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Global Value Chains and the EU Industry

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Focusing on four important manufacturing industries (chemicals, chemical products and man-made fibres; machinery and equipment; electrical and optical equipment; and transport equipment) the ongoing trends of the internationalisation of production is studied. To account for the multi-faceted phenomenon of the internationalisation of production processes and its consequences, a comprehensive review of the literature is provided first. This is followed by an overview of the patterns and trends in vertical specialisation across countries for the four selected industries. This section is based on the World Input-Output Database (WIOD), which allows the integration of production patterns and processes to be studied at a global level. As this is accompanied by similar trends in trade before and over the crisis the next section focuses on the changes in trade patterns of these industries which is based on detailed Harmonised System (HS) 6-digit trade data allowing for a differentiation between use categories of products: trade in parts and components is important for the machinery and equipment, electrical and optical equipment and transport equipment industries, while trade in semi-finished products is important for the chemicals industry.

As the offshoring decisions are made at company level it is important to understand the motives leading firms to offshore, the drivers of the decisions with respect to characteristics of the host and the destination country and the characteristics of the offshoring firms. Section 5 therefore focuses on the offshoring decisions at the company level: it analyses the motives and determinants of company strategies with respect to the relocation of production. Section 6 provides a summary.

Keywords: *vertical integration, trade in intermediates, offshoring*

JEL classification: *F1, F15, F19*

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Global value chains and the EU industry

1. Introduction

The ongoing globalisation has altered the economic landscape: uncertainty over future trends in the aftermath of the global crisis has become more important. Many products used to be produced locally using inputs drawn largely from the domestic economy, which implied that most of the value chains or production processes used to be located in the country where a firm had its headquarters. Technological development has facilitated the geographical fragmentation of production processes, resulting in the emergence of global value chains. Different parts of a firm's production processes can now be located in different parts of the world, according to the comparative advantages of the locations. This 'slicing up of the value chains' (and the dispersal of the various elements to different parts of the world) has given rise to increased trade. A large share of this trade is intra-firm trade in intermediate goods, conducted by multinational firms. The use of imported intermediate goods in manufacturing industries has increased globally, thereby involving more industries and countries in the value chains.

The increasingly important role of global value chains for EU industry is emphasised in the EU flagship initiative 'An integrated industrial policy for the globalisation era' which states: 'The EU needs to pay greater attention to the manufacturing value-chain … [I]ndustry is increasingly dependent on inputs of raw material and intermediate goods, and is also crucially dependent on the business services industries that add value and help to design and market new goods and services. This new perspective requires a different approach to industrial policy that takes increased account of the interlinkages' (European Commission, 2010). A number of policy areas that would facilitate EU enterprises' ability to reap the benefits of globalisation and to compete on global markets are identified.

The design of appropriate policies to meet the requirements of the new perspective requires the collection of research findings and data in a number of areas on which this report focuses:

- What have been the main changes in industries' value chains since 1995? The study provides information on inter-industry and inter-regional linkages within the EU (split into the EU-15 and the EU-12 to account for the important integration process) and in extra-EU relations. Also inter-industry and inter-regional linkages for the US, Japan, the BRIC countries and other countries (such as Mexico, Canada, Korea, etc.) are analysed. Specifically there is a focus on such questions as:

- What is the scale and the role of international fragmentation of production in the four selected industries, and how have these changed over time?
- Which countries have become more important, and is this differentiated with respect to different industries?
- What are the main differences across the major industrialised countries and within the EU?
- What is the role of vertical specialisation with respect to the value added captured by an economy?
- What are the effects of energy efficiency in the production of exports?

- The effects on trade of the ongoing economic crisis that broke in 2008 and since then has triggered volatile and heterogeneous developments across countries and industries. The focus is on changes in the supply structures with respect to traded intermediates in selected industries and whether the crisis has led to a change in the structure of vertical specialisation and supply chains.
  - Has the crisis had a differentiated impact on consumption goods versus investment and intermediates?
  - Have trade structures changed during the crisis (intensive vs. extensive margins)?
  - Has there been a change in geographical sourcing structures?

- The offshoring decision is made at company level. Thus it is important to understand the motives leading firms to offshore, the drivers of the decisions with respect to characteristics of the host and the destination country and the characteristics of the offshoring firms. Therefore, based on company surveys the following questions are addressed:
  - How many and which European manufacturing companies have relocated parts of their production abroad? What types of firms are more likely to offshore? Is offshoring a phenomenon that is restricted to large firms, or are small and medium-sized enterprises (SMEs) also offshoring some of their activities?
  - What are the preferred target countries for the production relocation of European manufacturing companies? What are the motives for production relocation to these countries? How is offshoring related to framework conditions in the different locations?
  - Has the propensity of firms to offshore production activities changed in recent years? Of particular interest is whether offshoring has decreased or increased due to the 2008/09 economic recession.
  - How is offshoring related to R&D, innovation, company performance and the production processes of firms? Does offshoring hollow out firms and endanger their long-term competitiveness, or does it help firms to become more flexible and productive?

These questions are addressed by focusing largely on four important manufacturing industries, classified according to NACE Rev. 1.1: chemicals, chemical products and man-made fibres (DG), machinery and equipment (DK), electrical and optical equipment (DL) and transport equipment (DM). To account for the multi-faceted phenomenon of the internationalisation of production processes and its consequences, a comprehensive review of the literature is provided . The first batch of questions is tackled in Section 3, which provides an overview of the patterns and trends in vertical specialisation across countries for the four selected industries. This section is based on the World Input-Output Database (WIOD), which allows the integration of production patterns and processes to be studied at a global level. Section 4 focuses on the changes in trade patterns of these industries by geography, and is based on detailed Harmonised System (HS) 6-digit trade data. This allows differentiation between use categories of products: trade in parts and components is important for the machinery and equipment, electrical and optical equipment and transport equipment industries, while trade in semi-finished products is important for the chemicals industry. Section 5 focuses on the offshoring decisions at the company level: it analyses the motives and determinants of company strategies with respect to the relocation of production. Section 6 provides a summary.

2. A review of the related literature

2.1 Introduction

The perceived – and feared – economic consequences for advanced economies of the ongoing global dispersion of production have resulted in a wealth of conceptual and analytical papers that describe and analyse the implications of global structural shifts in production processes.

By focusing on *governance* and on *value capture*, global value chain (GVC) analyses have moved beyond the product and industry perspectives of trade and foreign direct investment (FDI) analyses. Instead of simply ringing alarm bells because of offshoring-related job losses, GVC analyses allow a precise identification of changes in the value-adding activities of developed regions or economies (and of the mechanisms for the upgrading of developing economies and 'GVC integration'-driven modernisation). Thereby the GVC perspective can rather explicitly highlight the impact of production fragmentation on the competitiveness of regions or economies, and also the mechanisms through which changes in competitiveness become manifest.

This literature review focuses on a well-delineated part of the GVC literature: on the changes in the GVC activities, and consequently in the competitiveness of advanced economies in general, and of the European Union's industry in particular.

Starting with a summary of the analytical background, there is a review of the emergence and evolution of the GVC framework of analysis in general, and of the trade-in-task perspective in particular. This is followed by a survey of the literature on the impact of offshoring, with a particular emphasis on one of the key drivers of the new globalisation wave: the offshoring of business services. This is complemented by a survey of patterns of changing specialisation in the old and new paradigms, as argued in Baldwin (2006, 2011), with a special focus on the changing specialisation within GVCs of advanced-economy actors. Next, the review focuses on the literature that assesses Europe's position in terms of the intangible constituents of GVCs; it concludes with a survey of recent papers on crisis-induced transformations in GVCs and the implications thereof for EU industry.

Before embarking on the literature overview, it is worth mentioning a caveat with respect to the position of European industry in the *global* value chain. Substantial empirical literature demonstrates that, despite the rapidly increasing volume of global trade, trade is still regional rather than global (Rugman and Verbeke, 2004a,b; Oh, 2009; De Backer and Yamano, 2011) and European industry is particularly regionalised. Using World Trade Organization (WTO) data, Dicken (2011: 19–20) calculated that – in contrast to Asia, where more than half of total trade is extra-regional, or North America, where the figure is approximately 50% – in Europe three-quarters of all trade is intra-regional.[1] According to Dunning et al. (2007), however, Europe's extra-regional equity involvement exceeds the level of its extra-regional trade involvement. This finding is rejected by Oh (2009), who developed comprehensive measures for intra-regional activity and showed that European firms are predominantly regionally focused in terms of both sales and assets. It is no surprise that, according to Jacoby (2010), in Europe's case the mechanism of 'managing globalisation is managing Central and Eastern Europe'.

EU enlargement was supposed to result in increased regional integration. However, according to recent empirical analyses (Curran and Zignano, 2010; Behar and Freund, 2011) there is no evidence that enlargement has enhanced the regionalisation of EU trade. Both papers tried to explore the regionalisation dynamics of EU trade by analysing trade flows in intermediate products. They found that, although old Member States' sourcing from new EU Member States (NMS) has expanded considerably (albeit with significant industry and country-level divergence), the share of the NMS in the EU's total intermediate trade has not increased. The reason for this is that extra-EU imports have surged as well, underscoring the increasing importance for Europe of global value chains, rather than intra-EU value chains.

[1] The term 'regionalised' refers to the home-region focus of actors in the broad 'Triad region' (EU, Japan and US), and 'region' in the case of Europe refers to EU-27 countries.

In summary, EU industry is still predominantly regionally integrated,[2] although over the past decade the *global* aspects of GVCs have evolved in tandem with the regional aspects: the trade and investment integration with Central and Eastern Europe.

2.2 The GVC framework of analysis and 'trade in tasks'

The decline in transportation, communication and coordination costs has accelerated a long ongoing process: the fragmentation and geographical dispersion of production (Feenstra, 1998; Arndt and Kierzkowski, 2001). Globalisation-induced increases in the depth and scope of offshoring and outsourcing (facilitated by advances in information and communication technology (ICT) and by organisational innovation)[3] have produced important changes in the organisation and governance of the global economy.

Numerous studies describe and analyse the new features of the global economy. One strand of international research is concerned with the trade impact of the enhanced division of labour. Scholars have investigated (i) changes in the trade elasticity of output and the underlying reasons (see Escaith et al., 2010 and the references therein); (ii) the co-movement of manufacturing exports and imports (OECD, 2010); (iii) the dynamics of the share of intermediates within total trade (large and somewhat controversial – metrics-dependent evidence in this respect is surveyed by De Backer and Yamano, 2011).

A voluminous literature investigates the increases in offshoring, the changing patterns of vertical specialisation, and its impact on the world income distribution (the next sub-section provides a detailed literature overview).

In contrast to trade-based analyses, the point of departure for scholars investigating the transformation of the global economy from an organisational perspective (using firms and inter-firm networks as the central unit of analysis – Gereffi, 2005) is that the simple increases in the volume of integrative trade and in the geographical spread of economic activities cannot be regarded as the key feature of the recent global transformation. The key novelty is rather the *functional integration* of globally dispersed activities (Dicken, 2003). A related strand of the literature emphasises the *relationship-specificity* of investments that

[2] The degree of regional integration has important policy implications. On the one hand, there is a strong perceived link between global integration and productivity, though the direction of causality is ambiguous (Curran and Zignano, 2010). This finding is rejected, however, by scholars who draw on the theses of the transaction cost theory. Representatives of this latter research strand (surveyed by Banalieva et al., 2012) argue that the home region is associated with lower transaction costs than are geographically distant markets. Hence, home-region focus produces efficiency gains for multinational corporations (MNCs).

[3] Organisational innovations are oft-forgotten though crucial aspects of industries' globalisation. Most papers mention only the radical decline in the costs of processing and transmitting information, together with the development of product standards and business protocols. Thereby the codification of transactions has become easier (cf. Gereffi et al., 2005), which has facilitated the coordination of complex activities from a long distance and contributed thereby to the spread of GVCs.

GVC actors make in order to get integrated into GVCs (Nunn, 2007). According to this strand, the global business environment can be regarded as a web of relationships, rather than as a neoclassical market, with independent suppliers and customers (Johanson and Vahlne, 2009). Hence, in this business model the global economy is structured around GVCs.

The GVC framework of analysis[4] focuses on sequences of value added, from product concept to end use. Thereby it moves beyond scrutinising merely the distribution of production activities (and related flows of trade in intermediates) and investigates all the activities of firms' value chains, including production-related support activities and activities that enhance the intangible value of products. Hence, the GVC framework incorporates (and contributes to) a better understanding of trade in business services, a constituent of global trade whose volume is expanding at a tremendous rate (Gereffi and Fernandez-Stark, 2010).

Evergreen research questions[5] are re-examined with the help of the GVC methodology, and this perspective refines and sheds new light on perennial debates. One of these concerns the make-or-buy decisions of firms and investigates the extent of unbundling.[6] Scholars trying to extrapolate from recent trends (the point of departure being that technological advances have made production tasks increasingly separable, tradable and offshorable, which has resulted in an ever finer division of labour) argue that global shifts in production will continue, and that, with a steady increase in the number of 'footloose tasks', more and more activities will disperse and move to low-cost economies (Friedman, 2005).

Ketokivi and Ali-Yrkkö (2009: 35) reject this argument, contending that 'as knowledge intensity of economic activity increases, the unbundling of several functional activities may no longer be possible: R&D, innovation, design, and branding may be activities that are intimately related with the manufacture of physical products'.

In fact, a claim that lies between these two poles – i.e. that the *technical feasibility* of offshoring will not automatically boost a progressive fragmentation of global value chains – is

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4 Various terminologies have been employed as antecedents of (or to complement) the term 'GVC', including global production networks (Ernst and Kim, 2002), global commodity chains (Gereffi, 1999; Gereffi and Korzeniewicz, 1994), global production sharing (Yeats, 1997) and business networks (Johanson and Vahlne, 2009).

5 The main focus of GVC-based investigations includes issues such as globalisation, economic competitiveness, (changes in) the geographic location of various value-adding activities, governance in intra- and inter-firm networks, institutional aspects that shape local actors' competitiveness, upgrading and learning through networks (Gereffi, 2005, provides a comprehensive survey of the literature). Recent new research questions addressed from a GVC perspective include labour regulations and workforce development (e.g. Gereffi et al., 2011), and environmental aspects (Bolwig et al., 2010; *Riisgaard et al.*, 2010), development, poverty and social upgrading (www.capturingthegains.org).

6 According to Baldwin (2006), globalisation and the slicing up of value chains proceeded in two waves. The first unbundling – 'the end of the necessity of making goods close to the point of consumption' – started with the technological advances of the first industrial revolution, which have led to the first dramatic fall in transportation costs and consequently to an explosion in trade. The recent wave of globalisation that started a couple of decades ago (in the 1980s) triggered the second unbundling: 'the end of the need to perform most manufacturing stages near each other'.

gradually gaining acceptance. Drawing on systematic data compilation about whether the activities that are, in principle, prone to offshoring had actually been offshored, Lanz et al. (2011: 33) assert, that with an opening up to the possibility of trade in tasks, the pendulum is not swinging back towards Taylorism'.[7]

With digitisation, codification and modular product architecture, more tasks are becoming *commoditised* than ever before. Nevertheless, while offshoring increases transaction and coordination costs, keeping tasks together produces economies of scope (Larsen et al., 2011), coupled with intrapersonal task complementarities,[8] that yield non-negligible synergy effects. Moreover, as stressed by Görlich (2010), in knowledge-based economies a rising level of multitasking can be observed, facilitated by technical progress in ICT – a factor identified in most papers as the enabler of increased unbundling.

In summary, there are several factors working against the 'unlimited' unbundling of tasks (that reduce the hypothetical contestability of a number of tasks).

The other side of the coin is that the recognised advantage of keeping tasks together may result in the co-location of related tasks, and may lead to *increased* offshoring, which has provoked fresh anxiety in advanced economies. The relocation of production is often followed by the relocation of certain R&D tasks as well, in order to reduce the physical distance between R&D engineers and the operation,[9] and to 'ensure that problems are solved at source as they arise' (Lanz et al., 2011: 4). Similarly, sooner or later, it is deemed sensible to shift the testing of products or materials, the training of workers and various other tasks, and to co-locate them with production. This contributes to the functional upgrading of peripheral subsidiaries (Humphrey and Schmitz, 2004), or – as it is referred to in international business literature – to their 'charter extension' (Birkinshaw, 1996; Birkinshaw and Hood, 1998; Dörrenbächer and Gammelgaard, 2006).

Several scholars argue, though, that a careful distinction has to be made between contestable activities, which are bound to result in dispersion, and non-contestable activities, the geographical concentration of which is not reduced (Leamer, 2007). This leads to another evergreen question examined from a GVC perspective: the changing patterns of countries' specialisation in the current 'world of outsourcing and offshoring', in which 'the boundaries of ... firms have ... simultaneously shrunk organizationally and expanded geographically'

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7 'When moving away from mass production of standard products to differentiated products, the productivity gain from [further] fragmenting production has become ambiguous. Instead of Taylorism an increasing number of economic actors have adopted the business model of Toyotism, characterised by multi-tasked, multi-skilled workers working in teams' (Lanz et al., 2011: 33).

8 Many tasks complement each other, as is argued in Görlich (2010). Rather than specialising in one specific job task, workers perform bundles of tasks. If two tasks complement each other, their unbundling (and offshoring) *reduces* productivity.

9 This is referred to by Görlich (2010), as *inter*personal task complementarities; it reduces the offshorability of certain jobs – or increases the likelihood of the co-location of certain advanced services to previously offshored manufacturing.

(Contractor et al., 2010: 1418). The related literature, as well as the distributional implications of Europe's changing specialisation, will be addressed in subsequent sections.

This is preceded by a brief discussion of the emergence and evolution of the trade-in-tasks perspective – a recent methodological approach which allows precise insights into the patterns and dynamics of countries' specialisation. The new perspective and the related international data compilation (Lanz et al., 2011) have been the academic reaction to the observed process of an ever finer division of labour. A far-reaching finding of early GVC scholars was that what matters for competitiveness is not what countries produce (e.g. the technology mix of production and export) and how their world trade share evolves, but rather the dynamics of their exporters' value capture, i.e. how their share in the total value added of their export products evolves (Gereffi, 1999; Kaplinsky and Morris, 2001; see also: Linden et al., 2010; Ali-Yrkkö et al., 2011). Economic performance is determined by actors' added value, which in turn shapes their value capture. GVC scholars started to measure actors' move from low to high(er) value-adding activities by identifying generic business functions and gathering data on them (Sturgeon, 2008; Brown, 2008; Sturgeon and Gereffi, 2009; Eurostat;[10] Boileau and Sydor, 2011).

In contrast to these scholars' implicit assumption that both firms and countries increasingly *become specialised in specific functions* within GVCs, case study evidence suggests that several subsidiaries (as well as suppliers) host 'identical' business functions: support functions (administration, HR, finances, accounting, transportation, logistics, distribution, procurement, general management, customer support, etc.) and even functions that pertain to the intangible constituents of the value chain, e.g. design, research and development, engineering, ICT services, knowledge-intensive software development, etc. (Cohen et al*.,* 2009; Contractor et al. 2010; Pavlínek and Zenka, 2011; Szalavetz, 2012; Winter, 2010). These functions are far from being identical, however. In reality, there are large inter-subsidiary differences in the complexity and value-adding capability of individual business functions, given that business functions themselves can be sliced up. Business functions are decomposable and consist of dozens of sub-functions (Contractor et al., 2010; Gereffi and Fernandez-Stark, 2010).[11] Lead firms can decide which sub-function they locate to which subsidiary. Empirical evidence suggests that, even in the case of advanced high

[10] Eurostat carried out a survey of enterprises with 100 or more employees in 11 European Member States (plus Norway). Data collection revealed the magnitude and the destination of international sourcing (i.e. the total or partial movement of core and/or support business functions to affiliated or non-affiliated foreign enterprises) in selected European economies. The share of both core and support functions sourced from abroad in the surveyed economies was also investigated:

http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/International_sourcing_statistics

A similar exercise was carried out in Canada: the Survey of Innovation and Business Strategy compiled data on Canadian companies' engagement in offshoring, outsourcing and inshoring by activity and by sector, over the period 2007–09 (Boileau and Sydor, 2011). The authors compared Canadian firms' level of engagement in international sourcing of various activities with that of the EU Member States surveyed by Eurostat.

[11] On the organisational decomposition of the R&D function, see Schmitz and Strambach, 2009.

value-adding activities, the slices (the tasks) that are offshored are less knowledge-intensive than the segments of the same business function that are kept in-house: these latter are the tasks that require non-routine, cognitive and analytical competencies. On the other hand, with the organisational decomposability of business functions, no single function can be unambiguously described with a couple of adjectives (e.g. low-tech *and* labour-intensive *and* low value-adding; or advanced *and* knowledge-intensive *and* high value-adding).

Decomposable as they are, broad business functions, as units of international trade analyses, give an incomplete and potentially misleading picture in cross-country comparisons. This deficiency called for an even finer level of trade analysis that takes account of the fact that the many kinds of activities related to specific business functions can be disaggregated, and that the ones that can be standardised, codified and routinised are increasingly offshored.

Hence, it is the spatial distribution of corporate *activities* – or even the location of each value-adding act (Stehrer et al., 2011a) – that should be examined, rather than the distribution of business functions. Grossman and Rossi-Hansberg (2008) model trade as an exchange of identifiable and discrete units of work. This recognition motivated data compilation and analyses of trade at the task level (Lanz et al., 2011). This methodology has various advantages. First, it compensates for the above-detailed deficiencies of business function-based analyses. Secondly, it contributes to a better understanding of the features that make an activity offshorable: standardisation, codification, routinisation, skilled labour intensity, i.e. the degree it requires cognitive and analytical competencies (Autor et al., 2003) – note that these characteristics determine the added value of individual activities.

The trade-in-tasks perspective triggered the ongoing reassessment of the traditional classification of core and non-core activities, by explaining the logic behind a recent worrying phenomenon: the offshoring and offshore outsourcing of advanced, high value-adding activities (Contractor et al., 2010; Manning et al., 2008). Before embarking on an account of the literature on the changing patterns of specialisation in European industry, this survey addresses a stream of the literature that is closely linked to the GVC concept: the literature on offshore outsourcing.

2.3 Impact of captive offshoring and offshore outsourcing

2.3.1 The definition 'maze'

Global value chains are connected to various other concepts, each of which tries to depict the same or similar phenomenon: the changing international structure of production. Various concepts and definitions are used to describe basically the same phenomenon, for example global production sharing, (international) fragmentation, slicing up the value chain, vertical specialisation, international (out)sourcing, offshoring, etc. Different starting points and targets of analysis induce researchers and experts to emphasise certain aspects of these changes and to neglect others. This has led to a plethora of definitions in the literature. Here, an account of most of the categories used is given. As a starting point, one of the rigorous, precise and accurate definitions is used, and other categories are related to that.[12]

Offshoring and offshore outsourcing refer to a company's decision to transfer certain activities, which were hitherto carried out inside the company, to another unit of the firm in a foreign location (intra-firm or captive offshoring) or to an independent firm (offshore outsourcing). Offshoring and offshore outsourcing are referred to in some cases as (international) relocation (OECD, 2004; UNCTAD, 2004; Kirkegaard, 2005). These and related terms are used in a rather chaotic way in the literature, and this is something that needs to be taken into account.[13]

Table 2.3.1

Understanding intra-firm or captive offshoring, outsourcing and offshore outsourcing

Location of production	**Internalised (inside the company)**	**Externalised (outside the company, outsourcing to an independent firm)**
Home country	Production kept in-house at home	Outsourcing (at home)
Foreign country (offshoring)	Intra-firm (captive) offshoring	Offshore outsourcing

Source: Based on UNCTAD (2004: 148).

Offshoring is also widely used to describe relocation processes to foreign countries, regardless of their links to the relocating company (affiliate or independent) (see, for example, Olsen, 2006; Bertoli, 2008; Jabbour, 2010).[14] In that case, attention is focused only on the movement of production and related jobs between countries. Similarly, in other papers there is no distinction made between offshoring and offshore outsourcing – they are usually called offshoring (see, for example, Görg et al., 2008; Wagner, 2011). Here again, the emphasis is on the fact that activities are moved abroad from the home country. Sometimes the same categories are used (Table 2.3.1), but under different headings: for example, Olsen (2006) essentially differentiates between four categories (as in Table 2.3.1), but calls captive offshoring 'international insourcing', and offshore outsourcing 'international outsourcing'.

[12] The terminology used in the media is even more chaotic and is also distorted by ideological and political influences.

[13] Bhagwati et al. (2004) drew attention as early as 2004 to the problem of the lack of a consistent use of definitions.

[14] However, in her actual empirical analysis Jabbour (2010) differentiates between vertical FDI (captive offshoring) and international outsourcing (offshore outsourcing).

In other cases, outsourcing is used to refer to the process of transferring activities to another firm outside the company, regardless of the location (foreign or domestic) of the firm where the activities are transferred (e.g. Feenstra, 2010). On the other hand, foreign sourcing in Feenstra and Hanson (1996) refers to the practice by domestic firms of importing intermediate inputs. Moreover, as with offshoring, the terms outsourcing or international sourcing are sometimes used with the meaning of captive offshoring and offshore outsourcing (e.g. Geishecker et al., 2008; Neureiter and Nunnenkamp, 2009a,b).[15]

According to another distinction, 'real' offshoring occurs when 'there is water to cross': thus, in the case of US companies, for example, the transfer of activities to Canada and Mexico is not offshoring – only a transfer to India, the Philippines, etc. (ACM, 2006). This view is understandably more prevalent in the US.

International 'trade in tasks', as opposed to trade in finished goods (see e.g. Grossman and Rossi-Hansberg, 2008) refers to captive offshoring and offshore outsourcing. This approach is used in many theoretical models. Instead of trade in final goods, which prevailed for centuries, the decrease in transportation and communication costs has meant that international trade is increasingly 'trade in tasks', where different countries add value to global supply chains. Baldwin (2006) also argued that the international division of labour is now occurring at a much finer level of disaggregation. Specific tasks are offshored that previously were considered to be non-tradable. Advances in technology have led to an unbundling of tasks. While the first unbundling meant that factories and consumers could become geographically separated, this second unbundling has 'spatially unpacked the factories and offices themselves' (Baldwin, 2006: 7). According to Blinder (2007), the difference between tradable and non-tradable goods and services is becoming more and more blurred, and thus high-skilled jobs may be offshored as easily as low-skilled jobs, except when physical proximity is required to offer a service.

The activities affected can be either manufacturing or services activities (or both). Materials offshoring usually refers to productive activities (analysed, for example, by Bertoli, 2008, for Italy), while services offshoring (understandably) indicates the relocation of services tasks (e.g. Amiti and Wei, 2009).

Two other concepts are widely used in the European context, underlining the previously mentioned phenomenon of Western European firms concentrating their offshoring and offshore outsourcing activities in Central and Eastern Europe (Jacoby, 2010): 'nearshoring' underscores the geographical proximity between the offshoring and outsourcing company and its affiliate/partner; 'nearsourcing' is used as an equivalent to nearshoring (ACM,

[15] The Eurostat survey uses the term 'international sourcing', which is followed by the authors here. According to Alajääskö (2009), captive offshoring is about twice as common as offshore outsourcing in the sample. A similar share is indicated for services (shared service centres and business process outsourcing) (Bangemann, 2011).

