EUROPEAN COMMISSION

Brussels, 28.10.2010
SEC(2010) 1276 final
VOLUME II

COMMISSION STAFF WORKING DOCUMENT

European Competitiveness Report 2010

Accompanying document to the

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

An integrated Industrial Policy for the Globalisation Era
Putting Competitiveness and Sustainability at Front Stage

{COM(2010) 614}
{SEC(2010) 1272}

COMMISSION STAFF WORKING DOCUMENT

European Competitiveness Report 2010

Table of Contents

2. TRADE IN INTERMEDIATE PRODUCTS AND EU MANUFACTURING SUPPLY CHAINS

2.1. Introduction

Where does your mobile come from? This simple question is not easy to answer. It has probably been assembled using components from different countries, using services both from domestic and foreign economies. This multi-country nature of products is not just a feature of more complex high tech products such as mobile phones and cars. Rarely is a product made up entirely of components or inputs from the country where it is finally assembled or sold; at least some of the components and services involved to bring the product to the customer are often purchased abroad. This is the case for direct inputs, when firms purchase intermediate inputs for production domestically and abroad, but even more so for indirect inputs. A component from a particular country might already include other inputs from other countries, and these are thus used indirectly for production purposes. The other way round, companies might ship high tech components to other countries where assembly of the final product takes place. The complex nature of supply chains at a detailed level of individual products has been documented in a number of case studies for various products, such as T-shirts (Rivoli, 2004), Barbie dolls (Tempest, 1996), computers (Kraemer and Dedrick, 2002), the iPod (Linden, Kraemer and Dedrick, 2007; Varian, 2007) and Boeing (Grossman and Rossi-Hansberg, 2009).

The purpose of the study

The aim of this chapter is to shed light on the relative importance of trade in intermediates in overall trade for the EU-27 and individual country groups, its specific structure, and trends over time. The chapter therefore answers the following questions: What is the extent of trade in intermediate products in overall trade, in both exports and imports? Has the share of intermediate trade changed over time and — if yes — was this driven by within or by between sectoral shifts? Are there specific differences in the way that some countries mostly act as providers and others as users of intermediate inputs?

Section 2 of this chapter analyses specialisation patterns with respect to intermediate trade across countries. The magnitude of two-way trade and the geographical structure of intermediates over time are also analysed.

The importance of trade in intermediates with respect to user industries is analysed in section 3 for the following questions: What is the extent of intra-industry linkages across particular industry groups, including service industries, and — more importantly for this study — what is the share of imported intermediates across these industry groups and to what extent has this changed over time? Given the complex nature of the international production process, the chapter also provides a detailed case study for a particular product, addressing the question: Who captures the value of the production process?

The economic crisis has had a severe impact on trade flows, and trade in intermediates may have played a particular role. The effect of the financial crisis on intermediates trade is analysed in section 4 where the following questions are addressed: To what extent has trade in intermediates been more affected than other product categories? Does the stronger impact on intermediates trade stem from an overall decline in trade for industries with high shares of parts and components trade, or has there been a common break which has led to an overall disruption of supply chains?

These questions have to be addressed at different levels of analysis: at the level of the total economy, for particular industries or product groups, and finally, at the level of individual firms or even products. At the more aggregate levels, the complex nature of international linkages is reflected particularly in trade patterns reflecting aggregate supply chains. This chapter therefore also contains analyses at different levels of aggregation, using detailed trade data, and data from input-output statistics. There is also a case study for a particular product, the Nokia N95. For a detailed description of the data used, see annex A. Each of these datasets has its merits. Detailed product level trade data allows for differentiating products regarding their use as intermediate inputs, capital goods or consumer goods; or at even more detailed categories, though such a distinction might not be clear in a number of cases.[1]

Relying solely on trade statistics, however, does not provide a complete picture of manufacturing supply chains. In particular, it does not reveal cross-industry differences with respect to sourcing structures. The reason for this is that imports of intermediate products cannot be attributed to industries using trade statistics. As an example, even if there is data on the imports of a particular intermediate product, trade data cannot show which industries imported the products, nor the extent to which the imports are used in the production process. This can, however, be studied using information from input-output tables as discussed in detail below. At the level of particular products, the actual supply chains and strategies of firms can only be revealed using detailed case studies looking at sourcing structures, national or international, for each individual component of that product.

2.2. Patterns of trade in intermediate products

Production structures are increasingly adapting and adjusting to more international sourcing structures and cross-border production networks. This is a prominent feature of the globalisation process. Accordingly, it is commonly argued that intermediate goods trade as a share of total trade is increasing because of international outsourcing. Firms distribute their production activities and develop their supply chains over different locations according to comparative advantages in a broader sense. They also take the legal situation into account in potential target countries for outsourcing. Such trends in trade structures of intermediates versus other product types for the EU-27 countries over the last decade are analysed in this section. It is based on descriptive analysis and common methods in the trade literature, with an emphasis on trade in intermediates.

2.2.1. The extent of trade in intermediates

To document the relative importance of trade for the EU-27 and the individual member states, table 2.1 presents the shares of imported and exported products in total imports and exports for each of the four product categories in 2008.[2] The share of imported intermediate inputs for the EU-27 is 53.7 percent, and thus accounts for the greatest bulk of imports. Consumer goods are the second largest category, with 22.6 percent, closely followed by capital goods (17.6 percent). This broad structure of imports is found in most countries, with few exceptions. Along with Germany, five Central and Eastern European countries, Slovenia, Poland, Czech Republic, Hungary, and Slovakia, show the highest shares of intermediates. One explanation for this could be that these countries are more specialised in manufacturing, and that

[1] To stick to the example of a mobile phone: This can be used for personal purposes (chatting with friends) or in production processes (negotiating with clients).

[2] Detailed explanations on data used and classifications applied in the study can be found in the annex.

industries in these countries find cross-boarder production networks particularly important. This will be discussed in further detail below.

Table 2.1 also indicates that exports of intermediates constitute an important part of trade for all countries. Patterns of intermediate exports are compared to the other categories of goods. Shares of the different product categories for the EU-27 are very similar to those for imports. Intermediate goods account for more than half of exports, with a share of 53.7 percent, while exports of consumer goods and capital goods account for 22.6 and 17.6 percent respectively.

The observed large shares of intermediate imports and exports in almost all countries indicate that a clear distinction between typical outsourcing and target countries is not useful, so such classifications have to be made with caution. Further, this points towards the existence of a significant amount of intra-product trade, which will be considered in more detail below.

Table 2.1: Share of end-use categories in total imports and exports in 2008, in percent

	Imports				Exports			
	Inter-mediates	**Consumer goods**	**Capital goods**	**Mixed category**	**Inter-mediates**	**Consumer goods**	**Capital goods**	**Mixed Category**
AT	54.2	22.0	17.8	6.0	55.7	18.1	21.6	4.6
BE	55.4	24.8	12.2	7.6	55.8	25.6	10.6	8.0
BG	52.4	19.6	21.5	6.5	61.9	24.6	8.4	5.0
CY	45.7	29.2	12.9	12.2	34.8	48.0	11.6	5.7
CZ	59.5	17.7	19.7	3.1	55.0	15.2	21.9	7.9
DE	58.0	19.3	17.8	4.9	49.0	16.0	23.8	11.1
DK	48.2	27.4	19.9	4.5	41.8	35.7	20.9	1.6
EE	51.9	21.7	15.0	11.4	58.0	20.9	11.6	9.5
ES	55.2	23.6	14.3	6.9	50.2	24.5	11.9	13.4
FI	51.8	19.2	21.6	7.4	53.0	7.4	33.9	5.8
FR	52.6	25.0	16.0	6.4	49.1	25.6	19.0	6.2
GB	46.8	28.1	17.3	7.7	50.7	22.8	17.3	9.3
GR	38.7	34.5	20.2	6.7	54.5	35.3	9.6	0.6
HU	60.8	15.4	19.5	4.3	46.7	19.5	26.6	7.3
IE	44.5	25.8	24.4	5.3	53.0	30.9	16.0	0.1
IT	54.7	22.9	14.3	8.2	50.2	26.8	19.4	3.5
LT	46.7	24.7	20.2	8.4	52.4	22.2	12.0	13.3
LU	43.8	15.9	32.0	8.3	50.6	9.5	37.8	2.1
LV	46.2	27.3	18.5	8.0	56.6	26.5	13.6	3.3
MT	59.4	26.4	9.6	4.6	68.2	22.2	8.2	1.4
NL	51.1	20.3	24.7	3.9	52.1	20.3	24.1	3.5
PL	57.5	17.4	20.2	4.9	51.8	28.6	13.0	6.6
PT	50.7	26.0	16.5	6.8	53.3	28.4	11.5	6.8
RO	53.9	18.7	21.4	6.0	57.8	21.8	12.8	7.5
SE	55.1	21.7	17.9	5.2	58.1	15.4	19.9	6.6
SI	56.6	16.7	16.2	10.5	51.7	22.8	12.7	12.8
SK	62.3	17.1	15.8	4.8	47.7	23.9	11.1	17.4
EU-27	53.7	22.6	17.6	6.1	51.2	21.6	19.6	7.6

Source: Eurostat COMEXT; wiiw calculations.

So far, analyses have focused on the situation in 2008. The public and academic debate on trade in intermediates has as its major concern the changes with respect to the importance of trade in intermediates and the relative importance of cross-border production networks. On this question, table 2.2 presents an index of nominal import and export values for 2008, expressed as an index where the value in 1999 equals 1. The respective changes in shares are expressed in percentage points for the four end-use categories between 1999 and 2008.

Table 2.2: Changes in import and export values and import and export shares by end-use categories for EU-27

	Index 1999=1				Change in shares (in percentage points)			
	Inter-mediates	Consumer goods	Capital goods	Mixed category	Inter-mediates	Consumer goods	Capital goods	Mixed category
Imports	1.85	1.82	1.55	1.49	2.75	0.74	-2.38	-1.12
Exports	1.87	1.84	1.64	1.69	1.99	0.46	-1.94	-0.51

Source: Eurostat COMEXT; wiiw calculations.

The value of EU-27 intermediate imports increased faster than other categories of goods by 85 percent, closely followed by consumer goods imports, which increased by 82 percent. This resulted in a 2.75 percent higher share of intermediates in 2008 compared to 1999. Consequently, the shares of capital goods and the mixed product category fell. However, some individual countries experienced much stronger increases in the value of intermediate imports over this period, for all product types. This group of countries mainly consists of the EU-12, for which the increase tends to be above 3 percent[3]. The value of imports has also grown for these countries in the other product categories. It might therefore be more informative to look at the extent to which the structure of imports has shifted over time, as indicated by the respective shares[4].

Interestingly, the share of imported intermediate inputs even decreased for a number of countries. This group also includes some countries from the New Member States, e.g. Romania, Hungary, and Bulgaria, along with countries from the EU-15 such as Great Britain and Finland. Another group of countries experienced increases in the share of intermediate goods imports. This group includes Germany, Spain, Austria, Italy and Sweden to name a few from the EU-15, but also Slovakia, Slovenia, the Czech Republic and Poland. Thus, although there has been a general tendency towards a higher share of imported intermediate goods, almost half the countries in the EU-27 experienced a decline in the share of imported intermediates and the extent in these changes differed markedly across countries. One may note that these general tendencies are not a result of the economic crisis which hit the world economy in 2008.

A similar pattern, though at slightly different magnitudes, is found for changes between 1999 and 2007. EU-27 exports of intermediates displayed the highest growth rate, closely followed by exports of consumer goods. Growth rates of exports were higher than those for imports, though the difference is relatively small in the case of intermediates and consumer goods in particular. The specific patterns of individual countries across product categories are again rather mixed (see annex table A.6 for details). One should, however, notice that growth rates for the EU-12 are often higher for product groups other than intermediates. This group of countries started from a rather low level, which partly explains the high growth rates. Within the EU-15, typical exporter countries such as Germany performed only slightly better than the EU-27 average across product categories. However, exports for other larger countries such as Great Britain, France, and Italy grew below the average growth rate.

[3] See annex tables A.5. and A.6. for details.
[4] See annex table A.5 for details.

Finally, the extent to which there are differences in these patterns among industries is presented. Table 2.3 shows the shares of imported and exported intermediates in total imports and exports by industry for the EU-27[5]. Imports of intermediates range from almost zero for industries manufacturing tobacco and wearing apparel, to very high shares, up to 100 percent, for industries manufacturing basic metals. It turns out that these patterns are relatively stable over time and very similar across countries. Correlation analyses yield correlation coefficients for all cases above 0.8 and in most cases above 0.9[6]. The structures for exports are very similar to those for imports, as documented in table 2.3.

Table 2.3 — Shares of intermediate imports and exports by industry for EU-27 in 2008, in percent

		Imports	Exports
15	Food and beverages	22.5	17.0
16	Tobacco	0.9	0.4
17	Textiles	50.8	62.5
18	Wearing apparel	0.8	2.3
19	Leather	12.3	14.4
20	Wood products	95.2	97.9
21	Pulp and paper	83.4	80.1
22	Publishing	26.7	30.7
23	Coke	92.5	77.1
24	Chemicals	69.8	63.5
25	Rubber and plastics	72.7	73.4
26	Other non-metallic	90.0	91.1
27	Basic metals	100.0	100.0
28	Metal products	80.3	81.5
29	Mach. and equipment	43.6	39.7
30	Office machinery	17.4	19.0
31	Electrical machinery	75.7	73.3
32	Radio and television	37.6	32.6
33	Instruments	16.1	15.4
34	Motor vehicles	37.7	35.1
35	Transport equipment	46.4	36.2
36	Furniture and nec	19.0	18.4

Source: Eurostat COMEXT; wiiw calculations.

2.2.2. Geographical structures of trade in intermediates

Intermediate inputs can be sourced from different countries or groups of countries around the world. Table 2.4 provides information on the groups of countries from which intermediate goods are sourced, and on the countries to which they are exported. Considering EU-27 as a whole, one sees that the bulk of intermediate products are sourced from EU-15 countries. With respect to other country groups, the advanced OECD countries account for 11.1 percent, the EU-12 and BRIC countries account for equally large shares, 8.7, while the Asian countries account for only 3.8 percent. For these other country groups, the variation across EU-27

[5] With respect to imports an important aspect here is that these industries should not be considered as 'importing industries' rather than imports of products 'typically produced by those industries'. For example, 22.5 percent of imports corresponding to NACE 15 (food and beverages) are considered being intermediate products; however, these products might be used in other industries for production purposes, e.g. in the hotels and restaurants sectors. The use of imported intermediates of a particular product across industries will be considered in the second part of the study.

