Value added exports by country, 1995-2011

	Extra-EU demand				Intra-EU demand				Domestic demand			
	1995	2000	2007	2011	1995	2000	2007	2011	1995	2000	2007	2011
AUT	9.7	12.5	15.7	18.5	14.0	18.3	20.1	16.0	76.3	69.2	64.2	65.5
BEL	10.9	13.9	15.7	17.7	28.3	27.9	25.2	22.2	60.8	58.2	59.1	60.2
BGR	17.7	19.2	17.4	18.2	11.8	14.4	18.1	14.9	70.5	66.5	64.6	66.9
CYP	9.6	10.5	9.3	10.3	7.2	6.1	7.4	5.2	83.2	83.4	83.3	84.5
CZE	10.7	11.8	13.6	16.7	22.3	25.5	28.5	25.9	67.0	62.8	57.9	57.4
DEU	9.3	12.5	17.2	18.7	9.9	12.8	16.1	13.2	80.8	74.7	66.8	68.1
DNK	12.8	15.1	16.7	18.2	15.1	16.9	15.5	14.1	72.1	68.0	67.8	67.7
ESP	5.5	6.8	6.9	8.6	9.5	11.4	10.0	9.9	85.0	81.8	83.1	81.5
EST	14.3	12.2	14.1	17.9	23.1	26.8	20.8	19.3	62.6	61.0	65.1	62.8
FIN	14.6	15.7	17.1	17.6	14.4	16.6	14.5	10.1	71.0	67.7	68.4	72.3
FRA	8.7	9.8	8.9	10.2	9.2	10.7	9.6	7.9	82.1	79.5	81.5	82.0
GBR	11.8	12.0	11.5	14.2	9.8	9.3	9.3	8.9	78.3	78.8	79.2	76.9
GRC	3.0	6.8	8.4	8.9	3.2	3.7	4.1	2.4	93.8	89.6	87.6	88.7
HUN	12.3	14.7	17.7	21.8	15.3	20.3	23.4	24.5	72.4	65.0	58.9	53.8
IRL	16.7	25.1	25.7	37.3	29.7	27.5	22.9	19.5	53.6	47.4	51.4	43.2
ITA	9.7	10.2	10.9	11.9	10.1	10.1	10.1	8.5	80.3	79.7	79.0	79.6
LTU	15.9	14.3	16.4	20.7	13.6	13.1	15.3	13.0	70.6	72.6	68.3	66.3
LUX	16.2	17.0	37.7	39.7	37.8	39.6	24.6	20.3	46.0	43.3	37.7	40.0
LVA	17.8	17.3	14.3	18.6	12.9	12.8	11.3	10.9	69.3	70.0	74.4	70.5
MLT	10.4	17.6	21.1	21.4	20.9	18.8	20.4	18.3	68.6	63.6	58.4	60.2
NLD	13.5	14.5	13.9	16.9	23.1	22.9	23.3	22.4	63.4	62.5	62.8	60.8
POL	6.5	6.3	10.5	13.1	13.7	14.7	18.3	17.2	79.8	79.0	71.2	69.7
PRT	5.8	7.1	8.3	8.4	13.0	12.4	12.6	10.1	81.2	80.6	79.1	81.5
ROU	9.2	11.0	10.3	12.4	9.7	12.6	11.6	10.5	81.1	76.4	78.1	77.2
SVK	9.9	10.4	13.1	14.0	27.2	28.7	30.2	24.4	62.9	60.9	56.7	61.6
SVN	12.2	12.1	16.3	15.9	19.4	20.9	21.4	18.3	68.4	67.0	62.3	65.8
SWE	15.6	18.1	20.1	21.0	14.4	14.8	15.0	12.1	70.1	67.1	64.9	66.9

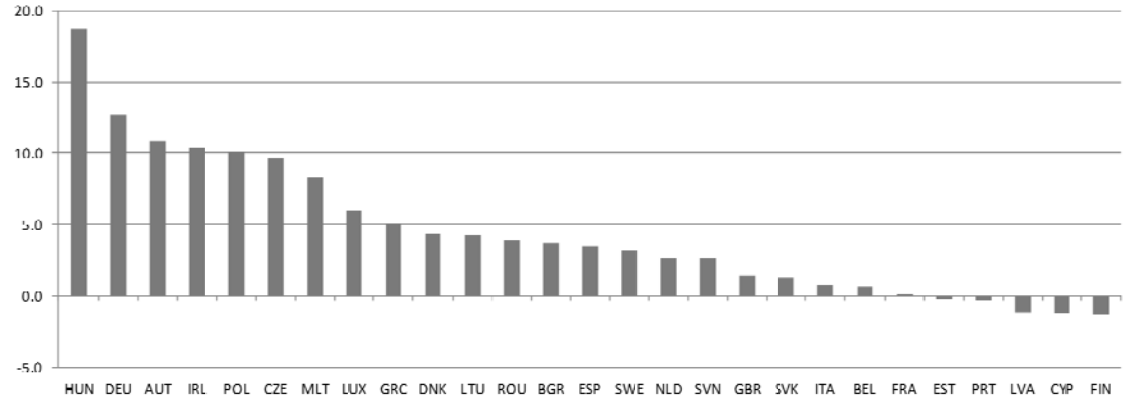
Source: WIOD, own calculations.

There are a few interesting patterns that emerge from these figures. First, domestic – and as the counterpart foreign – dependency varies widely across countries. In 2011, for countries such as Greece (88.7%), Cyprus, France, Portugal, Spain, Italy, Romania and Great Britain the domestic share was still above 75%, whereas for the Czech Republic, Hungary, Ireland and Luxembourg these shares were below 60%.

Apart from these differences in levels, the changes which occurred over time are also interesting. Figure 2.3.1 highlights this by presenting the percentage change of value added due to foreign demand between 1995 and 2011. Some countries (Hungary, Germany, Austria, Ireland and Poland) faced significant increases of 10 percentage points or more (up to almost 20 per cent), with smaller changes ranging from 2 to 4 per cent observed in Denmark, Sweden, Spain and Great Britain. A small number of countries, amongst them Finland, faced small decreases, however. It is remarkable that the first group of countries, i.e. those with strong declines, consists of a group of Eastern European countries plus Austria and Germany, two countries geographically close to and strongly linked with Eastern European countries.

Figure 2.3.1

Change in foreign shares (in percentage points), 1995-2011



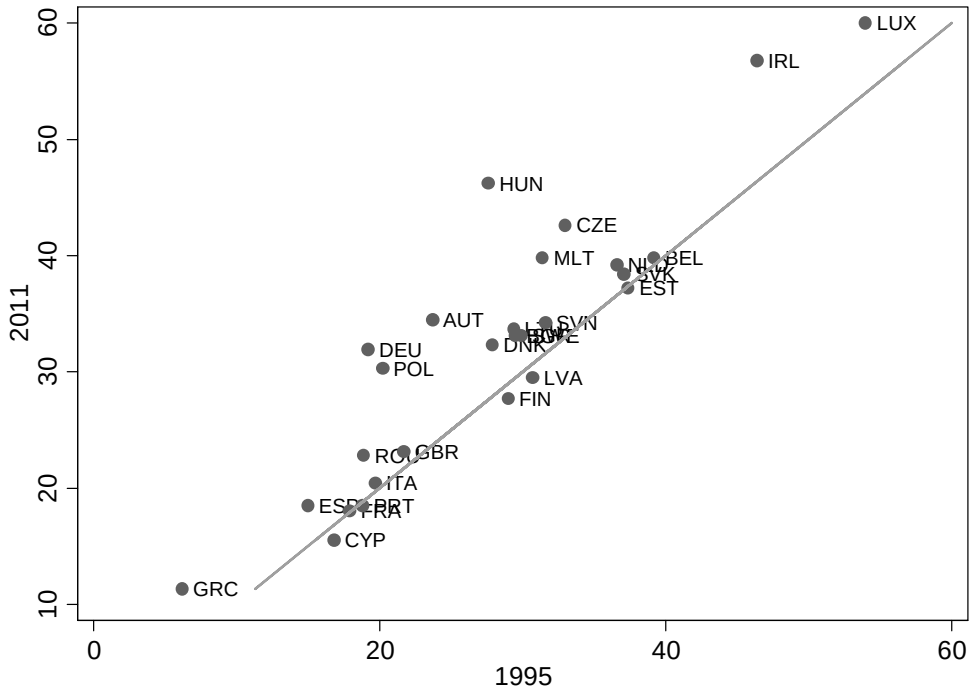
Source: WIOD, own calculations.

Generally, it seems that EU countries have become more dispersed in this respect. Whereas the standard deviation of these shares was 10.3 in 1995, it increased to 11.7 in 2011, pointing towards increasing differences in the international exposure of national economies, possibly driven by differences in national economic policy strategies. This can be seen more clearly by plotting the shares in 1995 against those in 2011 as shown in Figure 2.3.2. Whereas Luxembourg and Ireland had already high shares in 1995, these increased further to 60% and 56.8%, respectively. A second group of countries also faced strong increases in this share but starting from lower levels in 1995. This group comprises Poland, Germany, Austria, Malta, the Czech Republic and Hungary. A third group of countries consisting of Denmark, Slovenia, Bulgaria, and Sweden with shares of about 30% in 1995 showed less significant increases of about 5 percentage points only. There is a fourth group of countries which showed only small changes in these shares, which can again be differentiated into two groups: Estonia, the Slovak Republic, Belgium and the Netherlands began with comparably high shares (of about 40%), while a second group of countries - Cyprus, France, Portugal, Spain, Italy, Great Britain and Romania – had and still have rather low shares of 20% or slightly less. Among these countries Spain and Romania show larger increases of 3-4 percentage points. Finally, in Greece the respective change was

more significant: its share was still rather low (11.3%) in 2011 but had experienced a remarkable increase from 6.2% in 1995.

Figure 2.3.2

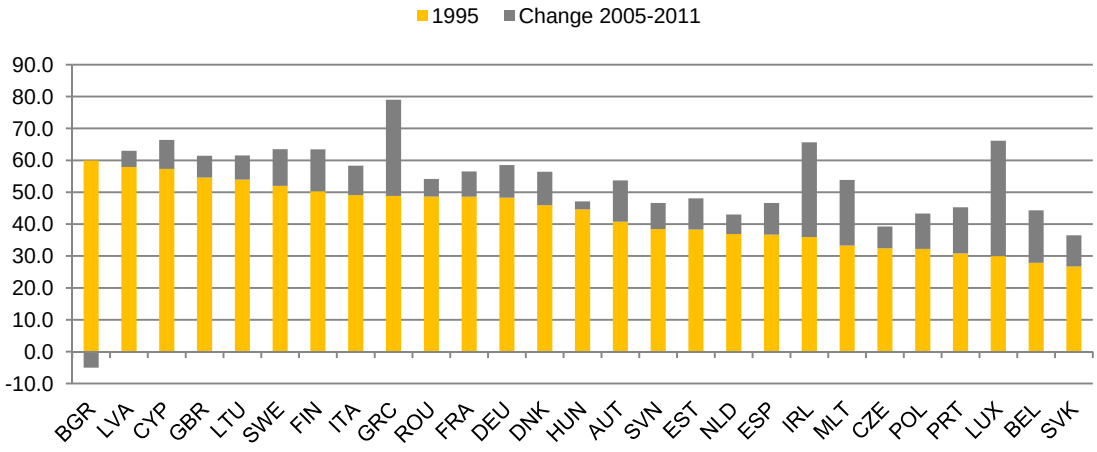
Foreign shares (in %), 1995 and 2011



Source: WIOD, own calculations.

Figure 2.3.3

Value added created due to extra-EU demand (in % of value added created due to foreign demand), 1995 and 2011



Source: WIOD, own calculations.

Dependency on external demand for the individual member states can be differentiated between the part stemming from EU member states and non-EU countries. As shown in

Section 2.2 the EU as a whole has become more dependent on final demand outside the EU. Figure 2.3.3 therefore splits the value added created in each economy due to foreign final demand into these two components. Figure 2.3.3 ranks the countries according to the relative importance of extra-EU demand in 1995. These shares range from 60% in Bulgaria to less than 30% in Belgium and the Slovak Republic. Twelve countries show shares close to or above 50% and thirteen countries close to or below 40%. With the exception of Bulgaria these shares have increased – in line with the evidence for the total EU – though to different extents. Greece, Ireland and Luxembourg faced striking increases in these shares by 30 percentage points or more. Thus, for these countries the increasing dependency on external demand is mostly driven by an increasing dependency on extra-EU final demand.[7] Increases in the other countries range from 2.5% in Hungary to 20.6% in Malta. Amongst these countries significant changes are observed for Finland (13.1%), Austria (13.0%), Portugal (14.5%) and Belgium (16.5%). Thus, in 2011 seventeen countries show shares of more than 50% while only two countries (the Czech Republic and the Slovak Republic) show shares of less than 40%.