2006). For example, in the US, nearshoring is referred to in the context of relocations to Canada or Mexico (Olsen, 2006). Similarly, in Europe, nearshoring is usually used in the context of offshoring and offshore outsourcing to Central and Eastern Europe.[16] The importance of nearshoring is underlined by the fact, already mentioned, that global value chains are more regional than global (De Backer and Yamano, 2011). The term 'backshoring' or 'reshoring' is used when previously captive offshored or offshore outsourced activities are brought back to the original location. In certain cases, it also covers the phenomenon of an activity being relocated closer to the original location, for example, in the European context, when activities offshored to China are located back either to the original location in Western Europe or to Central and Eastern Europe (e.g. Leibl et al., 2011).

Other approaches rely on various trade data to analyse in a similar way changes in the structure of global production and the increase in trading links across countries. One approach in this strand is trade in parts and components. Yeats (1997) was the first to use these data to try to measure the phenomenon; he called it 'production sharing'. Other studies with the same approach include Ng and Yeats (1999) and Kaminski and Ng (2001). Trade in intermediates is a similar concept, and it is usually used as a measure in the empirical analyses connected to various approaches.

International fragmentation (e.g. Jones and Kierzkowski, 1990; Deardoff, 1998) concentrates more on production activities, where fragmentation is defined as the splitting of production processes into parts that can be done in different countries (see e.g. Baldone et al., 2001, and Helg and Tajoli, 2005, in the European context).[17]

Vertical specialisation (Hummels et al., 2001) is based on trade between different countries, each specialising in a particular production stage. The authors make the connection between the fragmentation of production and exports by sectors by calculating direct and indirect (through suppliers) imports of inputs that are then incorporated in the exports of a given country, in order to determine that country's specialisation.

Offshoring and offshore outsourcing affect both manufacturing and services activities. While historically, manufacturing activities were impacted upon first, even certain services, which became tradable due to technical developments and services trade liberalisation, have become more and more involved in the process. More recently, as has already been mentioned, other 'newly fragmentable' activities, such as certain R&D tasks, have also been offshored or offshore outsourced.

[16] An incorrect use of 'nearshoring' can be found in the leaflet of ITDH, the Hungarian Trade and Development Agency, entitled 'Nearshoring in Hungary', which contains information on success stories in services captive offshoring and outsourcing, such as the Hungarian affiliates of the Indian Tata, the US Lexmark or the US Morgan Stanley, among others.

[17] Besides the economics literature, one can find papers in the business, management and economic geography literature on these concepts; understandably, the focus of these is different.

The 'business-function' offshoring and outsourcing approach was elaborated in relation to the global value chain theory (Sturgeon and Gereffi, 2009), in order to find a better measure for industrial upgrading. Thus it has a development economics viewpoint as well. The authors advocate setting up databases which contain company-level data on business functions carried out in these firms. To this end, they compile a standardised set of generic business functions. This dataset could then provide valuable information on the roles of domestic and foreign (owned) companies and sectors in global value chains. It could also give information on which business functions (as opposed to activities or production of concrete services or goods, spare parts and components) are captive offshored and/or offshore outsourced. The authors propose a list of 12 different business functions: strategic management; product or service development; marketing, sales and account management; intermediate input and materials production; procurement; operations; transportation, logistics and distribution; general management and corporate governance; human resource management; technology and process development; firm infrastructure; customer and after-sales service. Thus this approach embraces a much wider spectrum of changes in the international division of labour. This approach also draws attention to the importance of the captive offshoring and offshore outsourcing of certain service activities carried out inside manufacturing companies.

There are further definition problems when offshoring and offshore outsourcing in services activities are analysed. In the economics literature, services are usually analysed with the same methods (sometimes even together with) manufacturing. There the same approaches are used as are described above. In the business literature, the distinction is made between captive offshoring and offshore outsourcing: shared service centres (SSC) refer to captive offshoring and business process outsourcing (BPO) is equivalent to offshore outsourcing. In services, the problem is complicated by the fact that, while in manufacturing these two categories are usually not confluent, in services they may be. For example, according to van Gorp et al. (2006: 16–17), a combination of captive offshoring and offshore outsourcing represents at least a quarter of all offshoring of Dutch- and US-owned service firms executed from the Netherlands. Besides the general problem with services (in terms of defining the services sector and services activities, and separating them from manufacturing – see e.g. Nachum, 1999; van Gorp et al., 2006; and Netland and Alfnes, 2007, for a review of the problem and of the related literature), a more important problem relates to that subgroup of services that is affected by the captive offshoring and offshore outsourcing process. Here it would seem that the definition used results in a more chaotic situation than in manufacturing. A lack of clear definitions and classifications is one of the most important hindrances to research in that area. Various names are used to describe the same, similar or a bigger or smaller subset of groups of services activities that are affected by these processes. For example, the following categories are used in the literature: professional services, knowledge services, knowledge-intensive services, knowledge-based services, business services, other business services, IT-related services, IT and software and business services, computer and business services (for an overview see Netland and Alfnes, 2007). The way in which various authors treat research and development activities also differs. This can partly be explained by the fact that the process of offshoring and offshore outsourcing of these services is very dynamic. It may be assumed that it is even more dynamic than in the case of manufacturing: there are more and more activities involved over time, and this in itself can make the coverage of research outdated relatively quickly (UNCTAD, 2004).

2.3.2 Methodological approaches

As is obvious from the chaos of definitions, the old approaches and the widely existing data are considered by many of researchers to be inadequate or inappropriate to grasp this phenomenon. For example, when approaching these concepts at the macro-level, offshore outsourcing and offshoring are related differently to FDI and foreign trade. Understandably, offshore outsourcing is usually not connected to FDI, while it is usually connected to international trade. In the case of captive offshoring, an initial FDI project of the vertical type is always involved, and later the output is exported to other affiliates and sold to the local affiliate of the same company, if such exists.[18] In contrast to offshore outsourcing, in captive offshoring all these transactions remain inside the boundaries of the company; thus they encompass the problems of intra-firm trade, especially transfer pricing. So here FDI is involved, but foreign trade is also affected. The problem can be even more complicated in certain cases, if these two functions are mixed, i.e. the company provides services to its sister companies as well as to 'independent' companies.

Thus neither the available FDI data nor the foreign trade data are able to cover fully the developments connected to offshoring and offshore outsourcing. Similar problems emerge in the case of existing and available labour data, for example on jobs or occupations. Thus, in the empirical literature, richer databases are created and used for the purposes of tracing the existence, development, extent and impact of global value chains. Naturally, the aim of the analysis also influences which type of dataset is used. For example, foreign trade data are used to measure the extent of offshoring and offshore outsourcing. When the labour market impacts are measured, usually wage data are used, either at the individual or at the sectoral level. For estimating the impact of the productivity of firms, company-level data or surveys are used.

[18] These relationships are made even more complicated when, in the case of captive offshoring, the affiliate reinvests its profit gained locally, which again is counted as FDI, similarly to credit transactions between the affiliate and the parent company. In the case of offshore outsourcing, if the independent service provider seeks cheaper/more efficient locations to carry out a part of or the whole activity, it sets up a foreign affiliate, and then even in that case FDI is involved. When the new plant is established, the service will be traded internationally and/or will be sold in the host country, thus after that it mainly affects foreign trade developments. Moreover, in cases where former exports from the home country are replaced by final goods production abroad to serve the local and foreign markets (export-platform), horizontal FDI may be involved.

It must also be emphasised that widely used measures based on trade statistics should be used with great caution. Because of the increase of trade in parts and components or intermediaries, using trade statistics designed to collect trade flows in final products may be misleading. For example, revealed comparative advantage indicators, specialisation indices or classification according to the technology content of products may give an erroneous result concerning the specialisation and the role of a given country in the international distribution of labour.

In order to trace the various characteristics of offshoring and offshore outsourcing, various techniques are used that do not rely on foreign trade data. In many cases, only proxies can be used to estimate the effects of the variables analysed. Methodological concerns also arise in connection with the fact that complex econometric models using similar techniques and datasets arrive at different conclusions.

2.3.2.1 Using foreign trade data

Foreign trade statistics are relatively widely used to measure the extent and impact of captive offshoring and offshore outsourcing. Especially trade in intermediate goods is applied. Yeats (1997) was the first to use the foreign trade data on parts and components. Understandably, this calculation may give only an approximation of the size of offshoring and offshore outsourcing, as not all parts and components finish up in a finished product; but on the other hand, calculations are made only for the Standard International Trade Classification (SITC) 7 product group. Yeats (1997) compiled a list of goods in SITC Rev. 2 that are parts or components at the 4- or 5-digit level in the SITC 7 product group (Machinery and transportation equipment), which represents around half of world trade in manufacturing products. Calculating the share of these parts and components in total foreign trade or in total SITC 7 trade can give some insight into the extent of changes in the international division of labour. One should note that the SITC 7 product group does not cover all parts and components, as even for the automotive and electronics sector an important share of parts and components originates in non-SITC 7 industries, such as metallurgy, plastics or glass production, etc.

Trade in intermediate products is also used for analysis. In that case, products traded are classified according to their use for further processing or as a final product, using the United Nations Broad Economic Classification. In this approach, and in contrast to the previous one, all goods can be categorised, and calculations can be made for total trade (see, for example, Miroudot et al., 2009; Stehrer et al., 2011a). Sturgeon and Memedovic (2010) relied on an updated classification of intermediates and final goods in certain industries.

2.3.2.2 Combining foreign trade and other data

Feenstra and Hanson (1999) and Campa and Goldberg (1997) combine foreign trade data with input coefficients that can be found in input-output tables. Campa and Goldberg (1997) try to estimate the extent of captive offshoring and offshore outsourcing from the share of imported intermediate inputs in the production value of a given sector. They call their indicator the 'index of vertical specialisation'. Here is an 'upper limit' problem, as not all intermediate inputs are the result of offshoring or offshore outsourcing. Feenstra and Hanson (1999) reduce that share to those imported intermediate non-energy inputs that cannot be produced locally. They use US import data and data from the Census of Manufactures. That approach, on the other hand, is very sensitive to the level of aggregation in estimating the extent of offshoring and offshore outsourcing.

Hummels et al. (2001) calculate the amount of imported inputs included in exported goods. They calculate a measure using input-output tables, in order to determine not only direct but also indirect imported inputs that are then incorporated into exported goods. A similar exercise is carried out by Yi (2003), Bergoeing et al. (2004) and Chen et al. (2005).

Other combined datasets include, for example, panel data on firms combined with foreign trade data (Burger and Rojec, 2008). Foreign trade and input-output data are combined by Geishecker (2006).

2.3.2.3 Using industry-level data

Usually input-output matrices are used, which distinguish between domestically produced and imported intermediate goods (see, for example, Amiti and Ekholm, 2006; Ekholm and Hakkala, 2008; Schöller, 2007, for services offshoring). In that case, proportionality is assumed, meaning that the calculations presume – in the absence of detailed data – that a sector uses an import of a product to the same extent as its total use of the product. This assumption was challenged by, among others, Winkler and Milberg (2009) on the basis of German data. Moreover, Castellani et al. (2011) showed problems of using sectoral input-output data for measuring offshoring (and offshore outsourcing).

2.3.2.4 Using firm-level data

Firm-level data, either from datasets or from specialised surveys, are also widely used. For example, for Germany Moser et al. (2009) used firm-level data to trace the employment effect of offshoring and offshore outsourcing. Criscuolo and Leaver (2005) use a unique dataset on UK firms from three sources: the first of these sources is the ARD (Annual Respondents Database), the second is the ITIS (International Trade in Services), and the third source is information on ownership and the multinational status of firms from the AFDI (Annual Foreign Direct Investment Inquiry) register. For Ireland, Görg and Hanley (2011) used this type of data, as did Tomiura (2005) and Ito et al. (2008) for Japan.

Company survey data can originate either from special surveys that do not focus on offshoring or/and offshore outsourcing, or from surveys that focus particularly on these topics. For example, Wagner (2011) uses unique new data for German manufacturing enterprises from matched regular surveys and a special-purpose survey conducted by the federal statistical office. Marin (2006) used a survey of German and Austrian companies that invested in Eastern Europe, in order to study the determining factors and impact of relocations in this relation. Buch et al. (2007) uses company survey data and micro data on FDI for Germany to find the factors and employment effects at the regional and sectoral level. Neureiter and Nunnenkamp (2009a) use data from a Eurostat survey on international outsourcing among European companies in ten EU countries.

2.3.2.5 Other combined datasets with firm-level data

Geishecker and Görg (2005) use combined individual-level data from the German socio-economic panel and industry-level information on imported inputs from input-output tables to trace the effect of offshoring and offshore outsourcing on wages. Bachmann and Braun (2011) use a similar dataset for Germany, based on individual-level data, a sample provided by the Institute for Employment Research, and industry-level data on the import of intermediate products. Jabbour (2010) uses data from the 'International Intra-Group Exchanges' survey, which provides information on captive offshoring and offshore outsourcing activities among French manufacturing firms in 1999 and which contains data on imported input and source country and the input's industrial classification. This dataset is combined with firm characteristics provided by the annual firm survey of the Ministry of Industry.

Company panel data, combined with either input-output tables or industry-level data (including data on the import of intermediate inputs), are used by, among others, Farinas and Martín-Marcos (2010) for Spain, Görg et al. (2008b) for Ireland, Ito et al. (2008) for Japan, Jabbour (2010) for France, Kurz (2006) for the United States and Morrison Paul and Yasar (2009) for Turkey.

2.3.2.6 Individual-level data

Data on individual workers' wages, occupations and skills are also used in the empirical literature. These data are usually used to assess the labour market impact, and especially the wage impact, of materials offshoring and offshore outsourcing. For example, *Egger et al.* (2007), Geishecker (2008) and Munch and Skaksen (2009) used these data for European countries, while Ebenstein et al. (2009) did the same for the US. Liu and Trefler (2008) analyse the impact of services offshoring from the US to China and India using this type of data.

Occupation and other labour data are used in the 'trade in tasks' approach. Blinder (2007) gives an indicator of offshorability at the occupation level, as do Schrader and Laaser

(2010). Jensen and Kletzer (2005) calculate the geographical concentration of occupations, in order to estimate the share of offshorable jobs in the US. Görlich (2010) uses individual-level data on job tasks. Baumgarten et al. (2010) add information on workers' skill levels in their analysis.

2.3.3 The extent and the impact of offshoring and offshore outsourcing

These analyses concentrate, on the one hand, on showing the presence and the evolution of global value chains; they discuss the size and importance of these for the global economy. On the other hand, there are studies that try to assess the impact of offshoring and offshore outsourcing on individual countries or country groups. These latter studies usually focus on developed countries, with particular reference to labour market impacts (job losses and relative wages). Altogether, manufacturing is relatively well researched, compared to services (van Gorp et al., 2006).

2.3.3.1 Presence and extent of global value chains

Evidence on the existence and operation of global value chains is provided by many empirical works (see, for example, Campa and Goldberg, 1997; Hummels et al., 2001; Strauss-Kahn, 2003, mainly based on foreign trade data). There are also case studies at the (branded) product level giving evidence of the increasing international distribution of labour (e.g. Stehrer et al., 2011a). Sturgeon and Memedovic (2010) showed an increase in intermediate trade using an updated classification of intermediate goods. Studies on intra-industry trade also point to the increase in offshoring and offshore outsourcing (e.g. Türkcan, 2011, for the automotive sector).

At the country level, there are more studies, since other sources of data (especially input-output tables or firm-level data) can be used to calculate developments in offshoring and offshore outsourcing in individual countries. For example, Farinas and Martín-Marcos (2010) show that there was a large increase in the number of Spanish manufacturing firms that directly imported intermediate inputs from abroad over the period 1990–2002: at the end of the period, more than half the companies were doing so. There was a growth in the period both in the extensive margin (the number of firms doing it) and in the intensive margin (the intensity, i.e. the share of foreign intermediate imports). There are numerous studies which show that, in Germany, offshoring and offshore outsourcing has increased considerably. Among others, Godart and Görg (2011) provided evidence on the importance of global value chains for Germany. OECD (2010) provides harmonised input-output tables for the member countries: the increase in imported intermediates indicates an increase in offshoring and offshore outsourcing in the majority of member states between 1995 and 2005. Agnese and Ricart (2009) calculate three indices: imported inputs in total inputs, imported inputs in gross output, and a measure of vertical specialisation for 40 countries (mainly OECD and large countries) for 1995, 2000 and 2005. According to their results, offshoring is carried out by larger and smaller countries alike. Manufacturing still dominates services in the analysed field.

Using foreign trade data, Yeats (1997) tried to assess the extent of global production sharing by analysing foreign trade in parts and components. He showed that trade in machinery and transport equipment components had grown much quicker than in final products; parts of motor vehicles, office machinery, telecommunications equipment and switch gears accounted for about 70% of total world trade in parts and components. Using Yeats' methodology, Ng and Yeats (1999) analysed production sharing in East Asia, pointing to the underestimated nature of data for East Asia's role in global production sharing, the great pace at which trade in parts and components had grown in that part of the world, and the increasing share of East Asia in global production sharing. Kaminski and Ng (2001) carried out an analysis for the Central European economies. They showed that these economies had become increasingly integrated into the production networks of the European Union. They pointed to the advances especially in three sectors: furniture (which is characteristic of almost all analysed economies), automobiles (the Czech Republic, Hungary, Poland, Slovakia and Slovenia) and sectors experiencing the 'information revolution' (Estonia and Hungary). De Simone (2008) uses trade in parts and components as one of the independent variables determining the industrial geography changes between the EU-15 and the Central and Eastern European countries. According to his results, the contribution of imported intermediates is positive and substantial in just the 'Motor vehicles' and the 'Office machinery' industries. In these sectors, higher levels of imports of middle products go together with higher relative shares of sectoral production in Central and Eastern Europe.

2.3.3.2 Labour market impact

The impact of offshoring and offshore outsourcing is most often studied in terms of its labour market impact. However, the overwhelming majority of studies have found a very modest labour market impact – i.e. that offshoring and offshore outsourcing have a neutral or small positive effect. Crinó (2009a) gives a comprehensive review of the literature up to 2006 on the labour market impacts, separately for materials and services offshoring and for offshore outsourcing.

Many studies have found a negative impact on the wages of low-skilled workers (Munch and Skaksen, 2009) and growing inequality between unskilled and skilled wages. Feenstra (2008) shows that, in the 1990s, the wages of skilled workers increased relative to unskilled workers, while relative employment decreased. Winkler (2009) used industry-level data to investigate how outsourcing affected the relative wages of skilled and unskilled workers and found that offshoring and offshore outsourcing indeed raised the relative wages of skilled workers. Geishecker and Görg (2010) investigate the effects of services offshoring on wages, using individual-level data combined with industry data for the United Kingdom. They show that services offshoring (and offshore outsourcing) affects the real wages of low- and medium-skilled individuals negatively, while skilled workers may have higher real wages.

Another strand of the literature addresses the question if the location of offshoring and offshore outsourcing affects wage and employment developments in the home country. Harrison et al. (2007) found this to be relevant for US firms. According to the results of Becker et al. (2005) lower wages in Central and Eastern Europe (CEE) tend to reduce employment in Germany. However, Konings and Murphy (2006) reject the notion of employment substitution between European manufacturing parent companies and their affiliates located in low-wage regions of the EU and Central and Eastern Europe. Geishecker et al. (2008) examine the impact of outsourcing on individual wages in three European countries with different labour market institutions: Germany, the UK and Denmark; they also differentiate according to the location of offshoring and offshore outsourcing. They found the location to be relevant in only a few cases. The wages of skilled UK workers benefited from outsourcing to (the more advanced) non-CEE countries. In Germany, high-skilled workers are negatively affected by outsourcing to CEE, while low-skilled workers are affected by outsourcing to non-CEE countries. However, other studies could find no evidence of the 'location impact': Criscuolo and Leaver (2005) could not find any robust evidence of the offshoring-productivity association being driven by a particular partner country. Nor could Neureiter and Nunnenkamp (2009a) find relevant evidence of a distinction between low- and high-wage locations.

As far as the employment effects are concerned, for Germany, Moser et al. (2009) found a positive employment effect from offshoring and offshore outsourcing in the offshoring firm. Wagner (2011) found a small positive employment effect for Germany. Neureiter and Nunnenkamp (2009a) examine the location choices and labour market impacts of offshoring and offshore outsourcing. They found the job loss impact to be modest; any impact is also partly compensated by the creation of new jobs, particularly for high-skilled workers. Schöller (2007) found a negative impact from offshoring and offshore outsourcing on *employment*, and for this she puts the blame on the strict labour market regulations in Germany. As noted before, during analysis of the wage effect, Geishecker et al. (2008) take account of the difference in labour market institutions (Germany having the least flexible and the UK the most flexible). They use individual-level datasets for the three countries, distinguishing between skill levels. The authors construct comparable measures of outsourcing at the industry level, relying on Feenstra and Hanson (1999). They demonstrate that labour market institutions play a role in the mode of adapting to the impact of outsourcing: rigid wages cause adjustment through labour quantities, while more flexible wages induce adjustment through wages. Crinó (2009b) analyses the labour market impact of services offshoring (and offshore outsourcing) in Italy. He found no impact on the level of employment, but it does affect the composition of labour in favour of highly skilled workers.

He found the same results for nine Western European countries (Crinó, 2012) and for the US (Crinó, 2007).

Some studies take account of the intersectoral spillover effects of offshoring, and thus their analysis of the labour market impact is more nuanced. For example, Bertoli (2008) uses an index built on input-output matrices disaggregated at the 2-digit ISIC classification code over the period 1995–2003 to trace the impact of material offshoring in Italian manufacturing. He found that the direct effects of offshoring on employment are not significant, once one allows for scale effects, while the intersectoral effects are negative and highly significant. The reason for this is that offshoring and offshore outsourcing 'can lead to the disruption of domestic sub-contracting relationships, and … the adverse occupational consequences are not concentrated in the sectors that are directly involved in the offshoring process'. Another paper underscoring that impact in the case of Italy is Costa and Ferri (2008).

Another line of the literature analyses the labour market impact by estimating the risk of becoming unemployed due to offshoring or offshore outsourcing. Here again, studies on Germany are the most numerous. Bachmann and Braun (2011) and Geishecker (2008) use large samples of data on individual workers, combined with data on imported inputs from input-output tables. They estimate whether offshoring (and offshore outsourcing) increases the risk of an individual worker becoming unemployed or moving out of the labour market. However, they arrive at different results, in spite of the similarity of the method and of the data used. Geishecker (2008) finds that offshoring (and offshore outsourcing) significantly increases the risk of becoming unemployed. Bachmann and Braun (2011) show that the risk of becoming unemployed remains unchanged, while that of moving out of the labour market does change. However, none of the studies find differences in these effects among skill groups.

Occupation and other labour data are used in the 'trade in tasks' approach. Blinder (2007) gives an indicator of offshorability at the occupation level, Görlich (2010) moves from the occupation to the task level, relying on the presence of task complementarities and task bundling. On the basis of individual-level data about job tasks, he shows that the number of potentially offshorable jobs is significantly lower when task complementarities are accounted for. (A similar result emphasising the overestimation of the number of offshorable jobs is given by Demiroglu, 2008, for the US.) Previously, at the occupation level, Schrader and Laaser (2010) calculated that 45% of jobs are potentially offshorable in Germany. On the basis of the analysis of tasks, Görlich (2010) found that only 44% of the tasks of these 'easily offshorable' occupations are really offshorable, i.e. 44% of the 45%. (It can be added here with certainty that the number not only of offshorable but also of outsourceable tasks/jobs may be lower.) Baumgarten et al. (2010) expand on this analysis by adding data on workers' skill levels. They find a stronger effect of offshoring and outsourcing on low skilled workers. Ariu and Mion (2010), drawing on an analysis of services offshoring and offshore outsourcing in Belgium, also emphasise the importance of the task-based approach.

2.3.3.3 The productivity impact

This impact is usually analysed at the company level. However, Daveri and Jona-Lasinio (2008), using the National Institute for Statistics (ISTAT) input-output data for Italy for the period 1995–2003, found that material offshoring positively influences productivity, measured as the growth rate of value added per full-time equivalent worker, while service offshoring has an ambiguous or even a negative impact. They also demonstrate (like Bertoli, 2008) a significant variability across sectors according to the level and the changes in offshoring and offshore outsourcing. In services offshoring and offshore outsourcing, Hijzen et al. (2007a) use firm-level data on services trade (imports). They found no negative impacts of services offshoring, but firms relying on services offshoring experience faster employment growth. Den Butter and Pattipeilohy (2007) analysed Dutch data for the period 1972–2001, and found a positive and larger R&D effect of offshoring (and offshore outsourcing) on total factor productivity in the country. Bournakis et al. (2011) found different impacts in the case of material and of services offshoring in the US, Japan and Europe: material offshoring (and offshore outsourcing) leads to a rise in the share of industry in GDP, unlike services offshoring (and offshore outsourcing). High-tech industries may be especially negatively affected. However, this negative impact can be compensated for by innovative and R&D efforts.

2.3.4 The impact of offshoring and offshore outsourcing on companies doing them

There are two main problems addressed by this literature, which is relatively scarce (Olsen, 2006; Jabbour, 2010): which firms relocate and how this impacts upon their performance. In the business literature, the main research area is the strategy of multinational corporations. Moreover, the advantages and disadvantages of relocation for firms are also analysed.

2.3.4.1 Which firms offshore or offshore outsource?

Do offshoring firms differ from non-offshoring ones? If they do, is there self-selection? In theory, as with FDI or exporting, large sunk costs related to offshoring and offshore outsourcing can be handled only by larger and better-performing firms (Antrás and Helpman, 2004). At the sectoral level, the differences are well documented. For example, Munoz (2009) found evidence of relocation in Spain, first, in sectors with more FDI, and second, in the food, paper, recycling and medical equipment sectors. There was also intensification of relocation in certain service activities, such as retail trade, telecommunications and financial activities.

Empirical evidence gives support to self-selection: offshoring and offshore outsourcing companies, even before they transfer abroad certain activities, usually perform better than non-offshoring and non-outsourcing firms. For example, Farinas and Martín-Marcos (2010) examine the relationship between foreign sourcing and firm productivity on the basis of a sample of Spanish manufacturing firms. Their hypothesis is based on the model in Antrás and Helpman (2004), according to which high-productivity firms take part in arm's-length trade or source abroad, while low-productivity firms do not source abroad. They found large differences in productivity between these two groups of firms. They discovered that both the number of firms and their reliance on foreign sourcing (imported intermediate inputs) has been growing. Larger firms, they determined, are more inclined to source from abroad. There was also a high degree of heterogeneity of foreign sourcing across sectors: electronics, motor vehicles and chemicals were the most 'popular' from that point of view. Moreover, high-productivity firms sourced intermediate inputs internationally, while low-productivity companies sourced such inputs at home. The authors found evidence of self-selection.