[6] More specifically, the correlation coefficients of trade shares are calculated by product categories in the industries considered (e.g. the share of intermediate imports in industry X) across countries or for a particular country for the first and last year available.

countries is even larger. Thus, in 2008, almost 70 percent of intermediates were sourced from within the EU-27.

The sourcing structures of intermediates are somewhat different from those of the other product categories. The EU-15 and EU-12 groups account for about 70 percent of imports of intermediates, consumer goods and capital goods, and an even higher share for the mixed category, 84.6 percent. But there are some differences for the other sourcing partners, e.g. the BRIC countries account for 13.5 and 13.0 percent, respectively, for consumer goods and capital goods, but only for 8.7 percent of intermediates. On the other hand, the advanced OECD countries have relatively high shares, 11.1 percent of intermediates and 13.7 percent of capital goods respectively.

Table 2.4: Import structures by end-use categories and partner countries for EU-27 in 2008, in percent

	EU-15	EU-12	Adv. OECD	Asia	BRIC	RoW
			Imports			
Intermediates	60.9	8.7	11.1	3.8	8.7	6.7
Consumer goods	59.0	8.8	7.8	3.7	13.5	7.3
Capital goods	55.1	6.8	13.7	7.7	13.0	3.7
Mixed category	73.9	10.7	8.8	2.2	1.1	3.3
			Exports			
Intermediates	58.1	10.1	11.6	3.3	5.9	10.9
Consumer goods	62.8	8.4	13.4	2.1	4.3	9.0
Capital goods	48.6	9.2	12.8	3.7	9.9	15.7
Mixed category	57.0	6.9	18.2	1.2	5.3	11.4

Source: Eurostat COMEXT; wiiw calculations.

Similarly, the bulk of intermediate exports from EU-27 countries are destined for the EU-15 countries. The EU-15 share is 58.1 percent for the EU-27 and thus only slightly lower when compared to imports. The EU-12, the advanced OECD countries and the Rest of World receive one tenth each of EU-27 exports. The share of EU-27 exports to the BRIC countries is 5.9 percent, whereas only 3.3 percent of EU-27 exports are destined for the Asian countries. Further, the share of exports from EU-12 countries to other EU-12 countries is also very large in most cases. Together with results on import structures, this reveals that there is also a lot of intra-regional trade in intermediates among EU-12 countries taking place, showing that outsourcing is important not only between advanced and less advanced economies, but also within similarly developed countries.

A comparison of the geographical patterns for EU-27 exports of the four product categories shows that the share of exports of consumer goods to the EU-15 is large, 62.8 percent, when compared with intermediates, 58.1 percent, and capital goods, 48.6 percent. EU-27 exports of intermediate and capital goods to EU-12 countries are larger than the other categories of goods. This pattern is reversed for the advanced OECD countries. For the other country groups, capital goods exports are more important, in particular for the BRIC countries and the Rest of World category.

Whether this pattern is stable over time is analysed below. Table 2.5 provides evidence for the EU-27 over the period 1999-2008. EU-15 and the advanced OECD countries have seen large declines in market shares of total EU-27 imports, by -4.6 and -5.3 percentage points

respectively, whereas the EU-12 and BRIC countries have gained market shares, by 3.9 and 4.9 percentage points respectively. Considering the EU-27, one thus finds a significant shift from imports sourced from EU-15 countries towards imports from EU-12 countries. Once again, there is considerable country differentiation with respect to changes in geographical patterns. A common feature is that the EU-12 and BRIC countries have gained in all countries, whereas the advanced OECD countries have lost market shares.

It remains to be considered whether these shifts are similar for all product categories or whether there is a specific pattern for intermediate products. The EU-15 countries have lost market share in all categories, but these have been more pronounced for capital goods and for the category of mixed goods. Similarly, the advanced OECD countries have lost market share to a large extent in capital goods, -9.52 percent, and in intermediates, -5.32 percent. The BRIC countries have gained mostly in capital goods, 9.64 percent, with the gain being similar in magnitude to the decline in OECD countries. The BRIC countries' gains in market share in consumer goods amounted to 5.21 percent, and 4.94 percent for intermediates. Finally, the second biggest winners in terms of increasing market share are the EU-12 countries, which have seen gains ranging from 5.98 percent in the category of mixed goods to 3.18 percent in consumer goods.

Thus, a marked shift occurred in this period within Europe, from EU-15 to EU-12 countries as suppliers of intermediate products. However, the EU-12 countries started from a relatively low level of exports. It is interesting to note that these gains and losses were of a similar magnitude. Simultaneously, there occurred a significant reorientation towards the BRIC countries at the expense of the advanced OECD countries. Thus one observes a reorientation of sourcing structures within the EU as well as in extra-EU import patterns.

Table 2.5: Changes in export and import shares by end-use category and sourcing region for EU-27, 1999-2008 (in percentage points)

	EU-15	EU-12	Adv. OECD	Asia	BRIC	RoW
			Imports			
Intermediates	-4.57	3.87	-5.32	-0.81	4.94	1.89
Consumer goods	-3.06	3.18	-1.93	-2.49	5.21	-0.90
Capital goods	-5.31	4.22	-9.52	-0.23	9.64	1.20
Mixed category	-5.87	5.98	-2.16	-0.46	0.67	1.84
			Exports			
Intermediates	-5.06	3.90	-3.42	-0.62	3.09	2.11
Consumer goods	-3.86	3.82	-2.86	-0.06	2.46	0.50
Capital goods	-10.95	4.59	-3.95	0.02	6.11	4.17
Not classified	-14.50	3.98	-1.38	0.49	4.75	6.66

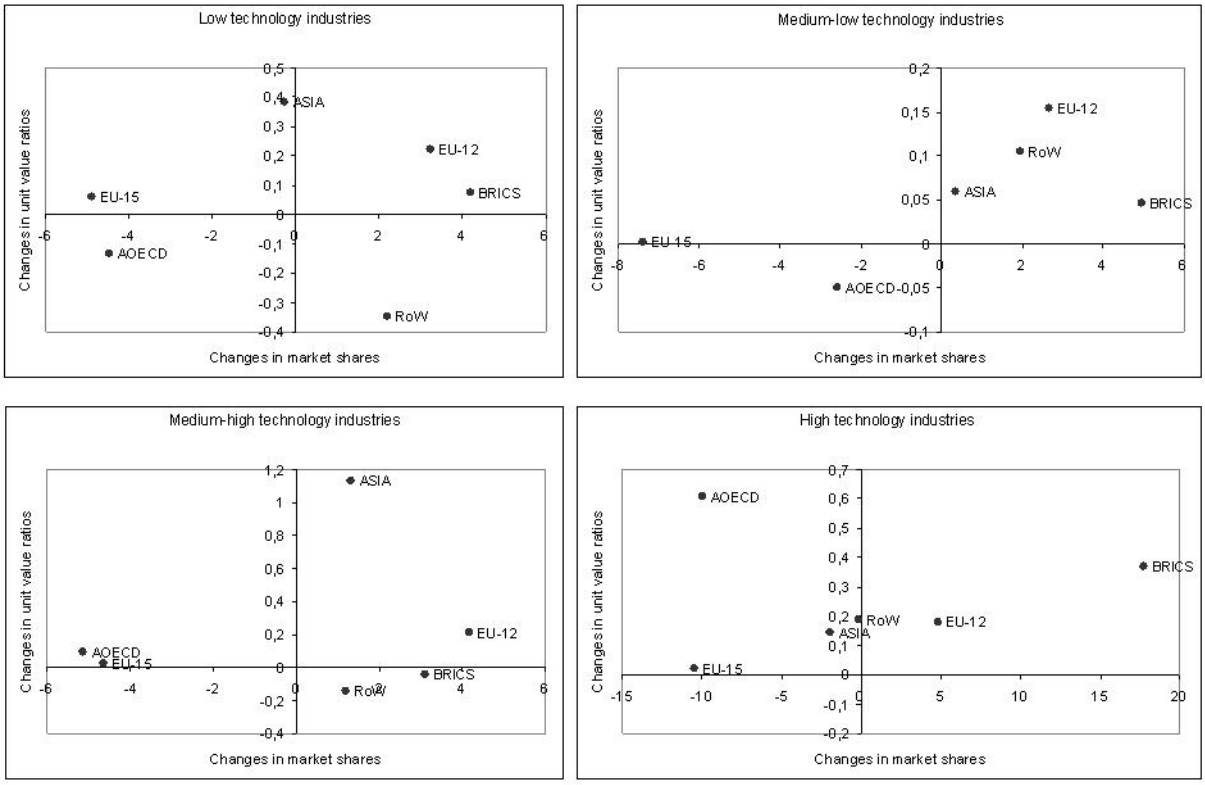
Source: Eurostat COMEXT; wiiw calculations.

The geographical pattern of EU-27 exports has also changed over the last 10 years. EU-27 export shares to EU-15, advanced OECD countries and Asia declined, while EU-27 export shares increased to EU-12, BRIC and the Rest of World. These patterns can with a few exceptions also be found for individual EU-27 countries. Considering the EU-27 change in geographical export structure across the product categories, one finds that exports to the EU-15 declined much more for capital goods and for the mixed category of products. The export

shares increased for these product categories to the BRIC countries and the Rest of World. The changes are most similar across product categories with respect to the EU-12, the advanced OECD countries and Asia.

These shifts in market shares can be related to changes in relative unit values reflecting emerging cost advantages or quality upgrading. This issue is analysed by means of changes in unit value ratios and market shares between 1999 and 2008[7]. The analysis shows that EU-12 countries have been successfully upgrading the quality of goods exported to the EU-27 markets. A similar pattern is found for BRIC countries, though with less pronounced quality upgrading. These patterns are similar across product categories and seem to be more pronounced in high-technology industries in general, cf. Figure 2.1.

Figure 2.1: Changes in market shares and unit value ratios for intermediates by industry groups, 1999-2008



An analogous exercise on the exporter side reveals that within EU-27 countries, France and Great Britain in particular have been losing export shares, defined as exports of the particular country of total EU-27 exports[8].

2.2.3. Revealed comparative advantages in trade in intermediates

The patterns described above point towards the countries or groups of countries which tend to specialise in the production of intermediates relative to other product categories. It is however not easy to discern from the descriptive analysis alone whether particular countries or groups of countries have tended to specialise in the provision of intermediate inputs compared to

[7] See the annex for a detailed explanation of the methodology.
[8] The details of the analyses are available in the background study for the chapter.

others and to what extent this has changed over time. This section sheds light on this issue by using a measure of revealed comparative advantages (see Box 2.1) at the level of end-use categories and groups of countries.

Box 2.1: Measuring revealed comparative advantages

In the literature, various measures of revealed comparative advantages (RCA) have been proposed, early examples being Balassa (1965), Vollrath (1991). Greenaway and Milner (1993) provide good discussions of the measures used in the literature. Here, Vollrath's third measure of revealed competitiveness is used:)

$$RCA_j^c = \ln \frac{X_j^c / \sum_k X_j^k}{\sum_n X_n^c / \sum_{k,n} X_n^k} - \ln \frac{M_j^c / \sum_k M_j^k}{\sum_n M_n^c / \sum_{k,n} M_n^k}$$

Where X and M denotes exports and imports respectively and j denotes an index for the product category under consideration and c is an index for country. The first term denotes the relative export advantage, which is analogous to the Balassa index, and the second term denotes the relative import advantage. The index ranges from minus infinity to plus infinity and is symmetric around zero. A positive value reveals a comparative advantage. One accounts for double counting by excluding the respective country in the aggregates over countries and the particular product categories in the product aggregates. The index was calculated for a group of 40 countries comprising a significant part of world trade.

Table 2.6 reports the results of this analysis for all countries included in the exercise. Looking at the figures for 2007, it is interesting to note that the set of countries with a comparative disadvantage is rather heterogeneous. With respect to EU-27, this set includes advanced economies such as Germany, Denmark, and Italy on the one hand and EU-12 countries, e.g. Slovakia, Hungary, Poland, Slovenia and the Czech Republic on the other hand. This should, however, not be interpreted as a comparative disadvantage or advantage with respect to factor endowments or productivities, but rather reflects the structure of national industries or within-industry specialisation.

Many of the countries which have a revealed comparative disadvantage in intermediates show a strong comparative advantage in other categories: e.g. Cyprus, Hungary, Lithuania, Poland, Romania, Slovakia and Slovenia have a comparative advantage in consumer goods. In all cases, the group of other advanced countries shows a positive index for intermediates, but a negative one for consumer goods, contrary to the pattern discussed above. With respect to the BRIC countries, these — with the exception of Russia — seem to have a comparative advantage in producing consumer goods, thus being relatively large importers of intermediates in producing final goods. The exception is Russia, for which primary goods are included. With respect to the group of other advanced countries, they all seem to have a comparative disadvantage, whereas they have comparative advantages in exports of consumer goods, though there have been some shifts over time.

Table 2.6: Revealed comparative advantage index, 1999 and 2007

	Intermediates		Consumer goods		Capital goods	
	1999	2007	1999	2007	1999	2007
EU-27	-0.061	-0.028	0.138	0.024	0.088	0.164
EU-15						
Austria	0.31	0.07	-0.26	-0.23	-0.16	0.08
Belgium	-0.09	-0.05	0.15	0.20	-0.21	-0.29
Germany	0.12	-0.13	-0.60	-0.37	0.42	0.51
Denmark	-0.35	-0.14	0.57	0.41	-0.09	-0.16
Spain	-0.40	-0.20	0.43	0.26	-0.53	-0.54
Finland	0.10	-0.01	-1.22	-1.12	0.51	0.61
France	-0.15	-0.06	0.01	-0.01	0.09	0.02
Great Britain	0.13	0.20	-0.27	-0.29	0.04	-0.14
Greece	-0.03	-0.02	0.81	0.34	-1.73	-1.27
Ireland	0.11	0.19	0.40	0.06	-0.24	0.00
Italy	-0.41	-0.26	0.65	0.30	0.07	0.27
Luxembourg	1.11	1.16	-0.40	-0.49	-1.00	-0.58
Netherlands	-0.29	-0.20	0.30	0.17	-0.02	0.19
Portugal	-0.43	-0.15	0.81	0.36	-0.87	-0.54
Sweden	0.01	-0.01	-0.36	-0.30	0.19	0.11
EU-12						
Bulgaria	-0.45	-0.01	1.18	0.48	-1.21	-1.22
Cyprus	-1.24	-0.45	1.18	0.54	-0.76	-0.15
Czech Republic	0.09	-0.20	-0.08	-0.11	-0.50	0.04
Estonia	0.34	0.47	0.15	0.05	-0.66	-0.65
Hungary	-0.50	-0.42	0.58	0.21	-0.06	0.27
Lithuania	-0.32	-0.05	0.57	0.35	-1.29	-0.85
Latvia	0.88	0.84	-0.02	0.02	-1.65	-1.01
Malta	0.14	0.72	0.28	-0.13	-0.37	-0.65
Poland	-0.32	-0.11	0.91	0.67	-0.78	-0.80
Romania	-0.78	-0.06	1.35	0.54	-1.04	-0.89
Slovakia	-0.43	-0.77	0.15	0.46	-0.63	-0.57
Slovenia	-0.10	-0.04	0.62	0.44	-0.72	-0.56
Other advanced economies						
Australia	1.08	1.13	-0.15	-0.27	-1.93	-1.91
Canada	0.37	0.76	-0.17	-0.57	-0.48	-0.55
Japan	0.19	0.14	-1.51	-1.67	0.85	0.67
USA	0.49	0.31	-0.85	-0.84	0.13	0.15
BRIC countries						
Brazil	0.13	-0.14	0.78	0.81	-0.76	-0.34
India	-1.23	-0.77	2.91	1.99	-1.23	-1.49
Russia	1.36	1.78	-2.28	-2.11	-1.76	-2.16
China	-1.61	-1.19	3.07	2.42	-0.41	0.10
Other						
Indonesia	-0.11	0.37	1.41	0.93	-1.39	-1.35
South Korea	-0.95	-0.62	0.67	-0.69	0.52	0.61
Mexico	-0.69	-0.47	0.93	0.66	0.12	0.08
Turkey	-1.01	-0.95	2.40	1.63	-1.46	-0.65

Source: UN COMTRADE; wiiw calculations. Note: EU-27 includes intra-EU trade.