2.3.2 Patterns in near- and far-shoring for EU member states

Analogous to the above we also calculate the measure of vertical specialisation for each EU country. It should be noted that foreign sourcing for each country in this case includes sourcing from other EU economies also (this will be further split up below). The results of the foreign value added content of exports are reported in Table 2.3.2 for the years 1995, 2000, 2007 and 2011 for both the total economy and the manufacturing sector only (NACE 15t16 to NACE 36t37).

In 1995 this share ranged from about 17% in Germany and Poland and 19% in Great Britain to almost 40% in Belgium, Ireland and Estonia (not considering the even higher shares of the small countries Malta with 50.8% and Luxembourg with 45.1%). Between 1995 and 2007 most countries experienced a strong increase in this share which was particularly strong in Eastern European countries due to the rapid integration of these countries into the European economy (exceptions being Romania and the Baltic countries). The other European economies faced increases of between 5 and 10 percentage points with the exception of the UK which more or less remained at the comparatively low level of 1995 and Belgium which had a comparatively high share already in 1995.

These ongoing dynamics are graphically documented in Figure 2.3.4(a), which plots the shares of 1995 against those of 2007. The dynamic changes more or less stopped or even reverted over the crisis period, with about two thirds of countries remaining at the same level or experiencing minor increases (such as the Netherlands) and around ten countries experiencing relatively strong declines. These latter countries comprise again Eastern

[7] This needs a more in-depth analysis of industry and trade structures and changes of these to explain these differences.

European countries, particularly the Slovak Republic, Slovenia and Bulgaria, plus Malta, Estonia and Latvia, but not the Czech Republic and Hungary. Other countries with strong declines include Portugal, Greece and Romania (see Figure 2.3.4(a)).

Table 2.3.2

Vertical specialisation (foreign value added content of exports), 1995-2011

	Total economy				Manufacturing			
	1995	2000	2007	2011	1995	2000	2007	2011
AUT	23.9	28.2	33.3	34.2	28.4	33.1	39.3	40.8
BEL	38.7	41.5	43.4	46.0	44.0	47.0	50.7	54.2
BGR	32.4	36.5	44.5	34.7	38.8	45.2	52.6	42.5
CYP	26.9	32.3	28.3	27.2	39.2	46.0	39.9	35.6
CZE	29.9	38.4	45.9	46.5	34.9	43.3	50.5	51.9
DEU	17.1	22.2	26.7	27.3	18.3	23.9	29.0	29.8
DNK	26.3	30.0	36.7	37.1	26.1	28.8	33.0	33.8
ESP	20.6	27.2	29.2	29.7	23.7	31.6	34.5	35.3
EST	37.9	44.5	38.1	33.3	40.2	49.5	42.5	37.4
FIN	23.4	27.5	32.6	34.5	24.7	28.8	35.3	38.4
FRA	19.5	24.4	26.7	28.5	22.1	27.2	29.8	32.5
GBR	19.3	18.9	18.1	21.6	23.0	23.9	25.9	30.8
GRC	19.1	30.7	28.3	24.3	24.4	34.3	40.6	33.7
HUN	28.8	48.0	48.2	46.0	35.4	56.5	56.7	53.5
IRL	38.5	44.8	40.6	44.6	41.6	49.7	49.1	51.6
ITA	18.7	20.8	25.1	27.1	20.6	22.9	27.8	30.1
LTU	32.9	33.9	32.0	33.9	40.9	44.3	41.7	47.6
LUX	45.1	58.3	61.3	61.3	50.8	50.7	53.8	51.9
LVA	25.1	26.2	30.4	24.6	28.6	34.4	40.6	34.1
MLT	50.8	52.6	45.5	39.7	65.1	65.6	58.7	52.2
NLD	31.4	34.5	35.0	39.2	36.4	40.7	42.7	48.3
POL	17.2	26.3	32.8	34.3	19.3	29.8	36.7	38.6
PRT	27.6	30.0	31.4	27.9	31.2	34.7	37.3	33.0
ROU	23.3	26.7	27.6	23.9	26.9	31.7	33.8	29.7
SVK	31.5	42.7	47.5	42.0	36.1	46.5	52.9	47.2
SVN	33.9	36.9	42.2	36.5	36.7	39.4	46.2	40.4
SWE	25.7	29.8	31.9	31.9	27.5	33.2	36.9	37.8

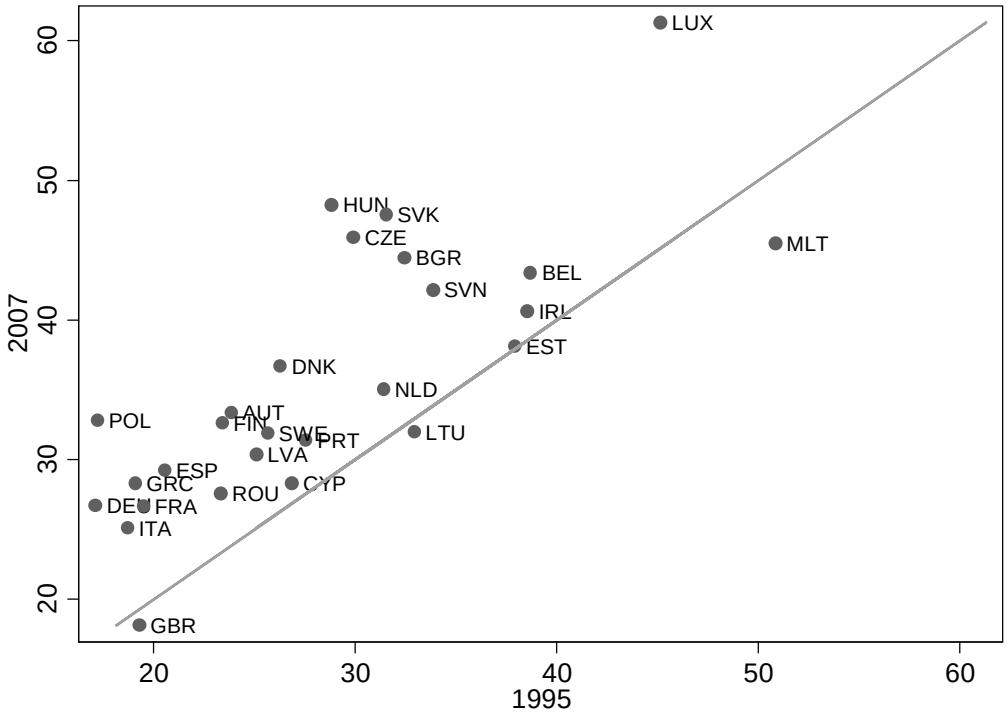
Source: WIOD, own calculations.

This pattern seems to be in contrast with the finding above that for the EU as a whole the foreign share of value added increased between 2007 and 2011 also. This stems from the fact that in this case we only consider extra-EU sourcing whereas in the analysis above intra-EU sourcing for each country is also taken into account. This will be discussed in more detail below. Before this however, we look at the dynamics of the manufacturing sector.

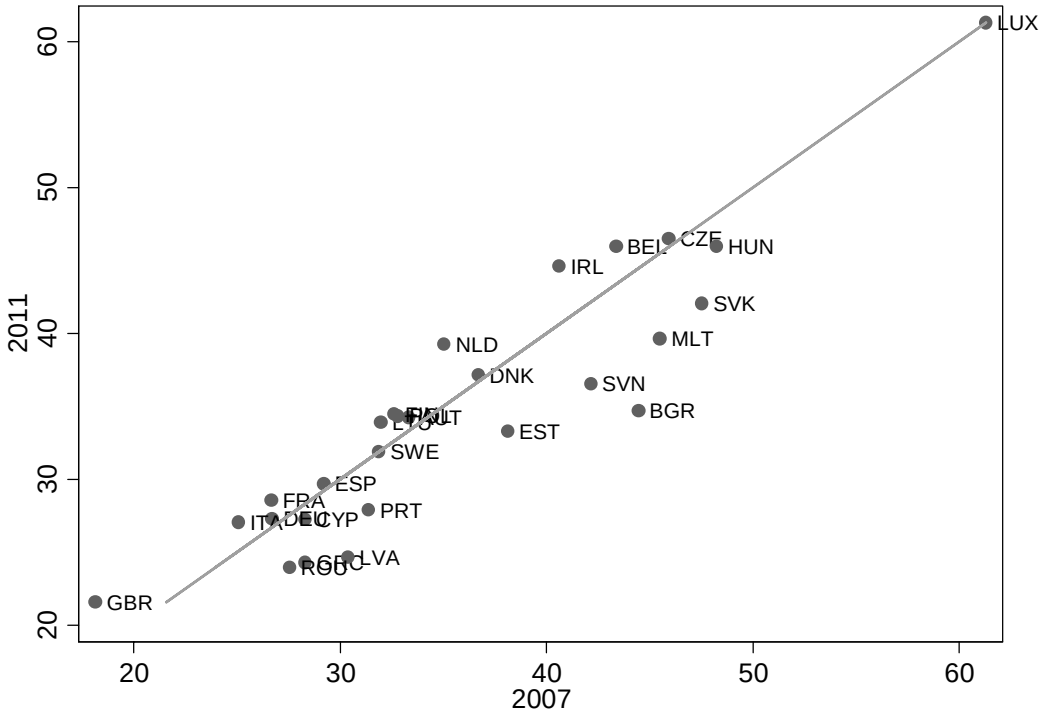
Figure 2.3.4

Vertical specialisation

(a) 1995 and 2007



(b) 2007 and 2011

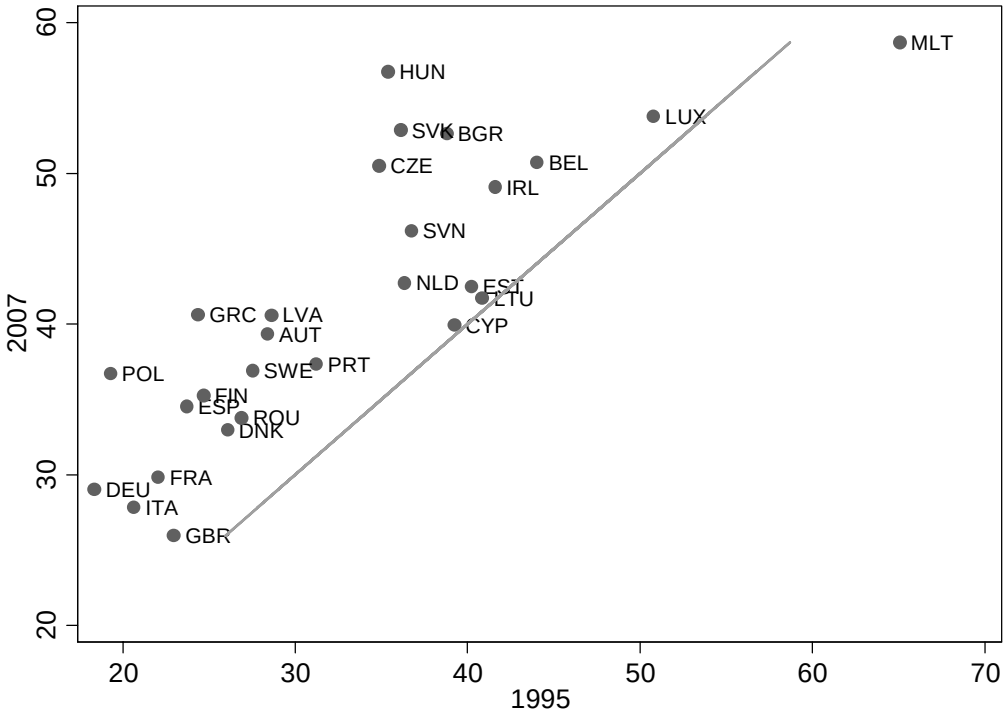


Source: WIOD, own calculations.