Tomiura's (2005) results indicate that more productive firms in Japan are more likely to engage in offshoring or offshore outsourcing. Another study shows that relocating firms in Germany are usually larger, more productive, more human capital intensive and more export intensive (higher export/sales ratio). These findings held for the year before relocation was carried out, thus more profitable and competitive firms are more inclined to offshore, which points to the self-selection of offshoring firms (Wagner, 2011). For the UK, Criscuolo and Leaver (2005) found that UK firms that offshore (or outsource) services were mainly firms with international links, i.e. exporters of services and multinationals, both domestic and foreign. They also found support for self-selection: offshorers were, on average, larger, more capital intensive, used more ICT capital and paid higher wages than firms which did not offshore. The choice between vertical FDI (captive offshoring) and (offshore) outsourcing at the company level in French manufacturing firms is examined by Jabbour (2010). She shows that variables representing company efficiency – like productivity and scale – enhance the relative prevalence of international outsourcing (in the meaning of offshoring and offshore outsourcing). Seemingly not connected to our topic, Geishecker et al. (2009) analyse the characteristics of European multinationals, using a European firm-level dataset. According to their findings, companies that have affiliates abroad (here one can assume a link to captive offshoring) account for a disproportionately large share of output, employment and profits in their home countries. These firms also exhibit higher survival rates and productivity growth when compared to those non-internationalising through FDI. This may be self-selection of captive offshoring firms in Europe.

2.3.4.2 What is the impact of offshoring and offshore outsourcing on the performance of the firm?

According to a summary of a literature review by Görg, Greenaway and Kneller (2008) for manufacturing firms, offshoring results in higher labour productivity. Later research attains similar results. For example, Görg, Hanley and Strobl (2008) analyse Irish manufacturing firms. They found a positive effect of (offshoring and) outsourcing services for exporters, and a negative effect of material (offshoring and) outsourcing for non-exporters. Morrison

Paul and Yasar (2009) examine the impact of outsourcing (both national and international) on the productivity of Turkish textile and apparel firms, which they found to be positive. Amiti and Wei (2009) and Moser et al. (2009) found higher labour productivity and higher foreign market share in offshoring (and offshore outsourcing – as they used the increase in imported intermediate goods as a measure) German firms. Kasahara and Rodrigue (2008) analyse whether importing intermediate goods improves plant performance, using plant-level Chilean manufacturing panel data. They find evidence of improved productivity in importers of intermediate inputs. Görg and Hanley (2011) also find that international out-sourcing of services has a positive effect on profitability at the firm level. Using Irish firm data, the authors analyse whether firms engage in outsourcing in order to locate some of their 'non-core' labour-intensive production stages abroad. This enables them to reduce labour costs for production at home, and to use the increased profit to enhance their com-petitiveness through R&D and innovation. Thus international outsourcing of services has a positive impact on the innovative activity at the plant level. Criscuolo and Leaver (2005) found for UK firms, controlling for other variables, that a 10 percentage point increase in offshoring intensity is associated with a 0.37% increase in total factor productivity.

Differentiating between offshoring and offshore outsourcing brought contradictory results. Jabbour (2010) analysed French manufacturing firms and showed that aspects of the off-shoring strategy have different impacts on productivity and profitability, mainly through the choice of the mode of governance (here the distinction is between vertical FDI (offshoring) and offshore outsourcing) and the chosen location of offshoring and offshore outsourcing. According to her results, vertical FDI (captive offshoring) is a less efficient organisation mode of production for French manufacturing firms than international outsourcing. Neure-iter and Nunnenkamp (2009b) similarly analyse the different productivity impact of the dif-ferent modes of international sourcing. They found that captive offshoring (internationalisa-tion within the multinational company), especially through using existing subsidiaries, is more effective in terms of gaining access to new markets. However, the various modes of 'international sourcing' (here again, captive offshoring and offshore outsourcing) all have a relatively pronounced effect on market access, compared to knowledge creation and tech-nological upgrading.

The different impact of offshoring and offshore outsourcing locations is addressed in com-pany-level studies as well. Ito et al. (2008) differentiate between locations: outsourcing to the United States or Europe results in higher production efficiency, followed by outsourcing to Asia. Criscuolo and Leaver (2005) could not find a 'partner country effect'. Jabbour (2010) found that international outsourcing in developing countries improves the perform-ance of the firm.

Analysis of the impact of offshoring and offshore outsourcing over the longer term is car-ried out by Burger and Rojec (2008), who examined the impact of intermediate inputs offshoring on firm productivity for Slovenian manufacturing companies in the period 1994–2005. They found a temporary boost in productivity growth for those firms which start offshore outsourcing, and an increase in the productivity level of offshoring firms in the medium term (after four years).

Amiti and Wei (2005) differentiated between the offshoring and offshore outsourcing of different activities. They looked at the offshoring and offshore outsourcing of both services and material activities in US manufacturing industries and analysed their correlation with productivity. They found that services offshoring is positively associated with productivity, but this is not true of materials offshoring and offshore outsourcing. A similar conclusion was reached by Hijzen et al. (2007a). They used disaggregated firm-level data on job creation and loss, and firm-level data on services import. They do not find any negative effects of services offshoring and offshore outsourcing, but firms that start offshoring services have faster employment growth than others. Ito et al. (2008) found that offshoring of tasks for production of intermediate goods and final assembly (i.e. material offshoring and offshore outsourcing), as well as the offshoring of certain services tasks (R&D and information services), positively affects productivity growth in Japanese firms. At the same time, outsourcing of other service tasks has no significant impact on productivity. Criscuolo and Leaver (2005) could not find an effect of a particular type of service.

2.4 The changing specialisation of advanced economy actors in Baldwinian old and new paradigms

Analyses of countries' specialisation in general, and of European industry in particular, have long been limited to *production patterns* (industry mixes by technology intensity), to the degree, the dynamics and the nature of specialisation, as well as to the drivers and competitiveness implications of changes in specialisation.

Industry-level analyses associated the prospect of industries with the productive factors used most intensively in the given industry (Baldwin, 2011). This line of thinking has, however, left several questions unanswered, producing at the same time some hard-to-explain puzzles, such as Europe's historical strength in low- and medium-tech (LMT) industries, and the remarkable stability of LMT sectors in terms of both employment and value added.[19] A much debated issue was whether Europe's traditional specialisation can be regarded as a (partial) explanation for its lagging growth and productivity performance (Fagerberg et al., 2000; Sapir, 2004).[20]

19 According to Rammer at al. (2011: 43), the share of LMT industries in total manufacturing value added was 73% in several EU countries in 2007.

20 Conversely, Peneder's (1999) paper about the Austrian paradox highlighted a seemingly puzzling controversy between good macroeconomic performance (high productivity and income) and Austria's specialisation in traditional low- and medium-tech industries.

The impact of Europe's traditional specialisation pattern on its growth and productivity performance has been extensively investigated. Several authors have argued that (i) traditional industry-level taxonomies (i.e. the classification of innovativeness along the 'low-tech – high-tech' spectrum) are misleading: non-science-based industries are also innovative, albeit on measures other than science-based ones[21] (see, for example, Kaloudis et al., 2005; Mendonça 2009; von Tunzelmann and Acha, 2005); (ii) high-tech and low-tech industries are interrelated, and low- and medium-tech industries constitute a key *market for innovation* produced in other industries (Hauknes and Knell, 2009 Hirsch-Kreinsen, 2008; Robertson and Patel, 2007; Hansen and Winther, 2011); (iii) productivity growth performance across countries is not correlated with the share of high-tech industries in the manufacturing mix (e.g. Dalum et al. 1999; van Ark et al., 2008) – albeit empirical evidence in this latter respect is controversial.[22]

The point of departure of another stream of research – more related to the focus of our investigation – is that no industry is internally homogeneous: each industry is composed of a wide variety of high-, medium- and low-tech firms (Kirner et al., 2009; Peneder, 2010). Low-technology *industries* are therefore not to be equated with low-technology *firms*, and conversely, high-tech industries also include a considerable number of non-innovative firms. Hence, 'industry' cannot be considered the appropriate level for competitiveness analyses. A related research strand argues that, as a consequence of widespread vertical specialisation (Hummels et al., 2001), specialisation in high-tech exports does not necessarily reflect indigenous technological capabilities (Mani, 2000; Srholec, 2007). This is what explains large intra-GVC, cross-country differences in value creation and value capture (Farrell, 2005; Linden et al., 2010; Ali-Yrkkö et al., 2011). The other side of the coin is that, in offshoring literature, the surveyed destinations are mostly restricted to developing and rapidly catching-up economies. Offshoring literature hardly takes into account the fact that advanced economies themselves are important destinations for offshoring – depending on the sophistication level of the activities (Jensen and Pedersen, 2011).

These findings suggest that it is the industry-level distribution of activities in specific regions that determines the given region's competitiveness and sheds light on the real nature of specialisation. This is the focus of Baldwin's (2006; 2011) arguments. Baldwin asserts that the current wave of globalisation – which he refers to as the 'second unbundling', and in which many of the previously untraded business functions have become tradable – has produced a new paradigm. Under the new paradigm, competition is manifest not at the level of sectors and industries (as in traditional trade theories), but rather at the level of

[21] Cf. the non-technological innovation literature (surveyed, e.g., by Schmidt and Rammer, 2007).

[22] Some papers (e.g. Fagerberg, 2000; Peneder, 2003) provide evidence for the claim that industrial structure is among the important explanatory factors of inter-country growth and productivity performance differences. In contrast to static investigations focusing on the relation between structure and growth, investigations with a *dynamic perspective* (that focus on *changes* in the industry mix and growth), yield more unambiguous results, and show a substantially strong correlation of the two indicators (cf. Krüger's, 2008, literature review).

individuals (and the tasks they perform). This recognition produced the most recent move in an ongoing process, in which the unit of analysis of international specialisation shifted to increasingly finer levels: from industries (and industry-associated skill groups) to goods, from goods to intermediates (Stehrer et al., 2011a), and finally to tasks. This new methodological approach has finally dispelled the myth of a strong causal relation between industrial structure and macroeconomic performance – at least if industrial structure is analysed using the low-tech–high-tech taxonomy.

However, to the best of our knowledge, data about countries' or regions' industry-level shares of firms that specialise in high value-adding activities are not available, even though this is what could give an accurate picture of the specialisation patterns of European industry. So far, no empirical investigations have been carried out on the task-level specialisation of European industry (either at the aggregate level, or by technology-intensity categories or industries), and there are no broad Triad-level comparisons in these respects – a gap in the literature that calls for further research and data compilation.

Nevertheless, a number of industry studies are available on the impact of globalisation on the industry-level global division of labour, on the geographical patterns of production, on firms' adjustment strategies, etc.[23] The majority of these studies are concerned with local learning and upgrading in developing economies that are undergoing network-driven (GVC insertion-driven) modernisation, or with governance issues that have institutional aspects (e.g. how local innovation systems shape GVCs). Hence, in most cases they only deal indirectly with *lead firms'* strategies.[24] In the European context, deliverables of the 'Sectoral Innovation Watch' of the Europe INNOVA project offer in-depth insight into Europe's (and other advanced economies') innovation performance in the industries surveyed (http://www.europe-innova.eu/web/guest/publications/europe-innova-projects-publications), which is, however, only one aspect of lead firms' GVC specialisation.

From these industry studies, corporate case studies and from international business literature, there is anecdotal evidence of various aspects of advanced-economy firms' changing *activity* specialisation.

One example is the transformation of manufacturing firms into service providers. In order to add value, increase profitability and withstand competition from low-cost producers, manufacturing companies try to integrate service provision into their manufacturing products (cf. the 'servitisation of products' in Vandermerwe and Rada, 1988; Martinez et al., 2010) or to achieve convergence of manufacturing and services.[25] They compete with business solu-

[23] A near comprehensive listing of this literature is provided in www.globalvaluechains.org

[24] One exception is Dicken (2011), who details the major producers' strategies in selected industries.

[25] In their background paper to the European Competitiveness Report 2011, Stehrer, Biege, Borowiecki et al. (2011) provide a comprehensive literature overview of the related terminologies. The authors discuss the role of knowledge-intensive services as inputs to manufacturing, as well as the evolution of services as output of manufacturing. They

tions (Prencipe et al., 2003), a combination of products, services networks and infrastructures, delivered as a system to the customer (Vladimirova et al., 2011). Manufacturing firms are considered predominantly service providers once their revenues from service activities exceed revenues from products.

A related concept is that of head-tail companies (particularly in the fashion industry) that specialise in activities such as design, brand management, marketing, logistics and retail, but outsource manufacturing (factoryless firms in Dicken, 2011).

The theoretical context underpinning these phenomena involves the two dimensions of firms' international competition: (i) coordination, and (ii) configuration of global activities (Porter, 1986). According to Hobday et al. (2005), systems integration is one of a lead firm's core capabilities. Nevertheless, the authors provide a narrow definition of systems integration, as bringing together 'all the necessary inputs for a system ... high-technology components, subsystems, software, skills, knowledge, engineers, managers, and technicians to produce a product...' (Hobday et al., 2005: 1110). By contrast, the trade-in-tasks perspective of system integration incorporates many other tasks in addition to the items listed above: (i) support services, (ii) services incorporated into the products, and (iii) service types of corporate activities that enhance the intangible value of products. Since each of these latter activities can be sourced internationally, systems integration (i.e. the global configuration of activities and their coordination) really can be regarded as lead firms' core competence. The authors argue that systems integration refers not only to the capability of managing outsourcing, but also to the capability of deciding on potential insourcing. Systems integration concerns configuring activities in an optimal way, in order to benefit from both of 'the simultaneous "twin" processes of vertical integration and disintegration' (ibid.: 1111), from 'both specialisation and integration' (ibid.: 1136).

The persistent dynamics of these twin processes, as well as the requirements for advanced-economy firms continuously to (re-)evaluate their core competences (i.e. narrow their scope) and to reconsider the configuration of each segment of the value chain, are best demonstrated by the increasing scale, scope and sophistication of relocated corporate functions.

Lead companies increasingly engage in international sourcing of R&D activities. R&D is a function that features large and increasing decomposability (Schmitz and Strambach, 2009; Chesbrough et al., 2006 – see also the R&D internationalisation literature, e.g. Archibugi and Michie, 1995; Meyer-Krahmer and Reger, 1999; Narula and Zanfei, 2005; UNCTAD, 2005). Routine R&D tasks are outsourced or offshored with motivations similar

document intra-European differences with respect to the share of services within manufacturing output, and relate service content of manufacturing to firms' innovation performance and examine the importance of various determinants of the service content of manufacturing output.

to the relocation of production activities or of administrative and technical services (cost saving). On the other hand, some non-routine, core R&D activities are also allocated to foreign providers (subsidiaries with a global mandate or contract research organisations), in a process of 'strategic sourcing', with the aim of thereby gaining access to embodied and disembodied technology and to talented professionals (at a time of pressing skills shortage in advanced economies), sharing risks, gaining legitimacy for foreign subsidiaries in important foreign markets, retaining a talented local workforce, etc. (Contractor et al., 2010; Hall, 2011; Kenney et al., 2009; Lewin et al. 2009; Manning et al., 2008).

In addition to R&D, other critical, high-value functions – such as design, engineering, IT-services provision, knowledge-intensive software development, and even marketing (McGovern and Quelch, 2005) – are subject to international sourcing (or at least the non-core parts of these core activities are).

Given this background, the next section reviews some papers that focus on patterns of Europe's GVC specialisation, with a special emphasis on the intangible constituents of the value chain.

2.5 Patterns of Europe's GVC specialisation

Beyond industry case studies, recent exercises seeking to conceptualise and develop the measurement of intangible capital[26] provide quantitative, internationally comparable, easier-to-generalise, albeit partial answers to the questions of how European industry actors' specialisation in advanced, high-value-capture activities has evolved, and how they compare in this respect to their main competitors.

Drawing on seminal conceptual and analytical papers (Lev, 2001; Brynjolfsson et al., 2002; Corrado et al., 2006), parallel efforts have started in the national statistical offices of advanced economies, with the aim of comparing country-level intangible capital deepening to investments in tangible capital, to estimate countries' intangible capital stocks, and to compile data on economic actors' expenditure on the individual constituents of intangible capital.[27]

Although the focus of these papers is on the contribution of intangible capital to GDP and to productivity growth, the accompanying database development also facilitates the assessment of Europe's GVC specialisation.

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[26] Intangible capital includes items such as R&D capital and all non-technological R&D-based innovative property, ICT capital, brand equity, and organisational capital that includes all firm-specific competencies. Together, these explain a substantial part of a company's market value, i.e. they contribute to the difference between a firm's market value and its book value (Piekkola, 2011).

[27] Recent results include van Ark et al. (2009); Corrado et al. (2009); Fukao et al. (2009); Edquist (2011); as well as the results (publications and database) of the FP7 INNODRIVE project (www.innodrive.org); see also the results of the FP7 CoInvest project (www.ceriba.org.uk) and of the FP7 IAREG project (www.iareg.org).

Van Ark et al. (2009) compare the investments of ten EU member States in the individual constituents of intangible capital with the investment of the US. The authors show that the EU Member States invest substantially less[28] than the US in those GVC activities[29] that promise the highest returns (!), as argued both by value capture case studies (Linden et al., 2010; Ali-Yrkkö et al., 2011) and by empirical, econometric investigations (Görzig and Gornig, 2010).

Of the activities associated with the intangible constituents of the value chain, R&D is considered to be of special interest. Moncada-釐Paternó-Castello et al. (2010) survey the literature about Europe's observed underperformance vis-à-vis its main competitors with respect to R&D investment and innovation, and scrutinise the underlying reasons (whether they are intrinsic or structural). Helmers et al. (2009) compare Europe's business R&D capital stock (as a percentage of real value added and of total tangible capital) with the respective indicators of the US and Japan. Both papers document the shortfall of the EU vis-à-vis its counterparts,[30] but point to substantial intra-EU differences (which exceed even those in tangible capital).

R&D expenditure and even synthetic innovation indicators – as proxies of countries' technological capabilities or as the main determinants of countries' prospects for growth and competitiveness – have come in for a lot of criticism (see, for example, surveys by Archibugi et al., 2009; Freeman and Soete, 2009). Arguing from the perspective of countries' GVC specialisation, the main problem is not Europe's underperformance in *overall* R&D investments, but rather the fact that Europe has failed to catch up with competitors in terms of business expenditure on R&D. As shown in Moncada-Paternó-Castello et al. (2010), company demographics – a factor that is overlooked in most 'benchmarking innovation' exercises – can also explain part of the US long-term advantage over Europe: while there is not a very big underinvestment gap by individual EU companies with respect to their US and Japanese counterparts in the case of companies at the very top of the global R&D ranking, the spread of R&D activities is much narrower in the EU (particularly if compared to the US). In Europe, a substantial proportion of business R&D is carried out by a relatively small number of firms that perform large volumes of R&D. In contrast, in the US there is a relatively large population of smaller companies that invest more strongly in R&D, and in a more consistent way, than EU companies – as argued in Moncada-Paternó-Castello et al. (2010).

[28] The authors stress, however, that significant intra-Europe differences apply in the degree to which intangible capital contributes to overall capital deepening at Member State level. This finding is reinforced by Piekkola's (2011) calculations and analysis.

[29] … such as branding, firm-specific human capital improvement, organisational capital improvement, innovative property development, firm-specific ICT development, etc.

[30] According to Moncada-Paternó-Castello et al.'s (2010) decomposition results, the dominant part of the gap can be ascribed to industry composition effects, whereas in Helmers et al. (2009), intrinsic effects also contribute to relative underperformance.

This finding documents Europe's underperformance with respect to specialisation in advanced R&D activities within GVCs better than any benchmarking exercise of countries' overall R&D performance, or of private R&D performance.

Despite the fact that the 'intangible capital'-related literature is concerned mainly with countries' R&D performance, and that case studies on functional upgrading also focus first and foremost on the R&D function, R&D capital does *not represent the highest share* of value added. As demonstrated both by the results of value capture case studies and by exercises that decompose the value-added shares of the individual constituents of intangible capital (Piekkola, 2011), it is rather *organisational capital* that is associated with the highest value capture. The value-added share of organisational capital exceeds that of R&D capital in most European countries (Piekkola, 2011).

Recent research on firms' critical capabilities (surveyed by Schmid and Schurig, 2003) has also identified organisational- (and marketing-) type capabilities as critical. These latter capabilities, above all that of systems integration – including the capability to (i) identify the core competences and determine the balance of vertical integration and specialisation, (ii) find the right suppliers (and geographical location), and manage and control the global sourcing process, (iii) integrate, coordinate and control distributed knowledge bases (Brusoni et al., 2001), and (iv) design and implement the global marketing and sales strategy – complement firms' technological and developmental capabilities, and are deemed critical for business success in general, and for value capture in particular.

The specialisation of European industry actors in organisational capital-related activities and business functions is examined indirectly by a research strand concerned with the (re)location of multinational companies' (divisional) headquarters (HQ). Since the most important managerial functions (decision-making about the configuration of activities, coordination and corporate governance, global financial and strategic management, etc.) are concentrated in the HQ, and consequently most organisational capital is associated with the HQ,[31] it is important to monitor changes in their spatial distribution. Despite the importance and the performance implications of the topic, data on this aspect are scarce and research has been confined mainly to identifying the motivations for,[32] and the performance implications of, HQ relocation (Birkinshaw et al., 2006; Laamanen et al., 2012; Strauss-Kahn and Vives, 2009).

It is the consensus opinion of scholars that the global distribution of HQs is shifting towards developing countries (at least regional and divisional HQs are established in developing

[31] In addition, HQs are important sources of high-value-adding jobs, and they represent hubs of high-end business services concentrated around them.

[32] The main motivations include efficiency considerations, legitimacy arguments and access to foreign markets (Benito et al., 2011; Birkinshaw et al., 2006).

economies), but sometimes corporate HQs themselves move to lower-cost locations or to locations that offer favourable tax conditions (Benito et al., 2011; Bloom and Grant, 2011). Although the number of news stories about businesses relocating their headquarters is increasing, it is still a fairly infrequent occurrence in advanced economies, and more data accumulation is necessary to enable the precise identification of a phenomenon still in its infancy.

2.6 Crisis and GVCs

The economic and financial crisis that broke in 2008 was accompanied by a great fall in foreign trade volumes; actually, the extent of trade collapse was greater than the decline in output. Thus international trade can be regarded as one of the great 'victims' of the world crisis. At the same time, it was also one of the channels through which the crisis was transmitted between countries. Thus the main research questions investigated were, first, why the collapse of international trade was greater than that of GDP, and second, whether (and how) foreign trade acted as a transmitter of the crisis.

When investigating the causes of the trade collapse (and especially its differing depth in various countries) and the role of international trade in 'transporting' the crisis from one country to another, even quite early on in the crisis GVC-related factors were included as possible transmission mechanisms (see, among others, Baldwin, 2009; Freund, 2009; Milberg and Winkler, 2010). It was hypothesised that the organisation of international production in GVCs was what caused a greater drop in trade than in GDP. Baldwin (2009, 2011) actually suggested that GVCs played a key role in the nature of the 'great trade collapse'. This meant that GVCs, a relatively neglected area of research, have come to the forefront in terms of analysing changes in world trade during the crisis.

However, it must be mentioned that there are some empirical papers that do not find this factor significant. For example, Rose and Spiegel (2010) could not find strong evidence that international trade linkages acted as transmitters of the crisis. According to their results, countries with higher exposure to the US economy (in terms of the share of their exports to the US) performed better during the crisis. Thus, trade linkages did not play a negative role in helping the crisis travel through countries. As for the causes of the trade collapse, other authors – for example, Chor and Manova (2010) – found that adverse credit conditions played an important role in transmitting the impact of the crisis to trade flows. The dependence on external finance by French exporters is also found to have been the most important factor by Bricongne et al. (2011).

Nevertheless, there are empirical studies which found that factors connected to GVCs may have played a role in the significant decrease in foreign trade volumes during the crisis, though they come up with various estimates concerning the actual extent of the impact of that factor. They also adopt various approaches – not only methodologically, but also in terms of the concepts they use to describe the changes in the international division of labour and the existence of global networks and value chains. There are also analyses which underline the importance of GVCs in 'spreading' the crisis to ever more countries; however, results differ in terms of the length, sign (positive or negative) and importance of that effect.

As for the relative importance of GVCs among the factors causing the trade crisis, an analysis conducted by the OECD (Cheung and Guichard, 2009) showed that demand factors and tight credit conditions were the main causes of the collapse in world trade during the crisis years. The unexplained part of the trade decline, which represented about 10–20% of the total fall, may reflect a breakdown in GVCs.

Similarly, Escaith et al. (2010) use historical data and also show that GVCs played a role in explaining the larger decrease in trade than in GDP. They present two GVC-related factors in that respect. The first is the composition effect: 'the initial demand shocks linked to the credit crunch concentrated disproportionally on consumer durables and investment goods, the most vertically integrated industrial sectors' (Escaith et al., 2010: 110). The second factor is called the 'bullwhip effect', which refers to inventory adjustments, the size of which becomes ever greater the further along the value chain one goes.

Shortage of trade finance has already been shown to have played a role in the collapse of trade. Milberg and Winkler (2010) applied a more nuanced approach to the problem of trade finance and linked this to GVCs. They showed that trade finance shortages have a greater effect on international trade if it is organised in GVCs, because the close relationships between the participating companies results in a quick transmission of the problem along the value chain.

Seemingly unrelated to our topic, Alfaro and Chen (2010) analyse the reaction and role of FDI during the global financial crisis. They examine firm-level data from more than 100 countries for 2007 and 2009. Their results can be related to the GVC approach, because they distinguish and examine three channels through which FDI impacts upon the performance of companies: production linkages, financial linkages and multinational networks. From our point of view, the most important results are that multinationals engaged in activities with vertical production linkages weathered the crisis better than their local counterparts. On the other hand, the horizontal type of FDI was affected more negatively. Moreover, companies operating as part of a multinational network on average performed better; here again, horizontal production linkages were affected more negatively than vertically integrated ones. Thus GVCs may have played a stabilising role.

Behrens et al. (2011) found, in the case of Belgium, that involvement in global value chains has some explanatory power for the fall in both exports and imports during the crisis, though domestic operations were equally affected. According to their results, the trade collapse was mainly caused by demand-side factors. They also point out that the fall in foreign trade is explained overwhelmingly by the intensive margin of trade (exporters reduced the volume of exports), while the extensive margin (i.e. reduction in the number of exporters) was negligible. This is in line with the findings of Békés et al. (2012), who analysed firm survey data from seven countries (Austria, France, Germany, Hungary, Italy, Spain and the United Kingdom). Moreover, they found that 'networking' and links with other companies (outsourcing or controlling other companies) helped firms to fare better during the crisis. This result can also be interpreted within the GVC framework. On the other hand, companies controlled by other firms were in a worse position. Thus the place of the firm in the production chain is an important determinant of the effect of the crisis.