2.2.4. Two-way trade in intermediate products

The analysis so far might have hidden the fact that there is — as in total trade — a lot of two-way trade taking place, i.e. countries being both exporters and importers of intermediates as well as in other product categories. The analysis below takes a closer look at the magnitude of this phenomenon and how it has evolved over time. This analysis is performed by applying the Grubel-Lloyd index at the level of product categories (see Box 2.2 for technical details).

Box 2.2: Measuring two-way trade

To measure two-way trade the common method is the Grubel-Lloyd index (Grubel and Lloyd, 1975). The analyses in this study use a version of this index correcting for trade imbalances (see Greenaway et al., 1994) which is calculated as:

$$RCA_j^c = \ln \frac{X_j^c / \sum_k X_j^k}{\sum_n X_n^c / \sum_{k,n} X_n^k} - \ln \frac{M_j^c / \sum_k M_j^k}{\sum_n M_n^c / \sum_{k,n} M_n^k}$$

This index is used for product categories and country groups based at the CN 8-digit level. The index ranges from 0 to 1 and can be interpreted as the share of two-way trade in total trade of this category. Whenever an export or import value is reported but no corresponding import or export value in the partner country, this is set to zero though it not possible to know whether the value is missing and consequently should be positive or zero. The alternative to skip those observations would result in higher two-way trade indices but the same conclusions would hold.

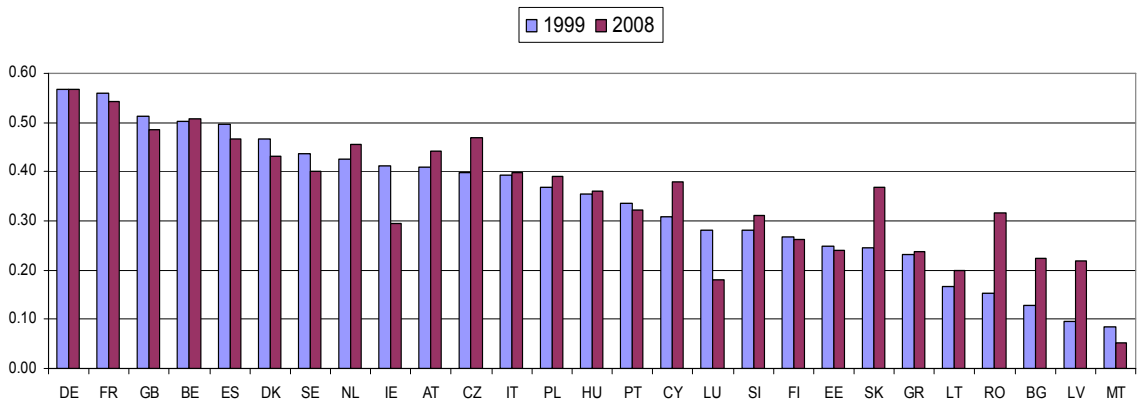
Generally, the index tends to be higher for consumer and capital goods compared to intermediate products. Taking country averages, the index in 2008 is 0.35 for intermediates, 0.40 for consumer goods and 0.39 for capital goods. However, there seems to be no clear pattern, though countries with a high index value in one category also tend to have higher values for other product categories. This may be due to country-specific factors such as country size and income per capita, being the most important determinants of intra-industry trade. A more striking fact is the large variation across countries. This is shown graphically in Figure 2.2 for intermediate goods trade, which also indicates changes in the index between 1999 and 2008.

The share of two-way trade in intermediates ranges from more than 50 percent in Germany and France to less than 10 percent in Malta. As expected, larger and more developed countries in terms of per capita income tend to have a higher index. Interestingly, the index decreased for a number of countries between 1999 and 2008. This was the case for France, Great Britain, Spain, Denmark, Sweden, Ireland, Portugal, Luxembourg and Estonia. But there are also a number of countries for which two-way trade increased. This was particularly the case in countries where two-way trade was low in 1999. Two-way trade increased particularly strongly for Latvia, Bulgaria, Romania, Slovakia and to a lesser extent for the Czech Republic[9].

Thus, despite its potentially different nature, there is also a considerable amount of two-way trade occurring in intermediates trade, blurring the distinction between typical producer and user countries of intermediates still further (Stehrer et.al. 2010).

[9] For a detailed comparison to other product categories, changes over time and industry-specific results see Stehrer et al. (2010).

Figure 2.2:Two-way trade in intermediates, 1999 and 2008

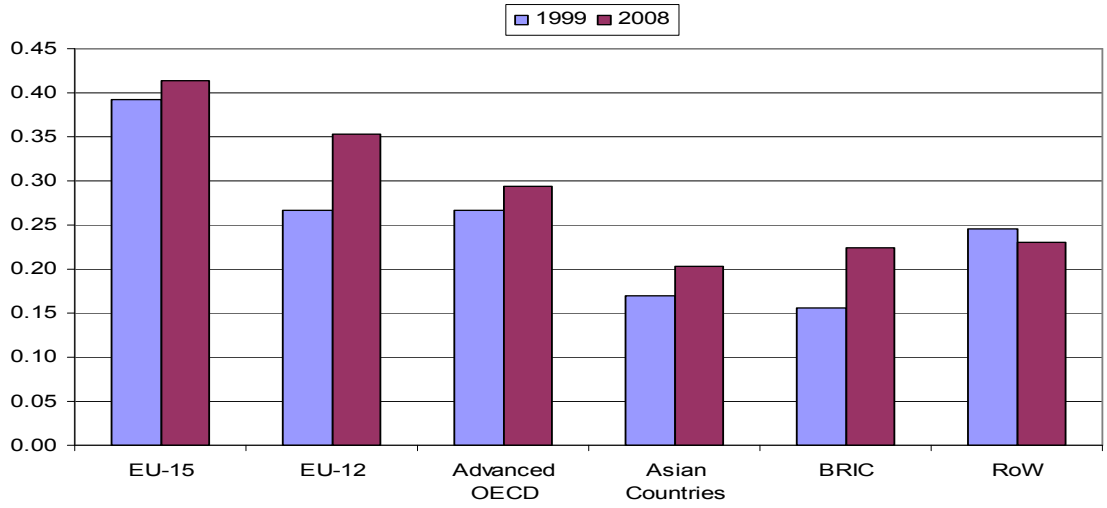


Note: Figures based on CGLI measure.

Source: Eurostat COMEXT; wiiw calculations.

Intra-EU trade in intermediate goods is more characterised by two-way trade than extra-EU trade. Two-way trade in intermediates increased for trade with all regions except the countries constituting the 'Rest of the World', for which it decreased slightly. Two-way trade with EU-12 increased by a third between 1999 and 2008, which may reflect stronger interlinkages between industries in EU-15 and EU-12.

Figure 2.3: EU-27 two-way trade in intermediates by region, 1999 and 2008



Note*:* Figures based on CGLI measure.

Source: Eurostat COMEXT; wiiw calculations.

2.3. Manufacturing supply chains and services

The analysis in the previous section is based on detailed trade data providing information on which products or product groups are traded between different countries. This does not, however, reveal anything about the industry using a particular product. A semi-conductor or light bulb might be used in different industries as intermediates. The question is to what extent particular industries are users of intermediates in general, and to what extent the structure of intermediate inputs is differentiated across industries and countries. On top of that, one might wonder about the extent to which these intermediate inputs are imported or sourced domestically, which is also a concern of this section and relates to the discussion of

imported intermediates above. It then leads naturally to considering the structure of inputs, either sourced domestically or internationally, for a particular product. This will also be shown in this section, namely in the case study on the Nokia N95. The analysis will show that there are considerable linkages between manufacturing and service sectors which are in most cases increasing over time, particularly when considering both direct and indirect linkages. A second result is that the shares of imported intermediates have grown over time. This implies that despite increasing interlinkages across industries, the domestic multiplier effects are roughly constant or even falling slightly.

2.3.1. Interlinkages between manufacturing and services

On the one hand, manufacturing industries use service inputs, i.e. act as clients of the service sector and hence create a 'pull' effect, by demanding service inputs as intermediates. On the other hand, manufacturing industries sell products to the services sector, i.e. provide products and hence create as a 'push' effect[10]. The pull effect is measured by the share of service inputs in manufacturing industries which are classified below by technology categories. Service inputs include both market and non-market services and represent direct service components embodied in manufacturing. The push effect is captured by the share of material inputs in services, detailed below by service categories[11].

Overall, high-technology industries received the largest share of service inputs in 2005, hence creating the largest pull effect. The average for all countries is 24.4 percent. The second largest share was held by low-technology industries, 23 percent, followed by medium-high technology industries with 22 percent. Medium-low technology industries required slightly less service inputs, 17 percent. These figures hide large differences across countries. EU-12 and Portugal had smaller service shares across all manufacturing industries, with the only exception of Hungary, which had a relatively higher service input share in medium-low technology industries.

There are large differences between countries, and these are most pronounced for the medium-high technology industries. The differences range from 7 percent of service inputs in Slovakia, and 70 percent in Ireland. When studying changes in the size of the shares between 1995 and 2005, service input shares increased in low-technology industries in almost all countries, which might be interpreted as outsourcing to upgrade production. In high-technology industries as well as in medium-high technology industries, many countries saw service input shares increase, though less so in the latter category. Service input shares decreased in most countries only in medium-low technology industries. Differences among countries are again large. Interestingly, EU-12 display decreasing service input shares in all four technology categories, which is surprising. Slovakia is an exception, in that low-technology service input shares and especially medium-low technology service input shares increased. This is surprising, given the generally lower shares of services in total manufacturing inputs in those countries.

Studying the push effect of manufacturing reveals that material inputs account for an average of 33 percent in trade and hotels and in community services, creating the largest push effects in these service industries. The share is smaller in business services, 22 percent, and also in transport services, 16 percent. Generally, the differences between countries are not pronounced, with larger differences being found in business services. Interestingly, the EU-12 are among the countries with relatively large input shares, especially in business services and

[10] This terminology follows European Commission, 2009, p.79.
[11] For details on the classification of material and service inputs see Timmer et al. (2008).

community services. Material input shares declined between 1995 and 2005 in all service categories and among all countries. Variations are less marked; Poland is the only country where material input shares increased in three service industries. Overall, it seems that the push factor of manufacturing on services is slightly larger than the direct pull factor. However, while the former declined over the last 10 years, the pull effect increased substantially.

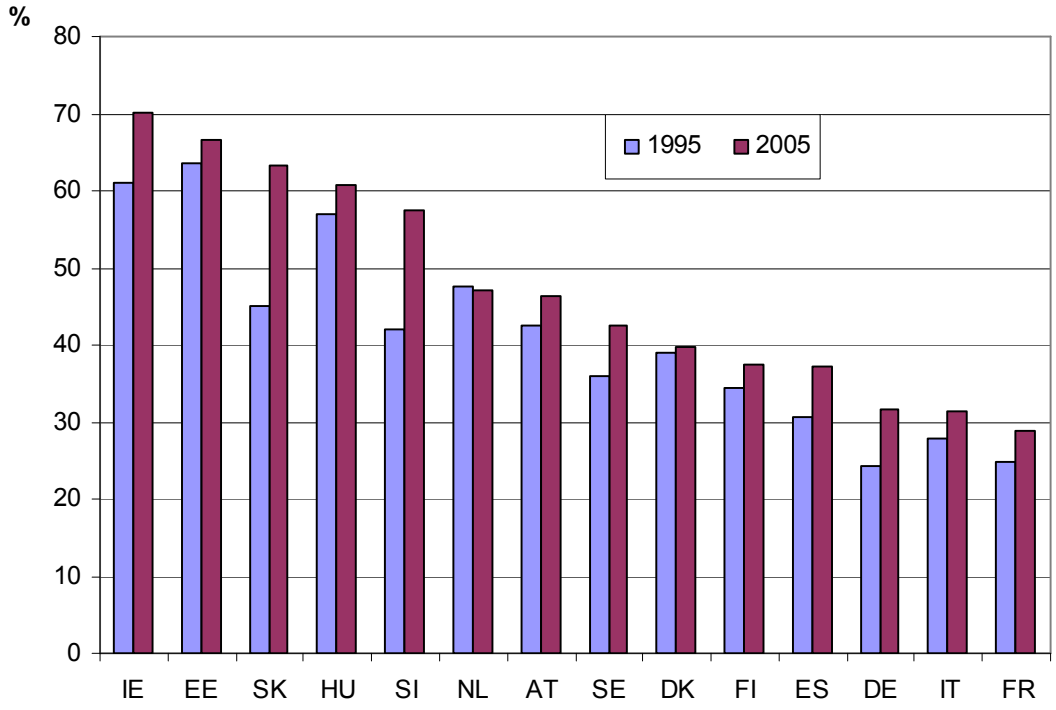
2.3.2. Imports of intermediate inputs by industry

This section takes a closer look at the structure and changes in imported versus domestically sourced intermediates. Specifically, patterns of imported intermediate inputs by user industry will be analysed with a focus on cross-industry and cross-country differences. First, the developments over time for the aggregate manufacturing and services respectively are analysed. The aggregates are then broken down into different types of manufacturing and services industries.