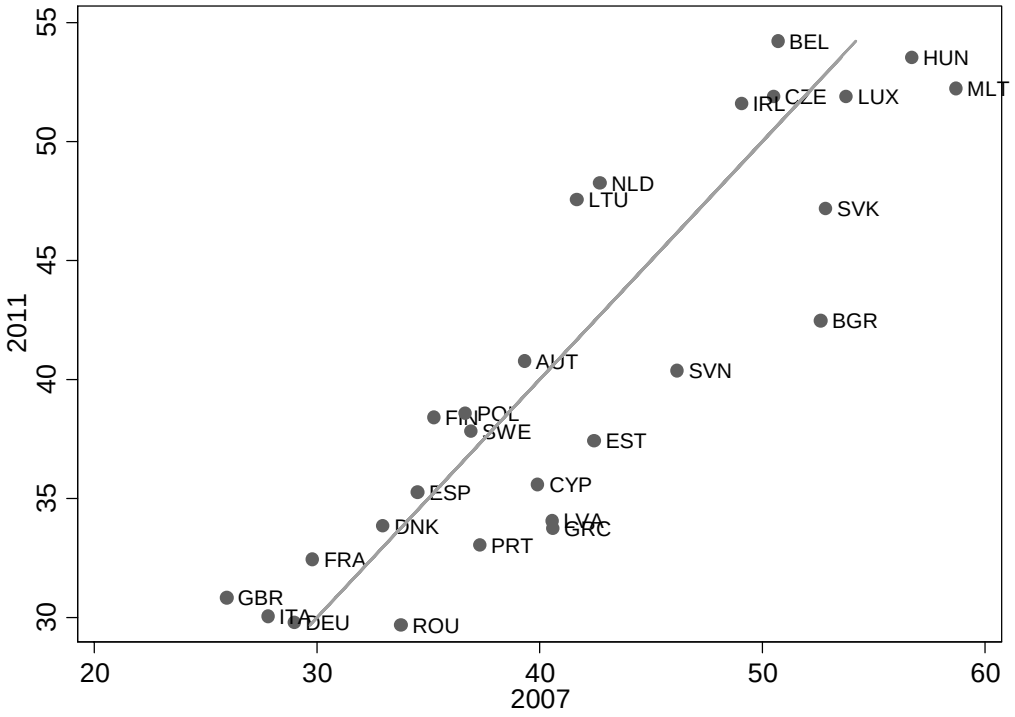
Figure 2.3.5

Vertical specialisation in manufacturing

(a) 1995 and 2007



(b) 2007 and 2011



Source: WIOD, own calculations.

Vertical specialisation in the manufacturing sector is generally higher when compared to the total economy as expected, with the difference being on average between 15 and 20 percentage points. The shares in 1995 range from 18.3% in Germany to 47% in Belgium, with even higher shares again observed for Luxembourg and Malta. The changes up to 2007 are similar to those for the total economy but seem to be more pronounced for most countries. The highest shares in 2007 are found in the Eastern European countries Hungary, Bulgaria, the Slovak Republic and the Czech Republic together with Malta, Luxembourg, Ireland and Belgium. The lowest degrees of vertical specialisation are observed for the larger economies such as Germany, Italy and France with shares of around 27-30%. The foreign content of export shares in Great Britain increased by only 2.9% to 25.9%, which is the lowest for all European economies.

Table 2.3.3

Share of non-EU sourcing in total foreign sourcing, 1995-2011

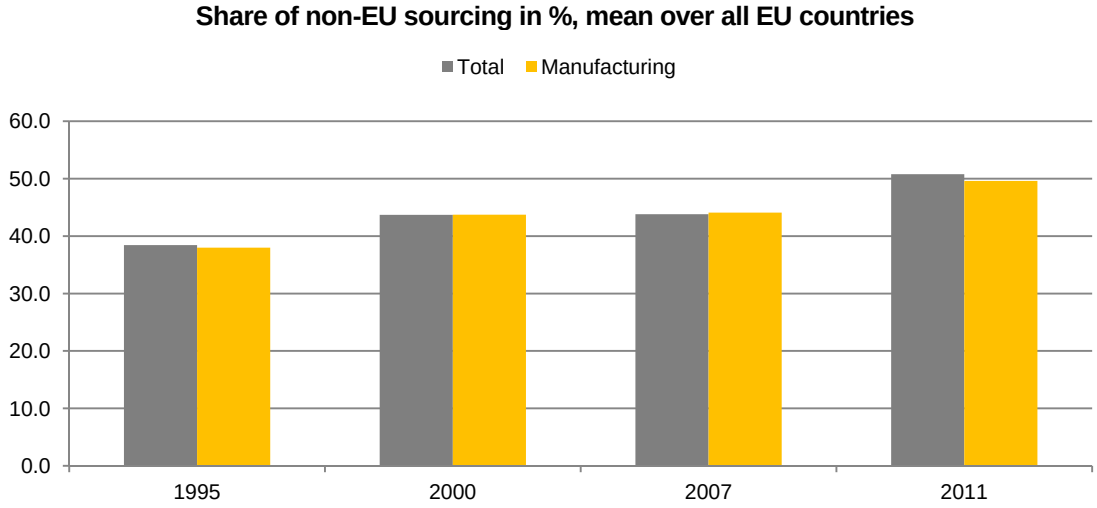
	Total economy				Manufacturing			
	1995	2000	2007	2011	1995	2000	2007	2011
AUT	30.8	34.5	34.6	39.2	28.5	32.4	34.0	37.7
BEL	28.1	35.8	36.8	43.7	27.5	35.0	37.1	42.8
BGR	63.0	59.9	49.3	60.7	65.7	62.7	50.3	60.8
CYP	44.9	55.6	39.5	52.4	47.1	64.2	42.9	46.9
CZE	30.7	32.4	36.6	44.0	29.8	30.6	36.2	43.8
DEU	41.8	47.2	48.8	52.5	41.7	47.1	48.7	52.0
DNK	32.4	37.3	42.0	51.4	29.0	33.9	36.0	42.1
ESP	34.5	41.3	50.0	57.0	33.8	40.5	49.7	57.0
EST	33.8	56.6	43.6	50.5	31.9	58.4	44.3	48.7
FIN	41.4	49.3	54.5	60.1	41.4	49.5	55.0	59.9
FRA	38.3	43.3	45.8	49.0	37.5	42.7	45.2	48.2
GBR	44.9	51.8	52.8	59.1	44.3	51.2	52.0	57.7
GRC	39.7	61.9	61.0	65.5	36.5	61.9	65.6	71.6
HUN	41.8	38.6	40.9	45.1	41.2	37.7	40.4	44.2
IRL	48.4	49.9	41.7	55.1	48.3	49.7	42.4	51.3
ITA	40.8	49.6	51.2	59.2	40.2	49.2	51.3	58.8
LTU	56.5	57.3	56.5	67.9	58.4	59.4	60.1	72.9
LUX	15.6	15.6	19.9	36.4	17.2	20.6	25.2	31.9
LVA	42.4	38.1	39.8	45.3	41.5	35.7	40.4	44.2
MLT	28.3	47.1	41.3	43.0	26.9	48.7	41.0	40.9
NLD	45.1	52.4	54.5	61.2	44.1	51.4	55.0	61.2
POL	37.4	35.1	40.8	48.5	36.7	34.3	40.3	47.5
PRT	32.6	34.1	38.9	41.6	32.1	32.7	36.8	39.4
ROU	47.3	42.6	43.0	40.6	47.7	42.5	43.3	40.1
SVK	38.4	41.2	45.9	47.6	38.7	38.6	46.0	47.5
SVN	25.1	29.0	31.9	41.8	24.1	28.3	31.0	40.0
SWE	34.1	42.5	40.9	52.6	34.1	42.0	40.3	50.7

Source: WIOD, own calculations.

Over the crisis period (2007-2011) this share increased in only a few countries, amongst them Great Britain, though shares in most countries remained rather stagnant or experienced strong declines. Countries in this latter group are mostly Eastern European countries with particularly strong declines observed in the Slovak Republic, Bulgaria and Slove-

nia, Romania and the Baltic countries (with the exception of Lithuania) together with Portugal and Greece.

Figure 2.3.6



Source: WIOD, own calculations.

It is striking to observe that the share of non-EU sourcing has increased over the whole period, but particularly so over the crisis period. Though there have been country-specific differences in the changes over time, the mean over countries (see Figure 2.3.6) shows that the share of non-EU sourcing increased by 5.3% (5.7% for manufacturing) between 1995 and 2000, and was then almost constant with increases of 0.1% and 0.4% for the total economy and manufacturing respectively. Between 2007 and 2011 this share increased by 7% for the total economy and 5.5% for manufacturing however. This suggests that the relative importance of 'nearshoring' decreased whereas that of 'farshoring' increased over the crisis period. Finally, Table 2.3.4 shows the average over countries by industry which indicates that this pattern also holds true for the individual industries.

Table 2.3.4

Share of non-EU sourcing in total foreign sourcing by industry (average over countries) in%, 1995-2011

	Share of foreign sourcing (VS)				Share of non-EU sourcing (in total foreign sourcing)			
	1995	2000	2007	2011	1995	2000	2007	2011
AtB	17.1	18.9	22.3	23.6	40.9	44.8	44.3	50.8
C	18.4	20.7	22.1	21.4	41.9	47.3	49.5	55.6
15t16	22.6	24.7	26.9	28.1	41.1	43.1	41.8	48.6
17t18	31.3	34.1	34.1	33.6	28.6	34.6	37.8	47.6
19	28.0	31.7	31.3	30.3	33.2	37.1	40.1	47.5
20	25.2	28.4	31.3	29.3	36.7	40.3	39.3	45.3
21t22	27.1	29.9	30.5	30.1	31.3	34.9	35.1	40.9
23	49.8	58.5	59.6	61.0	75.6	76.0	74.8	72.4
24	32.1	36.8	38.6	39.1	38.2	43.7	43.6	49.1
25	33.7	36.3	38.7	38.4	32.0	36.8	37.1	43.5
26	24.5	26.9	28.7	28.9	38.4	44.2	44.3	50.9
27t28	35.1	38.2	44.3	41.5	37.4	42.4	44.2	46.2
29	31.2	34.9	38.2	35.5	32.8	38.0	38.3	42.7
30t33	35.6	40.9	43.5	41.6	35.8	41.0	42.8	47.6
34t35	34.1	39.8	44.7	41.5	32.6	37.0	37.6	43.2
36t37	26.9	30.2	34.3	32.2	33.1	37.4	39.4	44.6
E	23.1	25.8	30.3	30.6	61.4	63.4	62.4	64.9
F	22.5	24.8	26.1	24.6	33.6	38.8	40.4	46.2
50	16.0	18.0	19.4	18.3	35.7	38.8	38.2	47.0
51	14.2	16.0	17.2	16.9	39.4	44.3	43.1	52.8
52	11.8	13.1	13.3	13.4	39.8	43.9	42.9	52.0
H	15.4	16.2	16.7	17.3	41.3	44.1	43.0	50.2
60	16.3	20.1	22.8	22.8	43.7	50.3	49.7	57.7
61	29.8	32.0	33.1	32.4	38.1	47.1	44.3	58.3
62	27.6	32.1	34.2	36.8	39.4	48.0	47.6	55.9
63	18.1	21.3	22.2	21.6	39.4	45.2	42.5	53.3
64	11.7	15.5	17.0	16.9	39.2	43.8	42.4	52.1
J	10.5	13.3	13.8	13.7	39.2	42.8	38.6	52.9
70	6.2	7.4	9.4	9.2	39.5	42.9	42.4	52.3
71t74	13.7	14.8	15.9	15.2	39.8	43.6	41.8	51.6
L	11.5	12.8	12.4	11.9	38.4	43.1	42.5	50.2
M	5.8	6.3	6.8	6.6	41.9	45.0	44.9	53.6
N	13.1	14.7	15.8	16.0	37.0	41.7	41.2	47.6
O	14.0	16.2	16.7	16.3	40.7	44.1	43.8	52.4
P	0.0	0.0	0.0	0.0				

Source: WIOD, own calculations.