Stehrer et al. (2011a) analyse trade in intermediates and (separately) trade in parts and components, in order to show whether the breaking up of GVCs played any role in the trade collapse during the crisis years. In their approach, they use CN (Combined Nomenclature) categories at a disaggregated level. First, they show how the elasticity of trade with respect to income increased in the OECD countries, comparing the two periods of 1961–84 and 1985–2009. They explain that this is at least partly driven by the increased vertical specialisation of countries, i.e. the presence of GVCs, as countries export and import a large amount of parts and components and other intermediate products ('intermediates' being parts and components plus semi-finished goods plus primary goods). The increased income elasticity of trade is then explained by the fact that trade flows are registered as gross (i.e. the full amounts), whereas GDP relies on the concept of value added (i.e. a kind of net value). During the crisis, in real terms they found a slight decline in the share of parts and components in total trade for the EU-27. They showed industry differences: on the one hand, the share of parts and components as a measure of the degree of vertical specialisation varied considerably, with electrical machinery, machinery and equipment, transport equipment and the automotive sector having the highest shares; on the other hand, industrial differences were also present in the extent of the decline in export and import volumes during the crisis. In this latter respect, the automotive sector stands out; other sectors that are less 'GVC intensive' on the basis of the trade shares of parts and components also experienced a large fall. According to the authors, the trade collapse may be an outcome of demand and supply-side factors, disruptions in GVCs being one of the many causes.

Bems et al. (2011) use a global input-output framework involving data from 55 countries. They found that GVCs (trade in intermediates) significantly mitigated the fall in world trade, as the extent of the decline in trade in intermediaries was less than half the fall in trade in final goods. They also used the concept of vertical specialisation – thus a subset of trade in intermediates – for their further investigations. Like Stehrer et al. (2011a), they distinguished between gross trade and value-added trade, and found that value-added trade decreased less than gross trade, which meant that vertical specialisation contributed (albeit modestly) to the greater decrease in total trade.

Altomonte et al. (2012) use transaction-level French trade data, matched with ownership data for 2007–09, to determine whether GVCs contributed to the collapse of international trade during the crisis. They found that trade in intermediaries was the most important cause of the trade collapse; thus the role of GVCs was significant in the trade decrease during the crisis. However, they also found that this type of trade rebounded faster – i.e. 'trade originated within hierarchies of firms reacted faster to the negative demand shock but has also recovered faster in the following months than arm's length trade' (Altomonte et al., 2012: 23). They also show the presence of the 'bullwhip effect' of inventory adjustment.

The connection between the crisis and GVCs is analysed from a development and developing-country perspective by those papers collected in the book by Cattaneo et al. (2010b). Besides studies on world trade and GVCs, sectoral issues are separately analysed for those industries in which GVCs predominate, such as the apparel, automotive, electronics and (business) services sectors. One of the main conclusions of the book is that GVCs proved resilient to the crisis; they became (and remain) important actors in the world economy and important modes of organisation for the production process in certain activities. On the basis of case studies, it is also underlined that, in certain cases, involvement in GVCs could have played a mitigating effect during the crisis – as when, for example, lead firms supported suppliers who were suffering from trade finance problems. Moreover, they call attention to the (possibly) longer-term impacts of the crisis on world trade – above all, its diversification in terms of a shift to the South, not only in supply but also in demand. A second long-term effect is the trend towards consolidation at the country and company levels. This means, at the country level, a shift towards large developing countries, especially China; at the company level it signifies an ever more pronounced preference on the part of lead firms for larger, more competitive and productive first-tier suppliers, which are able to operate globally.

In summing up the empirical literature written up to now on the role of GVCs in the trade crisis, the results seem to be contradictory. This can be attributed partly to the different approaches and different methodologies, datasets and time horizons used. However, it seems obvious that, on the one hand, GVCs had an amplifying effect in the first few months of the crisis in terms of the decrease in international trade. On the other hand, they also had a certain stabilising effect, at least in the slightly longer run. This may have been caused by the reversal of the bullwhip effect, as well as by the fact that companies inside the value chain helped each other (e.g. by providing trade finance). As for the changing role of GVCs as a result of the crisis, it is obvious that GVCs are here to stay; but consolidation tendencies are ubiquitous in GVCs.

3. Changes in industries' value chains since 1995

3.1 Introduction

Inter-industry and international linkages vary across industries and countries and change over time. Countries have to rely on imports of products not produced domestically, e.g. raw materials, but, additionally, industries are likely to participate in the international division of labour via offshoring of production of semi-finished products, parts and components, or assembly activities. This study investigates value chains and vertical specialisation patterns – and the changes over time – for EU-27 industries, in comparison with the US, Japan Mexico, Korea and the BRIC countries in the period from 1995 to more recent years (depending on data availability). This analysis gauges industries' backward and forward linkages, i.e. the input structures and supply structures. These are investigated within individual domestic economies, within Europe and with respect to various other countries of the world, and for both the overall economies and the four selected industries. This section explores the relative importance of imported inputs, with a focus on value chains of industries. The particular questions to be addressed are:

- Have specific industries faced significant changes in vertical specialisation patterns compared to total manufacturing?
- Have there been major shifts with respect to source patterns by geographical regions, and are there significant differences across countries?
- To what extent have the import content of exports and value-added chains changed over the longer term and in more recent years?

Methodologically the study follows the literature on vertical specialisation as developed by Hummels et al. (2001); see also Meng and Yamano (2010) for an overview of various measures of vertical specialisation. Based on a world input-output database, a more general measure using the advantages of a global input-output table can be applied. For the sake of comparison, similarities to and differences from the Hummels et al. (2001) VS1 measure are highlighted.

Related to the issue of vertical specialisation is the extent to which energy use has changed over time in different industries, and whether vertical specialisation has led to changes in resource efficiency of production. This question can be tackled in a similar fashion as above, though it requires additional data on energy use by industry.

3.2 The World Input-Output Database data

The data used for the analysis are taken from the 'World Input-Output Database' (WIOD). This section provides a brief description of the data to be used and how these have been constructed (for a detailed documentation see Timmer et al., 2012). The WIOD is the outcome of a recent effort undertaken in an ongoing project within the Framework 7 programme, which aims to bring together information from national accounts statistics, supply and use tables, trade in goods and services data and corresponding data on factors of production (capital and labour) for 40 countries over the period 1995–2006. The database covers all 27 EU countries, plus Turkey, and includes other major economies such as the NAFTA countries (USA, Canada and Mexico), the BRIIC countries (Brazil, Russia, India, Indonesia and China), Japan, Korea, Taiwan and Australia.

A brief description of this database follows. National accounts data have been collected for all countries over the period 1995–2006, and these serve as benchmark values. Existing supply and use tables have then been adjusted to these national accounts data, and some of the tables have been estimated for years for which data were not available. Some countries only provide input-output tables that have been transformed back into supply and use tables. By this process, all the tables are standardised over years and across countries with respect to product and industry classifications. The tables contain information on the supply and use of 59 products in 35 industries, together with information on final use and value added.

Accompanying this information, corresponding trade data were collected – with the same level of disaggregation – at the product level. Data on goods trade are taken from UN Comtrade at the HS 6-digit product level, which can be aggregated to the CPA products at the 2-digit level, as reported in the supply and use tables. However, services trade is only available from balance-of-payments statistics, which provide information on a detailed basis only in balance-of-payments categories. Using a rough correspondence, these were merged with the product-level data provided in the supply and use tables. Additionally, the trade data are split up into use categories fitting the needs of supply and use tables, i.e. intermediates, consumption and gross fixed capital formation. Goods trade has been split up by applying a categorisation of products into intermediates, final consumer goods and gross fixed capital goods. The correspondence used for this was created by starting with the usual Broad Economic Categories (BEC) classification (provided by the UN), but adapting this classification to the specific needs. In particular, the correspondence between HS 6-digit and BEC categories has been revised, and in a number of cases weights were used for particular products, in order to distinguish between intermediates and the other categories. For services trade, however, no such information is available. Therefore, data from existing input-output and supply and use tables have been used, and applied average shares across countries. Relying on these underlying data, the starting point has been the import vector provided in the supply tables. First , import values for each country and product are split up into the three use categories. Second, within each use category a proportionality assumption is applied to split up the imports for each use category across the relevant dimensions. For example, imports of intermediates are allocated across industries that use them in proportion to the structure in the total use table. Similarly, imports for final consumption are split up into final demand categories. Investments are allocated only to gross fixed capital formation (i.e. not considering changes in inventories and valuables). This results in an import-use table for each country. Finally, each cell of the import-use table is again split up by country of origin, resulting in 39+1 (including the rest of the world) import-use tables for each country. Merging these tables provides a full set of inter-country supply-and-use tables. Finally, an international input-output table was constructed by applying the transformations of model D, as described in the Eurostat manual (Eurostat, 2008) to which a rest of world was constructed. This results in a world input-output database for 41 countries (including rest of world) and 35 industries, i.e. the intermediates demand block is of dimension 1435x1435 plus additional rows on value-added and columns on final demand categories. The rest of the world is not explicitly modelled in this case, but appears only in the import columns (imports from rest of the world by product) and export column (exports to rest of the world). In the application, below an assumption on the structure of input coefficients is necessary (outlined below). Corresponding data at the industry level allow value-added to be split up into capital and labour income, as well as into physical inputs such as employment and capital.[33]

Table 3.2.1

Outline of world input-output table

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

3.3 A global account of the selected industries

This section provides a comparative overview of the four selected sectors with respect to their relative sizes in terms of gross output, value added and trade structures. The focus is on providing a descriptive analysis of the characteristics of these industries with respect to supply and use of their products, their relative importance in the world economy and individual country groups.

33 Furthermore, in an ongoing effort capital income will be split up into ICT and non-ICT income, and labour income into income of low-, medium- and high-educated workers. These additional data for the factor incomes correspond in construction to the method applied in the EU KLEMS database (see www.euklems.org) and efforts undertaken in the World KLEMS project.

Table 3.3.1

Gross output and value-added shares in world for selected industries, 2009, in %

		Share in total economy				Share in manufacturing			
		1995	**2000**	**2005**	**2009**	**1995**	**2000**	**2005**	**2009**
Value added	DG	1.9	1.7	1.7	1.7	9.8	9.4	9.8	10.4
	DK	1.7	1.5	1.4	1.4	8.6	8.2	8.4	8.4
	DL	2.4	2.6	2.2	2.1	12.5	14.1	12.8	13.0
	DM	1.9	1.9	1.8	1.5	9.8	10.2	10.3	9.4
Gross output	DG	2.9	2.8	2.9	3.0	9.4	9.5	10.1	10.3
	DK	2.4	2.2	2.2	2.1	7.8	7.5	7.6	7.4
	DL	3.8	4.1	3.5	3.7	12.0	13.9	12.1	12.8
	DM	3.7	3.7	3.6	3.2	11.7	12.3	12.4	11.0

Note: DG ...Chemicals and chemical products; DK ... Machinery and equipment; DL ... Electronic and optical products; DM ... Transport equipment

Source: WIOD; authors' calculations.

The first thing considered is the relative size of these four industry sectors in the world economy. Table 3.3.1 provides their shares of gross output, value added and employment in total manufacturing. The four selected industries are relatively small, with shares of less than 2% in value added (only NACE DL – Electrical products accounts for a slightly higher share) and between 2.5% and 4% in terms of gross output. However, within the manufacturing industries, these four make up more than 50%, and in this respect are quite important.

Table 3.3.2

Gross output and value-added shares in total manufacturing, 2009, in %

		EU-12	**EU-15**	**JPN**	**USA**	**CAN**	**CHN**	**BRII**	**KOR**	**MEX**	**TWN**	**OTH**
Gross output	[	6.3	11.1	9.9	12.9	8.4	10.2	10.0	9.9	9.6	15.4	7.8
	DK	6.7	9.9	7.3	6.0	5.2	8.6	6.2	7.7	2.1	7.5	4.6
	DL	13.2	9.8	13.1	10.4	4.7	18.3	6.7	20.4	15.0	30.6	11.2
	DM	13.2	13.2	15.7	12.7	18.7	7.1	9.8	16.5	13.1	4.5	7.6
Value added	DG	6.6	11.4	9.0	12.6	7.8	10.2	9.7	8.8	9.3	15.8	8.7
	DK	7.9	12.2	8.0	7.3	6.8	9.6	6.6	9.3	2.4	7.7	4.3
	DL	10.6	11.1	13.9	17.1	5.1	14.3	7.4	24.5	7.1	32.6	10.5
	DM	10.8	10.1	13.3	10.1	13.1	6.7	8.8	17.5	12.9	4.2	6.5

Source: WIOD; authors' calculations.

These shares, however, hide differences concerning the relative importance of the industries in individual countries or country groups. Table 3.3.2, therefore, provides information on the shares by the groups of countries defined above, for the latest year available.

There are some differences to be observed with respect to the share of value added and gross output of individual countries or country groups. Of the reporter countries considered, chemicals (NACE DG) tend to have a lower share in terms of gross output in the EU-12 (6.3%) and Japan (9.9%). Its share in the other countries is around 10–12%, with the highest value observed for Taiwan (15.4%). The gross output share of Machinery (NACE DK) is between 6% (USA) and 9.9% (EU-15) among the reporter countries, while in Mexico it is 2.1% and in China 8.6%. Higher shares are observed for the Electronics industry (NACE DL), reaching more than 13% in the EU-12 and Japan and around 10% in the EU-15 and the USA. There much more differentiation among the partner countries, with shares highest in Taiwan (30.6%), Korea (20.4%) and China (18.3%), and lowest in Canada (only 4.7%). In Transport equipment (NACE DM), the share of gross output is around 13% for the EU-12, the EU-15 and the USA, with a higher share observed for Japan (almost 16%). For the other countries, the share ranges from 4.5% in Taiwan to 16.5% in Korea and 18.7% in Canada; China has a share of only 7.1%. Compared to the shares of value added, there are some distinctive differences, which are highlighted in Figure 3.3.1. There are rather small differences among countries in the chemicals industry (NACE DG) with +/-1 percentage points and in machinery (NACE DK), with almost all countries showing larger shares of value added than of gross output. The most important differences can be seen for the electronics industry, with strong positive values (gross output being larger than value added) for the EU-12, China and Mexico, and large negative numbers for the USA and Korea. For the transport equipment industry, the four reporter countries plus Canada show higher gross output shares.

As mentioned above, the differences stem from the share of intermediates in the production process. Table 3.3.3 therefore presents the share of intermediate inputs in each industry by country, together with developments over time.

Table 3.3.3

Shares of intermediate inputs in gross output, 1995–2009, in %

		EU-12	EU-15	JPN	USA	CAN	CHN	BRII	KOR	MEX	TWN	ROW
Chemicals	1995	65.0	61.7	63.9	64.6	56.7	71.3	63.8	68.6	70.3	73.3	65.5
	2000	66.2	64.4	66.8	65.7	66.1	71.8	67.3	73.8	67.4	76.0	66.5
	2005	66.9	64.8	71.1	69.1	70.7	76.4	68.6	73.4	69.4	80.1	66.4
	2009	66.2	66.3	71.2	65.9	70.5	78.7	69.6	76.5	69.0	76.1	66.5
Machinery	1995	62.5	60.1	61.8	62.5	54.6	67.9	63.4	68.5	61.7	73.9	70.7
	2000	63.3	61.1	62.9	62.7	54.9	69.3	63.9	66.5	60.2	74.2	71.5
	2005	67.1	62.1	62.7	63.3	55.5	74.3	66.3	71.9	63.0	77.0	71.8
	2009	65.5	62.9	64.9	57.3	59.1	76.1	66.5	73.1	62.0	75.1	72.1
Electronics	1995	66.9	60.9	61.1	65.5	67.5	74.0	61.8	67.4	79.2	72.8	71.5
	2000	71.6	63.6	62.4	63.9	66.8	75.6	65.5	68.4	76.4	71.5	71.9
	2005	72.4	63.1	62.9	52.3	64.7	79.9	65.7	70.5	79.6	73.7	72.0
	2009	74.9	64.6	66.1	42.7	64.8	82.3	65.7	72.8	81.9	73.4	72.1
Transport	1995	72.1	68.7	73.9	71.6	71.0	73.0	67.4	68.6	68.9	68.6	72.2
	2000	76.8	72.4	74.4	69.9	71.4	73.3	67.9	71.6	66.3	67.5	73.3
	2005	75.2	73.2	73.7	71.7	74.1	77.6	70.8	75.7	65.6	72.2	73.8
	2009	73.3	74.5	73.0	71.5	75.4	79.8	71.0	76.0	64.7	75.2	74.0

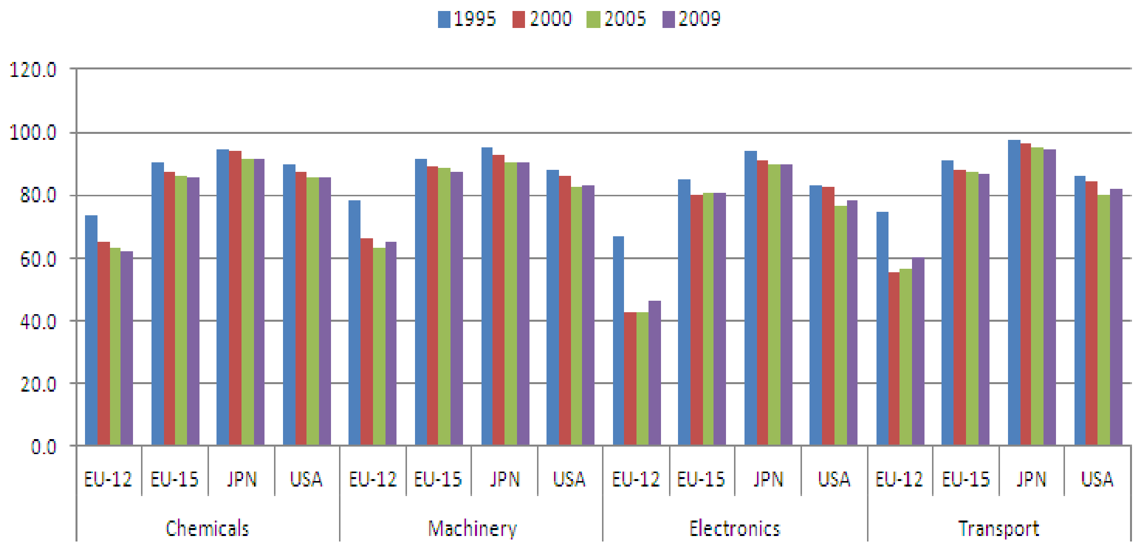
Source: WIOD; authors' calculations.

The most important information from this table is that the shares have been generally increasing over time, and in some cases particularly strongly. For example, the share of intermediates in the electronics industry (NACE DL) in China has risen from 74% to 82% (i.e. around the level of Mexico), but has declined in the USA from 65.5% in 1995 to less than 50% in 2009.

The central focus of this study is on where these intermediates are sourced – domestically or from foreign countries – and how this has changed over time. Figure 3.3.1 provides a first glimpse of this by just presenting the share of domestic sourcing of intermediates in the four selected industries. The most important point is that the share of domestic sourcing has decreased over time, pointing to the increasing internationalisation of production. The only exception is the EU-12, which, after a sharp drop between 1995 and 2000, started to increase its domestic share (with the exception of chemicals).

Figure 3.3.1

Share of domestic sourcing, 1995–2009, in %



Source: WIOD; authors' calculations.

3.4 *International linkages*

This leads to a more detailed consideration of changes in the international sourcing structures. Using information from the WIOD, the industry-level structures of sourcing and vertical specialisation can be studied in more detail. In the next section, there is a discussion of the measures of international forward and backward linkages which link to measures of vertical integration. In fact, a generalisation of the indicator suggested by Hummels et al. (2001) is proposed, which almost naturally links to the concept of backward linkages widely used in the input-output literature.

3.4.1 Methodological aspects

Here the methods used below to analyse inter-sectoral linkages and multipliers – to show the effects of a final demand stimulus in one sector on the output of other sectors, and therefore on general output levels – are briefly summarised. Such multiplier effects appear not just in one country, but spread to other countries due to the international production linkages. An increase in final demand in one sector, e.g. the car industry, has an *'initial'* impact on the output of that industry, but also induces *'direct'* effects in terms of demand in other sectors that serve as inputs into the car manufacturing industry. These inputs may either stem from other industries in the same economy, or they may be sourced abroad. As these other sectors also source their production from different sectors (perhaps again in a variety of countries) this creates further effects, which are summarised as *'indirect'* effects. The initial output effect is the value needed to satisfy the additional demand. The output multiplier then shows the ratio of the direct and indirect effects to this initial change. Formally, this can be represented in the way that gross output **x** (this is a vector of dimension Nx1, where N is the number of sectors) must equal demand for intermediates and final goods. Demand for intermediates is given from technical coefficients, i.e. inputs from other industries per unit of output, which is summarised in a coefficient matrix denoted by **A**. This matrix is of dimension NxN, where each column denotes demand of this industry in other industries. In the simplest case, one assumes that final demand in each sector, denoted by the Nx1 vector **f,** is exogenously given. Thus, total output can be written as

$$\mathbf{x} = \mathbf{Ax} + \mathbf{f} = (\mathbf{I}\text{-}\mathbf{A})^{-1}\,\mathbf{f}$$

This has an intuitive interpretation, which is exemplified with a change in final demand. A change in final demand first has a direct effect, **I** Δ**f**, where **I** denotes an identity matrix, the direct effect, i.e. demand created in other industries to produce this car, **A** Δ**f**, and the next round effects (demand of these industries on other industries), which is formally ($\mathbf{A}^2 + \mathbf{A}^3 +$ ...) Δ**f**. Summarising, one can therefore write the effects as

$$\Delta\mathbf{x} = (\mathbf{I} + \mathbf{A} + \mathbf{A}^2 + \mathbf{A}^3 + \ldots)\,\Delta\mathbf{f} = (\mathbf{I}\text{-}\mathbf{A})^{-1}\,\Delta\mathbf{f}$$

Thus, matrix $\mathbf{L} = (\mathbf{I}\text{-}\mathbf{A})^{-1}$, which is well known as the Leontief inverse, gives valuable insights into the effects of a final demand increase in one sector on the other sectors' output. Summing up, these columns provide insight into the total output effect in the economy, which is referred to as the 'simple output multiplier'. Looking at a particular column of the Leontief inverse therefore provides an estimate of the output effects in this (initial) and the other sectors (direct and indirect). Formally, this can be written as

$$\mathrm{m(o)_j} = \sum_{\mathrm{i}=1}^{\mathrm{N}} \mathrm{l_{ij}}$$

where l_{ij} denotes the coefficients of the Leontief inverse, *j* is the industry with the final demand stimulus and *i* denotes the other industries delivering inputs. The simple output multiplier for industry *j* is denoted by $m(o)_j$.

To take account of the international structure of production is formally easy when thinking of the coefficients matrix **A** in terms of a global sourcing matrix. For example, the German car manufacturing industry sources inputs per unit of output from other German industries, but also from industries in other countries (such as the Slovak Republic, Austria, etc.). By analogy with the above, one can therefore differentiate into direct and indirect (i.e. second-, third-, etc. round) effects. The **A** matrix in this case is of a much larger dimension, depending on the number of countries included. The output multiplier would then be written as

$$\mathrm{m(o)_j^c} = \sum_{\mathrm{r=1}}^{\mathrm{C}} \sum_{\mathrm{i=1}}^{\mathrm{N}} \mathrm{l_{ij}^{rc}}$$

where *C* denotes the number of countries and l_{ij}^{rc} denotes the coefficient of the Leontief inverse associated with the sourcing of sector *j* in country *c* in sectors *i* in countries *r*. Though it is conceptually relatively straightforward, taking account of these international linkages, it is challenging from a data point of view, as data are provided on a national basis. However, the international IO tables provided in the WIOD project allows these international linkages to be captured.

This concept of multipliers is related to measures of international linkages. Generally, two kinds of linkages are used in the framework of the input-output analysis. On the one hand, a sector needs inputs from other sectors. The interconnection of a particular sector with those 'upstream' sectors from which it purchases inputs is termed *backward linkage*. The economic effect on other sectors is to be found on the demand side: 'If sector *j* increased its output, this means there will be increased demands from sector *j* (as a purchaser) on the sectors whose goods are used as inputs to production in *j*' (Miller and Blair, 2009: 555). On the other hand, a sector sells its output to other sectors. This kind of interconnection of a particular sector with those 'downstream' sectors to which it sells its output is called *forward linkage*. The economic effect is to be found on the supply side: 'If sector *j* increased its output, this means there will be increased supplies from sector *j* (as a seller) for the sectors that use good *j* in their production' (Miller and Blair, 2009: 555).

Various measures have been proposed to calculate backward and forward linkages (see Miller and Blair, 2009, for a discussion). The 'total backward linkage indicator' captures both direct and indirect effects and is similar to the simple output multiplier as discussed above. It can be written as

$$\mathrm{BL_j^c} = \sum_{\mathrm{r=1,r\neq c}}^{\mathrm{C}} \sum_{\mathrm{i=1,i\neq j}}^{\mathrm{N}} \mathrm{l_{ij}^{rc}}$$

As the focus here is mainly on a sector's backward dependence on, or linkage to, the rest of the economy and other economies, the diagonal element in the Leontief inverse is omitted. In the applications, the linkage indicator is often normalised to the average of the other sectors, which might also include other sectors in other countries. This normalised indicator shows a value larger than 1 for sectors with above-average backward linkages.[34] Rasmussen (1957) termed this the 'Index of Power of Dispersion'.

Forward linkages are then calculated as the row sums of the coefficients matrix or Leontief inverse, the latter providing the 'total forward linkage indicator'. However, the literature suggests basing them on the Ghosh inverse. The latter is calculated by dividing each row by the sector output, which provides the allocation coefficient matrix **B**. Taking **G** = (**I-B**)$^{-1}$ provides the Ghosh or output inverse. Forward linkages (which can also be normalised, like the backward linkages) are then calculated analogously as[35]

$$FL_i^r = \sum_{c=1,c\neq r}^{C} \sum_{j=1,j\neq i}^{N} g_{ij}^{rc}$$

In the recent literature, other indicators are developed (see e.g. DeBacker and Mirodout, 2012, for an overview). Particularly, the 'index of the number of production stages' is suggested as a measure of the average length of global value chains, as argued in Fally (2011). This indicator is also based on the coefficients matrix and is defined for a particular industry as $n_j^c = 1 + \sum_{i,r}^{N,C} 1 + n_i^r a_{ij}^{rc}$ providing a linear system of NC equations in NC unknowns which has a unique solution. Rewriting in matrix notation, it turns out that the solution equals the backward linkages: denoting the (1 x NC) vector of indicators as **n** and the diagonalised vector as $\hat{\boldsymbol{n}}$, the above equation can be written as $\mathbf{1}'\hat{\boldsymbol{n}} = \mathbf{1}'\mathbf{I} + \mathbf{1}'\hat{\boldsymbol{n}}\boldsymbol{A}$ where **1** denotes a summation vector of the appropriate dimension. Rearranging yields

$$\mathbf{1}'\hat{\boldsymbol{n}} - \mathbf{1}'\hat{\boldsymbol{n}}\boldsymbol{A} = \mathbf{1}'\hat{\boldsymbol{n}}(\mathbf{I} - \boldsymbol{A}) = \mathbf{1}'\mathbf{I} \text{ or}$$
$$\boldsymbol{n} = \mathbf{1}'(\mathbf{I} - \boldsymbol{A})^{-1} = \mathbf{1}'\boldsymbol{L}$$

This is, however, exactly the backward linkages as defined above as the column sums of the Leontief inverse for the respective industry. Thus, the indicators of backward linkages are conceptually the same as the 'index number of production stages' in the interpretation of Fally (2011). This report sticks to the terminology of backward and forward linkages.