The analysis is based on Eurostat's symmetric input-output tables, product by product, which are computed for the total economy, the domestic economy and for imports. This enables the role of imports in the economy to be investigated in more detail.

Import shares increased among all manufacturing industries and almost all countries between 1995 and 2005, with only very few exceptions, cf. Figure 2.4 below. The figure presents the ratio of imported to domestic intermediates in 1995 and 2005 for the Member States for which data is available. The largest shares of imported intermediates are found in the smaller member states reflecting their smaller size and lesser ability to produce all necessary intermediates domestically.

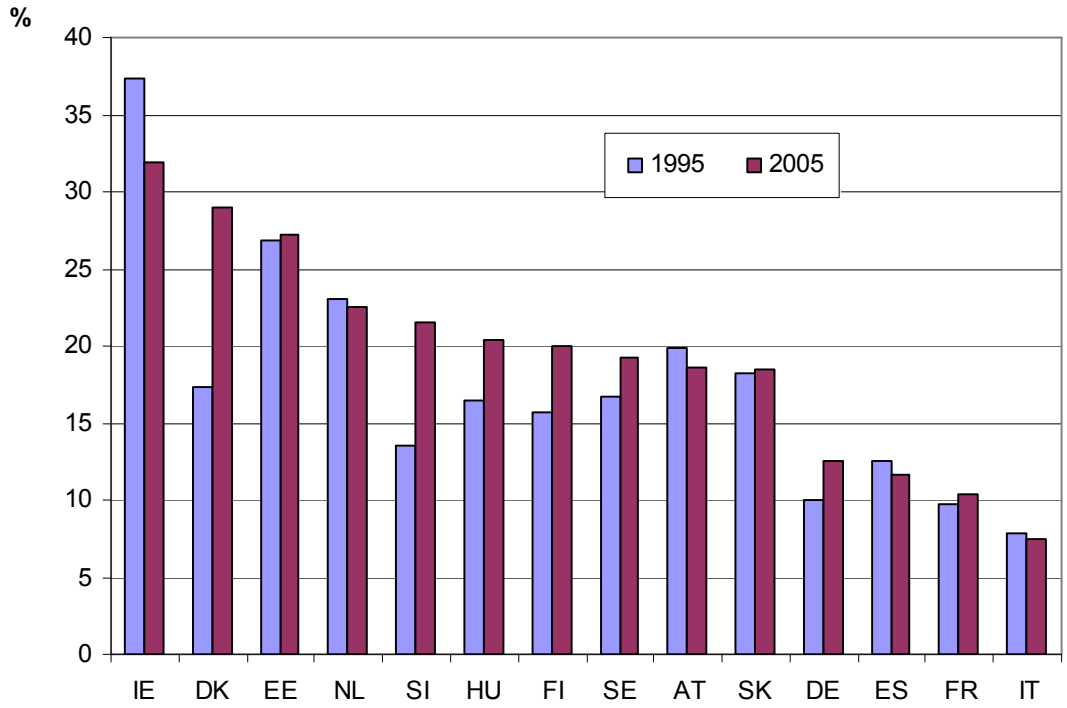
Figure 2.4: Ratio of imported to domestic inputs in EU manufacturing industries 1995 and 2005 (percent)



Source: Eurostat input-output tables, wiiw calculations.

Even though import shares of intermediates increased in most countries for service industries between 1995 and 2005, it was less pronounced than for manufacturing, cf. Figure 2.5. In fact, import shares decreased by some 5 percent in Irish service industries between 1995 and 2005.

Figure 2.5: Ratio of imported to domestic inputs in EU services industries 1995 and 2005 (percent)



Source: Eurostat input-output tables, wiiw calculations.

Moving to less aggregated industries, table 2.7 presents the share of intermediate imports in total intermediate inputs. Data are only available for the benchmark years 1995, 2000 and 2005.

Taking the shares of imported intermediates in total intermediates in four types of manufacturing industries first, data show that imported intermediates are most significant in high technology industries, where they account on average for 55 percent of total inputs in 2005. Imports still account for 50 percent of all intermediates in medium-high technology industries and 48 percent in medium-low technology industries. Low-technology industries require substantially less imports, amounting to some 30 percent of intermediates on average. Interestingly, the New Member States Estonia, Slovakia, Hungary and Slovenia, also Ireland, and to some extent Austria, show the largest import shares in substantially all technology categories. This may be due to the fact that they are all small open economies on the one hand, but also due to the New Member States' increased need for imported intermediates, as they are not able to source all necessary supplies of inputs domestically. The differences among countries are most pronounced for high-technology industries. Imported intermediates amount to 94 percent in Estonia, 89 percent in Hungary, 85 percent in Ireland and 76 percent in Slovakia on the upper range, and 29 percent in France and 33 percent in Germany in the lower range.

The largest increase occurred in the medium-low technology industries. The most pronounced import share increases for all four technology categories were in Slovenia and Slovakia. However, import shares also rose in EU-15 countries. There were above-average increases in Austria, Ireland, Germany, Sweden and Spain.

Analysing the share of imported intermediates in total intermediates in four service categories yields a different picture. Import shares are much smaller in service industries than in manufacturing industries, since fewer services are traded internationally. The services sector also has more SMEs than the manufacturing sector. The shares are about 17 percent for trade and hotels, and 16 percent for business services and community services. The share of imported intermediate goods is larger for transport services, 26 percent. It is interesting to note that the share of SMEs is smaller in these service industries than in others. In addition, differences among countries are small, with Italy displaying the lowest import shares and Ireland the highest. Import shares increased in most countries between 1995 and 2005, though there was much variation and no common picture. Import shares in business services decreased for three New Member States, Hungary, Estonia and Slovakia.

Output multipliers and their changes over time can be used to study changes in inter-industry linkages across sectors. By using output multipliers, both direct and indirect effects are taken into account. It is, however, necessary to distinguish carefully between the effects of changes in interlinkages — which can be studied by analysing total multiplies — and the effects of a change in the share of imported intermediates by calculating domestic multipliers only. Total output multipliers are calculated from input-output tables which include imports of intermediate goods, while domestic multipliers are based on the domestic input-output tables which do not include imports. The fact that a significant share of intermediates is sourced from abroad therefore implies that the domestic multipliers evolve differently from total multipliers. For the domestic multipliers, one would expect an increase due to an overall increase in linkages across industries, whereas the fact that intermediates are sourced from abroad would work in the other direction. In a recent study, the European Commission (2009) reports the average of multipliers over 22 countries at the product level and highlights important differences when considering the total and the domestic multipliers. This is done by showing that the sectors with the highest total multipliers and domestic multipliers do not coincide. A similar exercise was undertaken by Stehrer et al. (2010) for three EU-15 countries, Austria, Germany and Spain. The most important finding was that the domestic multipliers are between 20 to 40 percent lower compared to the total multipliers on average. This difference even widened over the periods considered. The total multipliers were increasing in most countries, pointing towards increasing interlinkages, whereas the domestic multipliers were roughly constant or even slightly declining, indicating that imports of intermediates have been increasing over time.

Table 2.7: Shares of imported intermediates (in percent)

	Low-tech industries			Medium-low tech			Medium-high tech			High-tech		
	1995	2000	2005	1995	2000	200	1995	2000	2005	1995	2000	2005
AT	26.6	33.3	33.2	39.6	51.5	49.2	51.3	58.1	55.9	52.3	57.8	47.4
BE	37.5	41.2	.	46.7	51.4	.	59.4	57.9	.	58.8	57.7	.
DE	20.4	23.6	22.5	28.5	37.4	42.2	24.5	29.0	29.2	23.4	30.7	33.1
DK	23.0	28.2	30.2	44.1	42.7	40.2	42.7	43.9	44.1	45.9	49.5	44.0
EE	41.6	45.7	44.5	65.3	52.8	61.8	56.4	61.8	66.8	90.5	95.9	93.5
ES	17.0	21.9	19.1	32.0	39.1	38.2	38.2	48.5	46.1	35.5	39.2	45.1
FI	16.2	18.4	18.5	30.4	36.1	41.3	37.4	37.3	40.2	53.8	44.2	49.5
FR	14.2	17.0	16.3	30.4	38.5	41.4	26.3	28.6	28.8	28.0	32.8	29.4
HU	29.5	39.1	32.3	47.0	57.7	54.6	68.6	69.6	67.3	82.4	90.7	89.2
IE	40.7	48.6	58.9	57.2	57.7	51.0	64.7	88.4	85.7	81.1	90.2	85.1
IT	19.4	20.2	20.8	29.7	35.2	38.5	27.2	29.3	31.2	35.5	38.8	34.7
LT	.	36.4	24.0	.	54.6	46.9	.	79.2	74.0	.	53.0	42.9
NL	39.2	38.2	34.3	55.8	58.7	60.4	46.0	46.7	44.4	48.9	51.7	49.0
PL	.	19.8	20.3	.	36.7	40.7	.	35.7	42.1	.	41.0	49.3
RO	.	21.7	23.0	.	30.8	34.4	.	31.0	32.9	.	40.8	51.0
SE	19.7	21.7	23.9	40.4	47.0	52.6	40.8	42.1	42.6	43.1	45.5	51.0
SI	32.5	43.2	43.9	35.4	51.0	61.4	51.1	64.7	61.7	49.5	56.9	62.4
SK	24.4	42.6	44.7	42.5	55.9	62.2	59.8	78.1	70.1	53.6	75.4	75.8
UK	23.4	.	.	25.6	.	.	32.1	.	.	38.2	.	.

	Trade and hotels (GH)			Transport services (I)			Business services (JK)			Community services (LP)		
	1995	2000	2005	1995	2000	2005	1995	2000	2005	1995	2000	2005
AT	15.6	16.4	18.9	32.0	29.8	25.9	14.8	11.4	13.0	16.9	16.1	16.4
BE	19.6	26.2	.	23.2	29.6	.	14.6	19.9	.	16.8	17.5	.
DE	8.7	10.9	10.0	13.6	18.0	17.2	6.7	10.4	10.2	11.0	15.2	12.9
DK	11.9	20.6	22.6	40.3	59.2	61.8	4.6	10.5	14.1	12.5	15.9	17.6
EE	23.1	20.1	22.3	37.4	39.9	35.7	25.8	22.0	21.9	20.9	31.2	28.8
ES	6.4	4.1	7.8	19.7	17.9	16.5	8.1	9.8	9.1	15.8	17.0	13.2
FI	13.8	17.9	20.0	21.2	21.4	25.1	13.5	14.6	16.9	14.1	17.2	18.1
FR	9.4	10.8	10.8	12.5	11.0	11.9	8.0	8.3	7.5	8.9	11.4	11.5
HU	12.6	22.5	19.3	16.6	28.0	31.7	22.6	22.1	15.3	14.0	17.0	15.0
IE	43.4	30.7	25.4	43.9	38.9	36.4	32.1	56.6	47.0	30.2	34.9	18.7
IT	6.2	6.3	5.9	9.5	10.2	9.0	10.3	9.8	9.0	5.4	5.9	6.1
LT	.	22.4	15.0	.	29.5	23.6	.	17.3	13.0	.	21.5	13.8
NL	27.6	26.3	24.2	31.3	33.7	33.6	15.3	14.6	18.6	17.7	15.5	13.8
PL	.	10.7	11.4	.	14.6	15.7	.	6.3	7.4	.	6.5	8.5
RO	.	24.0	19.6	.	20.0	18.6	.	21.8	23.3	.	34.2	32.8
SE	20.2	25.1	22.8	21.4	21.1	24.3	12.7	15.2	15.8	12.7	14.5	13.9
SI	9.7	11.0	19.6	17.0	25.2	28.0	12.9	16.6	16.3	14.5	17.5	22.4
SK	14.0	16.3	13.3	26.8	43.7	26.7	19.1	12.6	15.7	12.9	13.2	18.3
UK	12.8	.	.	15.1	.	.	10.2	.	.	14.5	.	.

Source: Eurostat input-output tables, wiiw calculations.

2.3.3. Case-study. The Nokia N95 mobile phone

The standard level of trade analysis is usually undertaken by sector, industry, product group or labour skill-groups, as in sections 2 and 3 above. Global trade and globalisation of economic activities, however, occur at a much finer level of aggregation — at the level of tasks (see e.g. Grossman and Rossi-Hansberg, 2008, for a theoretical approach). Stages of production that used to be performed by the same company in the same geographic location are now fragmented around the world. The various stages are either owned and controlled by one manufacturer, or owned and controlled by independent suppliers. This forms the system

of global supply chains — increasingly not only for goods, but also for services. Services have become increasingly involved in international trade due to digitalisation.

A *supply chain* refers to the global flows of intermediate goods/services — both provided in-house and purchased from outside, unaffiliated, companies — involved in providing a good/service for final consumption. In each step, the vendor employs inputs, conducts its own value-adding activities, and transfers its output to the other participants in the supply chain. *The sum of all value-adding activities equals the final retail price* before any applicable taxes. Figure 2.6 represents a stylised supply chain for the Nokia N95. In the case of tangible components, there are typically 4–8 layers between Nokia and the extraction of metals and minerals from the earth's crust (Nokia 2009a). All components embed intangible assets in some form, and conform to one or more industry standards. In the case of intangible components — licensed and purchased embedded and standalone software — the flows cannot be readily mapped in a similar manner, but there are typically fewer layers. The actors in the supply chain of the N95 are categorised into five groups in the figure: mines and refiners, component vendors and sub-assemblers, software and technology providers and licensors, the actual phone assembly by Nokia, or by an original equipment manufacturer (OEM), as well as wholesale and retail distribution by telecommunication network operators and/or by general traders. Unlike some of its competitors, Nokia maintained significant in-house manufacturing and assembly capacity and thus relied less on OEMs[12]. In the case of the N95, all final assembly was done by Nokia itself. It did not use providers of electronic manufacturing/assembly services (EMS's) or outsource this task.

2.3.3.1. Who captures value — where the value is created?

Since GDP (Gross Domestic Product) can be measured as the sum of the values added by all organisations in a particular country, it is often interesting to know *where* within the supply chain the value capturing takes place. This is not an easy task, as companies are reluctant to reveal the geography of their operations even at level of the firm, let alone at the level of a specific offering. It is nevertheless possible to do some calculations that are fairly accurate at least as far as broader regions are concerned. The geographical allocations of the country of final sales and final assembly depend on the individual case. For instance, in the case of a N95 assembled in Salo, Finland, destined for the German market, 2.1 percent would go to Finland and 14.5 percent to Germany. The outcome would be different in the case of assembly in Beijing, China, destined for the US market. An average was calculated for all potential combinations of assembly locations and destination markets. The average is presented in Figure 2.7[13].