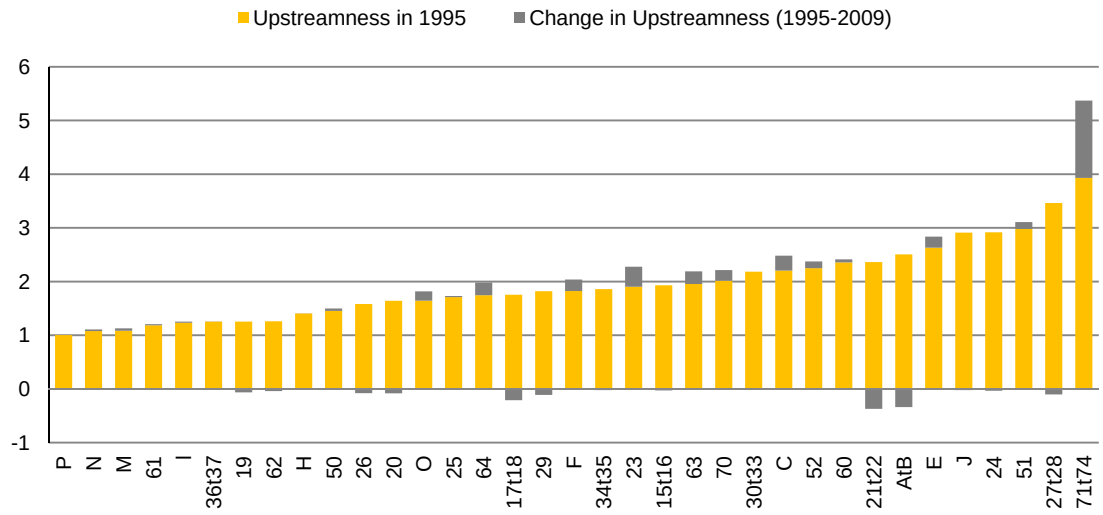
2.4 Upstreamness of production and growth

With the fragmentation of production across national boundaries being a feature of the world economy for a number of years now, an important question that arises is whether countries are specialising in particular stages of the global production process, and if so, whether this impacts upon aggregate performance. Recently, a couple of papers have looked into calculating measures of industry upstreamness and downstreamness to capture how far production is on average from final use.

Antras et al. (2012) when discussing their method note that it is equivalent to the method that has also recently been proposed by Fally (2011). They further acknowledge that these measures are not actually new and are themselves both equivalent to the measure of forward linkages that is well known in the input-output literature (for an overview see Miller and Blair, 2009, Chapter 12).

Figure 2.4.1

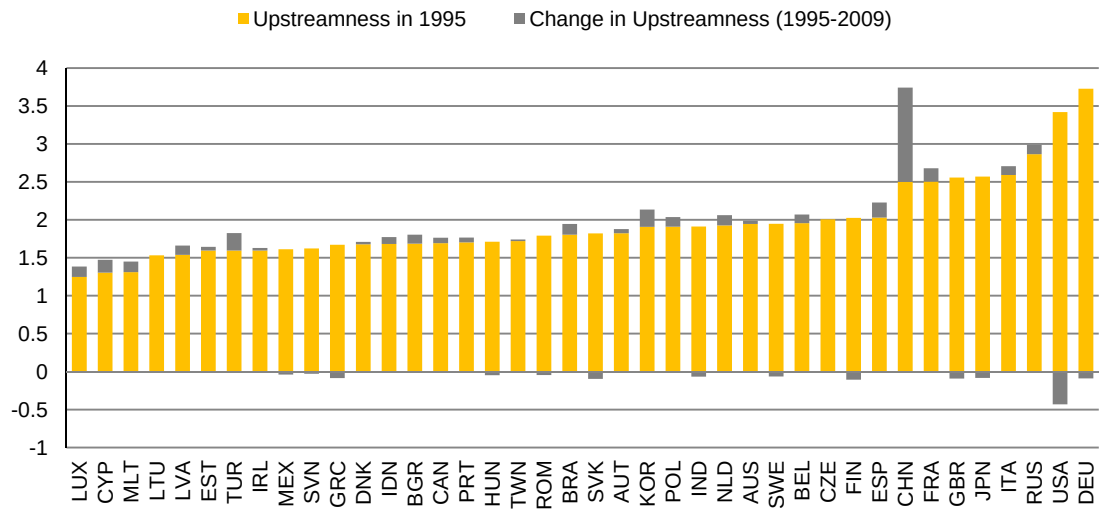
Initial upstreamness and the change in upstreamness by industry (1995-2009)



Source: WIOD, own calculations.

Figure 2.4.2

Initial upstreamness and the change in upstreamness by country (1995-2009)



Source: WIOD, own calculations.

After discussing their indicator of upstreamness, Antras et al. (2012) calculate it for 2002 for 426 industries in the US. They then relate their measure of the average upstreamness

of exports to a number of potential determinants and find that stronger institutions relating to the rule of law and financial development are correlated with a propensity to export in relatively more downstream industries. Fally (2011), using his measure for the US over the period 1947-2002, finds that the weighted average number of production stages for the US is below 2 and that this has been declining since 1947 (being around 1.76 in 2002). One argument put forward for this is the increasing role played by services in the economy, which are likely to require fewer production stages. Fally further shows that at least half of this decrease can be explained by a shift of value added towards industries that are closer to final demand, and that the production of more complex goods appears to be relatively less vertically fragmented. Fally also shows that goods involving fewer stages of production and closer to final demand are more likely to be imported to the US from rich countries.

We have much fewer industries than both Antras et al. (2012) and Fally (2011), but we do have a broader country sample. Appendix Tables A.3 report the number of production stages averaged over all countries for the year 1995. The values range from around 1.00 (due largely to missing values for industry NACE P) to around 4.0 (though this hides large differences – some industries have very high values in particular countries, e.g. NACE 17t18). A number of services tend to have relatively low values of the index, which is what we would expect, while other services have relatively high values. Appendix Table A.4 reports the average number of production stages by country. This shows that the average number of production stages tends to be higher for larger, richer countries as well as large developing and transition countries such as China and Russia. Figures 2.4.1 and 2.4.2 show the average initial values of the upstreamness measures by industry and country respectively, along with the change in the value of the index between 1995 and 2009. The main changes according to these figures are that 'Renting of M&Eq and Other Business Activities' has become significantly more upstream since 1995 as has activity in China on average (while that in the US has become more downstream).

2.5 The sophistication of exports

So far we have looked at a country's position in global value chains. This is now complemented by further considering a country's export structure which might also be important for growth perspectives. Hausmann et al. (2007) argue that what a country produces and exports may be an important determinant of growth. There are a number of economic arguments as to why this may be the case, such as learning-by-doing, which may be more rapid for some products than for others. Baldwin (2011) criticises this approach, arguing that this does not take the global value chain importance into account, however argues in a static framework. For a country however it is still important to 'climb up the ladder' by shifting workers to higher-productivity jobs and to benefit from learning-by-doing effects in the longer run, even though these might still be at the lower end of the global supply chain (see Stehrer and Wörz, 2009).

Hausmann et al. (2007) test for and find some empirical validity for their arguments. To do this they construct a measure of the sophistication of exports. We begin our discussion of this measure with some descriptive analysis. Appendix Tables A.3 and A.4 report the fifteen products with the lowest and highest values of the PRODY index respectively. As would be expected, agricultural products tend to have low values of this index. The products with the highest values are a fairly mixed group including metals, electronics and fish. Looking at data for the initial year – i.e. 1995 – we can also identify the countries with the lowest and highest values of the sophistication index. Table 2.5.1 reports the bottom and top 15 countries according to the sophistication of their exports respectively. As expected, countries with the lowest values of the export sophistication measure tend to be in Africa (and South and Central America to a lesser extent), while countries with the highest values are in Europe, North America (and Japan). Consistent with results found by Hausmann et al. (2007) China appears to rank high relative to its GDP per capita. In 2005 for example, China is ranked 31st in terms of its EXPY value, while for the same year it is ranked 142nd out of all countries and regions reported in World Development Indicators.

Table 2.5.1

Countries with the lowest values of the sophistication measure in 1995

Lowest Values		Highest Values	
Country	EXPY	Country	EXPY
Ethiopia	1045.5	**France**	**13005.5**
Burundi	1449.3	**Netherlands**	**13246.3**
Malawi	1878.2	**Malta**	**13304.8**
Sudan	2210.0	USA	13420.3
Uganda	2257.7	**United Kingdom**	**13735.9**
Burkina Faso	2339.5	Canada	13748.0
Niger	2520.8	Greenland	13767.3
Togo	2865.8	**Austria**	**13817.7**
Honduras	3067.9	**Denmark**	**14197.8**
Madagascar	3147.2	**Germany**	**14669.7**
Haiti	3163.8	**Sweden**	**14822.2**
Cote d'Ivoire	3370.3	Japan	15441.1
Zambia	3873.5	**Finland**	**15463.8**
Paraguay	3931.3	Switzerland	17569.6
Bangladesh	4427.8	Iceland	18044.0

Note: EU countries are in bold.

Source: UN COMTRADE; own calculations.

Table 3.3.2 reports the initial value of the sophistication measure for all WIOD countries in the first column. Turkey and India are ranked at the bottom of the list, while Finland, Japan and Sweden are ranked at the top. China ranks 23rd out of the 34 countries available in 1995. Its income level (i.e. GDP per capita) in 1995 however was lower than in all other countries except India. Table 3.3.3 reports the initial values of the sophistication measure for different industries. The table is largely as we would expect with textiles, agriculture, wood products and leather at the bottom of the list and machinery, chemicals and transport equipment at the

top. As well as the (initial) level of this sophistication index it is also of interest to consider how this index has changed over time for countries and industries. The tables therefore report the change in the sophistication index between 1995 and 2011 for (WIOD) countries and industries respectively. The tables indicate a great deal of heterogeneity in the developments in export sophistication across countries and industries. For five countries (i.e. Malta, Canada, Australia, Finland and Brazil) we observe a decline in measured sophistication, while strong increases are found in China and Korea, as well as Hungary and Cyprus. By industry we observe declines in the measure for Coke, Petroleum and Nuclear Fuel and for Basic Metals and Fabricated Metals, with the largest increases observed for Chemicals and Chemical Products; Leather and Footwear; and Pulp, Paper, Printing and Publishing.

Table 2.5.2

Sophistication measure for WIOD countries in 1995

Country	1995	Change 1995-2011
Finland	**15463.8**	**-13.1**
Japan	15441.1	542.1
Sweden	**14822.2**	**342.7**
Germany	**14669.7**	**571.2**
Denmark	**14197.8**	**487.4**
Austria	**13817.7**	**449.5**
Canada	13748.0	-1024.4
United Kingdom	**13735.9**	**1033.1**
USA	13420.3	1001.5
Malta	**13304.8**	**1000.3**
Netherlands	**13246.3**	**431.3**
France	**13005.5**	**1109.3**
Italy	**12307.9**	**660.7**
Spain	**11929.5**	**530.4**
Slovenia	**11614.8**	**1419.9**
Czech Rep.	**11441.9**	**1607.5**
Rep. of Korea	11261.8	1846.2
Mexico	11014.1	-1830.2
Slovakia	**10644.7**	**846.5**
Latvia	**10090.6**	**2766.7**
Hungary	**10055.2**	**3090.0**
Australia	9875.3	-370.5
China	9664.4	2594.3
Estonia	**9546.0**	**1491.3**
Poland	**9372.7**	**665.0**
Cyprus	**9145.9**	**3652.0**
Portugal	**9138.9**	**2053.7**
Lithuania	**8917.2**	**1140.4**
Greece	**8540.3**	**1922.7**
Brazil	8441.2	-9.5
Romania	**8322.6**	**1999.5**
Indonesia	8071.1	271.5
India	7488.7	1959.2
Turkey	7349.4	1862.0

Note: EU countries are in bold.

Source: UN COMTRADE; own calculations.

Table 2.5.3

Sophistication of exports by WIOD industry in 1995

Industry	1995	Change 1995-2011
Machinery, nec	15152.2	612.6
Chemicals and chemical products	14464.8	1344.1
Transport equipment	13247.5	810.0
Electrical and optical equipment	13151.2	1100.0
Pulp, paper, printing and publishing	12604.6	1920.1
Rubber and plastics	12457.1	534.6
Coke, refined petroleum and nuclear fuel	11832.2	-4530.4
Renting of M&Eq and other business activities	11538.0	0.0
Basic metals and fabricated metal	11385.7	-671.5
Other non-metallic minerals	10816.6	877.3
Manufacturing NEC, recycling	9526.7	204.1
Food, beverages and tobacco	8332.9	872.7
Mining and quarrying	8198.8	207.5
Electricity, gas and water supply	8033.2	352.1
Wood and products of wood and cork	7819.1	651.1
Agriculture, hunting, forestry and fishing	7813.5	484.2
Textiles and Textile Products	7286.8	746.5
Leather, Leather and Footwear	5918.0	1447.7

Source: UN COMTRADE; own calculations.