3.4.2 Patterns of international linkages and changes over time

The results of this exercise for the non-normalised backward and forward linkages for the four selected industrial sectors are presented for the EU-12 (the 'new' EU Member States), the EU-15 (the 'old' EU Member States), Japan and the US. The EU is split into these two regions because of the important role the EU-12 countries have in the European production network. The years of observation include 1995, 2000, 2005, 2007 and 2009, the last of these providing some hints as to the initial effects of the crisis.

Figure 3.4.1 provides a first overview for the year 2007. As one can see, backward and forward linkages differ markedly by region and sector: backward linkages are highest for all

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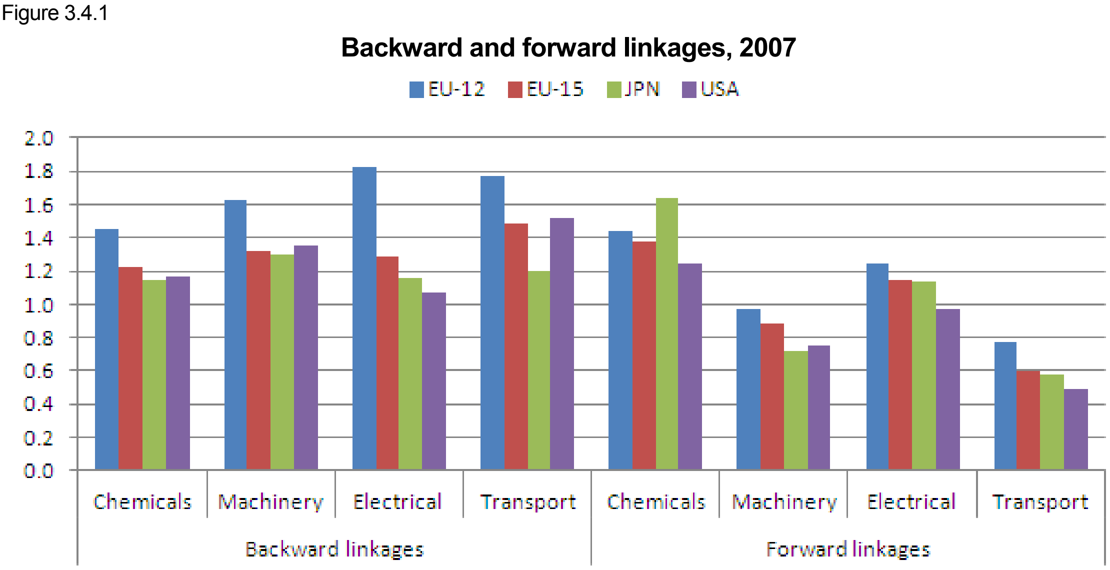
34 In the literature also various weights are suggested to calculate the normalised indicators.

35 A further extension would be the so-called 'net backward linkage' (see Dietzenbacher, 2005; Miller and Blair, 2009).

sectors in the EU-12 countries and are distinctly smaller in the other three regions, reflecting the strong connection between the EU-15 and the EU-12, as assembly of final goods requires the components to be delivered by firms located in the EU-15. Referring to sectors, transport equipment exhibits the highest backward linkages (except for Japan, where machinery has the highest backward linkages), followed by the machinery sector. Next are the electrical equipment and the chemical sectors. When compared to forward linkages, backward linkages are larger and hence more important for machinery, the electrical and transport equipment sectors. Forward linkages are slightly larger for the chemicals sector, due to its intermediate role in production. Again, forward linkages are most pronounced in the EU-12, except for in the chemicals sector, where Japan shows the largest forward linkage. In terms of sectors, the electrical equipment sector has the largest forward linkages after chemicals. Machinery and transport equipment have distinctly smaller forward linkages.

Figure 3.4.1 does not distinguish between linkages with the domestic economy and with other countries: using the WIOD, it is, however, possible to make not only this distinction, but also to look at linkages on a region/country basis. This allows differentiation between products sourced domestically and internationally in the case of backward linkages, as well as products supplied at home or in other countries in the case of forward linkages. Table 3.4.1 gives a detailed picture of forward and backward linkages between the regions observed and the rest of the world.

Figure 3.4.1



Source: WIOD; authors' calculations.

The *EU-12 countries* are strongly interlinked with the EU-15 countries. Backward linkages to the domestic economy and the EU-15 are strong in all four sectors. Linkages to the EU-15 are even larger than domestic linkages in the electrical and transport equipment sectors. Backward linkages to China, Japan and Korea are important in the electrical equipment sector and to the BRII in the chemicals sector. As regards forward linkages, here linkages to the EU-15 dominate domestic linkages, except in chemicals. Forward linkages with the rest of the world are also important. It is interesting that the EU-12 has strong forward linkages with the EU-15.

Table 3.4.1

Backward and forward linkages, by region, 2007

	Backward linkages				Forward linkages			
	Chemicals	**Machinery**	**Electrical**	**Transport**	**Chemicals**	**Machinery**	**Electrical**	**Transport**
				EU-12				
BRII	0.126	0.056	0.047	0.049	0.079	0.049	0.027	0.043
CAN	0.006	0.007	0.010	0.008	0.007	0.006	0.006	0.005
CHN	0.037	0.072	0.282	0.081	0.052	0.048	0.089	0.032
EU-12	0.630	0.659	0.436	0.586	0.556	0.230	0.179	0.113
EU-15	0.441	0.596	0.635	0.776	0.436	0.448	0.646	0.420
JPN	0.014	0.031	0.078	0.048	0.017	0.010	0.014	0.013
KOR	0.010	0.021	0.070	0.038	0.010	0.012	0.012	0.006
MEX	0.002	0.003	0.006	0.005	0.006	0.004	0.009	0.002
USA	0.033	0.036	0.063	0.047	0.069	0.041	0.057	0.029
ROW	0.150	0.143	0.197	0.135	0.204	0.124	0.204	0.109
				EU-15				
BRII	0.041	0.035	0.033	0.038	0.055	0.042	0.030	0.034
CAN	0.007	0.008	0.007	0.011	0.020	0.008	0.009	0.007
CHN	0.033	0.061	0.119	0.065	0.094	0.097	0.134	0.039
EU-12	0.026	0.054	0.057	0.077	0.073	0.047	0.077	0.042
EU-15	0.886	0.964	0.831	1.042	0.651	0.440	0.569	0.263
JPN	0.016	0.025	0.034	0.043	0.041	0.014	0.020	0.019
KOR	0.008	0.012	0.023	0.021	0.025	0.019	0.019	0.008
MEX	0.003	0.004	0.005	0.007	0.016	0.005	0.010	0.004
USA	0.058	0.041	0.057	0.066	0.168	0.060	0.074	0.047
ROW	0.146	0.114	0.121	0.118	0.229	0.150	0.208	0.133
				Japan				
BRII	0.036	0.027	0.024	0.027	0.028	0.021	0.020	0.052
CAN	0.007	0.006	0.006	0.006	0.008	0.006	0.009	0.016
CHN	0.059	0.095	0.122	0.083	0.256	0.159	0.365	0.066
EU-12	0.003	0.004	0.004	0.006	0.009	0.008	0.021	0.009
EU-15	0.081	0.060	0.056	0.090	0.087	0.066	0.112	0.083
JPN	0.891	1.032	0.858	0.910	1.054	0.356	0.424	0.216
KOR	0.021	0.030	0.035	0.025	0.089	0.036	0.054	0.017
MEX	0.002	0.003	0.003	0.004	0.009	0.005	0.022	0.009
USA	0.046	0.043	0.048	0.049	0.096	0.060	0.106	0.108
ROW	0.222	0.123	0.131	0.109	0.169	0.112	0.208	0.154
				USA				
BRII	0.021	0.028	0.019	0.029	0.028	0.018	0.018	0.012
CAN	0.045	0.052	0.030	0.089	0.052	0.038	0.027	0.047
CHN	0.042	0.092	0.135	0.102	0.072	0.067	0.135	0.032
EU-12	0.005	0.007	0.006	0.009	0.007	0.006	0.010	0.004
EU-15	0.133	0.105	0.074	0.143	0.105	0.067	0.101	0.063
JPN	0.021	0.038	0.034	0.085	0.030	0.016	0.034	0.019
KOR	0.009	0.018	0.023	0.029	0.022	0.022	0.029	0.007
MEX	0.014	0.029	0.037	0.048	0.047	0.022	0.038	0.018
USA	0.766	0.885	0.621	0.885	0.783	0.398	0.398	0.209
ROW	0.116	0.094	0.096	0.097	0.100	0.103	0.181	0.076

Source: WIOD; authors' calculations.

Compared with the EU-12 pattern above, the *EU-15 countries* are not as strongly interlinked with other countries, since backward linkages to the domestic economy dominate. Linkages to China are even slightly larger than to the neighbouring EU-12 countries (the only exception being transport equipment). As regards forward linkages, again domestic linkages are distinct but less pronounced. Forward linkages to the rest of the world do matter, linkages with the US are important in the chemicals sector, and linkages to China are again larger than those to the EU-12 (again with the exception of transport equipment).

Japan, too, is not strongly interlinked with other countries, especially in terms of backward linkages. Backward linkages to the domestic economy dominate; linkages to the rest of the world, China and the EU-15 are comparatively small. Forward linkages to the domestic economy are large for the chemicals sector, but distinctly smaller for the other three sectors. Forward linkages to China are important, especially in the electrical equipment sector. In addition, forward linkages with the US and the EU-15 are important.

The US, as the EU-15 and Japan, is not strongly interlinked with other countries. Both backward and forward linkages are concentrated on the US, although this is less the case with forward linkages (except in chemicals). In addition, backward and forward linkages with the EU-15, China and Canada are of some importance.

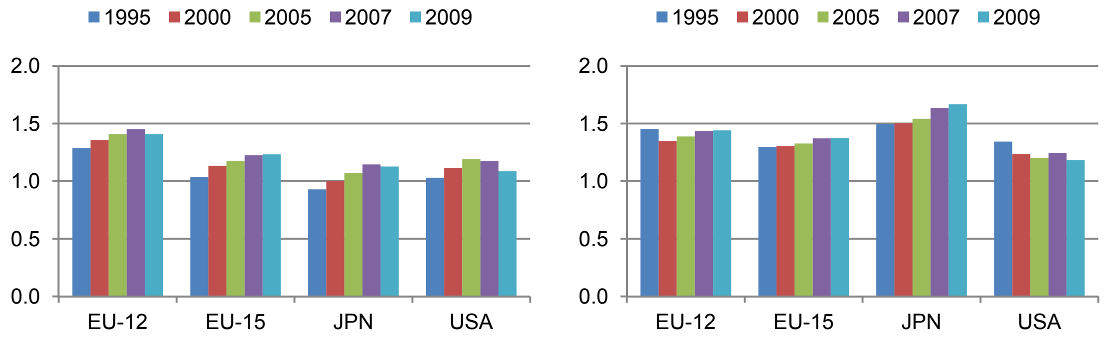
Figure 3.4.2 provides a picture of the development of total backward and forward linkages over time. Overall, both linkages mostly increased between 1995 and 2007, while trends differed between 2007 and 2009. During this latter period, backward linkages became smaller in the EU-12 and the US, while they continued to increase in the EU-15 and Japan. Forward linkages continued to grow in the machinery and electrical equipment sectors, though they tended to remain the same in chemicals and the transport equipment sectors (with some country exceptions to each of these patterns). There is only one profound exception: the US chemical industry, with a constant decrease in forward linkages between 1995 and 2009.

It is interesting to look at the source of these changes: have total backward and forward linkages increased or decreased because of changes in domestic or international linkages? Between 1995 and 2007, total backward and forward linkages increased due to growing international linkages, while domestic linkages remained rather stable (see Figure 3.4.3). The decline in domestic backward linkages observed for the EU-12 happened between 1995 and 2000, when the production integration process gained momentum. This is also in line with the findings reported in DeBacker and Mirodout (2012). For the period 2007 to 2009, these developments differ between forward and backward linkages and are shown in Figure 3.4.4. Looking first at backward linkages, one can observe a growth in domestic linkages (not in the US) and a decline in international linkages. For forward linkages, both domestic and international linkages have increased slightly.

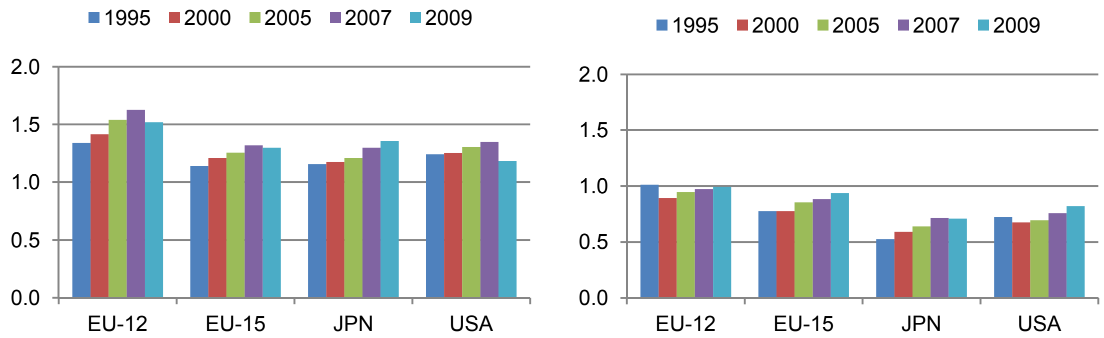
Figure 3.4.2

Developments of backward (left panels) and forward (right panels) over time

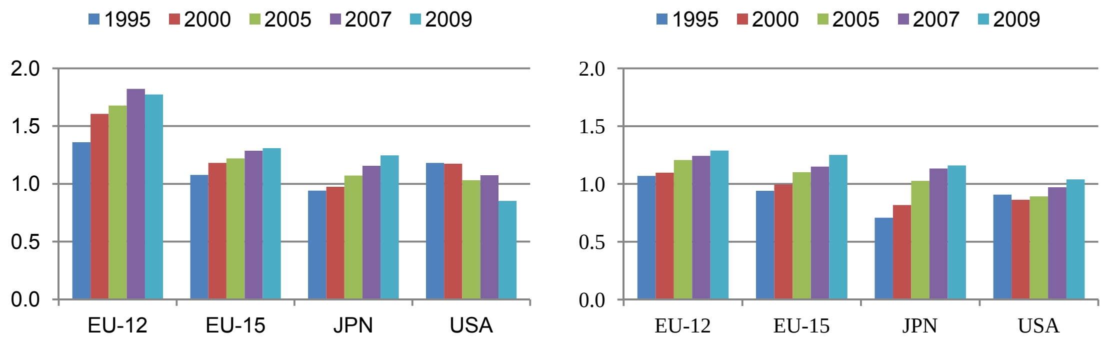
NACE 24 – Chemicals and chemical products



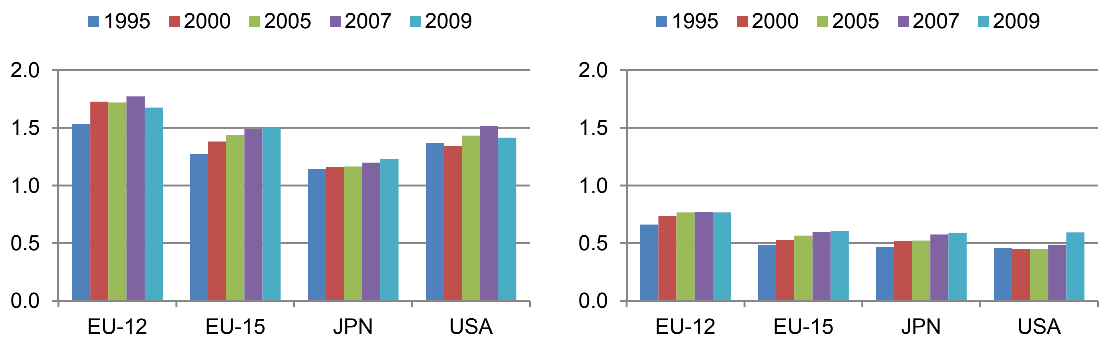
NACE 29 – Machinery



NACE 30–33 – Electrical equipment



NACE 34–35 – Transport equipment



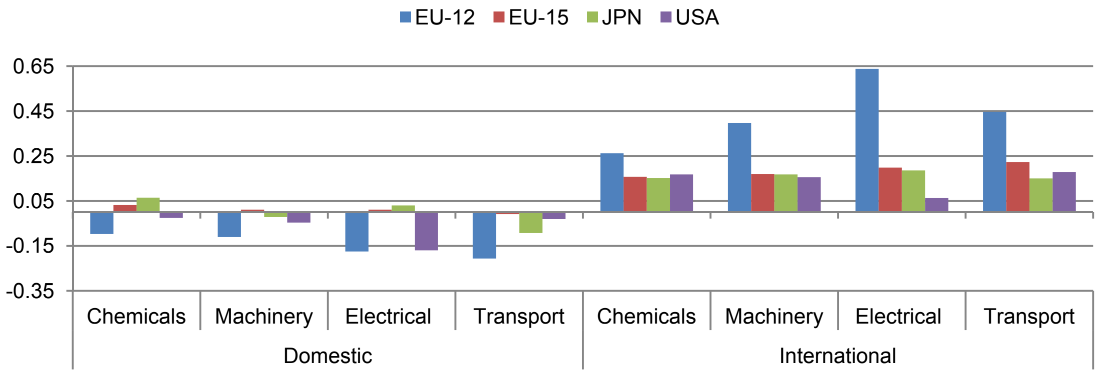
Source: WIOD; authors' calculations.

Summarising, the findings suggest that overall backward linkages are larger than forward linkages due to the very nature of sectors and their products. The EU-12 does exhibit the largest backward and forward linkages and turns out to be the most interlinked region (with the EU-15), while the EU-15, Japan and the US are more domestically oriented in their sourcing structures and their supply structures (although less so). While both backward and forward linkages have increased over the last ten years, the crisis has slowed or even slightly reversed the process.

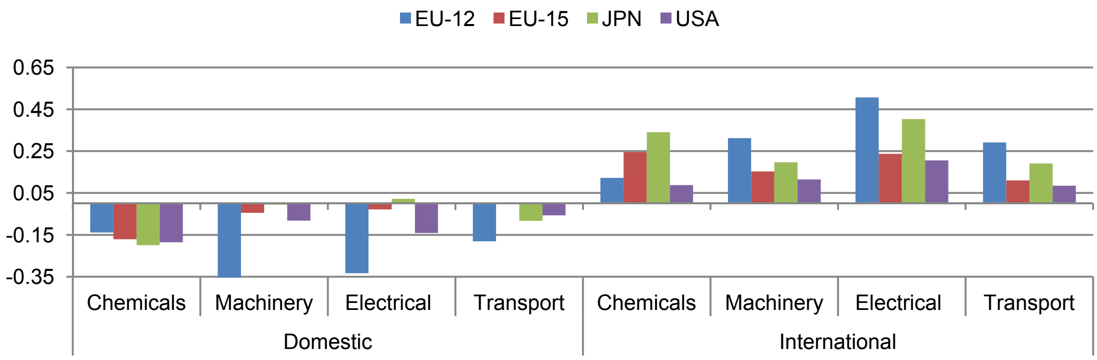
Figure 3.4.3

Changes in backward and forward linkages, 1995–2007

Backward linkages, 1995–2007



Forward linkages

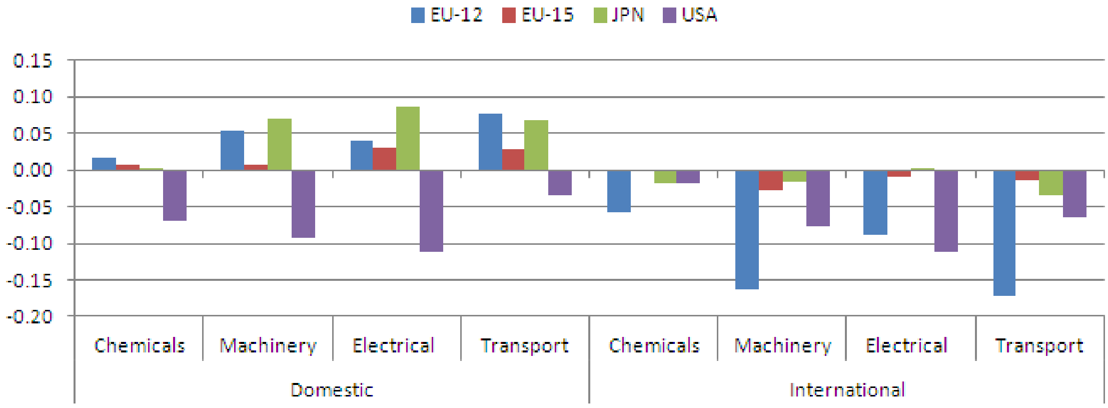


Source: WIOD; authors' calculations.

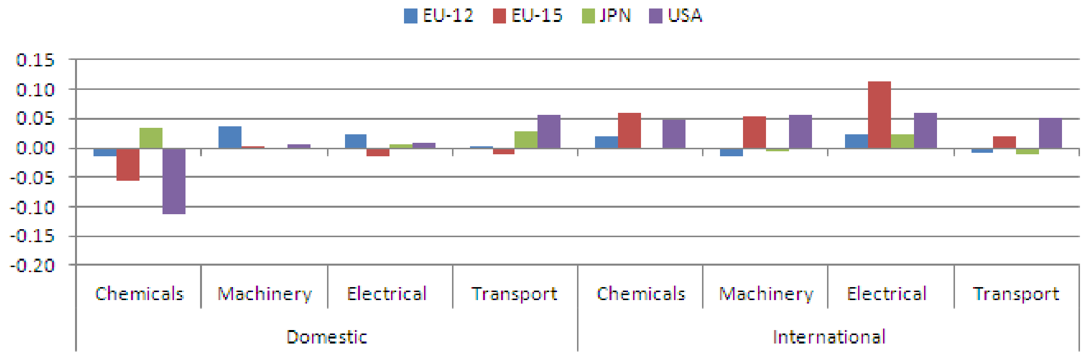
Figure 3.4.4

Changes in backward and forward linkages, 2007–09

Backward linkages



Forward linkages



Source: WIOD; authors' calculations.

3.5 Offshoring and the foreign content of exports

Hummels et al. (2001) suggested a widely used measure of vertical integration, which has been extended and made more sophisticated in various ways. Given the availability of a world input-output table (as provided by the WIOD project), a world Leontief inverse can be calculated, from which a vertical specialisation indicator can be derived. In this sense, the vertical specialisation measure is closely related to the notion of backward linkages (as discussed above) and therefore also to the concept of output multipliers.

3.5.1 An overview of vertical specialisation measures

In most of the applied literature, the concern is to calculate the 'import content of exports', though other variables of interest are analysed as well. In the simplest case, an indicator of vertical specialisation is calculated as $\mathrm{VS}^{\mathrm{r}} = \frac{1}{\mathbf{1}'\mathbf{x}^{\mathrm{r}}}\mathbf{1}'\,\mathbf{A}^{\mathrm{M,r}}\mathbf{x}^{\mathrm{r}}$ where $\mathbf{A}^{\mathrm{M,r}}$ denotes country *r*'s import coefficient matrix (imports per unit of output) of dimension NxN (with N being the number of sectors) and $\mathbf{x}^{r}$ the Nx1 vector of exports. $\mathbf{1}$ is a summation vector of ones of dimension Nx1. Note that, in this case, no inter-industry linkages are considered. Therefore a more sophisticated and widely used measure is

$$\mathrm{VS0^r} = \frac{1}{\mathbf{1}'\mathbf{x}^\mathrm{r}}\mathbf{1}'\ \mathbf{A}^{\mathrm{M,r}}(\mathbf{I}-\mathbf{A}^{\mathrm{rr}})^{-1}\mathbf{x}^\mathrm{r}$$

which includes intra-country inter-industry linkages as $(\mathbf{I}-\mathbf{A}^{rr})^{-1}$ is the Leontief inverse of the domestic coefficients. Both of these measures only include a total import coefficients matrix, i.e. no information on different sourcing countries is considered. This is reported in most empirical studies, as only import matrices of the reporter countries are available (e.g. Eurostat, OECD). However, a global input-output database, as provided by WIOD, allows this additional dimension to be considered, i.e. imports to be distinguished by partner countries, which leads to the indicator

$$\mathrm{VS1^r} = \frac{1}{\mathbf{1}'\mathbf{x}^\mathrm{r}}\sum_{\mathrm{p=1(p\neq r)}}^{\mathrm{C}}\mathbf{1}'\ \mathbf{A}^{\mathrm{pr}}(\mathbf{I}-\mathbf{A}^{\mathrm{rr}})^{-1}\mathbf{x}^\mathrm{r}$$

This measure, however, does not take account of inter-country linkages, i.e. imports from country *p* might include (directly and indirectly) imports from other countries or even the country under consideration *r*. The availability of a world input-output table therefore allows these inter-regional linkage effects also to be taken into account. This would suggest an appropriate indicator – which is called VS2 here – using the Leontief inverse of the global input-output table:

$$\mathrm{VS2^r} = \frac{1}{\mathbf{1}'(\mathbf{I}-\mathbf{A})^{-1}\mathbf{x}^\mathrm{r}}(\mathbf{1}^{-\mathrm{r}})'(\mathbf{I}-\mathbf{A})^{-1}\mathbf{x}^\mathrm{r}$$

Here, the vector $\mathbf{x}^\mathrm{r}$ denotes a NCx1 vector with country *r*'s exports included in the appropriate sub-matrix of country *r* and 0's otherwise; $\mathbf{1}^{-r}$ denotes a summation vector (of dimension NCx1) with 0's in country *r*'s sub-vector and 1's otherwise. (For example, if country *r* is the first country, then the export vector would have positive entries in the first N cells and 0's otherwise; the summation vector would have 0's in the first N cells and 1's otherwise). $\mathbf{1}$ is a summation vector of NCx1. If the focus is on particular regions or sectors, these summation and export vectors have to be adjusted accordingly.[36] To provide information at the level of a particular industry (or subset of industries) the export vector has to include only those flows.