The best estimate is that, on average, overall, 55 percent of the value added of Nokia N95 mobile phone is captured in EU-27. This is a remarkably large share for a truly global product. Even in the case of final assembly in China and final sales in the US, EU-27 captured 51 percent of the value added — despite the fact that the phone was 'Made in China'. While final assembly is obviously the main step in the physical incarnation of the product, this stage

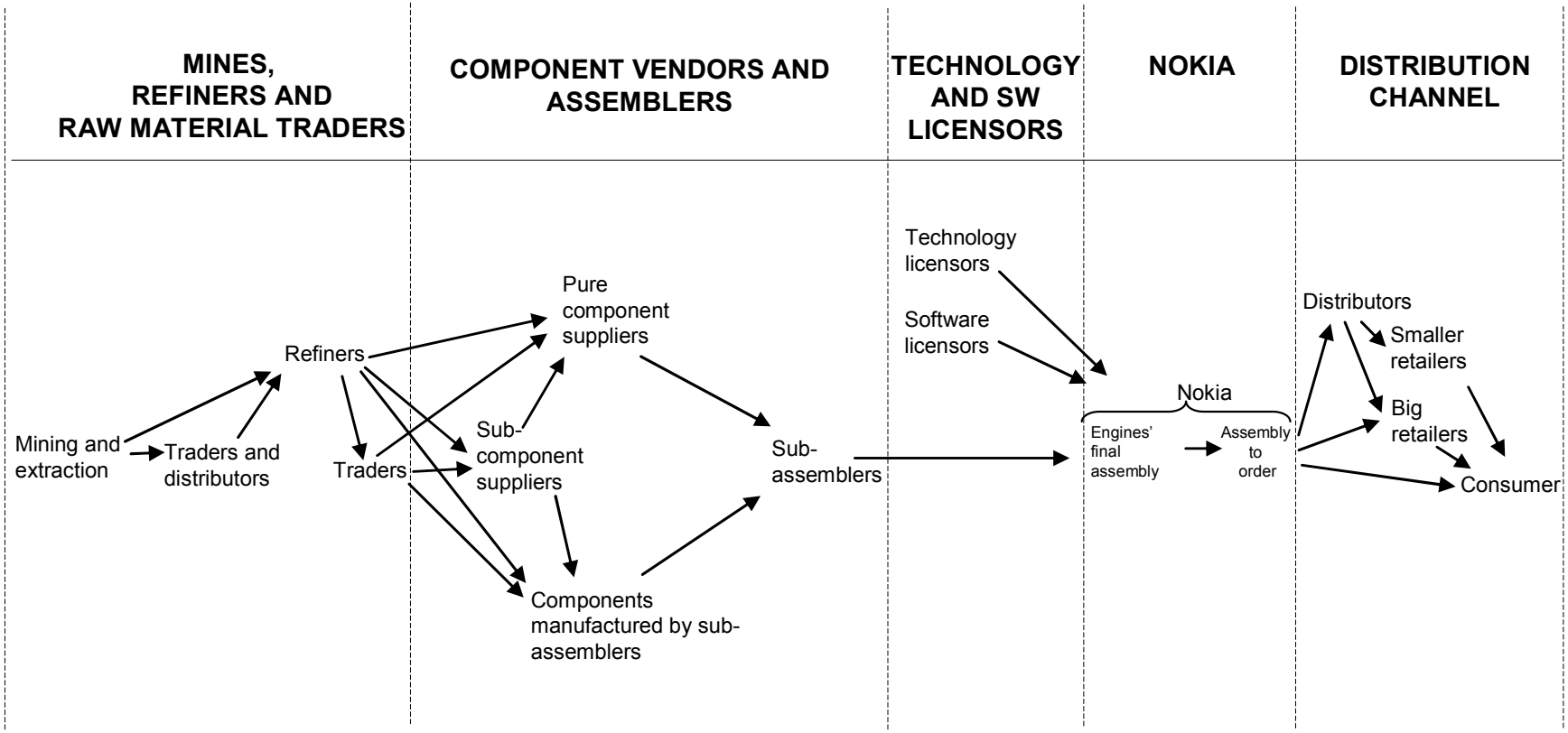
[12] In 2007 Nokia outsourced 20 percent of its total manufacturing volume (including all models) of mobile device engines (Nokia 20-F report, 2007, p.36).

[13] In 2007, the basic principle of Nokia was that smartphones for the European market were manufactured in Europe and correspondingly smartphones for the Asian market were manufactured in Asia. According to the available information, smartphones for the U.S market are mainly manufactured in Asia. Thus using these three as guidelines, potential combinations are: (assembled in EU and sold in EU; assembled in EU and sold in other countries; assembled in Asia and sold in Asia; assembled in Asia and sold in North America; assembled in Asia and sold in other countries).

only commands 2 percent per cent of the overall value added. On the other hand, the distribution channel and particularly its final retail loop capture a large share of the value added — worth many times more than the final assembly. Taking into account the value added tax or sales tax, the value added received by the country of final sales is even bigger.

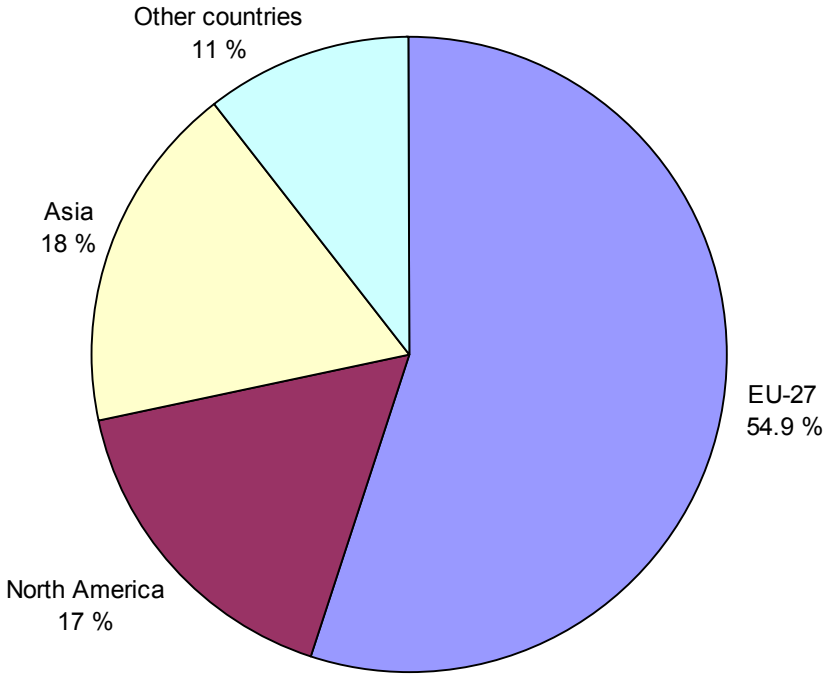
How is it possible that EU-27 captures so much of the value from a seemingly minor role? The simple reason is that Europe was dominant in the branding, development, design, and management of the N95 and related processes. To uncover these geographical connections often requires some detective work. For instance, in the case of N95's main processor and *Texas Instruments* (US): The hardware design was made in Dallas (US) and in Nice (France). Much of the software design and its integration to hardware were of Indian origin. Besides Dallas (US), the processor was also manufactured in Japan. A single component might be imported and exported several times, at least if the 'in transit' status is not determined appropriately. Even if it is, imports and exports are measured in gross value terms, although the value added at any given location may be small.

Figure 2.6: The stylised supply chain of Nokia N95 mobile phone



Source: ETLA database

Figure 2.7: The value added breakdown by regions taking into account the value added created in the country of final sales



Source: ETLA database

The ICT sector and the N95 handset take into account a specific industry and a specific case while looking at the whole industrial landscape. However, they represent the electronics industry as a whole quite well and lead the way in global industrial transformation. Many industries are following suit. On the other hand, there are industries where unbundling of production has been the rule for decades, but localisation decisions differ from those observed in electronics.

The most notable example is the automobile industry, where outsourcing and separation of different stages of production have proceeded quite far. Advanced information and communication technologies have facilitated outsourcing offshore, but much of the production has remained regional rather than becoming global. The simple reason is transportation costs. ICT helps to coordinate the activities of international supply chains, but intercontinental shipping of some auto parts is costly compared to electronics components.

Hence, there are regional clusters or hubs specialising in auto parts within a reasonable distance from the final assembly. Nevertheless, the same logic applies; manufacturing that was originally done by the same company in the same factory is today dispersed into a network of hundreds of suppliers and subcontractors to achieve advantages through economies of scale and specialisation.

The current economic crisis has spurred a discussion about the way in which global supply chains are affected. Has some of the off-shored production been in-shored back to its original location, or will it be? There are arguments for and against this scenario. While the need to seek more cost-advantaged locations has probably only increased for some producers, the crisis has revealed the vulnerability and unpredictability of production chains for others. The net effect is likely to be relatively small.

Unbundling and trade in tasks will most likely expand in services as a consequence of digitalisation. More and more services are becoming tradable once digitally transformed. Firms — both in manufacturing and services — will grow their offshore outsourcing of services to a much greater extent than ever happened in manufacturing. In addition to manufacturing, other tasks such as product development have also been transferred to low-cost countries.

2.4. The role of intermediates in the trade collapse in the EU-27: cause, effect or both

The trade collapse following the financial market turbulence of September 2008 which peaked in the winter months of 2008/2009 was in many respects unprecedented. The trade slump was even steeper than in the Great Depression (Eichengreen and O'Rourke, 2009), and it occurred on a global scale with an extraordinarily high degree of synchronisation (Araújo and Martins, 2009; Araújo, 2009). Moreover, the decline in global trade in real terms was much more pronounced than that of real GDP. This also reflects a change in the structure of global trade, which is increasingly characterised by vertical specialisation across countries, i.e. countries are not necessarily specialised in the production of goods, but in certain stages of production of particular goods. Vertical specialisation implies that countries produce and export large amounts of intermediate products, parts and components in particular, which are then further processed or assembled in other parts of the world.

Hence, before a country exports a final product, a series of related trade flows of intermediate goods (including imports of primary, semi-finished goods and parts and components) will already have taken place. If, as was the case during the crisis, demand declines in many parts of the world, this affects not only the trade flows of finished goods, but also related trade flows in semi-finished goods and parts and components. By this mechanism, trade in intermediate goods increases the sensitivity of trade with respect to changes in the business cycle. The increasing role of international supply chains and consequent vertical specialisation led to a significant increase in the income elasticity of trade that is well documented in the literature (e.g. Cheung and Guichard, 2009; Freund, 2009). For the EU-15, this elasticity was 1.95 during the period 1961 to 1984, which means that global trade changed by 1.95 percent when world GDP changed by 1 percent. The elasticity increased to 2.45 percent in the period 1985 to 2009.

For the year 2009, however, global trade took a stronger blow than suggested by the long-term elasticity of trade, as the decline in real global trade outstripped the decline of GDP by a factor of 5 (IMF, 2009). Various explanations for the disproportionate trade collapse of 2008-2009 have been suggested, including increased trade costs due to the credit crunch (Escaith and Gonguet, 2009), protectionist tendencies by major trading partners (Evenett, 2009) and a composition effect, i.e. industries most involved in international trade were hit harder by the decline in global demand.

What has happened to intermediate goods and in particular of parts and components — a subgroup of intermediates that accounts for approximately 30 percent of the EU-27 trade in intermediates — during the crisis is interesting per se, given their important role in international supply chains. Parts and components are of particular interest because they are the goods category most closely associated with the notion of international intra-industry vertical supply chains in the actual debate. They are therefore those most likely to be influenced by potential structural changes that may have occurred during the crisis due to the sourcing decisions of companies operating globally. This section analyses in more detail the development of EU-27 export and import of parts and components using monthly trade data.

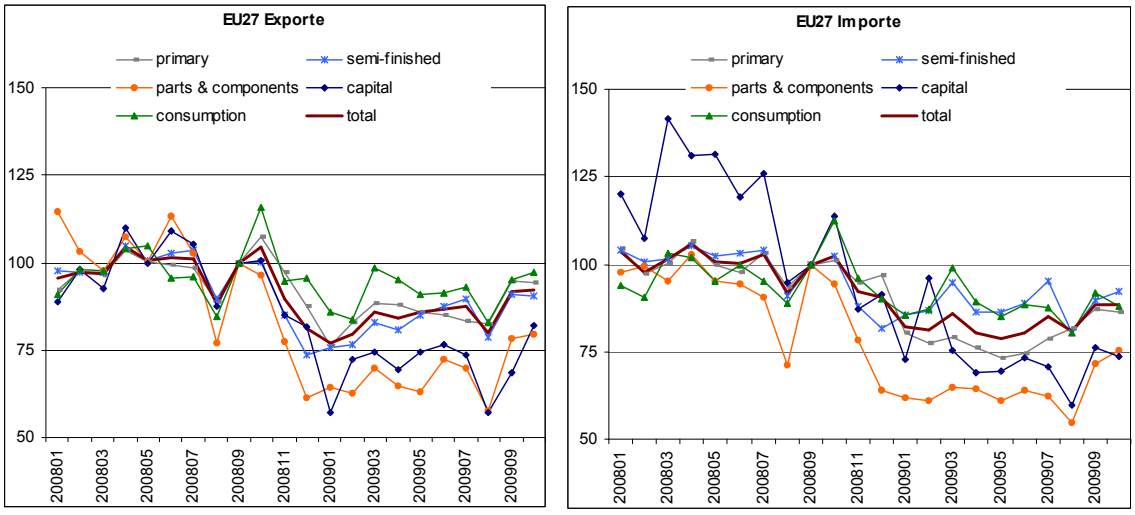
2.4.1. The impact of the crisis on trade flows by end-use categories

The first step in the analysis of the impact of the crisis on trade flows is to compare the decline in various end-use categories, including parts and components, with that of overall trade. Looking first at the development of aggregate exports during the crisis, Figure 2.8 reveals that export volumes declined sharply between October 2008 and January 2009, when the index of aggregate exports reached its trough at a level of 77 percent compared to the September 2008 volume, i.e. a decline of 23 percent in real values. The start and the intensity of the trade collapse were similar on the import side, but the decline was somewhat more extended, lasting until April 2009, when the volume index reached its low at 80 percent. Hence, during the peak of the crisis, the export decline of 24 percent was larger than the decline in imports, which amounted to 20 percent in real terms.

Differences are also observable for the initial recovery phase discernible on the export side, starting in February/March 2009 and — setting aside the seasonal drop in August — lasting until October 2009, the last available observation for this analysis. In contrast, for imports, no real recovery can be detected before September 2009, so that one year after the outbreak of the crisis, the index level of exports was 4 percentage points above the import level, despite the initially stronger drop in export volumes. These differences in the recovery of trade volumes largely reflect differences in the overall recovery from the crisis, which appears to be more sluggish in the EU-27 than in other regions, particularly Asia and China.