3 Vertical specialisation and growth

Having described the patterns of internationalisation of the EU economy and its individual member states in the previous section, it will be interesting to look at how this ongoing internationalisation is related to the performance of countries and industries with respect to output, value added, employment and productivity growth. We therefore present results using fairly standard growth regressions including indicators of openness and trade, focusing on the role of internationalisation of production in the recent decades. In particular, we investigate the association of vertical specialisation and upstreamness of countries and industries and the role of 'export sophistication' with measures of performance.

3.1 Openness and macroeconomic growth

In the first exercise we regress measures of gross output and value added in real terms and employment growth on a set of standard growth variables. A country's growth performance should, first, be positively related to its productivity growth. This is measured using total factor productivity (TFP) growth which was calculated using the socio-economic accounts of the WIOD. Total factor productivity growth rates have been calculated at the industry level and aggregated up to the total economy using gross output and value added shares, respectively. Implausibly large values (in absolute terms) which appeared in some cases for small industries have been excluded. Second, an increase in endowments should also positively impact on value added growth though not necessarily on employ-

ment growth, as e.g. capital accumulation can be of a labour-saving nature. Similarly, an increase in endowments with human capital is also expected to positively impact on growth. This we measure as the difference of growth rates of high-educated to overall employment growth which indicates an increasing share of high-educated workers in the total labour force which tends to be conducive for growth. We further control for value added per hour worked capturing the ongoing catching-up process of lagging economies which before the crisis tended to grow faster. To account for the international dimension we include the growth rate of exports which is expected to impact positively on growth and the measure of vertical specialisation, i.e. the foreign share of value added in a country's or industry's exports. The effects of this might be ambiguous as on the one hand a country which sources more from abroad uses more foreign resources than domestic ones which might lower the growth rate. On the other hand, these countries might exploit specialisation gains and gains from efficiently sourcing intermediate inputs which positively impacts on growth.

The regression model is estimated using data for the period 1995-2007, i.e. the period before the onset of the global crisis.[8] We report results for both the full WIOD sample comprising 40 countries and the EU economies only. Tables 3.1.1 and 3.1.2 report the results for the total economy, Tables 3.1.3 and 3.1.4 present industry-level results. Regressions at the total economy level include country-fixed effects.

Table 3.1.1

Regression results at total economy level

	Total sample			**EU countries**		
	Gross output growth	Value added growth	Employment growth	Gross output growth	Value added growth	Employment growth
TFP growth	0.751 ***	0.528 ***	-0.676 ***	0.745 ***	0.455 ***	-0.741 ***
	(0.113)	(0.038)	(0.058)	(0.171)	(0.050)	(0.076)
Log value added per hour worked	-0.027 ***	-0.014 ***	-0.015 **	-0.046 ***	-0.018 ***	-0.017 *
	(0.007)	(0.004)	(0.006)	(0.010)	(0.006)	(0.010)
Growth rate of capital	0.664 ***	0.596 ***	-0.002	1.103 ***	0.701 ***	0.047
	(0.135)	(0.081)	(0.127)	(0.193)	(0.126)	(0.191)
Growth rate of high educated workers	0.112 ***	0.036 *	-0.080 ***	0.137 ***	0.031	-0.091 ***
(difference to overall empl. growth)	(0.031)	(0.019)	(0.029)	(0.035)	(0.023)	(0.035)
Export growth	0.072 ***	0.044 ***	0.078 ***	0.055 **	0.042 **	0.077 ***
	(0.020)	(0.012)	(0.018)	(0.026)	(0.016)	(0.025)
Vertical specialisation	0.289 ***	0.062 *	0.086	0.302 ***	0.088 *	0.156 **
	(0.058)	(0.034)	(0.053)	(0.076)	(0.049)	(0.074)
Constant	3.462	4.862 ***	4.706 **	5.603 *	4.225 **	1.810
	(2.175)	(1.305)	(2.027)	(2.990)	(1.927)	(2.928)
Observations	451	451	451	304	304	304
F-test	19.14	42.67	26.56	12.86	18.66	19.11
R-squared	0.15	0.37	0.13	0.14	0.34	0.18

Regressions include country fixed effects

*** p<0.01, ** p<0.05, * p<0.1

Standard errors in parentheses

[8] Data allows for the calculation of some of the variables until 2009 only (e.g. productivity, growth of capital stock). However, the particular crisis effects would distort results on longer-term growth and thus are not discussed here.

Total factor productivity growth is positively related to gross output and value added growth in all cases but negatively so for employment growth. The coefficient on the catching-up term is negative and significant, indicating that laggard countries tended to grow faster. As expected, the growth rate of capital is positively related to gross output and value added growth but insignificant with respect to employment growth. Countries with higher growth rates of high-educated workers relative to overall employment growth also experienced faster growth rates with respect to gross output and value added, with effects for employment being negatively significant. With respect to internationalisation, the growth rate of exports is in all cases significantly positive as expected. Thus countries performing better on the foreign markets tend to grow faster. The measure of vertical specialisation is positively significant for gross output and value added growth (though only at the 10% level), not significant for employment growth in the overall sample but positively significant when considering EU countries only. With respect to gross output and value added this would suggest that countries which are successfully integrating into international production processes can themselves exploit specialisation effects and profit from efficiently sourcing from other countries. With respect to employment growth, the insignificant effect for the total sample may be explained by the fact that offshoring has, on the one hand, a productivity effect, thus lowering demand for workers, but on the other hand, a scale effect as more competitive firms (industries or countries) tend to grow faster which compensates for the productivity effect (see Foster et al., 2013, for a more detailed discussion). The latter effect seems to be rather strong in the European Union.

Table 3.1.2

Regression results for total manufacturing

	Total sample			EU countries		
	Gross output growth	Value added growth	Employment growth	Gross output growth	Value added growth	Employment growth
TFP growth	1.092 ***	0.830 ***	-0.335 ***	1.811 ***	0.801 ***	-0.407 ***
	(0.155)	(0.031)	(0.052)	(0.245)	(0.040)	(0.068)
Log value added per hour worked	-0.018 ***	-0.004 ***	-0.007 ***	-0.026 ***	-0.002	-0.005
	(0.004)	(0.001)	(0.002)	(0.006)	(0.002)	(0.003)
Growth rate of capital	0.245 ***	0.125 ***	0.014	0.371 ***	0.146 ***	0.041
	(0.046)	(0.015)	(0.025)	(0.058)	(0.022)	(0.036)
Growth rate of high educated workers	0.007	0.005	-0.008	0.010	0.002	-0.011
(difference to overall empl. growth)	(0.011)	(0.004)	(0.006)	(0.012)	(0.004)	(0.007)
Export growth	0.077 ***	0.017 ***	0.032 ***	0.067 ***	0.013 **	0.026 ***
	(0.011)	(0.004)	(0.006)	(0.014)	(0.005)	(0.009)
Vertical specialisation	0.146 ***	0.017	0.025	0.161 ***	0.013	0.029
	(0.031)	(0.011)	(0.017)	(0.041)	(0.015)	(0.025)
Constant	2.240 *	1.119 **	1.767 **	2.420	0.282	0.666
	(1.288)	(0.439)	(0.722)	(1.613)	(0.599)	(1.001)
N	438	438	438	291	291	291
F-test	27.49	140.80	11.28	25.27	79.75	7.70
R-squared	0.07	0.48	0.03	0.12	0.65	0.06

Regressions include country and industry fixed effects

*** p<0.01, ** p<0.05, * p<0.1

Standard errors in parentheses

The results when including manufacturing industries only (Table 3.1.2) are qualitatively similar for most variables. However, the significance of the coefficient on the growth rate differential of high-educated workers is lost in all cases. This in conjunction with results reported for the total economy (Table 3.1.1) might suggest that gains from higher education might work mostly via the services sector. The results do indicate that there are no negative effects of higher education on employment growth. Further, the measure of vertical specialisation remains significant only for gross output growth in both samples. This might suggest that for the manufacturing industries the productivity effects emerging from vertical specialisation are just compensated by higher employment growth rates. In particular, we do not find negative effects of the integration of production on employment.

Table 3.1.3

Regression results including all industries

	Total sample			EU countries		
	Gross output growth	Value added growth	Employment growth	Gross output growth	Value added growth	Employment growth
TFP growth	0.526 ***	0.280 ***	-0.711 ***	0.502 ***	0.513 ***	-0.625 ***
	(0.005)	(0.010)	(0.010)	(0.006)	(0.018)	(0.011)
Log value added per hour worked	0.005 ***	-0.003	0.003	0.011 ***	-0.002	0.010 **
	(0.001)	(0.002)	(0.003)	(0.002)	(0.003)	(0.004)
Growth rate of capital	0.446 ***	0.265 ***	-0.058 **	0.426 ***	0.252 ***	-0.032
	(0.011)	(0.015)	(0.023)	(0.013)	(0.018)	(0.025)
Growth rate of high educated workers	0.003 *	0.003	-0.009 **	0.003	0.004	-0.006
(difference to overall empl. growth)	(0.002)	(0.003)	(0.004)	(0.002)	(0.003)	(0.004)
Export growth	0.068 ***	0.109 ***	0.090 ***	0.076 ***	0.107 ***	0.091 ***
	(0.004)	(0.005)	(0.008)	(0.005)	(0.007)	(0.009)
Vertical specialisation	-0.145 ***	0.263 ***	-0.127 ***	-0.191 ***	0.330 ***	-0.140 ***
	(0.018)	(0.024)	(0.038)	(0.024)	(0.032)	(0.045)
Constant	2.311 ***	-2.502 ***	2.863 ***	1.698 **	-5.210 ***	0.859
	(0.456)	(0.626)	(0.977)	(0.759)	(1.019)	(1.424)
Observations	15881	15850	15881	10483	10479	10483
F-test	2582.82	288.347	911.711	1534.12	237.593	594.327
R-squared	0.49	0.09	0.25	0.46	0.09	0.25

Regressions include country and industry fixed effects

*** p<0.01, ** p<0.05, * p<0.1

Standard errors in parentheses

Tables 3.1.3 and 3.1.4 report econometric results at the industry level including country and industry fixed effects. Qualitatively the results broadly support the findings for the aggregates. There are a few exceptions to this however. First, the coefficients on productivity often become significantly positively for gross output and employment, suggesting that a larger gap reduces the growth rates at the industry level which might capture strong productivity growth effects. The differential of high-educated worker employment to total employment tends to be mostly insignificant. Export growth positively impacts on growth and coefficients tend to be higher compared to the previous results. Interestingly, the vertical specialisation measure becomes negative now for gross output which might be expected as more intermediates are sourced from abroad. It remains however significantly positive

with respect to value added growth. Results on employment growth are mixed with effects in most cases being negative and in the remaining ones insignificant. This in conjunction with the above results might suggest that there are important gains from specialisation due to vertical integration which negatively impacts on employment growth in these industries but triggers overall positive effects for the total economy.

Table 3.1.4

Regression results for manufacturing industries

	Total sample			EU countries		
	Gross output growth	Value added growth	Employment growth	Gross output growth	Value added growth	Employment growth
TFP growth	0.525 ***	0.417 ***	-0.650 ***	0.447 ***	0.408 ***	-0.751 ***
	(0.007)	(0.023)	(0.011	(0.009)	(0.031)	(0.014)
Log value added per hour worked	0.008 ***	-0.006 *	0.003	0.017 ***	-0.002	0.016 ***
	(0.002)	(0.003)	(0.004	(0.004)	(0.005)	(0.006)
Growth rate of capital	0.450 ***	0.368 ***	-0.072 **	0.436 ***	0.407 ***	-0.069
	(0.022)	(0.029)	(0.034	(0.027)	(0.036)	(0.043)
Growth rate of high educated workers	-0.001	-0.010	-0.019	-0.002	0.003	-0.017
(difference to overall empl. growth)	(0.009)	(0.012)	(0.014	(0.011)	(0.014)	(0.017)
Export growth	0.110 ***	0.206 ***	0.151 ***	0.122 ***	0.212 ***	0.152 ***
	(0.007)	(0.010)	(0.012	(0.010)	(0.013)	(0.016)
Vertical specialisation	-0.167 ***	0.120 ***	-0.071 *	-0.223 ***	0.109 **	-0.086
	(0.026)	(0.035)	(0.041	(0.036)	(0.048)	(0.057)
Constant	2.832 ***	-0.589	1.123	2.295 *	-2.346	-2.308
	(0.822)	(1.116)	(1.305)	(1.390)	(1.847)	(2.186)
N	6782	6782	6782	4457	4457	4457
F-test	1038.22	171.53	550.01	518.85	106.54	485.63
R-squared	0.48	0.20	0.32	0.40	0.20	0.38

Regressions include country and industry fixed effects

*** p<0.01, ** p<0.05, * p<0.1

Standard errors in parentheses

3.2 Upstreamness of production and growth

As outlined in Section 2.4, for aggregating vertical specialisation at the industry level to an indicator at the total economy level the upstreamness measure can be exploited. We now relate the (logged) value of the upstreamness measure to the growth of value added per capita to examine whether there is any evidence to suggest that industries perform differently depending on their up- or downstreamness. We do this using data at the industry level for WIOD countries and a subsample comprising the EU economies. As control variables in our growth regression we include a measure of investment (the ratio of gross fixed capital formation to gross value added) and a measure of employment growth. We further include a measure of initial income (log gross value added per worker in 1995) and initial human capital (share of high-skilled workers in total hours worked in 1995) to capture initial conditions. In various specifications we also include country, industry, country-industry and year fixed effects. Similar specifications are estimated using employment growth as independent variable.