One should note that this measure is closely linked to the linkage indicators – or, more specifically, to the backward linkage measure – above, and to the concept of (simple output) multipliers which are also based on the Leontief inverse. Therefore, one would expect, first, a country to be more vertically integrated the higher are its (backward) linkages. If this country's output should increase (e.g. by assembly of final products), it needs more inputs from other countries, and thus the higher its backward linkages are and the more vertically integrated it is. Second, this also explains why larger countries tend to be less vertically integrated in the global economy, since large countries source relatively more from the domestic economy. Conversely, smaller countries are not able to produce all their inputs

[36] Instead of including country *r*'s total exports, one might look at bilateral or sector-specific integration patterns (or both) by splitting up the export vector appropriately.

themselves, and thus tend to be more vertically integrated.[37] Furthermore, as the gross output multipliers are also based on the Leontief inverse, the VS2 measure is closely related to the concept of multipliers. Note that the simple gross output multiplier is just the column sum of entries for a specific sector. However, the concept of multiplier has its interpretation of the effect of a change in the final demand vector. This would therefore suggest post-multiplying by the final goods export vector only, rather than by the total export vector, in order to avoid 'double counting'. Another question is how to normalise this measure of vertical integration. As can be seen in the formula above, it is suggested that gross output associated with the production of the particular exports should be used, i.e. $\mathbf{1}'(\mathbf{I}-\mathbf{A})^{-1}\mathbf{x}^{\mathrm{r}}$. In particular, this expresses the sourcing structure to produce a particular vector of exports as a percentage of total production needed for these exports. When multiplying by the total export vector, i.e. including the intermediates, there may be a risk of the 'double-counting' problem. On the other hand, a problem might arise if a country is mainly exporting intermediates. In this case, when using only the final goods exports vector, it would turn out that such a country is not vertically integrated, which may paint an inappropriate picture. In this report, information for both versions is provided, together with the VS1 measure for comparison.

3.5.2 Trends and patterns in vertical integration

3.5.2.1 Vertical integration at the country level

Before looking in detail at the four selected industries, it might be useful to provide the results at the overall country level. Specifically, the two VS2 measures are presented, using both the total exports and the final goods exports vector, and the VS1 measure to highlight differences and similarities from a methodological perspective. Figure 3.5.1 shows the results for the four reporter countries under consideration in the period 1995–2009.

There are some striking results to be observed from this comparison.[38] First, the measures are very close to each other, with VS1 being slightly higher in the cases of the EU-12, the EU-15 and Japan, but slightly lower in the case of the US. Thus, in this sense the generalisation of the measure does not affect a country's overall vertical specialisation index, as is known from other literature. The reason for this is basically that the higher-order effects tend to be rather small. It also turns out that the overall level does not depend very much on whether one uses total exports or final goods exports only. Second, the results are very much in line with other studies, and therefore do not add too much. However, the VS2 indicator can be interpreted neatly in terms of linkages.[39] Third, from an empirical point of view vertical integration is much higher for the EU-12 countries, which – as was shown above – show rather strong backward linkages with the EU-15 countries (the geographical structure

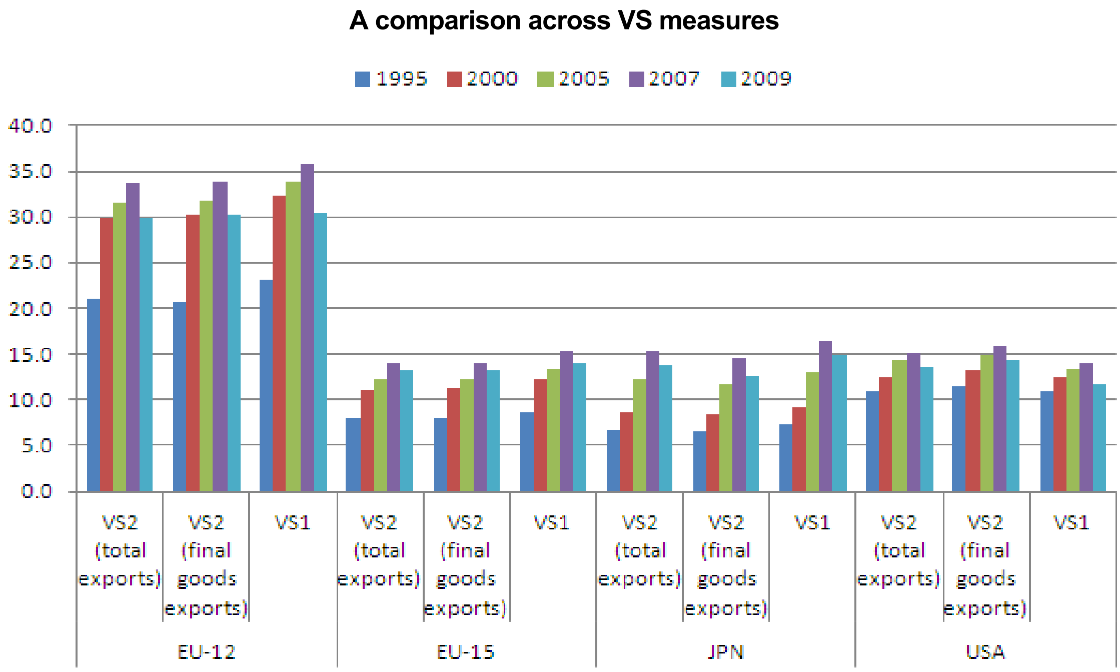
[37] This might also suggest developing a vertical specialisation indicator based on forward linkages.

[38] These findings do not depend on the year chosen.

[39] This can also be linked to the value added in trade measures, as outlined in Stehrer et al. (2012).

of vertical specialisation for these four reporter countries is discussed below in more detail). Fourth, Figure 3.5.1 also shows the changes in the VS2 measure over time for the four countries under consideration. As expected, vertical integration increased over time in all four countries considered, and particularly so for the EU-12 countries; this points towards a strong integration process with the EU since 1995, in particular via production networks. Even in 1995, those countries had a much higher index than the other countries, which is partly due to the strong backward linkages they already had as providers of intermediate inputs mainly for the EU-15, and is also due to the fact that the countries in this group are smaller in size as compared to EU-15, Japan or the US. The integration then intensified even more over time, peaking in 2007 at slightly more than 35%. The other three countries show initial levels of 5–10%; interestingly, in 1995, the level was higher for the US than for the EU-15. One should note, however, that at this time the NAFTA agreement was already in place. In all cases vertical integration increased for these three countries to levels of about 14–16%, dropping slightly during the economic crisis (1–2 percentage points). This fall was even stronger for the EU-12 countries (5 percentage points).

Figure 3.5.1



Source: WIOD; authors' calculations.

Two questions arise from these trends and patterns. First, is the vertical integration of the EU-12 with respect to vertical integration with the EU-15 different from, for example, Mexico's with the US, Korea's with Japan, or China's in general? Second, which countries have driven the increasing vertical integration of the four countries under consideration?

To answer the first question, Figure 3.5.2 presents the vertical integration measure for all countries and groups considered in this study. The BRII (Brazil, Russia, India and Indonesia) group shows a similar level as the other most developed countries – the EU-15, Japan and the US: between 5% and 10% in 1995, increasing to 10–15% in 2007 or 2009. It should be noted that this group of countries consists primarily of large and (partly) resource-rich countries with (partly) high export shares of primary products. Other countries, which predominantly are considered as supplier countries of assemblers, show much higher levels, ranging from 25% to 35% in the later period. These include Korea, China, Mexico and the EU-12, which shows the largest vertical integration due to strong intra-EU trade. The EU-12 (particularly) and Korea started with much lower levels than Canada and Mexico, but have shown a rapid increase and have converged with (or even surpassed) those other countries. In all cases, vertical integration has increased for these countries (surprisingly with the exception of China in the later years). It is interesting to note also the sharp decline in vertical integration in Canada – from almost 30% in 2000 to less than 20% in 2009.

It is also curious to note that these patterns change slightly when only trade in final goods is considered; this is shown in the lower panel of Figure 3.5.2. In particular Mexico shows a higher level of vertical integration than the EU-12.

To answer the second question, one needs to look at the individual partner countries and the imports of the reporter countries from these. Table 3.5.1 below shows the VS1 and VS2 measures, respectively, for the four reporter countries considered, with the vertical integration measure broken down by partner countries, expressed as a percentage of total sourcing.[40] Before the trends over time are considered, a snapshot of the structure of vertical integration in 2007 is provided in Figure 3.5.3.

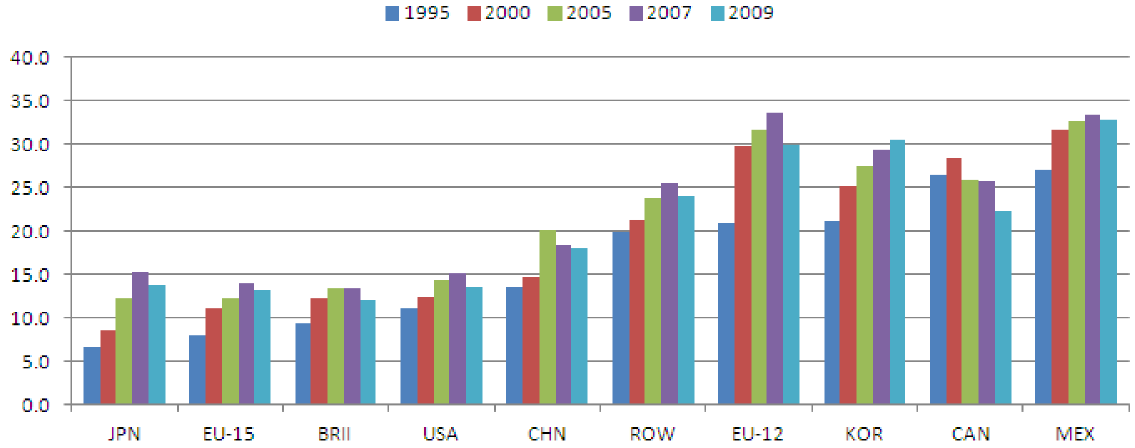
From the methodological point of view it can be seen that there are only relatively small differences between the two alternatives for VS2; this basically suggests that the sourcing structures of intermediates and of final goods are not too distinct. The reason for this is that geographical proximity matters in a similar way, and the input requirements might not be too different. One can, however, find some more pronounced differences when the VS2-based measures are compared with VS1. In particular, the share of less important countries becomes slightly larger, at the expense of more important countries. Looking at the USA, for example, the share of Mexico and Canada is higher on the VS1 measure than on the VS2 measure, whereas the opposite is true of China. The reason for this is precisely that inter-regional linkages – for which higher-order effects are more important – are taken into account appropriately when using the VS2 measures.

[40] Here both the VS1 and VS2 measures are reported to allow for comparisons, but as again both these measures are similar, the text concentrates on the VS2 measure.

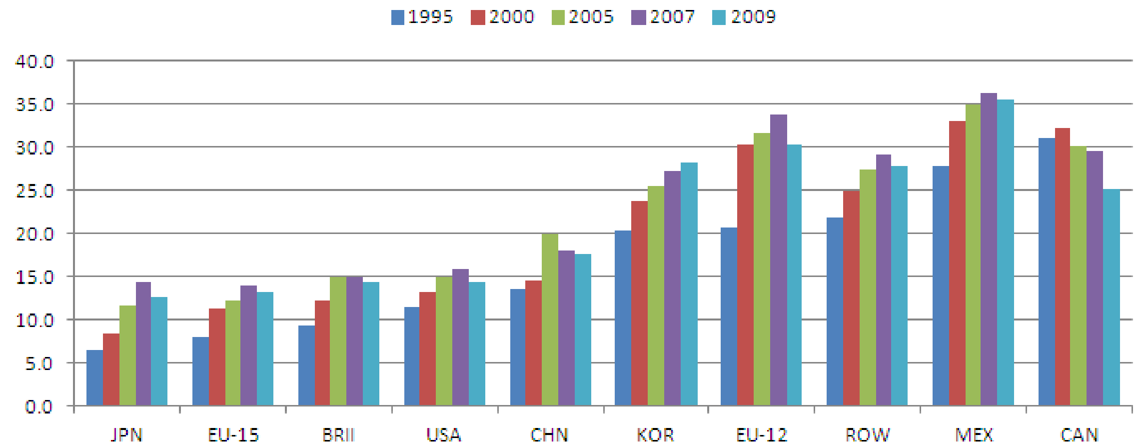
Figure 3.5.2

Vertical specialisation over time, 1995–2009

VS2 based on total exports



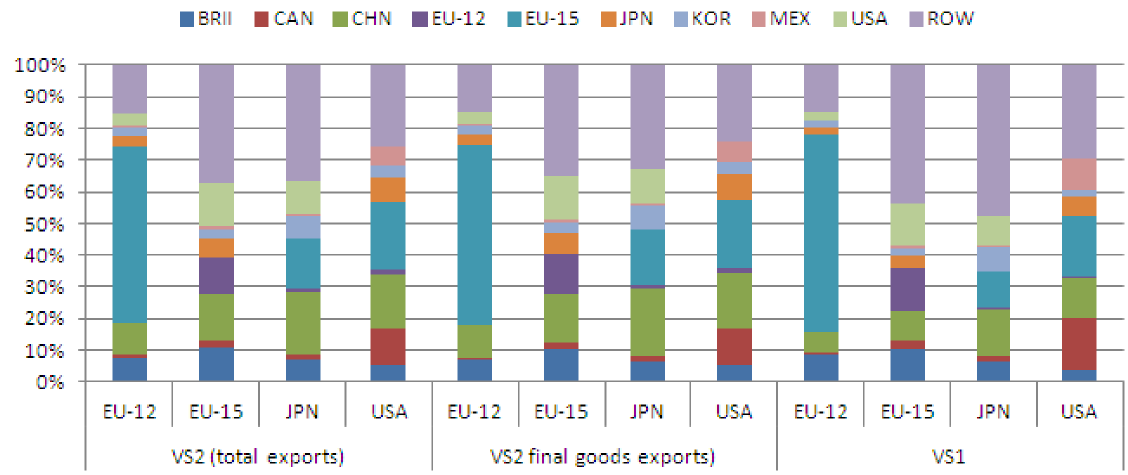
VS2 based on final goods exports



Source: WIOD; authors' calculations.

Figure 3.5.3

Geographical patterns of vertical specialisation by partner, 2007, in % (extra sourcing)



Source: WIOD; authors' calculations.

The BRII group accounts for about 10% or less of the import content of all countries, with a slightly larger share in the EU-15. But it is interesting to note that this group, though it includes India (which is comparable in size to China), does not account for a higher share of vertical integration, particularly not with the USA. Canada is – not surprisingly – important for the USA (even more so than Mexico). China accounts for about 10% in the EU-12, 15% in the EU-15 and about 20% or more in Japan and the USA. The EU-12 is only important in vertical integration for the EU-15, accounting for about 12%. On the other hand, the EU-15 is very important for the EU-12 countries, which use a lot of imports from the EU-15 for production of their final goods exports. The EU-15 accounts for about 20% of imports by the US and Japan. Japan is slightly more important for the USA than the EU-15. As expected, Mexico is mainly important for the USA, with about 5%, but only tiny shares in the other countries considered. Finally, the USA itself contributes about 15% to European imports and 10% to Japanese. The remaining part is accounted for by imports from the rest of the world –particularly high in Europe. One should note here that this group includes countries like Switzerland and Norway (which are proxied by the ROW category in the WIOD tables) and Turkey, which have strong trade relations with the EU countries. On the other hand, for the USA this group includes a number of Latin and South American countries and – also important for Japan – a host of further Asian countries that have strong production networks themselves.

How have these shares changed over time? This is documented in Table 3.5.1. It is, however, more informative to look at the development of the shares by geographical region of vertical integration. As may be seen above, vertical integration has risen for all reporter countries considered. This increase could be due to increasing vertical integration with all partners proportionally, or else to stronger linkages with one or more partners, perhaps at the expense of other partners. Therefore Figure 3.5.4 shows the shares and how they have changed over time.

The most impressive development is the rise of China in all the countries considered. The share of China in the EU-12 increased from a negligible amount in 1995 to more than 15% in 2009, mostly at the expense of the EU-15 and the BRII countries. In the EU-15, its share increased from slightly above 5% to about 20% at the expense of Japan and the USA. An even more pronounced increase is seen in Japan, where the share of China changed from about 5% to 30%, in this case with a shrinking share of the EU-15 and the US. For the US a similar change – from about 5% to 20% – took place at the expense of the EU-15 and particularly Japan, whose share dropped from almost 20% to less than 10%.

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Table 3.5.1

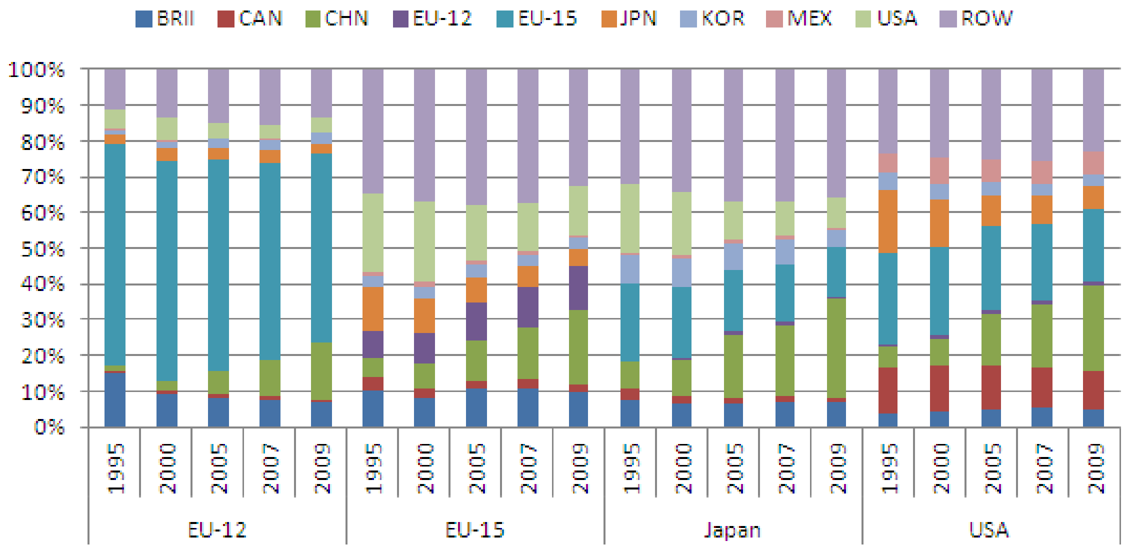
Vertical integration by partner

		VS2 (total exports)					VS2 (final goods exports)					VS1				
		1995	**2000**	**2005**	**2007**	**2009**	**1995**	**2000**	**2005**	**2007**	**2009**	**1995**	**2000**	**2005**	**2007**	**2009**
EU-12	BRII	3.1	2.8	2.6	2.6	2.1	2.7	2.4	2.3	2.3	1.9	4.2	3.8	3.2	3.0	2.5
	CAN	0.2	0.2	0.2	0.3	0.2	0.1	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.1
	CHN	0.2	0.8	2.1	3.4	4.8	0.3	0.8	2.2	3.5	4.9	0.2	0.5	1.6	2.4	3.6
	EU-12	79.0	70.2	68.4	66.4	70.1	79.3	69.7	68.2	66.2	69.7					
	EU-15	13.1	18.4	18.6	18.6	15.7	13.4	19.2	19.2	19.2	16.2	14.7	21.3	21.8	22.2	18.2
	JPN	0.5	1.1	1.1	1.2	0.9	0.5	1.2	1.2	1.2	1.0	0.2	0.7	0.7	0.7	0.5
	KOR	0.3	0.5	0.7	0.9	0.8	0.3	0.5	0.7	1.0	0.9	0.3	0.4	0.5	0.8	0.7
	MEX	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1
	USA	1.1	1.9	1.4	1.4	1.3	1.1	1.9	1.4	1.4	1.3	0.9	1.5	1.0	0.8	1.0
	ROW	2.4	4.0	4.7	5.1	4.0	2.3	3.9	4.5	4.9	3.9	2.5	4.0	4.8	5.4	3.9
EU-15	BRII	0.8	0.9	1.3	1.5	1.3	0.8	0.9	1.2	1.5	1.2	0.9	1.0	1.4	1.6	1.4
	CAN	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.4	0.3	0.4	0.3
	CHN	0.4	0.8	1.3	2.0	2.8	0.5	0.8	1.5	2.2	3.0	0.4	0.6	1.0	1.4	2.1
	EU-12	0.6	0.9	1.3	1.6	1.6	0.7	1.0	1.4	1.7	1.7	0.7	1.2	1.7	2.1	2.0
	EU-15	92.0	88.8	87.8	86.0	86.8	91.9	88.7	87.8	86.0	86.7					
	JPN	1.0	1.1	0.8	0.8	0.7	1.0	1.2	0.9	0.9	0.7	0.7	0.9	0.6	0.6	0.4
	KOR	0.3	0.4	0.5	0.4	0.4	0.3	0.4	0.5	0.5	0.4	0.2	0.3	0.4	0.3	0.3
	MEX	0.1	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.2
	USA	1.8	2.5	1.8	1.9	1.8	1.8	2.5	1.9	1.9	1.8	1.8	2.6	2.0	2.0	2.1
	ROW	2.8	4.1	4.6	5.2	4.3	2.7	4.0	4.4	4.9	4.1	3.4	5.1	5.8	6.7	5.2
JPN	BRII	0.5	0.5	0.8	1.1	0.9	0.4	0.5	0.7	0.9	0.8	0.5	0.6	0.7	1.0	1.0
	CAN	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.3	0.2
	CHN	0.5	0.9	2.2	3.1	3.8	0.5	0.9	2.2	3.1	3.9	0.4	0.8	1.9	2.5	3.3
	EU-12	0.0	0.0	0.1	0.1	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	0.0	0.1	0.1
	EU-15	1.4	1.7	2.1	2.4	1.9	1.5	1.7	2.2	2.6	1.9	1.3	1.5	1.7	1.9	1.5
	JPN	93.3	91.3	87.8	84.7	86.2	93.6	91.6	88.4	85.5	87.4					
	KOR	0.6	0.7	0.9	1.1	0.7	0.5	0.6	0.9	1.1	0.7	0.6	0.8	1.1	1.3	0.7
	MEX	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1
	USA	1.3	1.5	1.3	1.5	1.2	1.3	1.6	1.4	1.6	1.2	1.3	1.5	1.3	1.5	1.3
	ROW	2.1	3.0	4.5	5.6	4.9	1.9	2.7	3.8	4.7	3.8	2.7	3.8	6.0	7.9	6.7
USA	BRII	0.4	0.5	0.7	0.8	0.7	0.4	0.6	0.8	0.8	0.7	0.4	0.4	0.5	0.5	0.5
	CAN	1.4	1.6	1.7	1.7	1.4	1.5	1.7	1.9	1.9	1.5	1.9	2.2	2.2	2.3	1.7
	CHN	0.6	0.9	2.0	2.7	3.3	0.7	1.0	2.2	2.8	3.6	0.5	0.7	1.5	1.8	2.2
	EU-12	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
	EU-15	2.8	3.1	3.4	3.3	2.7	2.9	3.3	3.5	3.4	2.8	2.6	2.8	2.8	2.7	2.2
	JPN	1.9	1.6	1.3	1.2	0.9	2.1	1.8	1.4	1.3	1.0	1.5	1.2	0.9	0.8	0.5
	KOR	0.5	0.6	0.6	0.5	0.4	0.6	0.6	0.6	0.6	0.5	0.5	0.5	0.4	0.4	0.3
	MEX	0.6	0.9	0.9	1.0	0.9	0.6	1.0	1.0	1.1	1.0	0.8	1.2	1.2	1.3	1.1
	USA	89.0	87.5	85.7	84.8	86.3	88.5	86.8	85.0	84.1	85.6					
	ROW	2.6	3.1	3.6	3.9	3.1	2.6	3.2	3.6	3.8	3.2	2.8	3.4	3.8	4.2	3.1

Source: WIOD (Version January 2012); authors' calculations.

Figure 3.5.4

Vertical integration shares by partner, 1995–2009, in %



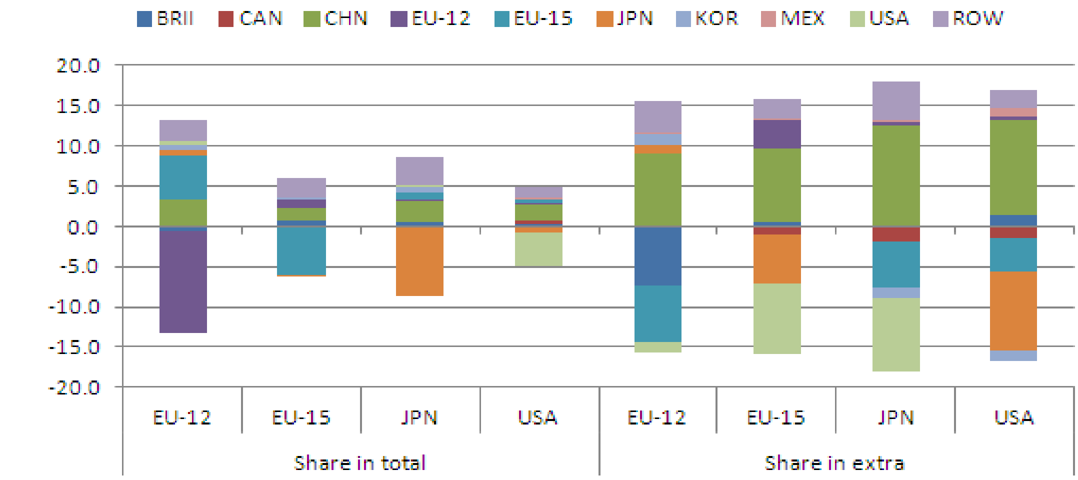
Note: VS2 measure using total exports.

Source: WIOD (Version January 2012); authors' calculations.

This, however, does not answer the question of whether the rise of China in world trade and vertical specialisation patterns has crowded out other countries. Figure 3.5.5 therefore looks at the change in the VS2 (based on total exports) measure between 1995 and 2007, indicating which countries have gained in share and which have lost, as well as the overall increase in vertical integration, as already documented above. The figure is split into two parts: the left part ('Share in total') presents the change in percentage points when including domestic sourcing; the right part ('Share in extra') shows the changes when considering only the shares of sourcing from partner countries.

Figure 3.5.5

Squeezing in or crowding out, 1995–2007



Note: Results based on VS2 measures using total exports.

Source: WIOD; authors' calculations.