Against this background, the most outstanding point that emerges from Figure 2.8 is that parts and components actually registered the most pronounced drop in trade volumes both on the export and on the import side, followed by capital goods. For example, in January 2009, imported parts and components stood at about 62 percent of their September 2008 volume level, and remained at a very low level until September 2009, when they began to recover. Both on the export and on the import side, EU-27 trade in parts and components remains depressed at around 75 percent of its September 2008 level at the end of the observation period. In contrast, the trade volume of consumption goods fell less sharply than other goods categories.

Figure 2.8: Development of EU-27 exports and imports by end-use categories during the crisis
(Trade volumes, September 2008 = 100)



Source: COMEXT, wiiw-calculations.

2.4.2. The share of parts and components in overall trade declined due to the crisis

The more than proportionate decline in the trade of parts and components led to a decline in the share of these goods categories when pre-crisis and post-crisis averages are compared[14]. More precisely, for exports, the share of trade in parts and components decreased by 2.3 percentage points, from 17 percent to 14.8 percent. For imports, the relative decline amounted to 1.1 percentage points, from 15.5 percent to 14.4 percent. But the fact that parts and components were the most strongly-hit goods category of EU-27 trade makes them particularly important for explaining the trade collapse[15].

One explanation for the strong decline in parts and components trade could be a change in the *structure of trade with respect to trade in parts and components*, i.e. a partial reversal of the trend towards ever-deeper and more complex forms of vertical specialisation. Such a trend reversal may have been triggered by a less favourable international environment, with the higher cost of trade finance and potentially protectionist policies implemented by trading partners. Another explanation for the strong decline in parts and components trade, which may be a rival as well as a complementary factor, is again a *composition effect*, similar to that mentioned above. According to this hypothesis, the trade slump was strongest in trade in parts and components because important industries in world trade which are also intensive in parts and components trade, such as the automobile industry, were relatively harder hit by the shock in global demand than other industries. The causality in this hypothesis is assumed to run from industries to shares in parts and components in total manufacturing trade. If the composition effect drives the strong downward movement of trade in parts and components, the stronger decline in this product category should vanish at the level of individual industries. On the other hand, if international supply linkages were partly disrupted as a consequence of the crisis, as suggested by the first explanation, the share of this category in total trade should have declined both at the total manufacturing level and for individual industries.

2.4.3. Parts and components trade and trade collapse across industries

This section takes a closer look at the share of parts and components trade in individual industries. Figures 2.9 and 2.10 present the shares of parts and components trade in individual industries for exports and imports on the vertical axes, and the industry-specific index of the trade decline on the horizontal axes. The horizontal axes show development between September 2008 and the month displaying the lowest value after September 2008. The series is constructed as an index with the level in September 2008 equal to 100. The lines crossing the data point 'Total manufacturing' indicate the shares of parts in components trade and the index of trade decline for total manufacturing for comparison, respectively.

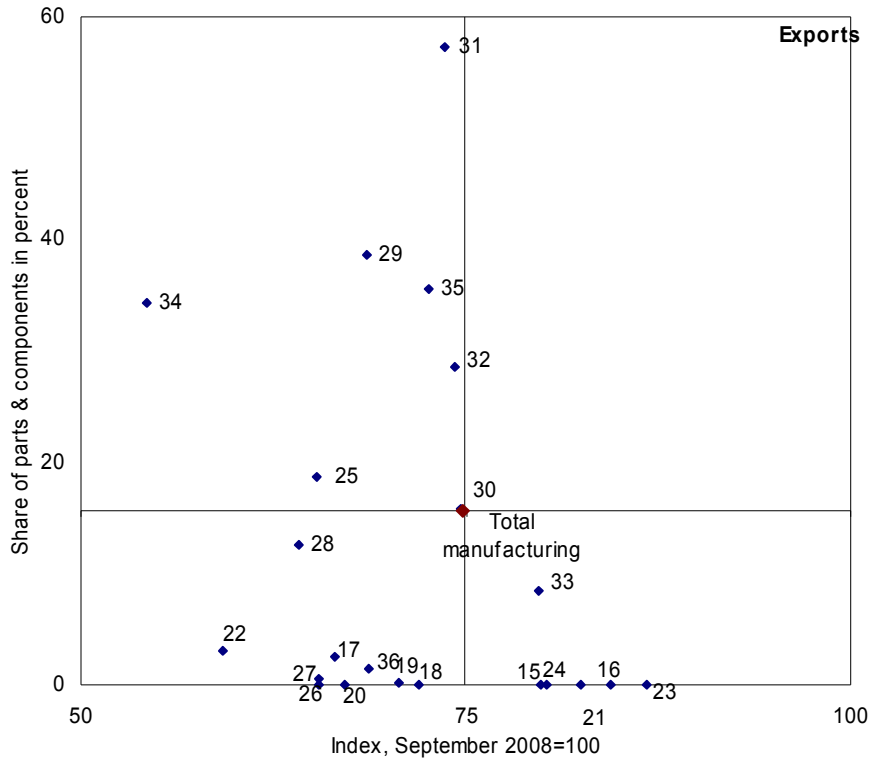
These figures show that vertical specialisation, as measured by parts and components trade, plays an important role in roughly half of manufacturing industries, mainly those with medium- and high-technology intensity. Industries with a high degree of vertical specialisation are found above the vertical line through 'Total manufacturing'. The highest degree of vertical specialisation in EU-27 exports is found in the electrical machinery industry (NACE 31), with 57 percent of exported goods constituting trade in parts and components, followed by the machinery and equipment industry (NACE 29), with a share of 39 percent in

[14] Pre-crises averages are calculated for January 2008 to September 2008 and post-crisis averages for the period October 2008 to October 2009.

[15] Note that the more than proportionate decline of parts and components is not the result of the multiplicative effect that trade in intermediates introduces into the trade statistics.

parts and components trade, see Figure 2.9. In the transport equipment (NACE 35) and automotive industry (NACE 34), parts and components account for 36 percent and 34 percent of industry exports respectively. The industry ranking by share of parts and components imports looks very similar despite some differences.

Figure 2.9: Index of real export values against share of parts and components trade of individual industries

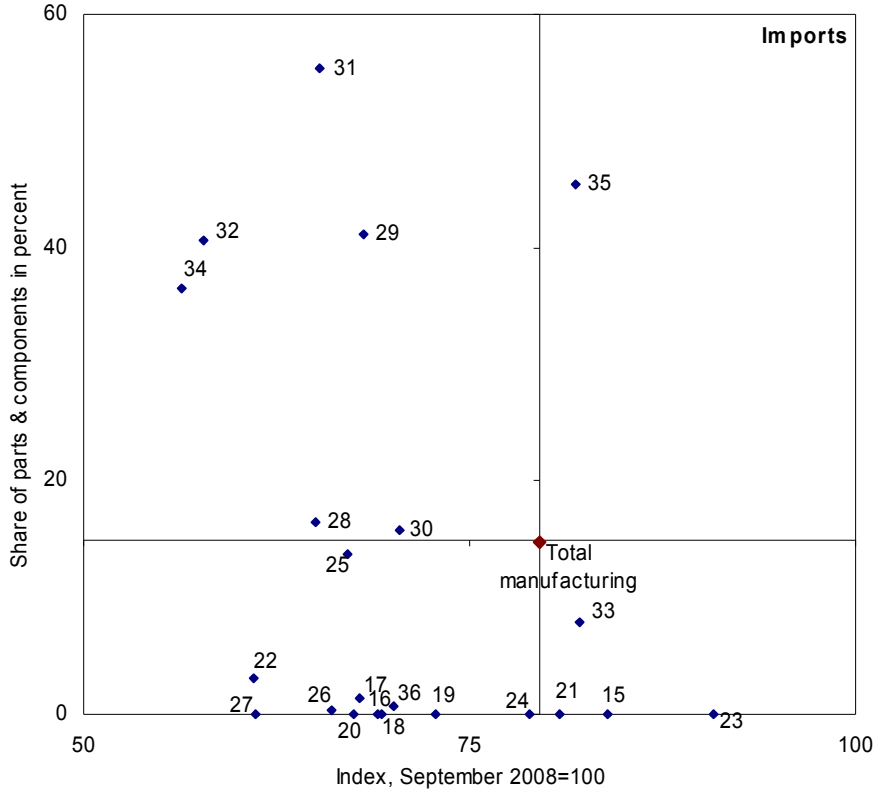


Note: The horizontal and vertical axes through 'Total manufacturing' refer to the shares and index of total manufacturing. Industries to the left (right) show a stronger (less strong) decline in trade compared to total manufacturing; the index refers to the lowest value after the crisis and thus might differ across industries. Industries above (below) show a higher (lower) share of trade in parts and components compared to total manufacturing.

Source: COMEXT, wiiw-calculations. August 2009 values neglected due to seasonal fluctuations. The total trade index for the individual industries and the entire manufacturing sector is the index corresponding to the post September 2008 monthly low.

While the electrical machinery industry (NACE 31) has the highest share of parts and components in imports with 55 percent, it is followed by transportation equipment, with 45 percent, see Figure 2.10. The machinery and equipment industry, the radio and television industry (NACE 32) and the automotive industry also have relatively high shares of parts and components in imports, see Figure 2.10. So, despite some differences in the precise ranking, the importance of parts and components is very similar on both the export and import side, with the five industries mentioned being those with the highest degree of vertical specialisation.

Figure 2.10: Index real import values against share of parts and components trade of individual industries



Note*:* The horizontal and vertical axes through 'Total manufacturing' refer to the shares and index of total manufacturing. Industries to the left (right) show a stronger (less strong) decline in trade compared to total manufacturing; the index refers to the lowest value after the crisis and thus might differ across industries. Industries above (below) show a higher (lower) share of trade in parts and components compared to total manufacturing.

Source: COMEXT, wiiw-calculations. August 2009 values neglected due to seasonal fluctuations. The total trade index for the individual industries and the entire manufacturing sector is the index corresponding to the post September 2008 monthly low.

The composition effect hypothesis could serve as a plausible explanation for the strong decline in parts and components trade only if those industries with a high share of parts and components trade suffered from a more than proportionate slump. As indicated above, Figures 2.9 and 2.10 show graphically the relationship between each industry's share of parts and components in total EU-27 export and imports (vertical axis) and the severity of the trade decline that the respective industry suffered (horizontal axis). The industries' positions along these dimensions are shown relative to the entire manufacturing sector (NACE 15-36). The severity of the trade decline of each industry is measured by its index of real trade value at the time of its post-crisis monthly low.

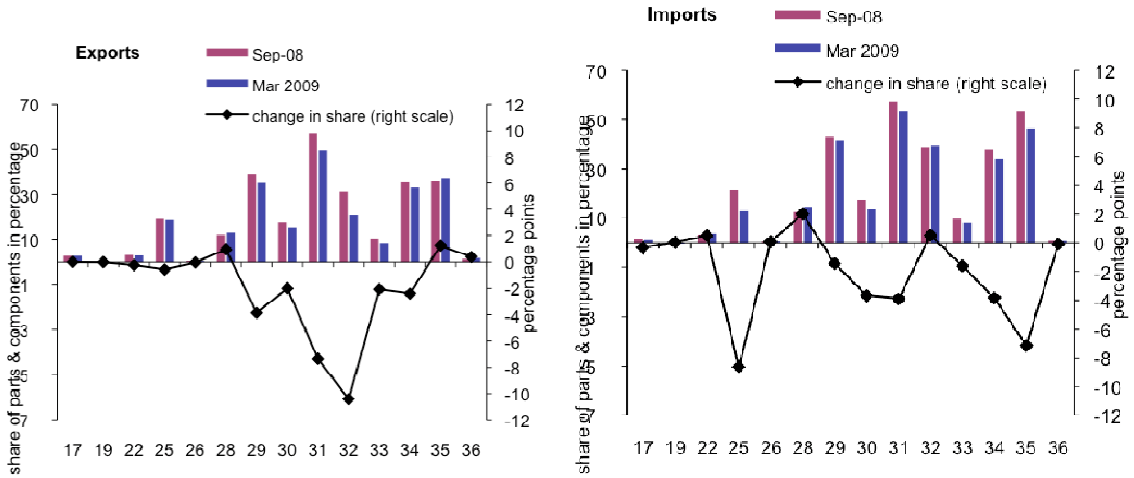
September 2008 values serve as the base month. Consequently, a low index number indicates a strong decline in the real export or import value. Therefore, industries that experienced a strong decline relative to manufacturing are found on the left hand side in Figures 2.8 and 2.9 while industries that fared relatively well, such as the chemical industry (NACE 23), are found on the right hand side. The index numbers on the horizontal axes are related to the share of parts and components in the same industry, which are shown on the vertical axis. The

figures show that there is indeed a large degree of variation in the growth performance of individual sectors (see dispersion along the horizontal axis). Focusing first on industries with the most pronounced declines of real trade values, the automotive industry's (NACE 34) exports and imports experienced the strongest declines, amounting to about 45 percent of its September 2008 level[16]. In line with the composition effect hypothesis, the automotive industry is also among the industries with the highest share in parts and components trade. Though developments in the automotive industry were devastating, other industries singled out as having high shares in the parts and components trade did not perform as badly. Nevertheless, the machinery and equipment industry (NACE 29) experienced a decline in real trade values, clearly above the average, as did the imports attributed to the electrical machinery industry (NACE 31) and the radio and television industry (NACE 32). The same is, however, true for a series of other industries with hardly any trade in parts and components such as publishing and printing (NACE 22), rubber and plastics (NACE 25), mineral products (NACE 26) and basic metals industry (NACE 27). Moreover, the transport equipment industry (NACE 35) registered a below-average decline on the import side.

Thus, Figures 2.9 and 2.10 indicate only a very weak negative correlation between the industries' decline in exports and imports respectively during the crisis. The share of parts and components trade lends limited support to the composition effect as the principal explanation for the strong decline in parts and components trade and the related loss in the relative importance of this goods category in overall exports and imports.

Moreover, Figure 2.11 shows that the crisis also led to a decline in the share of parts and components in overall EU-27 trade in almost all industries where vertical supply chains play a major role, such as the electrical machinery industry (NACE 31), the mechanical equipment industry (NACE 29) and the motor vehicles industry (NACE 34).

Figure 2.11: Index of real export values against share of parts and components trade of individual industries. Decline from Sep 2008 to post-crisis industry low



Source: Eurostat COMEXT, wiiw-calculations.