Table 3.2.1

Regression results for value added growth

	Total sample				EU countries			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log VA p.c. 1995	-0.003 ***	-0.003 ***	-0.010 ***		-0.003 **	-0.004 ***	-0.013 **	
	(0.000)	(0.000)	(0.004)		(0.001)	(0.001)	(0.006)	
High-skill share 1995	0.021 **	0.021 ***	0.036 ***		0.017	0.019	0.023	
	(0.008)	(0.008)	(0.013)		(0.012)	(0.012)	(0.022)	
GFCF / VA	0.012	0.013	0.000	-0.031	0.002	0.002	-0.011	-0.039
	(0.014)	(0.014)	(0.017)	(0.040)	(0.026)	(0.026)	(0.033)	(0.053)
Employment growth	0.230 **	0.222 **	0.211 **	0.394 ***	0.227 *	0.219 *	0.212 *	0.472 ***
	(0.106)	(0.103)	(0.101)	(0.069)	(0.123)	(0.120)	(0.118)	(0.085)
Log Upstreamness	0.014 ***	0.014 ***	0.014 ***	0.032 **	0.009 **	0.008 *	0.014 **	0.027
	(0.003)	(0.003)	(0.004)	(0.015)	(0.004)	(0.004)	(0.007)	(0.021)
Constant	0.024 ***	0.006	0.101 ***	-0.062 ***	0.028 ***	-0.093 ***	-0.137 ***	-0.011
	(0.004)	(0.008)	(0.038)	(0.016)	(0.007)	(0.014)	(0.021)	(0.026)
Year F.E.	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Country and ind. F.E.	No	No	Yes	Yes	No	No	Yes	Yes
Country-industry F.E.	No	No	No	Yes	No	No	No	Yes
Observations	18277	18277	18277	18,277	11557	11557	11557	11557
R-squared	0.06	0.08	0.10	0.10	0.05	0.07	0.10	0.12
F-test	20.34	27.09	21.73	33.77	6.09	15.36	12.62	25.77
Number of identifiers				1382				902

*** p<0.01, ** p<0.05, * p<0.1

Robust standard errors in parentheses

Table 3.2.2

Regression results for employment growth

	Total sample				**EU countries**			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log VA p.c. 1995	-0.002 **	-0.002 ***	-0.003		0.000	-0.001	-0.021	
	(0.001)	(0.001)	(0.015)		(0.001)	(0.001)	(0.029)	
High skill share 1995	0.053 ***	0.053 ***	0.015		0.066 ***	0.066 ***	0.061	
	(0.005)	(0.005)	(0.023)		(0.006)	(0.006)	(0.056)	
GFCF / VA	0.011 ***	0.011 **	0.000	0.003	0.004	0.002	-0.011	-0.007
	(0.004)	(0.004)	(0.009)	(0.009)	(0.006)	(0.006)	(0.016)	(0.010)
Log Upstreamness	0.009 ***	0.009 ***	0.009 ***	0.055 ***	0.014 ***	0.014 ***	0.009 **	0.068 ***
	(0.002)	(0.002)	(0.003)	(0.011)	(0.003)	(0.003)	(0.005)	(0.014)
Constant	-0.004	0.003	0.025	-0.066 ***	-0.013 *	-0.065 ***	-0.082	-0.021 *
	(0.004)	(0.006)	(0.044)	(0.008)	(0.008)	(0.009)	(0.081)	(0.013)
Year F.E.	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Country and ind. F.E.	No	No	Yes	Yes	No	No	Yes	Yes
Country-industry F.E.	No	No	No	Yes	No	No	No	Yes
Observations	18282	18282	18282	18282	11562	11562	11562	11562
R-squared	0.003	0.008	0.037	0.012	0.004	0.010	0.036	0.013
F-Stat	34.27	16.93	27.61	11.47	34.88	15.36	21.46	7.16
Number of identifiers				1382				902

*** p<0.01, ** p<0.05, * p<0.1

Robust standard errors in parentheses

Results are reported in Tables 3.2.1 and 3.2.2. Regarding value added growth the results on the additional variables are all as expected, with investment, initial human capital and employment growth having a significantly positive impact on value added growth, and initial

output having a negative and significant effect. The coefficients on the upstreamness measure are consistently positive and significant, suggesting that more upstream industries have grown faster over the period covered. This is also the case when considering employment growth though in this case the coefficients on upstreamness tend to be smaller. Furthermore, the coefficients on initial output become insignificant for the sample of EU countries which can be explained by jobless growth in the Central and Eastern European countries over this period.

3.3 Sophistication of exports and productivity growth in WIOD and EU countries

Finally we investigate whether it also matters what a country exports. In doing so, we relate the measure of export sophistication to growth performance in line with Hausmann et al. (2007) for our sample of countries. Before, however, we examine the issue of which variables might impact on a country's position in that respect.

Table 3.3.1

Determinants of the sophistication index

	(1)		(2)	(3)
Log value added	-0.010	-0.007	0.007	-0.035 **
	(0.007)	(0.005)	(0.013)	(0.014)
Log value added per worker	0.043 ***	0.034 ***	0.143 ***	0.100 ***
	(0.010)	(0.007)	(0.022)	(0.021)
Share of high skilled	0.719 ***	0.523 ***	0.444 **	0.061
	(0.159)	(0.138)	(0.206)	(0.209)
Constant	9.040 ***	9.148 ***	8.977 ***	8.783 ***
	(0.042)	(0.047)	(0.106)	(0.101)
Industry F.E.	No	Yes	No	Yes
Country F.E.	No	No	Yes	Yes
Observations	603	603	603	603
F-test	20.64	46.06	4.09	24.25
R-squared	0.09	0.61	0.21	0.70

*** p<0.01, ** p<0.05, * p<0.1

Standard errors in parentheses

3.3.1 Determinants of the sophistication index

Hausmann et al. (2007) consider the potential determinants of the sophistication index, finding for example that human capital and country size are positively correlated with the sophistication value (EXPY). Using data at the industry level we also follow this approach. In particular we regress the log of EXPY in 1995 on measures of size (log gross value added), income (log gross value added per worker), and a measure of human capital (the share of high-educated workers in total hours worked). Results are reported in Table 3.3.1. The results indicate that our measure of size has a negative impact on the initial value of

the sophistication index, though it is mostly insignificant. The measure of income levels or development (i.e. gross value added per worker) has a positive and significant sign as we would expect, while the measure of human capital – consistent with Hausmann et al. (2007) – also tends to have a positive coefficient which is usually significant. The major departure from our results at the industry level to those of Hausmann et al. (2007) at the country level therefore is that we find no role for country size in determining the value of the sophistication measure.

3.3.2 Export sophistication and growth

Hausmann et al. (2007) then look to correlate the initial value of the export sophistication measure with growth and find a large positive coefficient. Further splitting countries into different groupings (OECD, lower middle-income, etc.) they find that the effect is strongest at intermediate income levels. We also do this, but using data at the industry level for WIOD countries. As control variables in our growth regression we include a measure of investment (the ratio of gross fixed capital formation to gross value added) and a measure of employment growth. We further include a measure of initial income (log gross value added per worker in 1995) and initial human capital (share of high-skilled workers in total hours worked in 1995) to capture initial conditions. In various specifications we also include country, industry and year fixed effects.

Table 3.3.2

Growth and export sophistication

	(1)	(2)	(3)
Log value added per worker in 1995	-0.004 ***	-0.004 ***	-0.019 ***
	(0.001)	(0.001)	(0.003)
Share of high skilled in 1995	0.033 *	0.033 *	0.139 ***
	(0.018)	(0.017)	(0.036)
GFCF / VA	0.023 ***	0.026 ***	0.015 **
	(0.006)	(0.005)	(0.006)
Employment growth	-0.568 ***	-0.586 ***	-0.603 ***
	(0.014)	(0.014)	(0.014)
Log EXPY in 1995	0.023 ***	0.022 ***	0.001
	(0.004)	(0.004)	(0.007)
Constant	-0.175 ***	-0.181 ***	0.185 **
	(0.040)	(0.040)	(0.074)
Year F.E.	No	Yes	Yes
Industry F.E.	No	No	Yes
Country F.E.	No	No	Yes
Observations	7933	7933	7933
R-squared	0.18	0.21	0.24
F-Test	350.30	113.60	36.29

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Results are reported in Table 3.3.2, which indicates that initial income has a negative and significant impact upon subsequent growth, consistent with conditional convergence, while the initial human capital term is consistently positive and significant. The investment rate is also consistently positive and significant, while employment growth has a negative impact on per worker gross value added growth as expected. Finally, we observe that the coefficient on the initial value of the sophistication index is generally positive. The significance of the coefficients disappears however when country and industry fixed effects are included.

Following Hausmann et al. (2007) we also split the sample. In particular we create a dummy variable for those countries classified as high-income countries according to the 1995 World Development Report and include an interaction between this variable and the initial sophistication index to examine whether the impact of sophistication on growth differs between high- and non-high-income countries. The results are reported in Table 3.3.3 below. The results on the additional explanatory variables are largely similar to those in Table 3.3.2, as are the coefficients on the initial sophistication index. We also find however that the coefficients on the sophistication index interacted with the high-income dummy are consistently negative and significant, suggesting that high-income countries benefit to a lesser extent from export sophistication in terms of growth. In the final column, the coefficient on the interaction term is so large that it would suggest a negative impact of sophistication on growth in high-income countries (with an insignificant impact in the other countries).

Table 3.3.3

Growth and export sophistication by country group

	(1)	(2)	(3)
Log value added per worker 1995	-0.003 ***	-0.003 ***	-0.020 ***
	(0.001)	(0.001)	(0.003)
Share of high skilled in 1995	0.050 ***	0.055 ***	0.142 ***
	(0.018)	(0.018)	(0.036)
GFCF / VA	0.017 ***	0.018 ***	0.014 **
	(0.006)	(0.006)	(0.006)
Employment growth	-0.573 ***	-0.592 ***	-0.603 ***
	(0.014)	(0.014)	(0.014)
Log EXPY in 1995	0.028 ***	0.029 ***	0.005
	(0.005)	(0.004)	(0.008)
Log EXPY_95 * Share of high skilled in 1995	-0.002 ***	-0.003 ***	-0.018 *
	(0.000)	(0.000)	(0.010)
Constant	-0.223 ***	-0.244 ***	-0.037
	(0.041)	(0.041)	(0.075)
Year F.E.	No	Yes	Yes
Industry F.E.	No	No	Yes
Country F.E.	No	No	Yes
Observations	7933	7933	7933
F-Test	298.60	111.00	35.83
R-squared	0.18	0.21	0.24

*** p<0.01, ** p<0.05, * p<0.1

Standard errors in parentheses

Overall, there seems to be a positive relation between the countries' positions with respect to their export mixes and the growth performance. For a country as a whole, such results suggest positive productivity effects of shifting workers from activities in lower-productivity sectors to jobs in higher-productivity sectors, even if the job is similar, or shifting workers within broadly defined industries might impact positively on growth, notwithstanding potential dynamic gains from this.

3.4 Summary of econometric results

Generally, these results support the view that countries successfully integrating into the world – or at least regional – production systems do benefit with respect to value added growth as indicated by the positive effects of vertical specialisation on growth and the positive effects of upstreamness. These growth effects come from the possibility of exploiting comparative advantages triggering gains from specialisation not only across but also within industries as emphasised in the literature on 'trade-in-tasks'. Therefore results in this respect also tend to be stronger when looking at total economy effects as compared to single industries. Employment results are more mixed as expected, with negative effects found in a few cases. Particularly at the total economy level we find either insignificant or even positive results, suggesting that the implied productivity effect of vertical integration or offshoring is counteracted by a scale effect. Finally, the results reported suggest that countries with a more sophisticated export structure tend to grow faster, which is particularly strong for middle-income countries. Policies supporting the exploitation of gains from the ongoing internationalisation of production might therefore not only be successful in triggering growth but also for upgrading a country's product mix for exports which could have an additional positive effect.