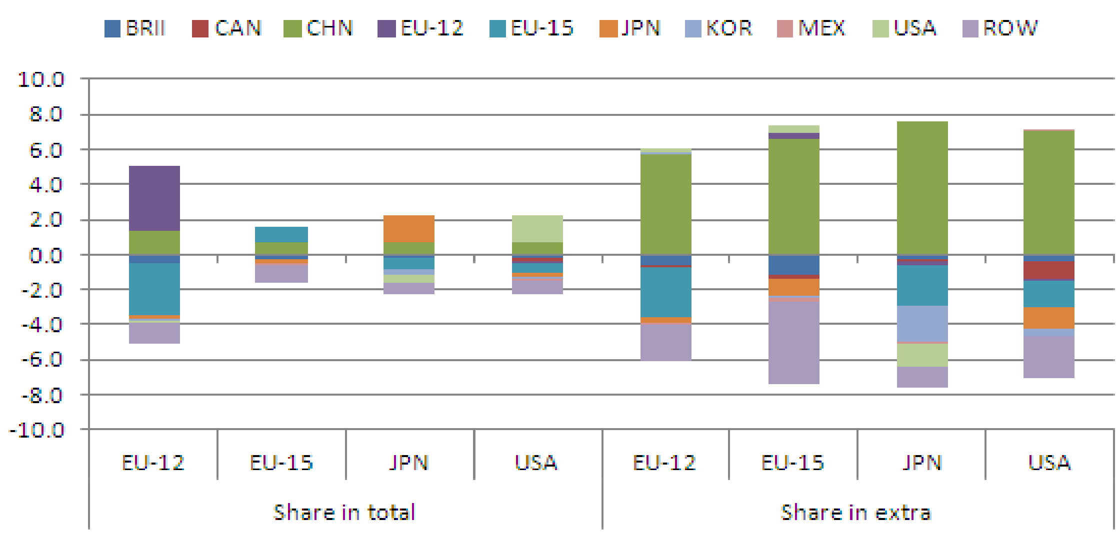
With only a few exceptions, the changes are positive, implying that partner countries – and particularly China and the rest of the world, plus the EU-15 in the case of the EU-12 – by and large did not crowd out other countries in the vertical specialisation patterns, but instead substituted for domestic sourcing in the period 1995–2007. When looking only at the shares regarding extra-sourcing, it appears that the BRII and the EU-15 lost out to China and (to a smaller extent) to the rest of the world in relation to the EU-12. Similarly, in the case of the EU-15, Japan and the US lost shares as sourcing partners to China and the EU-12. In the case of Japan, the losers were the EU-15 and the US; and finally, for the USA, Japan and the EU-15 lost shares.

A similar picture can be drawn for the effects of the crisis on vertical integration patterns. Figure 3.5.6 presents the change in shares between 2007 and 2009. As was shown above, the overall share of vertical integration in all cases went down between 2007 and 2009 (see Figure 3.5.2). This can also be seen from Figure 3.5.6, where – in the left part of the graph – the domestic shares appear as positive changes. For example, in the EU-12, domestic sourcing increased by about 4 percentage points; in the EU by less than 1 percentage point; and in the USA and Japan by about 1.5–2 percentage points.

It is striking to see, however, that, with respect to extra sourcing by these countries, only China shows still growing shares, whereas for all other partner countries and regions these shares are declining, i.e. over the crisis China and domestic sourcing have squeezed out the other countries. Sharp declines are seen in the share of the EU-15 (particularly in the EU-12, but also in Japan and the US) and in the share of the rest of the world category.

Figure 3.5.6

Vertical integration and the crisis, 2007–09



Note: Results based on VS2 measures using total exports.

Source: WIOD; authors' calculations.

3.5.2.2 Vertical specialisation patterns for selected industries

To what extent are these economy-wide findings reflected at the level of industries. Table 3.5.2 presents the levels of the VS2 measure (based on total exports) and the VS1 measure for the four countries over the period 1995–2009. From a methodological point of view, the results suggest that both indicators are quite similar, both in levels and trends. There are a few important findings. First, vertical integration rose in all cases in the period 1995–2007 and in most cases declined slightly over the crisis period. Second, vertical integration of the EU-12 is, in all cases, significantly higher than the other countries – as expected, because of the strong production linkages within the EU. This can be explained best by the concept of backward linkages: an increase in the output of a final product in the EU-12 (e.g. a car assembled there) triggers a lot of demand in other sectors and other countries in the EU-15 (the strong backward linkages), which shows up in high vertical integration. As one can see, this is particularly strong in transport equipment and electrical products, but also in machinery. It is far lower in chemicals, production of which relies less on intermediates sourced from other countries. Third, the other three countries show rather similar measures of vertical integration (though these tend to be somewhat lower in Japan for most industries). Generally, vertical integration of these countries is relatively high in machinery and transport equipment.

Table 3.5.2

Vertical integration measures by industry, 1995–2009

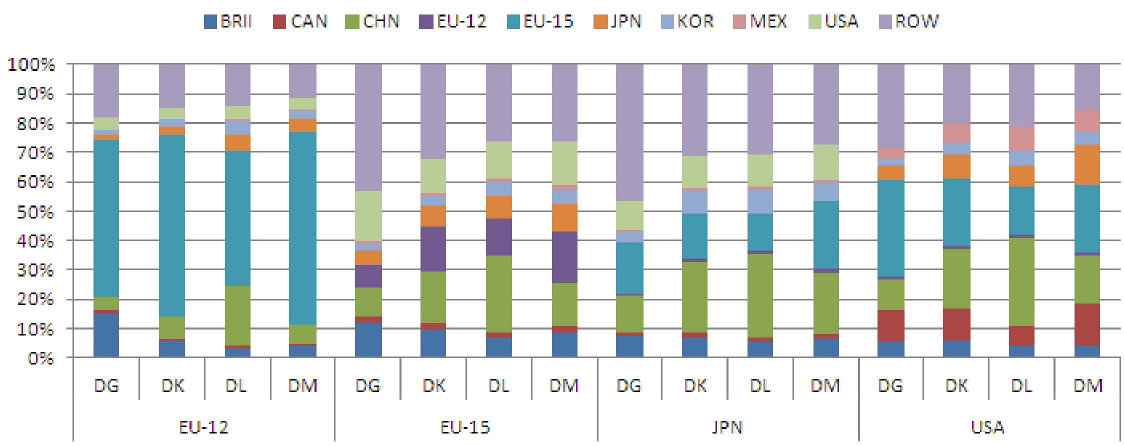
			VS2					**VS1**		
	1995	**2000**	**2005**	**2007**	**2009**	**1995**	**2000**	**2005**	**2007**	**2009**
					Chemicals					
EU-12	23.2	29.6	30.8	32.4	30.7	26.7	33.7	34.8	36.5	33.7
EU-15	8.0	11.2	12.4	14.0	14.0	9.0	13.1	14.4	16.2	15.9
JPN	6.8	8.6	14.1	17.4	15.5	7.5	9.9	17.0	21.8	18.3
USA	10.3	12.6	16.0	16.4	16.4	11.5	14.2	18.2	18.0	16.8
					Machinery					
EU-12	23.6	30.5	33.2	36.3	31.5	26.1	32.9	36.5	39.8	32.9
EU-15	8.2	11.2	12.1	14.5	13.5	8.7	12.1	13.1	15.6	14.0
JPN	6.2	8.5	12.1	15.2	13.5	6.6	8.9	12.2	15.6	13.5
USA	13.3	14.6	18.2	19.2	17.4	14.0	15.3	18.1	18.8	15.2
					Electrical equipment					
EU-12	29.8	43.4	45.0	47.4	44.9	33.7	49.5	50.6	53.2	48.1
EU-15	11.4	15.4	15.9	18.7	18.2	11.7	16.5	16.6	19.0	18.3
JPN	7.1	9.8	13.6	16.9	15.7	7.3	10.0	13.4	16.8	15.3
USA	16.6	17.7	19.7	21.2	18.1	17.4	18.3	16.6	17.3	12.5
					Transport equipment					
EU-12	27.6	38.2	38.5	40.9	36.0	32.5	45.4	44.4	46.5	39.6
EU-15	8.9	12.4	13.9	16.2	15.6	10.1	14.8	16.6	19.3	18.2
JPN	6.2	7.8	10.6	13.3	11.3	7.9	9.7	12.7	15.6	12.9
USA	17.1	19.1	22.1	23.1	21.5	20.2	21.9	24.4	25.3	21.9

Source: WIOD; authors' calculations.

It is interesting to look at the respective sourcing structures in Figure 3.5.7. The EU-12 sources most of its intermediates from the EU-15, with significant shares also from China in NACE DL (Electrical and optical products); Japan also has a slightly larger share than in the other industries. For the EU-15, it is interesting to note that the share of the EU-12 does not exceed 20% for these industries; this points to the strong backward linkages of the EU-12 countries with respect to the EU-15 and the weaker backward linkages of the EU-15 with respect to the EU-12. Here also Japan (with about 10%), the US (with about 10–15%) and China (with 15–20%, but about 25% in NACE DL – Electrical products) play an important role. For Japan, it is mainly China, the EU-15 and, to a lesser extent, the USA that have significant shares. Finally, for the USA further important shares are found for Canada (10–15%) and the EU-15 (which, with 20–30%, has a higher share than the USA in the EU-15). Mexico has a share of only about 10% (i.e. an even lower share than that of the EU-12 in the EU-15). Finally, the rest of the world also provides inputs, with shares of about 20% on average, but much larger shares in NACE DG (Chemicals) in the EU-15 and Japan.

Figure 3.5.7

Shares by partner in % (extra sourcing), 2007



Note: Results based on VS2 measures using total exports.

Source: WIOD; authors' calculations.

Table 3.5.3 provides an indication of the change in shares from 1995–2007 and 2007–09, respectively, in percentage points, including the domestic part. Generally, a very similar pattern arises as for the total economy, as shown above. In particular, there was generally no squeezing out of other partners (with a few exceptions), but rather a general increase in sourcing from all other countries, with China and (for the EU-15) the EU-12 showing the most significant increases. These figures fell during the crisis, though not with respect to China. Particularly strong declines are observed for the EU-12, due to the strong backward linkages of its constituent countries: due to low demand for products assembled in the EU-12, demand for EU-15 components fell.

Table 3.5.3

Change in shares by partner in percentage points, 1995–2007 and 2007–09

	Chemicals				Machinery				Electrical products				Transport equipment			
	EU-12	**EU-15**	**JPN**	**USA**	**EU-12**	**EU-15**	**JPN**	**USA**	**EU-12**	**EU-15**	**JPN**	**USA**	**EU-12**	**EU-15**	**JPN**	**USA**
								1995–2007								
BRII	1.1	0.8	0.8	0.5	-0.1	0.7	0.6	0.6	0.1	0.7	0.6	0.4	-0.3	0.6	0.5	0.5
CAN	0.1	0.1	0.0	0.5	0.1	0.0	0.0	0.4	0.2	0.0	0.0	0.2	0.1	0.1	0.0	0.2
CHN	1.3	1.1	1.9	1.3	2.5	2.1	3.2	3.0	9.2	4.2	4.2	5.2	2.5	1.9	2.4	2.9
EU-12	-9.1	0.5	0.1	0.1	-12.7	1.4	0.1	0.2	-17.6	1.7	0.1	0.2	-13.3	2.0	0.2	0.2
EU-15	3.5	-6.0	1.2	1.8	5.9	-6.3	1.1	0.6	1.3	-7.3	1.0	0.0	6.9	-7.2	1.0	1.0
JPN	0.1	-0.1	-10.6	-0.5	0.6	-0.1	-9.0	-1.0	1.5	-0.5	-9.8	-1.8	0.5	-0.2	-7.1	-1.0
KOR	0.1	0.1	0.4	0.0	0.5	0.2	0.6	0.2	1.8	0.4	0.7	-0.3	0.7	0.4	0.5	0.3
MEX	0.1	0.1	0.0	0.2	0.1	0.1	0.1	0.5	0.1	0.1	0.1	0.8	0.1	0.2	0.1	0.7
USA	0.1	0.5	0.4	-6.1	0.1	-0.1	0.4	-5.9	0.0	-0.5	0.2	-4.6	0.3	0.4	0.2	-6.0
ROW	2.7	2.8	5.8	2.2	3.0	2.0	2.8	1.4	3.4	1.4	3.0	0.0	2.5	1.9	2.2	1.1
								2007–09								
BRII	-0.4	-0.2	-0.2	0.0	-0.6	-0.3	-0.2	-0.3	-0.1	-0.1	-0.2	-0.2	-0.3	-0.2	-0.2	-0.2
CAN	-0.1	0.0	0.0	-0.2	-0.1	-0.1	-0.1	-0.3	-0.1	-0.1	-0.1	-0.3	-0.1	-0.1	-0.1	-0.6
CHN	0.7	0.7	0.3	0.9	1.0	0.9	1.0	1.3	4.0	1.4	1.5	1.0	1.1	1.0	0.6	1.5
EU-12	1.7	0.1	0.0	0.0	4.8	-0.1	0.0	-0.1	2.5	0.1	0.0	-0.1	4.9	0.0	0.0	-0.1
EU-15	-0.9	0.0	-0.1	-0.1	-3.4	1.0	-0.6	-1.0	-3.7	0.5	-0.5	-0.9	-4.1	0.5	-0.8	-0.8
JPN	-0.1	-0.1	1.8	-0.1	-0.2	-0.2	1.6	-0.3	-0.6	-0.3	1.3	-0.5	-0.3	-0.2	2.0	-0.5
KOR	-0.1	0.0	-0.2	-0.1	0.0	-0.1	-0.3	-0.1	-0.2	-0.2	-0.4	-0.3	-0.1	0.1	-0.2	-0.1
MEX	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.3	0.0	-0.1	0.0	0.0
USA	0.0	0.2	-0.2	0.0	-0.1	-0.1	-0.4	1.9	-0.2	-0.2	-0.4	3.2	-0.1	-0.2	-0.4	1.6
ROW	-0.9	-0.5	-1.4	-0.4	-1.5	-1.1	-1.0	-1.1	-1.6	-1.1	-1.1	-1.6	-0.9	-0.9	-0.8	-0.8

Note: Results based on VS2 measures using total exports.

Source: WIOD; authors' calculations.

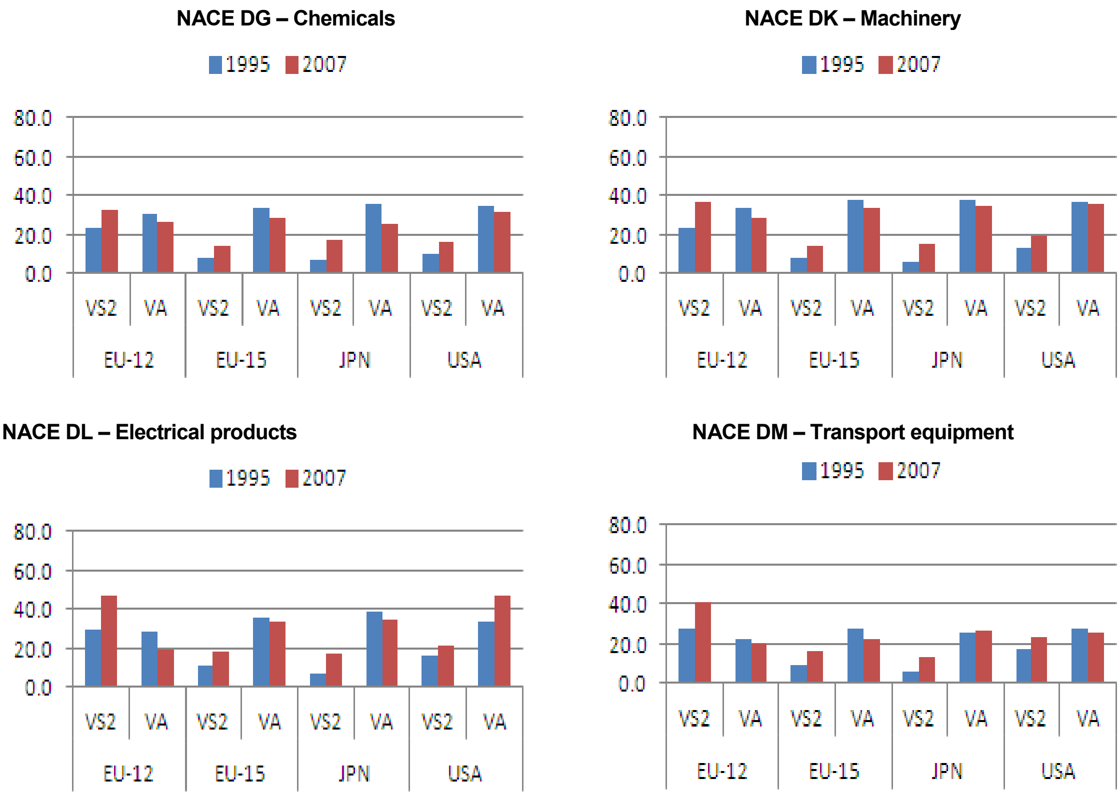
3.5.3 Vertical integration and value-added shares – a digression

The increasing international vertical integration tends to be related to lower shares of value added in gross output, as parts of production are sourced from abroad and thus less domestic value is added. However, if countries source more cost-efficiently from abroad or specialise in the more value-added intensive stages, one might expect a rising share. For example, if a country or industry offshores its labour-intensive stages of production, one might expect a decline in the value-added share; on the other hand, a country specialising in the provision of labour-intensive inputs (like services) could imply an increase in these shares. There might be some reason for a declining or increasing share of value added in gross output, which might or might not be related to offshoring patterns per se. For example, technology might change so that overall more intermediates are used in the production of a particular product which are either sourced domestically or abroad in which case the share should decline. There might also be some other effects that are important, like the changing patterns of primary factor inputs in these industries or within industry specialisation patterns.

Against this backdrop, it might therefore be interesting to look at these tendencies in a very simple manner. Figure 3.5.8 shows the changes in the vertical integration (VS2), as extensively discussed above, together with the changes in the shares of value added in gross output for the selected industries and countries in 1995 and 2007. Strikingly, in most cases vertical integration and the value-added share go in different directions, and rising vertical integration is accompanied by a decline in the value-added share. The only exception is machinery in the USA.

Figure 3.5.8

Vertical integration and the share of value added in %, 1995 and 2007



Source: WIOD; authors' calculations.

3.6 *Offshoring and energy efficiency*

One concern (or hope) might also be that offshoring helps a country increase its energy efficiency, as energy-intensive production stages might be offshored. At the global level, this would not mean, however, that energy efficiency for the total world is increasing, as the offshored stages might be produced with even *less* energy efficiency in the target country. It would go beyond the scope of this report to deal with these complex issues, however, and therefore it just investigates the relationship between offshoring and the energy intensity of exports. For this, a similar framework to that above can be applied. With data on energy use by industry, the Leontief inverse can be pre-multiplied by the energy coefficients vector (i.e. energy used per unit of output) and post-multiply by the vector of exports (or final goods export). This then also allows a separation of the energy directly and indirectly used by a partner country to produce another country's exports and its domestic energy use. When calculating energy input coefficients (i.e. energy use per unit of gross output) one has, however, to use deflated gross output series and be careful with respect to conversion into a common currency. Gross output is therefore deflated, using industry-level price indices for each country, which results in gross output in constant 1995 price series. These were then converted into a common currency (USD) by applying the exchange rates for 1995. Note that IO tables and exports at current prices were still used.

The WIOD data also provide data on gross energy use by sector in terajoule (TJ) for the period 1995–2009, i.e. an indicator similar to the VS2 measures above is calculated. In this case, it can either be expressed as energy use per unit of exports,

$$\mathrm{VES2}^{\mathrm{r}} = \frac{1}{\mathbf{1}'\mathbf{x}^{\mathrm{r}}}(\mathbf{e}^{-\mathrm{r}})'(\mathbf{I}-\mathbf{A})^{-1}\mathbf{x}^{\mathrm{r}}$$

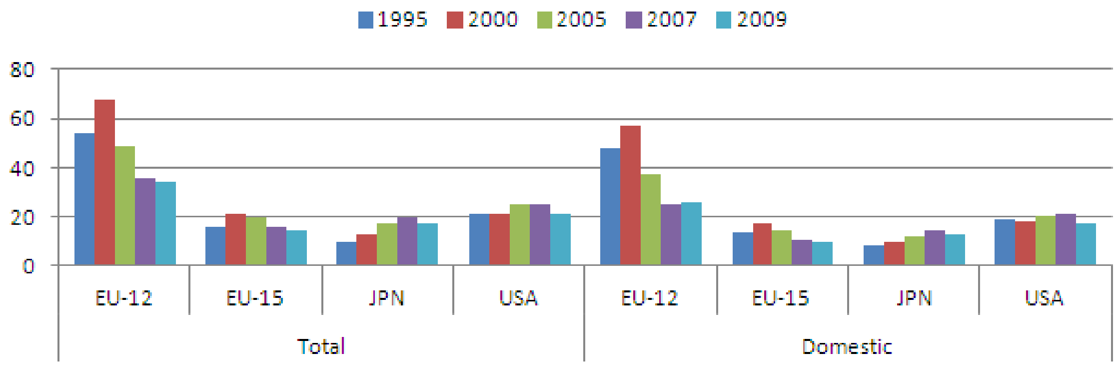
or in terms of shares (putting emphasis on the sourcing structure):

$$\mathrm{VES2}^{\mathrm{r}} = \frac{1}{\mathbf{e}'(\mathbf{I}-\mathbf{A})^{-1}\mathbf{x}^{\mathrm{r}}}(\mathbf{e}^{-\mathrm{r}})'(\mathbf{I}-\mathbf{A})^{-1}\mathbf{x}^{\mathrm{r}}$$

Here $\mathbf{e}$ denotes the NGx1 vector of energy use per unit of gross output, and $\mathbf{e}^{-r}$ is a corresponding vector, with the foreign countries entering with positive coefficients and 0 otherwise.

Figure 3.6.1

Energy use (TJ) per unit of exports (USD million), 1995–2009



Source: WIOD; authors' calculations.

3.6.1 Overall energy use of exports

Figure 3.6.1 presents the results for energy use per unit of exports for the four countries, over the period 1995–2009. Over time, in all the countries energy use per unit of exports declined in the EU-15, and particularly in the EU-12 countries. By contrast, for the US and Japan this indicator increased over time. For the EU-15 and EU-12, the overall change matches the domestic changes. In contrast, for the US and Japan, the increases were stronger for domestic use (in the US it is roughly constant), suggesting that those countries sourced from other countries that were producing in a less energy-efficient way. However, a more detailed analysis would require study of the composition of exports, as well as of the effect of the deflation and conversion procedures applied.

Table 3.6.1

Foreign energy use (in TJ) by unit of exports (USD million), 1995–2009

		Total exports				
		1995	**2000**	**2005**	**2007**	**2009**
EU-12	BRII	2.8	5.4	5.9	5.2	4.0
	CAN	0.1	0.1	0.1	0.1	0.1
	CHN	0.2	0.4	1.0	1.3	1.4
	EU-12	47.7	57.0	37.6	25.1	25.9
	EU-15	2.5	3.4	2.8	2.5	1.9
	JPN	0.0	0.1	0.1	0.2	0.1
	KOR	0.1	0.2	0.2	0.3	0.3
	MEX	0.0	0.0	0.1	0.1	0.1
	USA	0.3	0.5	0.4	0.4	0.3
	ROW	0.2	0.4	0.3	0.3	0.2
EU-15	BRII	0.6	1.5	2.7	2.6	2.3
	CAN	0.1	0.1	0.1	0.1	0.1
	CHN	0.3	0.4	0.6	0.8	0.8
	EU-12	0.4	0.7	0.7	0.6	0.6
	EU-15	13.5	17.2	14.1	10.9	9.5
	JPN	0.1	0.1	0.1	0.1	0.1
	KOR	0.1	0.1	0.2	0.2	0.2
	MEX	0.0	0.1	0.1	0.1	0.1
	USA	0.4	0.5	0.5	0.5	0.4
	ROW	0.2	0.3	0.3	0.3	0.2
JPN	BRII	0.5	1.2	1.9	2.2	2.0
	CAN	0.1	0.1	0.1	0.1	0.1
	CHN	0.3	0.5	1.2	1.3	1.3
	EU-12	0.0	0.0	0.1	0.1	0.0
	EU-15	0.2	0.3	0.4	0.3	0.2
	JPN	8.0	9.7	12.2	14.1	12.5
	KOR	0.3	0.6	0.6	0.5	0.5
	MEX	0.0	0.0	0.0	0.1	0.1
	USA	0.3	0.4	0.4	0.4	0.3
	ROW	0.1	0.3	0.3	0.3	0.3
USA	BRII	0.3	0.8	1.4	1.2	1.0
	CAN	0.5	0.6	0.6	0.5	0.4
	CHN	0.3	0.4	0.8	0.9	0.8
	EU-12	0.1	0.1	0.1	0.1	0.1
	EU-15	0.4	0.6	0.6	0.5	0.3
	JPN	0.1	0.2	0.2	0.2	0.1
	KOR	0.1	0.2	0.2	0.2	0.2
	MEX	0.1	0.2	0.4	0.5	0.5
	USA	19.2	17.9	20.5	21.1	17.7
	ROW	0.1	0.2	0.2	0.2	0.1

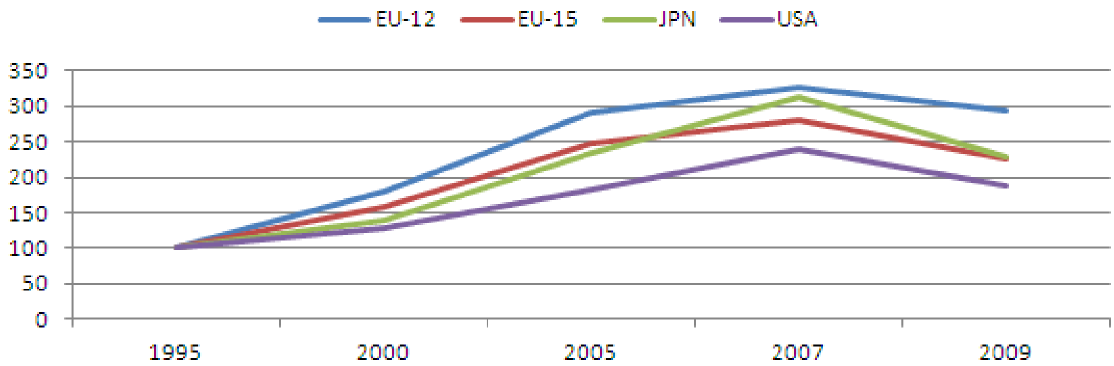
Source: WIOD; authors' calculations.

The difference between total and domestic energy use per unit of exports is sourced from other countries, i.e. embodied in the imports from other countries that are used for production. Table 3.6.1 shows this part broken down by individual partner countries. The geographical patterns follow expectations in the way that, for example, the EU-12 sources mostly from BRII and the EU-15, and increasingly from China. The rising share of China is also seen for the other countries, which is to be expected, as vertical integration with China strongly increased, as the previous sections showed.

The general decline in the energy use per unit of exports can, however, not be interpreted as meaning that overall energy use for production of exports also declined. Figure 3.6.2 therefore shows an index of total energy use, which was generally increasing as the volume of exports increased as well. The increase was particularly strong for the EU-12 and Japan, and less so for the EU-15 and the US.

Figure 3.6.2

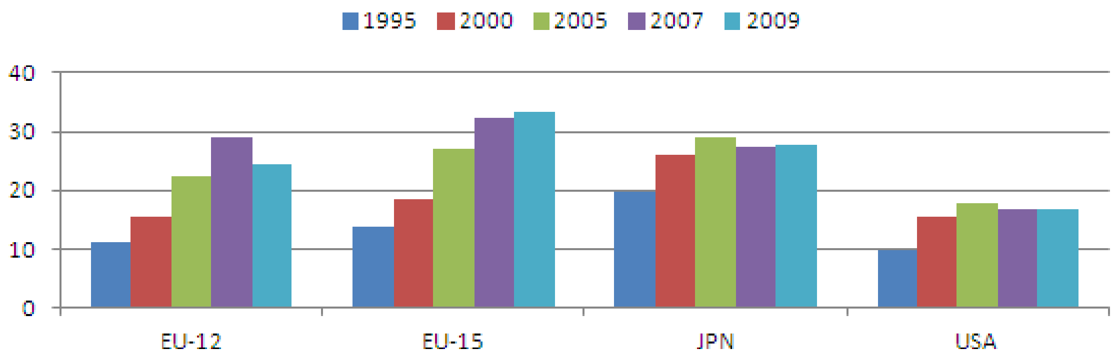
Index of energy use for exports, 1995–2009



Source: WIOD; authors' calculations.