This picture supports the hypothesis that some of the established international supply chains were disrupted. This could be the result of changes in the sourcing strategies of multinational corporations, such as shifting to domestic suppliers or *re-onshoring* of previously offshored activities. With respect to the decline in the share of parts and components at industry level in

[16] Since figures 2.7 and 2.8 measure the industries' total export and import indices, the trade declines are equal to 100 minus the respective index number.

overall EU-27 trade, a third factor, inventory adjustments, may explain developments. While inventories may certainly influence developments of trade values in intermediate goods in the short term, they are unlikely to be the major factor, because trends towards just-in-time delivery for production reduce the impact of inventory adjustments on developments of exports and imports. Moreover, trends for semi-finished goods do not show the same patterns as parts and components; this also supports the case of potential change in the structure of trade with respect to trade in parts and components.

2.5. Summary and conclusions

The analyses of trade in intermediates point towards their relative importance compared to other product categories and their dynamics over time. The share of intermediate imports in total EU-27 trade amounts to around 55 percent of total trade. Trade in intermediates is not too distinct from trade in other product categories despite its relative importance and its nature.

The study shows that the shares of imported intermediates in total trade are rather stable for each industry, and that there is a high correlation of these shares across countries at industry level. This suggests that specialisation patterns might play an important role in explaining cross-country differences and changes over time. The analyses showed that there has been a general trend towards increasing shares of trade in intermediates over time. The slightly larger increase in trade in intermediates as compared to other product categories is mostly due to a shift towards more knowledge-intensive industries in which imports of intermediates are more important than in other industries.

Some important changes in intermediates trade have occurred over the last decade with respect to the geographical structure of trade. Considering EU-27 imports first, a common trend is that the EU-15 countries, the advanced OECD countries, and the Asian countries have lost market shares in all product categories, whereas the EU-12 countries and the BRIC countries have gained market shares. A striking aspect is that these shifts can be observed across all industry categories. In particular, import shares from BRIC countries increased relatively strongly in high-tech industries at the expense of EU-15 and advanced OECD countries, whereas EU-12 gained mostly in high-tech consumer goods. The shifts are similar for other industry categories, but less pronounced. A similar pattern can be observed for EU-27 exports, with rising export shares observed for EU-12 and BRIC countries.

Overall, the analysis suggests that the pattern of trade in intermediates and its change over time tend not to be too different from other product categories, despite its more complex role as an input in the production process. As such, there seems to be no requirement for specific or distinct policies with respect to different product categories. The findings are suggestive of the importance of the international supply of products used in production processes which have to be taken into account in any bilateral policy measures. A further finding is that the industry dimension, i.e. specialisation patterns, shapes general patterns and volumes of trade in intermediates for individual countries. In some cases, the results indicate that trade in intermediates might serve as an important vehicle for successful trade integration into world markets, and may allow countries to overcome adverse initial specialisation patterns, thus allowing for dynamic shifts in comparative advantage structures through learning effects. Countries such as China (but also others) show particularly dynamic patterns in higher-tech industries or products, not only with respect to consumer goods, but also intermediate products.

The analyses show that most countries are both exporters and importers (i.e. the share of two-way trade is quite high) even at detailed industry levels. Smaller emerging economies, i.e, EU-12, are relatively more specialised in trade in intermediates as compared to other economies. Again, these specialisation patterns can be found both in imports and exports.

By using EU domestic and import symmetric input-output tables, analyses of the share of imported intermediate inputs in total intermediate inputs by industry were performed. The analyses were undertaken for both manufacturing and services industries. Imported intermediates are most important for high-technology manufacturing industries with an import share of about 55 percent. Imports of intermediates are also important in medium-high tech industries, where the import share amounts to 50 percent and to 48 percent in medium-low tech industries, but less so in low-tech industries, where only some 30 percent of input goods are imported. Again, there are quite substantial country differences indicating larger shares for small economies. These country differences seem to be more pronounced in high-tech industries. These shares, with a few exceptions, rose over the period 1995 to 2005. Regarding service industries, imports generally play a much less important role, ranging from around 16 percent in trade and hotels to about 26 percent in transport services. Differences across countries for services industries are smaller compared to manufacturing industries.

The analyses indicate an increase of the linkages between industries and countries over time. The increase in inter-industry linkages means that an industry facing an increase in demand requires more inputs from other industries to satisfy that demand than before. The increased industry linkages between countries mean that more of an industry's demand for inputs is satisfied from suppliers in another country than before. Calculations of output multipliers from the input-output tables show that there is an increase in the total output multipliers for the EU-15 economies, but a decrease for EU-12 economies, thus pointing to stronger inter-industry linkages for the former set of countries. When looking at domestic multipliers, the former group shows more or less constant multipliers, implying that increased imports of intermediates are the triggers for increased linkages in terms of multiplier effects.

Given the complexity of the production process and its international relations, aggregated trade data might not be the best source of information when aiming at a detailed analysis of supply chains at the level of firms or even products. In this case, detailed information of the unbundled supply chains in one particular case — Nokia 95 mobile phone — has been used to address these questions in more detail. It turns out that, on average, Europe captured 55 percent of the total value added. N95 was assembled both in Europe and China. When the device was assembled and sold in Europe, Europe's share of the value rose to 68 percent. Even when it was assembled in Beijing and sold in the US market, Europe captured as much as 51 percent of the value. The final assembly, although important, represents only a fraction of the overall value added of a high-tech product such as the mobile phone. The capture of value is largely detached from the physical flows of goods within the supply chain. Major parts of the value are attributed to design, R&D, brand, marketing and distribution, and management of these functions. The estimates based on trade statistics and national accounts tend to give a somewhat biased and inadequate picture of how value added spreads geographically. The only way to shed some light on the issue, given the availability of statistical data, is to conduct case studies. The black box needs to be opened to understand the very nature and consequences of production unbundling. The case study shows that an analysis which takes service flows into account and uses value-added-based information comes up with strikingly different conclusions on global trade flows than analyses which use gross values of flows of goods. This suggests that concerted efforts should be made to develop value-added-based trade statistics. The current system was developed for the 'old paradigm' globalisation, where trade and specialisation in the international economy was

based on comparative advantages of sectors. In order to dig deeper into the consequences of global trade in tasks, value-added-based data on trade flows are needed.

Finally, when analysing the impact of the crisis on EU-27 trade flows, a series of explanations has been offered for the trade collapse in the winter months of 2008/2009. The increasing role of trade in intermediates plays a central role in most of them. A first reason for this is the stylised fact that the larger share of trade in intermediates caused the income elasticity of trade to increase, which was reconfirmed here for EU-15 trade. One of the major results of the analysis is that parts and components were also the goods category worst affected by the crisis, standing at about 62 percent of its September 2008 volume at the peak of the crisis. As a result, the relative importance of parts and components in EU-27 trade declined, with the post-crisis share of parts and components in EU exports and EU imports declining by 2 percent and 1 percent respectively. This decline appears to be rather small, but when individual industries are considered, the changes become more pronounced for those with a high share of parts and components trade, reaching 7 percentage points for the share of parts and components in EU-27 exports in the electrical machinery industry. This result supports the hypothesis that some of the international supply chains established in the course of globalisation were negatively affected because of changes in the sourcing strategies of multinational firms in reaction to a less friendly trading environment.

The results of the analysis of parts and components trade also revealed that a composition effect is not the major explanation for the very pronounced slump in parts and components exports and imports of the EU-27. So, while the composition effect and possibly also inventory adjustments may have contributed to the more than proportionate decline in the exports and imports of parts and components, they seem to be insufficient to fully account for the changes seen. In any case, the severe decline in trade in parts and components is one of the elements explaining why the trade slump was even more pronounced than suggested by long-term income elasticity of trade. By viewing the recovery of trade flows, a rapid upturn in EU-27 trade could be expected if the strong decline in parts and components trade were primarily driven by the inventory cycle, as empty stocks have to be refilled. There is however a risk that the disruption of existing supply chains, caused by the financial crisis, may have a dampening effect on trade during the recovery.

REFERENCES

Araújo, S., (2009), *The great synchronisation: What do high-frequency statistics tell us about the trade collapse,* Paper presented at the 2nd WPTGS meeting, November 16-18, 2009, OECD, Paris.

Araújo, S., and Martins, J.O., (2009), *The great Synchronisatio: Tracking the trade collapse with high-frequency data*, http://www.voxeu.org/index.php?q=node/4290.

Ballassa, B., (1965), «Tariff protection industrial countries: An evaluation», *Journal of Political Economy*, 73(6), p. 573-94.

Chen, H., Kondratowicz, M., and Yi, K.-M., (2005), «Vertical specialization and three facts about U.S. international trade», *The North American Journal of Economics and Finance*, 15, p. 35-99.

Cheung, C., and Guichard, S., (2009), *Understanding the world trade collapse*, OECD Economics Department Working Papers No 279.

Eichengreen, B., and O'Rourke K.H., (2009), *A tale of two depressions*, http://www.voxeu.org/index.php?q=node/3421.

Escaith, H., and Gonguet F., (2009), *International trade and real transmission channels of Financial Shocks in globalized production networks*, WTO Staff Working Paper ERSD-2009-06.

European Commission (2009), *EU industrial structure 2009: Performance and competitiveness*, Enterprise and Industry DG, Brussels.

Eurostat (2008), *Eurostat Manual of Supply, Use Tables and Input-Output Tables*, Methodologies and Working Papers.

Evenett, S.J., and Venables, A.J., (2002), *Export growth by developing economies: Market entry and bilateral trade*, Mimeo.

Faust, M., Voskamp, U., and Wittke, V., (2004), *European Industrial Restructuring in a Global Economy: Fragmentation and Relocation of Value Chains*, SOFI Berichte, Soziologisches Forschungsinstitut an der Georg-August-Universität Göttingen.

Freund, C., (2009), *Demystifying the collapse in trade*, http://www.voxeu.org/index.php?q=node/3731.

Gaulier, G., Lemone, F., and Ünal-Kesenci, D, (2007), «China's emergence and the reorganisation of trade flows in Asia», *China Economic Review* 18, p. 209–243.

Greenaway, D., Hine, R.C., and Miller C.R., (1994), «Adjustment and the measurement of intra-industry trade», *Weltwirtschaftliches Archiv*, 130, p. 418-427.

Grossman, G.M., and Rossi-Hansberg, E., (2008), «Trading tasks: A simple theory of offshoring», *American Economic Review*, 98(5), p. 1978-1997.

Grossman, G.M., and Rossi-Hansberg, E., (2009), *Task trade between similar countries*, Unpublished Manuscript, *Princeton University.*

Grubel, P., and Lloyd, P., (1975), Intra-*Industry Trade: The Theory and Measurement of International Trade in Differentiated Products*, London: McMillan.

Hatzichronoglou, T., (1997): *Revision of the High-Technology Sector and Product Classification*, STI Working Papers 1997/2. Paris: OECD.

IMF (2010), *World Economic Outlook: Rebalancing Growth*, Washington D.C., April 2010.

Kraemer, K., and Dedrick, J., (2002), *Dell computer: Organization of a global production networ*k, Unpublished Manuscript, Personal Computing Industry Center, UC Irvine.

Linden, G., Kraemer, K., and Dedrick, J., (2007), *Who captures value in a global innovation system?, The case of Apple's iPod*, Unpublished Manuscript, Personal Computing Industry Center, UC Irvine.

Loschky, A., (2008): *Reviewing the Nomenclature for High-Technology Trade – The Sectoral Approach*, STD/SES/WPTGS(2008)9, OECD and European Commission, DG Joint Research Centre.

Miroudot, S., Lanz, R., and Ragoussis, A., (2009), *Trade in intermediate goods and services*, TAD/TC/WP(2009)1, OECD, Paris.

Rivoli, P., (2005), *A Travel of a T-Shirt in the Global Economy*, New Jersey: John Wiley and Sons.

Stehrer, R., Ali-Yrkkö, J., Hanzl, D., Foster, N., Rouvinen, P., Seppälä, T., Stöllinger, R., and Ylä-Anttila, P., (2010), *Trade in Intermediate Products and EU Manufacturing Supply Chains*, Study within the Framework Service Contract B2/ENTR/05/091-FC.

Tempest, R., (1996), *Barbie and the world economy*, *Los Angeles Times*, Sept. 22.

Timmer, M., O'Mahony, M., and van Ark, B., (2008), The EU KLEMS Productivity Accounts: An Overview, www.euklems.net

Varian, H.R., (2007), *An iPod has global value: Ask the (many) countries that make it*, *The New York Times*, June 28.

Vollrath, T.L., (1991), «A Theoretical Evaluation of Alternative Trade Intensity Measures of Revealed Comparative Advantage», *Weltwirtschaftliches Archiv*, 130, p. 265–279.

ANNEX

Data and classifications

Trade statistics

The analysis is firstly based on the EU COMEXT trade database which provides data at the detailed CN 8-digit level. The analysis is restricted to the period 1999-2008. This database provides information on export and imports at the detailed CN 8-digit product level with all other countries in the world as partner countries. The CN 8-digit nomenclature includes about 11500 product codes on average per year for which data on both values and quantities (in kilograms) of imports and exports are available. The information on the quantities traded is later on used to calculate unit values or unit value ratios. One important aspect is that the CN 8-digit classification is slightly changed every year, thus an average of about 500 product codes are replaced per year, though the overall number of products in the nomenclature is roughly constant. Whenever these changes in classification pose some problems, these are circumvented by aggregating the data to the CN 6-digit level which corresponds to the HS 6-digit classification for which the revisions are less problematic. For the detailed product-level data, correspondences exist to NACE industries (at the 2 and 3-digit level) and to end-use categories known as 'Broad Economic Categories' (BEC) classification as provided by UN. Table A.1 shows the list of BEC categories. At the 1-digit level there are seven categories classified which are broken down in primary goods and processed goods in the case of the first three 1-digit product categories, parts and accessories as a subgroup of capital goods and transport equipment goods; in this latter category, passenger motor cars are included. At the 3-digit level, part of the groupings are further classified, whether the products are mainly used by industry or for household consumption. This more detailed classification of products allows one to aggregate up to somewhat higher aggregates to consider trade in intermediates, in final consumer goods, and capital goods separately. There are, however, various ways how this aggregation is to be done exactly and various suggestions are made in the literature. This study follows the definitions as suggested by OECD which is shown in table A.3, see Miroudot et al., 2009, for an example[17]. The table provides evidence that this classification is not a one-to-one correspondence as many products might be used by households for final consumption as well as by industries as inputs in the production process. The most important example for this might be passenger cars, which are therefore not classified. Together with motor spirits (BEC 321) this category is, however, reported separately.

Note that this is a rather broad definition of trade in intermediate products, as it also includes primary products (111, 21, 31) as intermediates. An example would be milk produced in country A and exported to country B for the production of cheese[18]. This broad definition is used in most parts of the study; however, whenever it is advantageous, a more narrow definition is used, by separating single BEC codes or groups of these.