4. Conclusions

In this paper we argued that the EU has become more integrated in global value chains in line with overall trends. Today, around 15% of GDP in the EU is created which directly and indirectly contributes to satisfy final demand in other regions of the world. This share has increased over the past 15 years or so by about 5 percentage points. A similar trend though slightly less significant can be observed with respect to employment: almost 12% of jobs are dependent on final demand in other parts of the world. Emerging economies such as China gain importance in this respect at the expense of major advanced economies such as the United States and Japan. Similarly, as foreign markets have become more important as destinations for EU exports, inputs are increasingly sourced from other countries in the form of intermediates used in EU production systems. Adopting a common measure of vertical specialisation shows that about 15% of the value of the EU's total extra-EU exports is generated in other countries. This share has increased by about

7 percentage points since 1995. Together with the fact that the EU's overall trade balance, at around 1.5% to 2% of overall EU GDP, remained positive over this period can be interpreted as evidence that this period of increasing internationalisation was managed quite well, notwithstanding the turmoil which hit the world economy and the EU in the aftermath of the global financial crisis. From a policy perspective, the policy challenges that lie ahead are described in European Commission (2010a,b).

The EU as a whole has therefore been rather successful in withstanding global competition. This was driven not least by deeper integration of the EU economies amongst themselves. This integration in terms of trade and internationalisation of production is particularly visible with respect to the successful integration of the Central and Eastern European countries into the EU economy. However, the overall success of the EU as a whole and some countries in particular hides large differences across EU economies. Already in 1995 large differences existed with respect to the countries' foreign exposures concerning sales to intra- and extra-EU markets and sourcing structures. This pattern, however, seems to have become even more pronounced since 1995, with only a few countries – particularly Central and Eastern European countries, German, Austria, Ireland and Luxembourg – successful in their export performance in value added terms, with other countries maintaining or only slightly improving them. The reason for this might be the initial patterns of specialisation since internationalisation was largely driven by a few high-tech manufacturing sectors such as the automotive and electronics industries in combination with successful innovation and productivity performance and moderate wage policies. Further, the successful internationalisation of production – which within the EU resulted in the integration of Central and Eastern European countries in more advanced countries' production networks in these industries – played an important role. This improved international competitiveness of some countries which contributed to the EU's overall success with respect to its international position but also aggravated structural differences across EU economies (see also van Ark et al., 2013, on differentiated productivity performances), and these became visible during and in the aftermath of the global crisis and are still reflected in different positions concerning various strands of the policy debates (see e.g. European Commission, 2012 focusing on current account positions, and Visser, 2013 on wage bargaining systems; other issues concern financial integration, e.g. Obstfeld, 2013, and fiscal and monetary macroeconomic policies).

The evidence presented in this paper suggests that countries which are successfully internationalising have performed better with respect to their overall growth performance in the pre-crisis period. The challenges ahead are therefore to reduce the structural differences amongst EU member states which have emerged over the past several years and have become evident in the course of the crisis. Further integration of EU member states into production networks should make it possible for all countries to benefit from the overall globalisation process and its opportunities, and for the EU as a whole to withstand the challenges lying ahead due to this ongoing internationalisation process.

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Technical Appendix

A.1 The World Input Output Database (WIOD)

The data used for analysis are taken from the World Input-Output Database (WIOD), which became available in April 2012 (see www.wiod.org) and was compiled within the EU Framework programme. These data provide international supply and use and input-output tables for a set of 41 countries (EU-27, Australia, Brazil, Canada, China, India, Indonesia, Japan, Korea, Mexico, Russia, Taiwan, Turkey, USA and Rest of World) over the period 1995–2009. It was compiled on the basis of national accounts, national supply and use tables and detailed trade data on goods and services, combining information for 59 products and 35 industries. Corresponding data at the industry level allow the splitting-up of value added into capital and labour income. More detailed information is provided by Timmer et al. (2012) and Dietzenbacher et al. (2013).The database provides a time series from 1995-2009 which was unofficially updated until 2011. This results in a world input-output database for 41 countries (including Rest of World) and 35 industries, i.e. the intermediates demand block is of dimension 1435x1435, plus additional rows on value-added and columns on final demand categories. The outline of such a world input-output table is presented below. Each industry in a country listed vertically sources intermediates from its own industries and from other countries' industries. Together with value added from this country, the level of gross output is obtained. Furthermore, each country also demands products from its own economy and the other economies for final use, like consumption and gross fixed capital formation. The horizontal view shows what each industry provides to industries in its own and the other countries, and as final demand for domestic and foreign consumers. Gross output produced in one country equals the value of demand for each country's industries.

Outline of world input-output table (industry by industry)

	Intermediate use			Final use			
	Country A	**Country B**	**Country C**	**Country A**	**Country B**	**Country C**	
Country A	A sources from A	B sources from A	C sources from A	A demands in A	B demands in A	C demands in A	GO in A
Country B	A sources from B	B sources from B	C sources from B	A demands in B	B demands in B	C demands in B	GO in B
Country C	A sources from C	B sources from C	C sources from C	A demands in C	B demands in C	C demands in C	GO in C
Value added	VA in A	VA in B	VA in C				
Gross output	GO in A	GO in B	GO in C				

A.2 Value added trade and vertical specialisation

In this appendix we provide a quick technical discussion of the indicators used, which are derived from a world input-output table. Let **L** denote the Leontief inverse which is of dimension NCxNC, where N denotes the number of industries and C is the number of countries. $\mathbf{v}^{\mathrm{r}}$ denotes a vector of value added coefficients (value added over gross output) of dimension 1xNC with the coefficients of country r included and 0's elsewhere; $\mathbf{v}^{-\mathrm{r}}$ denotes a similar vector with 0's for country r and the coefficients included for all other countries. $\mathbf{f}^{\mathrm{r}}$

is a NCx1 vector of final demand in country r thus also including import demand. $\mathbf{f}^{-\mathrm{r}}$ is the vector of world demand minus demand of country r, i.e. $\mathbf{f}^{-\mathrm{r}} = \mathbf{f} - \mathbf{f}^{\mathrm{r}}$. The vector $\mathbf{x}^{\mathrm{r}}$ denotes a NCx1 vector of country r's exports with 0's included for other countries. $\tilde{\mathbf{f}}^{\mathrm{r}}$ is a NCx1 vector with final demand in country r, i.e. domestic and foreign demand for country r's products. The indicators calculated are then formally defined as:

- Country r value added due to domestic demand: $\mathrm{VA}^{\mathrm{r,dom}} = \mathbf{v}^{\mathrm{r}}\mathbf{L}\mathbf{f}^{\mathrm{r}}$
- Country r value added due to foreign demand: $\mathrm{VA}^{\mathrm{r,for}} = \mathbf{v}^{\mathrm{r}}\mathbf{L}\mathbf{f}^{-\mathrm{r}}$;
- Note that $\mathrm{VA}^{\mathrm{r,dom}} + \mathrm{VA}^{\mathrm{r,for}} = \mathbf{v}^{\mathrm{r}}\mathbf{L}\mathbf{f}^{\mathrm{r}} + \mathbf{v}^{\mathrm{r}}\mathbf{L}\mathbf{f}^{-\mathrm{r}} = \mathbf{v}^{\mathrm{r}}\mathbf{L}\mathbf{f} = \mathrm{VA}^{\mathrm{r}}$
- Country r value added imports due to domestic demand: $\mathrm{VA}^{\mathrm{r,imports}} = \mathbf{v}^{-\mathrm{r}}\mathbf{L}\mathbf{f}^{\mathrm{r}}$;
- Note that $\mathrm{VA}^{\mathrm{r,dom}} + \mathrm{VA}^{\mathrm{r,imports}} = \mathbf{v}^{-\mathrm{r}}\mathbf{L}\mathbf{f}^{\mathrm{r}} + \mathbf{v}^{\mathrm{r}}\mathbf{L}\mathbf{f}^{\mathrm{r}} = \mathbf{v}\mathbf{L}\mathbf{f}^{\mathrm{r}}$
- Vertical specialisation of country r with respect to exports: VS = $\mathbf{v}^{-\mathrm{r}}\mathbf{L}\mathbf{x}^{\mathrm{r}}$ as ratio to $\mathbf{v}\mathbf{L}\mathbf{x}^{\mathrm{r}}$
- Vertical specialisation of country r with respect to final goods demand: VS = $\mathbf{v}^{-\mathrm{r}}\mathbf{L}\tilde{\mathbf{f}}^{\mathrm{r}}$ as ratio to $\mathbf{v}\mathbf{L}\tilde{\mathbf{f}}^{\mathrm{r}}$

A.3 Upstreamness of production

The approach adopted by Antras et al. (2012) when constructing their measure of upstreamness is as follows. Begin with a closed economy with N industries. For each industry (i) the value of gross output (Y) equals the sum of its use as a final good (F) and its use as an intermediate input to other industries (Z):

$$Y_i = F_i + Z_i = F_i + \sum_{j=1}^{N} d_{ij}Y_j$$

where d_{ij} is the dollar amount of sector i's output needed to produce one dollar's worth of industry j's output. This expression can be written as:

$$Y_i = F_i + \sum_{j=1}^{N} d_{ij}F_j + \sum_{j=1}^{N}\sum_{k=1}^{N} d_{ik}d_{kj}F_j + \sum_{j=1}^{N}\sum_{k=1}^{N}\sum_{l=1}^{N} d_{il}d_{lk}d_{kj}F_j + \cdots$$

Antras and Chor (2011) suggest computing the weighted average position in an industry's output in the value chain, by multiplying each of the terms in the above by their distance from final use plus one and dividing by Y_i, i.e:

$$U_{1i} = 1 \cdot \frac{F_i}{Y_i} + 2 \cdot \frac{\sum_{j=1}^{N} d_{ij}F_j}{Y_i} + 3 \cdot \frac{\sum_{j=1}^{N}\sum_{k=1}^{N} d_{ik}d_{kj}F_j}{Y_i} + 4 \cdot \frac{\sum_{j=1}^{N}\sum_{k=1}^{N}\sum_{l=1}^{N} d_{il}d_{lk}d_{kj}F_j}{Y_i}$$

Assuming that $\sum_{j=1}^{N} d_{ij} < 1$ for all j, the numerator of this equals the i-th element of the $N \times 1$ matrix $[I - D]^{-2}$, where D is an element of the $N \times N$ matrix whose (i,j)-th element is d_{ij} and F is column matrix with F_i in row i. Fally (2011) has proposed an alternative measure of the upstreamness of production, which can be expressed as:

$$U_{2i} = 1 + \frac{\sum_{j=1}^{N} d_{ij}Y_j}{Y_i} U_{2j}$$

where $d_{ij}Y_j/Y_i$ is the share of sector I's total output that is purchased by industry j. This measure can be expressed as $U_2 = [I - \Delta]^{-1}\mathbf{1}$, where Δ is the matrix with $d_{ij}Y_j/Y_i$ in entry (i,j) and $\mathbf{1}$ is a column vector of ones.

Antras et al. (2012) discuss the extension of this to the open economy, in which case we have:

$$Y_i = F_i + Z_i = F_i + \sum_{j=1}^{N} d_{ij}Y_j + X_i - M_i$$

where X_i and M_i denote exports and imports of sector i output. The share of gross output in industry i that is used as intermediate inputs in industry j (at home or abroad) is given by the ratio:

$$\delta_{ij} = \frac{d_{ij}Y_j + X_{ij} - M_{ij}}{Y_i}$$

Antras et al. (2012) argue that since they do not have information on international inter-industry flows, X_{ij} and M_{ij}, this cannot be operationalised. To get around this issue, they assume that $\delta_{ij} = \frac{X_{ij}}{X_i} = \frac{M_{ij}}{M_i}$ so that the share of industry i's exports (imports) that are used by industry j producers is identical to the share of industry i output used in industry j (at home or abroad). This concept is closely related to measuring backward and forward linkages in input-output analysis (see Miller and Blair, 2009).