[17] Examples for slightly different classifications are Gaulier et al. (2007) or Frensch and Wittich (2009).

[18] There are many definitions of supply chains. All of them share this broad view as expressed in the following statement: 'Entire network of entities, directly or indirectly interlinked and interdependent in serving the same consumer or customer. It comprises of vendors that supply raw material, producers who convert the material into products, warehouses that store, distribution centers that deliver to the retailers, and retailers who bring the product to the ultimate user.' (http://www.businessdictionary.com/definition/supply-chain.html).

Table A. 1: BEC classification

1-digit	Description	2-digit	Description	3-digit	Description	
1	Food and beverages	11	Primary	111	Mainly for industry	Intermediates
				112	Mainly for household consumption	Consumption
		12	Processed	121	Mainly for industry	Intermediates
				122	Mainly for household consumption	Consumption
2	Industrial supplies n.e.s.	21	Primary			Intermediates
		22	Processed			Intermediates
3	Fuels and lubricants	31	Primary			Intermediates
		32	Processed	321	Motor spirit	Not classified
				322	Other	Not classified
4	Capital goods (except transport equipment) and parts and accessories thereof					Capital goods
		41	Capital goods			
		42	Parts and accessories			Intermediates
5	Transport equipment and parts and accessories thereof	51	Passenger motor cars			Not classified
		52	Other	521	Industrial	Capital goods
				522	Non-Industrial	Consumption
		53	Parts and accessories			Intermediates
6	Consumer goods n.e.s	61	Durable			Consumption
		62	Semi-durable			Consumption
		63	Non-durable			Consumption
7	Goods n.e.s					Consumption

An additional aspect concerns the detailed list of partner countries. As it is not possible to show the relevant figures for all partner countries, it is necessary to build country groups. The country groups considered are listed in table A.2.

Table A.2.: Country groupings

EU-15	Old Member States
EU-12	New Member States
AOECD	Advanced OECD
ASIA	Asia
BRICS	BRICs
RoW	Rest of World

EU-15 includes all countries being members of the EU since 1995, EU-12 includes all countries having joined the EU in 2004 or later (thus this group includes all Central and Eastern European countries together with Cyprus and Malta); EU-15 and EU-12 together is denoted EU-27. Further, there is a set of advanced OECD countries not included in EU-15 or EU-12 (Australia, Canada, Switzerland, Iceland, Japan, Norway, New Zealand, US), a group of Asian countries including Hong Kong, Indonesia, South Korea, Macau, Malaysia, Philippines, Singapore, Thailand, Taiwan and Vietnam, the BRIC countries (Brazil, Russia, India, and China) and finally a Rest of World category (RoW).

In some cases, trade data from UN COMTRADE at the detailed HS 6 product level are used. There exists also a correspondence to BEC categories for these data. This database allows the inclusion of other countries as reporter countries in the analysis.

Data from input-output tables

The analysis in Section 3 is based on the EU KLEMS data, which distinguish intermediates input by energy, material and services. These data are based on the respective use tables for each country and allow inclusion of 19 countries in the analysis. Here, the focus is mainly on the inputs of services in manufacturing and on material inputs in services. One should note that this analysis is based on nominal values. Total and domestic input-output tables provided by Eurostat are used to calculate the share of imported intermediates by industry. See Eurostat (2008) for a detailed outline of the compilation of European supply and use and symmetric input output tables. The manufacturing industries are grouped into four groups which are listed in table A.3.

Table A.3: Industry classification

NACE	Description	Group
15	Manufacture of food products and beverages	Low
16	Manufacture of tobacco products	Low
17	Manufacture of textiles	Low
18	Manufacture of wearing apparel; dressing and dyeing of fur	Low
19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	Low
20	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	Low
21	Manufacture of pulp, paper and paper products	Low
22	Publishing, printing and reproduction of recorded media	Low
23	Manufacture of coke, refined petroleum products and nuclear fuel	Medium low
24	Manufacture of chemicals and chemical products	Medium high
25	Manufacture of rubber and plastic products	Medium low
26	Manufacture of other non-metallic mineral products	Medium low
27	Manufacture of basic metals	Medium low
28	Manufacture of fabricated metal products, except machinery and equipment	Medium low
29	Manufacture of machinery and equipment n.e.c.	Medium high
30	Manufacture of office machinery and computers	High
31	Manufacture of electrical machinery and apparatus n.e.c.	Medium high
32	Manufacture of radio, television and communication equipment and apparatus	High
33	Manufacture of medical, precision and optical instruments, watches and clocks	High
34	Manufacture of motor vehicles, trailers and semi-trailers	Medium high
35	Manufacture of other transport equipment	Medium high
36	Manufacture of furniture; manufacturing n.e.c.	Low

Note*:* the classification of industries in technology intensities is based on Hatzichronoglou (1997 and Loschky (1998).

Monthly trade statistics

The analysis of the trade collapse (Section 4) builds on detailed (CN8 digit level) monthly trade data for the EU-27 from the COMEXT database, which provides the same level of detail as the yearly trade data described above. However, this section opted for a more refined categorisation of end-uses, which is more relevant for the analysis of the trade collapse. In particular, the analyses in section 4 follow the approach in Gaulier et al. (2007), and separate the broad category of intermediates of the OECD classification in *(i)* primary goods, *(ii)* semi-finished goods and *(iii)* parts and components (P&C). The two groups of final goods, capital goods and consumption goods are treated separately in line with OECD. Another important difference in this classification is that product groups for passenger cars (BEC category 51) are subsumed under consumption goods (instead of the catch-all group of category 'not classified' or 'mixed'). This finer split-up of intermediates is motivated by the fact that — though all intermediate goods enter the production process — the crisis reaction was very different for various categories of intermediates. Location and sourcing decisions for primary goods are probably quite different to those for parts and components, which also include a high share of inter-company trade of multinationals. The analysis of trade in parts and components which, in contrast to primary and semi-finished goods, include a high share of technologically sophisticated goods may in general be a more appropriate proxy for vertical specialisation *within* particular industries[19].

Calculations of unit value ratios

The value of exports to the EU-27 of commodity i by country c in year t is denoted by v_{it}^c and the quantity (measured in tons) by q_{it}^c, the export unit value is defined as

$$u_{it}^c = \frac{v_{it}^c}{q_{it}^c}$$

The unit values of country c's exports to the EU are then compared to the unit values of total EU imports (from the world, including intra-EU trade) by calculating the logs of the unit value ratios

$$r_{it}^c = \ln \frac{u_{it}^c}{u_{it}^{EU-27}}$$

Here, $u_{it}^{EU-27} = \sum_c v_{it}^c \Big/ \sum_c q_{it}^c$ denotes the unit value of total EU imports for a particular commodity i in year t. Taking the logarithm ensures a symmetric aggregation across products for ratios larger and smaller than 1 (see below). In logs, the ratio is thus larger (smaller) than zero if the export unit value of country c is larger (smaller) than the unit value of total EU imports. The unit value ratios to the level of product categories and industry groups are aggregated. This is done by constructing a weighted sum of the unit value ratios r_{it}^c across the products belonging to a particular industry group j and product group *k*. The weight used for a particular commodity i in such an aggregation is the share of its export value in the industry's or product group's exports of country *c*. Denoting the set of commodities i belonging to an aggregate j,k by $i \in I(j,k)$ the weights are calculated as

[19] Trade statistics as used here, in fact, only allows revealing intra-industry vertical specialisation because products are always allocated to the industry that typically produces this product and not to the industry where it is used for production purposes.

$$w_{it}^{c} = \frac{v_{it}^{c}}{\sum_{k \in I(j,k)} v_{(j,k)t}^{c}}$$

The unit value ratio for a particular aggregate j,k is then

$$r_{(j,k),t}^{c} = \sum_{i \in I(j,k)} w_{it}^{c} r_{it}^{c}$$

This measure can be interpreted analogously to the unit value ratios for a particular commodity as mentioned above. Since this exercise is performed for groups of partner countries (i.e. countries exporting to the EU-27), index c has to be interpreted as a group of partner countries (e.g. Asian countries, BRIC countries, etc.).

The market shares of a particular country (group) c in EU-27 markets (or individual countries or country groups) is defined as

$$m_{(j,k),t}^{c} = \frac{v_{(j,k),t}^{c}}{v_{(j,k),t}^{EU-27}}$$

i.e. the export values from country c of product category (j,k) relative to total import values of EU-27.

For exports of the EU-27 a similar exercise is performed. However, one has to keep in mind that using the EU COMEXT database does not allow use of total exports to the world (from all countries) as a unit for comparison as this dataset provides information on exports and imports of EU-27 countries only, thus excluding trade flows between non EU members. Consequently, the unit value ratios for exports is defined as

$$r_{it}^{c} = \ln \frac{u_{it}^{c}}{u_{it}^{EU-27}}$$

where u_{it}^{c} denotes the unit value of exports for country c being a member of the EU-27 and u_{it}^{EU-27} denotes the unit value of total EU-27 exports to the world. Export shares are defined as the share of country c's exports to the world in total EU-27 exports in the respective product and industry categories.

Table A.4: Change in import values and import shares by end-use categories

	Index 1999=1				Change in import shares (in percentage points)			
	Intermediates	Consumer goods	Capital Goods	Not Classified	Intermediates	Consumer goods	Capital goods	Not Classified
AT	1.90	1.67	1.60	1.59	3.81	-1.25	-1.88	-0.68
BE	1.92	2.32	1.70	1.95	-1.64	3.67	-1.93	-0.10
BG	5.04	5.18	5.26	4.31	-0.17	0.45	0.85	-1.13
CY	3.09	2.31	1.99	4.11	5.64	-5.12	-4.67	4.15
CZ	3.55	3.58	3.28	3.14	1.10	0.45	-1.22	-0.33
DE	1.92	1.42	1.59	1.20	6.79	-3.63	-1.12	-2.04
DK	1.77	1.85	1.69	1.71	-0.04	1.12	-0.92	-0.16
EE	3.16	2.97	2.68	7.48	-1.29	-2.03	-3.13	6.45
ES	2.09	2.33	1.47	1.31	3.98	3.92	-4.60	-3.29
FI	1.83	1.91	1.80	2.50	-1.31	0.36	-0.87	1.83
FR	1.59	1.65	0.99	1.59	4.23	2.90	-7.63	0.50
GB	1.27	1.58	1.19	1.17	-1.73	4.59	-1.90	-0.96
GR	1.77	2.14	1.51	1.49	-0.50	5.60	-3.75	-1.35
HU	2.35	2.51	2.75	3.56	-3.37	0.15	1.93	1.29
IE	1.09	1.84	1.16	1.12	-6.12	8.42	-1.76	-0.54
IT	1.67	1.80	1.30	1.30	2.50	2.58	-3.23	-1.85
LT	3.87	3.78	4.45	7.69	-3.10	-2.26	1.46	3.91
LU	1.98	1.46	3.00	1.96	-2.44	-6.77	9.76	-0.55
LV	3.91	3.55	3.34	5.41	1.66	-1.69	-2.40	2.42
MT	1.06	1.48	1.15	1.20	-5.77	5.71	-0.08	0.14
NL	1.98	1.78	1.90	1.33	2.57	-1.19	0.22	-1.61
PL	3.09	3.08	2.89	3.21	0.74	0.16	-1.14	0.24
PT	1.45	1.54	1.25	1.00	1.99	2.55	-1.83	-2.70
RO	4.87	5.65	6.67	35.18	-8.44	0.06	3.32	5.06
SE	1.84	1.87	1.58	1.38	2.27	1.25	-2.07	-1.45
SI	2.69	2.41	2.40	3.09	1.38	-1.49	-1.48	1.58
SK	5.02	4.64	4.41	5.23	2.04	-0.80	-1.59	0.34
EU-27	1.85	1.82	1.55	1.49	2.75	0.74	-2.38	-1.12

Source: Eurostat COMEXT; wiiw calculations.

Table A.5: Change in export values and export shares by end-use categories

	Index 1999=1				Change in export shares (in percentage points)			
	Intermediates	Consumer goods	Capital Goods	Not Classified	Intermediates	Consumer goods	Capital goods	Not Classified
AT	1.98	2.10	2.34	1.62	-1.99	0.48	2.71	-1.21
BE	2.01	2.26	1.68	1.33	1.77	3.59	-1.69	-3.67
BG	4.92	2.78	5.17	8.69	8.75	-12.87	1.53	2.58
CY	2.49	1.91	2.33	19.82	3.27	-8.68	0.35	5.06
CZ	3.60	3.80	5.91	3.67	-5.77	-0.70	7.14	-0.67
DE	1.96	2.11	1.88	1.65	0.89	1.45	-0.51	-1.83
DK	1.91	1.48	1.45	2.82	5.92	-3.85	-2.74	0.67
EE	3.70	2.57	3.63	119.95	0.10	-9.13	-0.20	9.22
ES	1.97	1.97	1.63	1.39	3.81	1.84	-1.44	-4.21
FI	1.36	1.93	1.68	2.66	-6.91	1.50	2.96	2.45
FR	1.41	1.52	1.00	1.18	3.44	3.38	-6.12	-0.69
GB	1.24	1.36	0.87	1.52	1.84	2.69	-6.52	2.00
GR	2.09	1.27	2.50	0.70	10.07	-12.32	3.06	-0.81
HU	2.65	2.54	4.09	3.65	-5.44	-3.26	7.34	1.36
IE	1.28	2.16	0.94	0.21	-3.68	11.37	-7.35	-0.34
IT	1.76	1.43	1.59	1.75	3.80	-3.68	-0.37	0.24
LT	6.66	3.69	12.36	11.46	3.31	-15.33	5.96	6.06
LU	1.62	1.32	6.77	1.96	-18.67	-6.48	25.42	-0.28
LV	3.54	3.72	10.04	6.09	-7.34	-2.00	8.20	1.14
MT	0.96	0.99	1.06	14.09	-2.11	0.17	0.59	1.34
NL	2.35	1.90	2.09	2.05	4.01	-2.89	-0.91	-0.20
PL	4.88	3.81	4.90	6.40	3.10	-5.80	0.83	1.86
PT	1.78	1.13	1.90	0.89	9.77	-8.12	2.69	-4.34
RO	5.35	2.04	7.18	13.26	12.52	-22.99	5.33	5.14
SE	1.60	1.71	1.30	1.67	1.83	1.44	-3.74	0.47
SI	2.84	2.22	3.51	3.85	0.27	-6.16	2.49	3.41
SK	4.30	6.72	5.65	5.59	-8.59	5.85	1.13	1.61
EU-27	1.87	1.84	1.64	1.69	1.99	0.46	-1.94	-0.51

Source: Eurostat COMEXT; wiiw calculations.