A.4 Sophistication of exports

First, an index of the weighted average of the per capita GDPs of countries exporting a given product is created – which they call PRODY – and which represents the income level associated with that product. This is constructed in the following manner. We can write the total exports of country j as:

$$X_j = \sum_l x_{jl}$$

where x_{jl} are the exports of country j in product l. Denoting the per capita GDP of country j as Y_j, we can write the productivity level associated with product k as:

$$PRODY_k = \sum_j \frac{(x_{jk}/X_j)}{\sum_j (x_{jk}/X_j)} Y_j$$

The numerator of the weight, x_{jk}/X_j, is the value-share of the commodity in the country's overall export basket. The denominator of the weight, $\sum_j (x_{jk}/X_j)$, aggregates the value-shares across all countries exporting the good. Hence the index represents a weighted average of per-capita GDPs, where the weights correspond to the revealed comparative advantage of each country in good k. The productivity level associated with country i's export basket, $EXPY_i$, is in turn defined as:

$$EXPY_i = \sum_l \left(\frac{x_{il}}{X_i}\right) PRODY_l$$

This is a weighted average of the PRODY for that country, where the weights are simply the value shares of the products in the country's total exports. Hausmann et al. (2007) show across a large number of countries that initial values of this measure are significantly related to subsequent growth. In our analysis, we use export data from COMTRADE at the HS six-digit level for the years 1995-2011. Real GDP per capita data is taken from the World Development Indicators database. The value of exports is measured in current US dollars. The number of countries reporting in each year varies considerably. In order to use a consistent sample we construct the PRODY measure for the years 2003-2006 using the set of countries that report data in all of these years. The total number of countries on which the PRODY variable was based was 126 countries. The average PRODY index from the 2003-2006 period is then used to construct the EXPY measure for all countries reporting trade data during the period 1995-2011. In addition to constructing this measure of the sophistication of exports at the country level it is also possible to aggregate up to the industry (and country) level to give a measure of export sophistication in particular industries within a country. We also adopt this approach and examine the impact of this variable on value added per worker growth in WIOD countries. It should be stated here that the data is on goods trade only, meaning that service sectors are excluded from this analysis.

Appendix Tables

Table A.1

Vertical specialisation for total final demand

	Sourcing structure															
	EU	Foreign	AUS	BRA	CAN	CHN	IDN	IND	JPN	KOR	MEX	RUS	TUR	TWN	USA	ROW
1995	95.0	5.0	1.2	2.0	2.3	2.1	1.0	1.0	6.1	1.7	1.1	6.1	0.8	1.1	16.6	20.3
1996	94.9	5.1	1.2	1.7	2.2	2.0	1.0	1.0	5.1	1.6	1.0	5.8	0.8	1.1	16.6	21.2
1997	94.7	5.3	1.3	2.0	2.3	2.5	1.0	1.1	5.2	1.6	1.0	6.3	1.1	1.2	18.2	17.5
1998	94.8	5.2	1.2	1.9	2.3	2.9	0.8	1.3	5.2	1.5	1.2	6.0	1.3	1.2	18.2	17.8
1999	94.5	5.5	1.1	1.6	2.4	3.1	0.7	1.0	5.0	1.5	1.1	4.3	1.0	1.2	17.5	20.4
2000	93.1	6.9	1.0	1.5	2.3	3.0	0.8	1.0	5.0	1.5	1.6	5.2	1.0	1.2	15.7	22.2
2001	93.3	6.7	0.9	1.6	2.1	3.3	0.7	1.0	4.2	1.2	1.5	4.8	1.0	1.0	16.3	22.9
2002	93.8	6.2	0.9	1.7	2.2	3.7	0.8	0.9	4.1	1.4	1.3	4.8	0.8	1.1	17.0	22.2
2003	94.0	6.0	1.0	1.6	2.0	4.1	0.8	0.9	4.2	1.3	1.2	5.2	0.9	1.0	14.9	21.9
2004	93.7	6.3	1.0	1.6	2.3	4.5	0.7	1.3	4.2	1.5	1.1	6.0	1.0	0.9	12.5	21.4
2005	93.0	7.0	1.1	1.6	2.1	4.4	0.7	1.3	3.5	1.6	1.3	6.5	0.9	0.8	11.4	22.6
2006	92.4	7.6	1.0	1.6	2.1	5.0	0.7	1.5	3.0	1.4	1.1	6.1	0.9	0.7	10.9	22.6
2007	92.3	7.7	0.9	1.8	2.0	5.7	0.7	1.6	3.0	1.5	1.1	6.6	0.9	0.8	10.6	21.5
2008	91.6	8.4	0.8	1.7	1.7	5.4	0.7	1.5	2.7	1.3	0.9	6.7	1.2	0.7	9.4	22.9
2009	92.9	7.1	0.9	1.8	1.8	6.3	0.8	1.5	2.6	1.4	0.8	5.6	1.3	0.7	11.3	21.6
2010	91.2	8.8	1.0	2.1	1.8	7.2	0.9	1.8	2.4	1.7	0.8	6.2	1.2	0.8	12.3	21.4
2011	90.8	9.2	1.0	2.3	1.9	7.7	0.9	1.8	2.2	1.7	0.8	7.2	1.4	0.7	11.8	20.7

Source: WIOD, own calculations.

Table A.2

Vertical specialisation for total final demand

		1995	2000	2007	2011
AtB	Agriculture, Hunting, Forestry and Fishing	4.9	6.6	8.1	10.3
C	Mining and Quarrying	5.3	6.1	8.5	9.7
15t16	Food, Beverages and Tobacco	7.5	8.9	10.0	12.7
17t18	Textiles and Textile Products	7.3	9.8	11.2	14.5
19	Leather, Leather and Footwear	7.8	10.0	11.3	12.9
20	Wood and Products of Wood and Cork	7.0	9.4	10.4	12.0
21t22	Pulp, Paper, Paper , Printing and Publishing	6.6	8.5	9.1	11.5
23	Coke, Refined Petroleum and Nuclear Fuel	32.1	42.9	50.1	47.4
24	Chemicals and Chemical Products	8.9	12.7	14.7	18.0
25	Rubber and Plastics	7.8	10.3	12.2	15.0
26	Other Non-Metallic Mineral	6.3	9.2	10.7	12.7
27t28	Basic Metals and Fabricated Metal	9.5	12.3	16.6	17.6
29	Machinery, Nec	7.6	10.3	12.2	13.9
30t33	Electrical and Optical Equipment	10.9	14.9	16.7	19.5
34t35	Transport Equipment	8.9	12.4	14.2	16.8
36t37	Manufacturing, Nec; Recycling	7.4	9.6	11.3	12.8
E	Electricity, Gas and Water Supply	8.8	13.5	18.1	20.1
F	Construction	5.3	7.4	7.9	9.2
50	Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel	4.1	5.7	6.2	7.4
51	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	4.1	5.7	6.1	7.8
52	Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods	3.2	4.3	4.9	6.0
H	Hotels and Restaurants	4.4	5.2	5.7	7.0
60	Inland Transport	4.6	7.0	8.5	10.5
61	Water Transport	10.2	15.3	16.0	18.8
62	Air Transport	7.5	12.4	14.2	18.6
63	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	5.3	7.5	7.8	10.5
64	Post and Telecommunications	3.8	6.8	6.6	8.3
J	Financial Intermediation	3.0	4.5	4.4	6.5
70	Real Estate Activities	1.6	2.1	2.3	2.9
71t74	Renting of M&Eq and Other Business Activities	3.3	4.5	4.5	5.8
L	Public Admin and Defence; Compulsory Social Security	3.2	4.7	4.8	5.8
M	Education	1.5	2.0	2.3	2.7
N	Health and Social Work	3.2	4.1	5.0	5.9
O	Other Community, Social and Personal Services	3.9	5.0	5.4	6.5
P	Private Households with Employed Persons	0.0	0.0	0.0	0.0

Source: WIOD, own calculations.

Table A.3

Upstreamness by Industry, 1995

NACE	Industry	Upstreamness Index
71t74	Renting of M&Eq and Other Business Activities	3.93
27t28	Basic Metals and Fabricated Metal	3.46
51	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	2.98
24	Chemicals and Chemical Products	2.92
J	Financial Intermediation	2.91
E	Electricity, Gas and Water Supply	2.63
AtB	Agriculture, Hunting, Forestry and Fishing	2.50
52	Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods	2.36
60	Inland Transport	2.36
21t22	Pulp, Paper, Paper , Printing and Publishing	2.25
C	Mining and Quarrying	2.21
30t33	Electrical and Optical Equipment	2.18
70	Real Estate Activities	2.01
63	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	1.95
15t16	Food, Beverages and Tobacco	1.93
23	Coke, Refined Petroleum and Nuclear Fuel	1.90
34t35	Transport Equipment	1.86
F	Construction	1.82
29	Machinery, Nec	1.82
17t18	Textiles and Textile Products	1.76
64	Post and Telecommunications	1.74
25	Rubber and Plastics	1.71
O	Other Community, Social and Personal Services	1.64
20	Wood and Products of Wood and Cork	1.64
26	Other Non-Metallic Mineral	1.58
50	Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel	1.45
H	Hotels and Restaurants	1.40
62	Air Transport	1.26
19	Leather, Leather and Footwear	1.25
36t37	Manufacturing, Nec; Recycling	1.25
L	Public Admin and Defence; Compulsory Social Security	1.23
61	Water Transport	1.19
M	Education	1.08
N	Health and Social Work	1.08
P	Private Households with Employed Persons	1.00

Source: WIOD, own calculations.

Table A.4

Upstreamness by country, 1995

Country	Upstreamness Index	Country	Upstreamness Index
Germany	3.73	Brazil	1.80
USA	3.42	Romania	1.79
Russia	2.87	Taiwan	1.72
Italy	2.59	Hungary	1.71
Japan	2.57	Portugal	1.70
UK	2.56	Canada	1.69
France	2.51	Bulgaria	1.69
China	2.50	Indonesia	1.68
Spain	2.03	Denmark	1.68
Finland	2.03	Greece	1.67
Czech Republic	2.01	Slovenia	1.62
Belgium	1.96	Mexico	1.61
Sweden	1.95	Ireland	1.60
Australia	1.95	Estonia	1.60
Netherlands	1.93	Turkey	1.60
India	1.91	Latvia	1.54
Poland	1.91	Lithuania	1.53
Korea	1.91	Malta	1.31
Austria	1.82	Cyprus	1.30
Slovakia	1.82	Luxembourg	1.25

Source: WIOD, own calculations.

Table A.5

Lowest values of the PRODY index, average 2003-2006

HS6	Commodity Description	PRODY
140310	Broom corn used in brooms or brushes	263.9
410519	Sheep or lamb skin leather, tanned or retanned, nes	281.6
410611	Goat or kid skin leather, vegetable pre-tanned	294.2
090500	Vanilla beans	302.4
260900	Tin ores and concentrates	327.5
430150	Raw musk-rat furskins, whole	346.1
261590	Niobium, tantalum and vanadium ores and concentrates	350.2
120792	Shea nuts (karite nuts)	350.9
140190	Vegetable materials nes, used primarily for plaiting	360.2
080131	Cashew nuts, in shell dr	383.0
261210	Uranium ores and concentrates	386.2
410511	Sheep or lamb skin leather, vegetable pre-tanned	394.2
120740	Sesamum seeds	404.3
130214	Pyrethrum, roots containing rotenone, extracts	407.6
520300	Cotton, carded or combed	421.2

Source: UN COMTRADE; own calculations

Table A.6

Highest values of the PRODY index, average 2003-2006

HS6	Commodity Description	PRODY
590290	Tyre cord fabric of viscose rayon	47899.2
730110	Sheet piling of iron or steel	46641.5
721633	Sections, H, i/nas, nfw hot-roll/drawn/extruded > 80mm	40780.0
721069	Flat rld prod alum coate	40465.9
481121	Paper, self-adhesive except labels	39697.1
741011	Foil of refined copper, not backed, t < 0.15mm	39349.5
560312	Nonwovens, man-made fila	38511.5
852313	Unrecorded magnetic tapes, width > 6.5 mm	38394.0
441139	Fibreboard 0.35- 0.5 g/cm2 worked/surface covered	37274.1
811300	Cermets and articles thereof, waste or scrap	36909.2
845691	Mach-tls f dry-etching p	36622.5
391810	Floor, wall, ceiling cover, roll, tile, vinyl chloride	36362.2
080250	Pistachios, fresh or dried	35741.6
901049	Apparatus for projection	35124.4
030373	Coalfish, frozen, whole	35040.2

Source: WIOD, own calculations.

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