Figure 3.6.3

Share of foreign energy use, 1995–2009



Source: WIOD; authors' calculations.

The concern in this report is, however, whether this additional energy is sourced via domestic intermediates or foreign intermediates (note that the focus is on the energy content of exports – via embodied energy in intermediate imports – and not on energy imports as such). Figure 3.6.3 suggests that, in all cases, the energy import content of exports was rising, particularly in the EU-12 but less in Japan. In that latter country and the US, this levelled off after 2005. The respective shares in 2009 in the EU-12 were 25% and in the EU-15 33%. Slightly lower shares are found for Japan, with less than 30%, and even lower for the US, with slightly above 15%.

Table 3.6.2 provides some more detailed information on the sourcing structure of embodied energy inputs. Note that these patterns are not only driven by the sourcing structures, but also by the respective energy inputs used for production in the partner countries. The striking fact again is the rise of China in all cases, particularly in Japan.

Table 3.6.2

Energy use by partner, 1995–2009

	EU-12					EU-15				
	1995	2000	2005	2007	2009	1995	2000	2005	2007	2009
BRII	5.1	8.0	12.1	14.6	11.7	4.0	6.9	13.8	16.0	15.8
CAN	0.1	0.1	0.2	0.2	0.2	0.8	0.7	0.7	0.8	0.7
CHN	0.3	0.6	2.0	3.6	4.0	1.8	1.8	3.7	5.4	6.5
EU-12	88.8	84.5	77.6	71.1	75.6	2.8	3.7	3.9	4.2	4.6
EU-15	4.6	5.1	5.8	7.0	5.5	92.1	89.7	86.4	83.1	83.2
JPN	0.1	0.2	0.3	0.5	0.3	5.9	5.2	5.0	5.8	4.5
KOR	0.1	0.3	0.4	0.8	1.0	1.1	2.2	2.5	2.6	4.1
MEX	0.0	0.1	0.1	0.2	0.2	0.5	1.0	1.4	1.5	1.8
USA	0.5	0.7	0.7	1.1	0.8	7.6	8.4	7.8	8.4	8.8
ROW	0.3	0.6	0.7	0.9	0.7	3.2	5.7	5.4	5.3	5.1
	Japan					USA				
	1995	2000	2005	2007	2009	1995	2000	2005	2007	2009
BRII	4.9	9.1	11.3	11.3	11.3	1.5	3.9	5.5	4.7	4.6
CAN	1.0	0.7	0.4	0.4	0.4	2.4	2.9	2.4	2.0	1.8
CHN	3.5	3.7	6.9	6.7	7.6	1.6	1.9	3.4	3.5	4.0
EU-12	0.2	0.3	0.3	0.3	0.3	0.2	0.4	0.4	0.3	0.2
EU-15	2.4	2.6	2.1	1.6	1.4	1.8	2.6	2.3	2.0	1.6
JPN	80.4	74.0	71.1	72.8	72.3	0.6	0.7	0.6	0.7	0.4
KOR	2.7	4.3	3.5	2.7	3.0	0.5	0.9	0.8	0.9	0.9
MEX	0.1	0.3	0.2	0.3	0.3	0.6	1.2	1.7	1.8	2.6
USA	3.3	3.0	2.4	2.3	1.8	90.1	84.5	82.2	83.4	83.2
ROW	1.4	1.9	1.8	1.7	1.7	0.5	1.0	0.9	0.8	0.7

Source: WIOD; authors' calculations.

3.6.2 Energy use of exports by selected sectors

This can be looked at in a similar way as the level of individual sectors. Table 3.6.3, therefore, provides this information for the four selected industries. In all cases, energy use for exports increased – sometimes strongly – due to the overall rise in exports. The foreign shares again increased in all cases. With respect to energy use per unit of exports, similar trends are to be observed. Striking differences are the much higher per unit inputs in the chemicals industry, compared to the other sectors. Also at the industry level, one can observe significant changes in the sourcing structures. The rise of China is particularly strong in the electronics industry. For all reporter countries, China's share increased to more than 30%, and by up to almost 50%.

Table 3.6.3

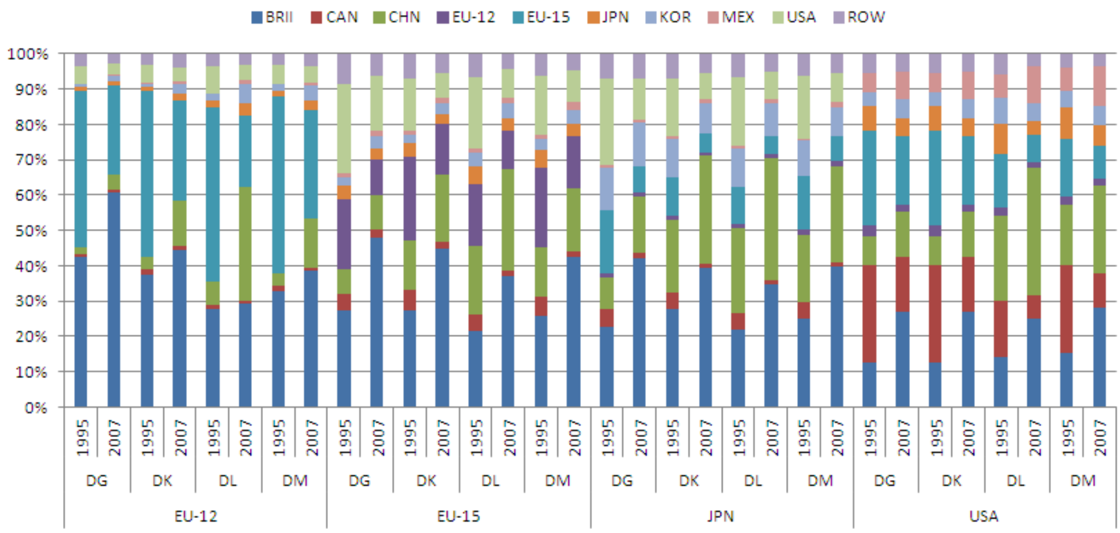
Index of energy use and foreign share, 1995–2009

	Index					Foreign share				
	1995	2000	2005	2007	2009	1995	2000	2005	2007	2009
					Chemical products (NACE DG)					
EU-12	100.0	140.7	224.0	255.5	243.3	8.6	11.3	17.3	21.9	19.9
EU-15	100.0	159.1	221.1	256.6	242.7	10.6	16.0	26.0	28.8	29.8
JPN	100.0	142.1	278.3	373.0	273.3	11.1	15.7	18.6	16.7	19.0
USA	100.0	133.2	210.2	233.1	206.1	6.5	10.6	13.9	13.7	14.2
					Machinery (NACE DK)					
EU-12	100.0	181.5	368.6	492.8	380.9	14.4	19.7	32.1	39.5	32.3
EU-15	100.0	129.1	210.3	274.2	212.1	25.4	33.2	45.5	51.8	49.5
JPN	100.0	132.6	186.7	222.4	145.8	25.3	34.0	41.2	41.1	42.3
USA	100.0	136.0	174.9	224.7	161.3	20.3	28.7	37.2	35.2	34.9
					Electrical and optical products (NACE DL)					
EU-12	100.0	365.6	694.6	949.8	857.2	19.9	32.2	49.4	58.4	55.1
EU-15	100.0	179.0	232.0	291.0	250.0	28.8	38.1	50.9	57.0	56.6
JPN	100.0	145.1	198.4	248.2	191.0	25.8	33.7	41.6	41.5	43.9
USA	100.0	139.2	122.3	148.4	96.0	22.4	33.8	45.2	43.2	45.7
					Transport equipment (NACE DM)					
EU-12	100.0	300.8	562.7	717.3	632.4	17.4	26.5	37.2	45.4	38.6
EU-15	100.0	161.5	262.6	320.8	237.0	25.8	35.5	48.0	53.8	52.6
JPN	100.0	148.9	242.8	322.5	211.0	26.2	32.1	38.3	38.8	40.0
USA	100.0	143.8	195.2	251.2	184.5	24.6	34.0	41.8	39.4	39.7

Source: WIOD; authors' calculations.

Figure 3.6.4

Sourcing structure of energy use for exports, 1995–2007



Source: WIOD; authors' calculations.

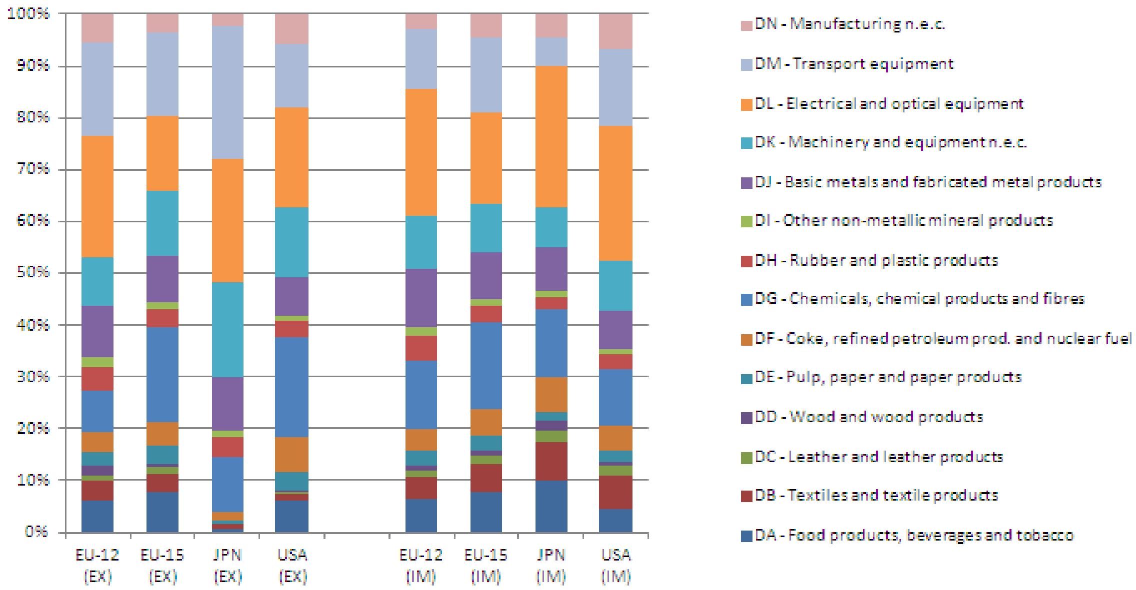
4. Effects of the economic crisis on changes in trade patterns and potential disruptions to international supply chains

4.1 Introduction

The financial crisis triggered an unprecedented slump in world trade in 2008, from which countries are partly recovering now. The study here shows the effects of this trade slump on trade structures of the EU-27 compared to other major economies, like the US and Japan. Of particular interest is whether the geographical patterns of exports and imports by industry are different from those preceding the crisis. Special emphasis is given to the industries mentioned above, for which trade in intermediates and parts and components is essential: 'Chemicals, chemical products and man-made fibres' (DG), 'Machinery and equipment n.e.c.' (DK), 'Electrical and optical equipment' (DL) and 'Transport equipment' (DM). Together, they make up 61% of the EU-27's manufacturing exports and 58% of its respective imports (see Figure 4.1.1).

Figure 4.1.1

Trade shares of manufacturing industries (2010)



Source: UN Comtrade; authors' calculations.

The analysis allows for an assessment of whether the crisis has led to a change in the structure of vertical specialisation. Particular attention is paid to international supply structures with respect to traded intermediates, and in particular semi-finished products and parts and components in these industries. For example, has EU-27 trade in parts and components changed with respect to the geographical patterns, and which regions have increased their importance as trading partners? Furthermore, the extent to which the crisis has changed the composition of traded products will be analysed with respect to changes in:

- the values of products traded;
- geographical patterns; and
- an industry's composition of trade.

The analysis will be based on the UN Comtrade data, which provide exports and imports at the HS 6-digit level; this allows for differentiation by broad economic categories (BEC) and NACE industries. The time period covered is 2005–10. Methodologically, the study builds on recent attempts to decompose the trade slump (e.g. Aurújo, 2009; Haddad et al., 2010; Levchenko and Lewis, 2009).

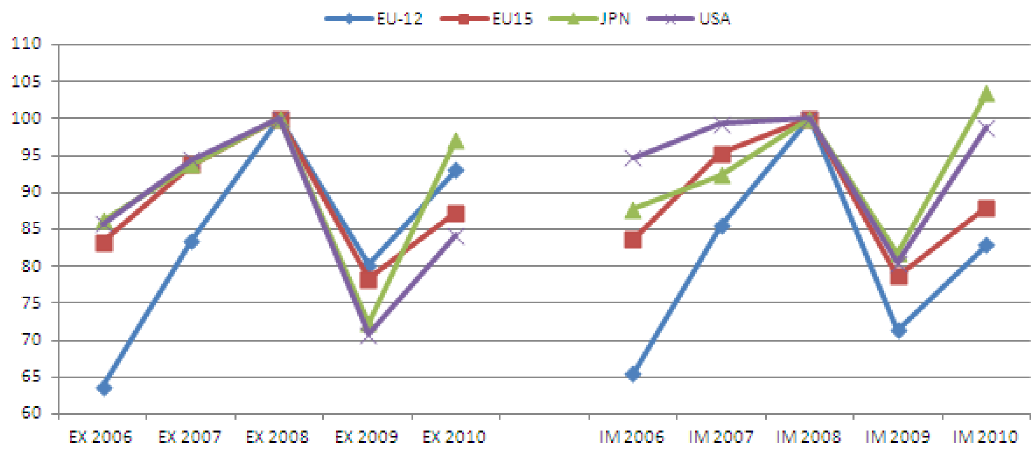
4.2 The trade collapse and after

4.2.1 The trade slump

The life-changing innovations in the communications sector that have occurred in the past decade have further increased the pace of the ongoing globalisation. Inexpensive and rapid means of communication and transportation have facilitated the emergence of global value chains. In many industries, most production processes are no longer located in the same country, but are scattered across different parts of the world. The existence of these global value chains is the major factor behind the 'Great Trade Collapse' (Baldwin, 2009).

Figure 4.2.1

Export/import developments of selected industries (2008 = 100)



Source: UN Comtrade; authors' calculations.

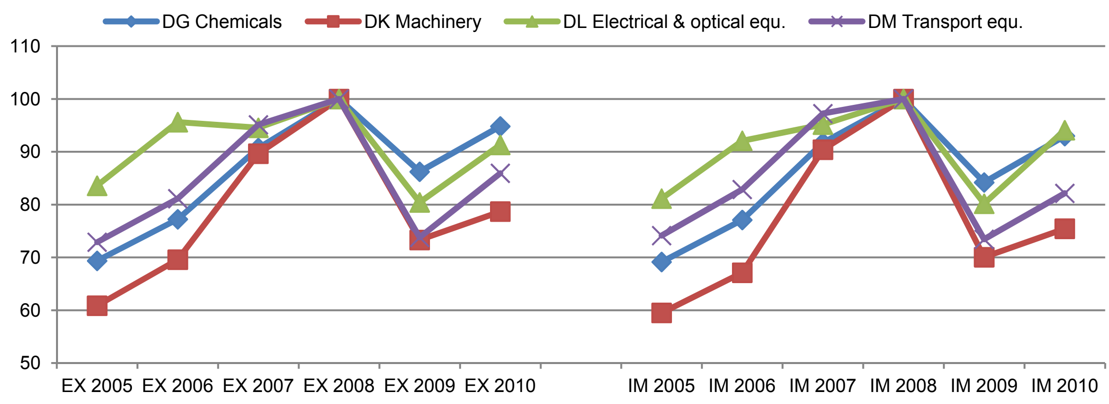
As a first step, there follows a broad overview of the recent trade developments in the four selected industries (NACE DG, DK, DL and DM). Before the crisis, in the period 2006–08, exports in these industries grew considerably faster in the EU-12 (57%) than in the EU-15 (20%), Japan (16%) or the US (17%), as can be seen in Figure 4.2.1. The increase in exports in the EU-12 even exceeded the growth in China (55%). Moreover, exports in the selected industries in the EU-12 grew faster than total manufacturing exports (53%), while the opposite is true for regions and countries closer to the technological frontier, like the EU-15 (24%), Japan (21%) and the US (23%).

The great trade collapse that started in autumn 2008 was digested quite differently in the major economies of the world. While China recovered very quickly from the trade slump of 2009, with growth rates of exports (imports) of 33% (34%) in 2010, advanced economies lagged far behind. China, however, had a positive effect on other economies in its region. After a very sharp decrease, Japan's exports recovered much faster than those of Europe and the US. As becomes clear later, in the analysis of trade by partner, China played an important role in the rebound of Japan's trade. In Europe, the EU-12 recovered faster than the EU-15 and continued the faster trade-growth path seen before the crisis. However, due to the fact that the EU-15 was hit rather hard by the crisis, exports to the EU-15 in 2010 were still way below the levels of 2008, especially in 'Machinery' and 'Transport equipment'. Although exports of small cars (<1500cc) have grown, those of larger cars, small trucks and road tractors for semi-trailers are still significantly lower than in 2008.

Before the crisis, trade growth rates in the industry 'Machinery' were especially high, as can be observed in Figure 4.2.2. The increase can be attributed, to a large extent, to the growth in trade of parts and components, which can also be observed in 'Transport equipment'. These high growth rates in trade in parts and components document the speed at which production processes are getting spread across countries and underline the central position of the two industries in the emergence of global value chains.

Figure 4.2.2

EU-27 import/export development (2008 = 100)



Source: UN Comtrade; authors' calculations.

4.2.2 Current bilateral trading structures

The EU-27 is by far the biggest player in global trade, and this holds true for the selected industries as well. Even after excluding intra-EU and intra-BRII trade, the EU-27 is still the largest advanced economy in terms of trade, and its exports even exceed those of the US and Japan put together in 'Chemicals' and 'Machinery'.

There now follows a more detailed look at the geographical component of trade (Table 4.2.1 and 4.2.2). The exports of the EU-12 are exceptionally concentrated in EU-27 countries, with shares reaching from 68% in ‘Chemicals’ to 79% in ‘Electrical and optical equipment’. This impressively documents the strong dependence of the EU-12 countries on a recovery in the EU-15. Traditionally, Russia was an important trading partner and continues to be a major export destination, with exports ranging from 5% to 9%. Also other countries in the region – like Ukraine, Belarus and also South East European countries (SEE) – maintained their strong economic connection with the EU-12. Other large economies like the US, Japan and China are of only minor importance as export destinations, and together make up only 1–5% of the industries’ exports. They are, however, much more important as sourcing countries, especially in ‘Electrical and optical equipment’. In 2010, imports from China amounted to almost a quarter of total imports in this industry (24%), but Korea (8%) and Japan (4%) are also prominently represented. China’s high imports and exports thereby reflect its role as an assembler country in the global value chains of this industry. The EU-27, the US, Canada and the BRII are huge net importers of electrical and optical equipment, whereas Korea and Japan are net exporters. Apart from the special case of this industry, EU-12 imports from other EU-27 countries are similar to its exports, reaching 73–79%. Russia as a sourcing country is rarely involved in the supply chains, other than as a provider of primary goods, which make up around three-quarters of the EU-12’s total imports from Russia.

The picture for the EU-15 looks similar, in that exports to the EU-27 are dominant, albeit to a much lesser extent. The shares of intra-EU exports range from 46% in ‘Machinery’ to 63% in ‘Chemicals’. The US and China rank second and third as export markets, with together 13% in ‘Chemicals’, 14% in ‘Electrical and optical equipment’ and 15% in ‘Machinery’ and ‘Transport equipment’. As regards imports, the US is a major trading partner in all four industries, while China has an especially strong position again in ‘Electrical and optical equipment’ (21%) and ‘Machinery’ (11%). As opposed to exports, imports from Japan are also rather significant.

The geographical trade pattern of Japan shows strong linkages with China and the US. China is the dominant export destination, with shares around 30%, apart from the industry ‘Transport equipment’. The EU-27 ranks third, with similar shares of 11–14% in all four industries. As can be seen from the table, exports to the rest of the world (RoW) are quite high, reflecting trade with other South East Asia countries. In terms of total exports by the selected industries, the most relevant countries are Taiwan (5.4%), Thailand (3.3%) and Singapore (2.7%). Concerning imports, Japan is a major recipient of transport equipment from the EU-27 (34%) and the US (30%), as well as of chemical products from the EU-27 (34%) and the US (21%). China, on the other hand, has the highest market share of Japan’s imports in ‘Machinery’ (43%) and ‘Electrical and optical equipment’ (43%).

Table 4.2.1

Exports of major economies in USD billion and share of partners in total trade (2010)

NACE	Reporter	Partner: EU-12		EU-15		JPN		USA		BRII		CAN		CHN		KOR		MEX		RoW	
DG	EU-12	12.2	28%	17.3	40%	0.2	0%	0.8	2%	4.1	9%	0.1	0%	0.4	1%	0.1	0%	0.1	0%	7.9	18%
	EU-15	42.8	6%	420.2	57%	14.6	2%	75.0	10%	29.9	4%	6.8	1%	18.5	3%	5.7	1%	4.7	1%	120.2	16%
	JPN	0.3	0%	8.5	11%			9.8	13%	3.2	4%	0.2	0%	21.5	28%	11.7	15%	0.3	0%	21.5	28%
	USA	0.6	0%	52.2	29%	10.4	6%			13.5	8%	23.6	13%	14.9	8%	6.5	4%	18.0	10%	37.8	21%
DK	EU-12	6.6	13%	31.6	61%	0.2	0%	1.3	2%	3.7	7%	0.2	0%	1.1	2%	0.3	1%	0.2	0%	6.8	13%
	EU-15	37.6	8%	206.5	41%	5.3	1%	34.7	7%	36.6	7%	4.2	1%	38.5	8%	9.1	2%	4.4	1%	123.8	25%
	JPN	1.0	1%	16.7	13%			20.8	16%	9.3	7%	0.9	1%	35.1	26%	11.7	9%	1.0	1%	36.3	27%
	USA	1.3	1%	19.5	15%	3.7	3%			9.0	7%	23.4	18%	9.7	8%	6.6	5%	11.2	9%	43.0	34%
DL	EU-12	19.6	15%	83.4	64%	0.4	0%	2.7	2%	5.4	4%	0.2	0%	2.3	2%	0.4	0%	0.4	0%	15.4	12%
	EU-15	54.5	9%	283.4	49%	9.0	2%	46.2	8%	25.3	4%	4.0	1%	31.7	6%	5.8	1%	3.5	1%	112.1	19%
	JPN	3.3	2%	18.9	11%			23.4	14%	5.4	3%	1.2	1%	59.4	35%	11.5	7%	3.0	2%	45.7	27%
	USA	1.6	1%	36.7	21%	9.9	6%			7.7	4%	20.9	12%	20.0	11%	7.2	4%	20.2	11%	54.4	30%
DM	EU-12	11.7	12%	64.7	66%	0.5	0%	1.9	2%	4.9	5%	0.8	1%	2.0	2%	0.2	0%	0.2	0%	11.6	12%
	EU-15	39.9	7%	312.0	53%	8.1	1%	55.9	10%	21.0	4%	5.4	1%	31.1	5%	4.6	1%	4.2	1%	101.2	17%
	JPN	1.7	1%	20.3	11%	0.0	0%	47.2	25%	11.6	6%	5.5	3%	19.8	10%	2.5	1%	3.2	2%	77.4	41%
	USA	0.6	1%	12.0	11%	2.5	2%	0.0	0%	2.3	2%	44.7	40%	5.1	5%	1.6	1%	16.8	15%	26.4	24%

Note: DG: Chemicals, chemical products and man-made fibres, DK: Machinery and equipment n.e.c., DL: Electrical and optical equipment, DM: Transport equipment.

Source: UN Comtrade; authors' calculations.

Table 4.2.2

Imports of major economies in USD billion and share of partners in total trade (2010)

		Partner																			
NACE	**Reporter**	**EU-12**		**EU-15**		**JPN**		**USA**		**BRII**		**CAN**		**CHN**		**KOR**		**MEX**		**RoW**	
DG	EU-12	11	15%	45	64%	1	1%	2	2%	3	4%	0	0%	1	2%	0	1%	0	0%	7	11%
	EU-15	17	3%	413	67%	11	2%	61	10%	13	2%	2	0%	15	2%	2	0%	1	0%	78	13%
	JPN	0	0%	20	34%			12	21%	1	2%	1	1%	8	14%	3	5%	0	0%	13	22%
	USA	1	1%	80	46%	11	6%			8	5%	23	13%	12	7%	3	2%	4	2%	31	18%
DK	EU-12	5	10%	34	63%	2	3%	2	3%	0	1%	0	0%	4	8%	1	2%	0	0%	5	9%
	EU-15	29	9%	182	54%	20	6%	23	7%	3	1%	2	1%	38	11%	3	1%	1	0%	33	10%
	JPN	0	1%	5	15%			5	13%	1	2%	0	0%	15	43%	2	7%	0	0%	6	18%
	USA	2	1%	36	24%	22	15%			3	2%	13	8%	37	25%	6	4%	18	12%	14	9%
DL	EU-12	14	11%	45	35%	5	4%	3	2%	1	1%	0	0%	32	24%	11	8%	1	1%	17	13%
	EU-15	75	12%	244	37%	27	4%	53	8%	7	1%	3	0%	135	21%	15	2%	6	1%	90	14%
	JPN	1	0%	9	8%			16	13%	2	1%	0	0%	54	43%	8	6%	1	1%	33	27%
	USA	4	1%	40	10%	26	6%			5	1%	12	3%	155	38%	19	5%	75	18%	78	19%
DM	EU-12	9	15%	39	62%	2	3%	2	3%	1	1%	1	1%	1	1%	2	3%	0	0%	6	10%
	EU-15	61	11%	342	64%	23	4%	38	7%	6	1%	3	1%	16	3%	13	2%	3	1%	32	6%
	JPN	1	2%	8	32%			7	30%	1	3%	0	2%	3	14%	1	3%	0	1%	3	14%
	USA	2	1%	51	22%	47	20%			3	1%	56	24%	9	4%	10	4%	45	20%	8	4%

Note: DG: Chemicals, chemical products and man-made fibres, DK: Machinery and equipment n.e.c., DL: Electrical and optical equipment, DM: Transport equipment.

Source: UN Comtrade; authors' calculations.

Finally, the trading patterns of the US show that the EU-27 is the most important partner for the US – in terms of imports, as well as exports.[41] Especially in the chemical industry, the EU-15 plays an important role in US trade, with shares in US import (export) as high as 46% (29%). In all industries apart from 'Electrical and optical equipment', the US is a net importer of goods from Japan and the EU-27. The close integration of the neighbour countries in the US value chains is documented by the strong linkages with Canada and Mexico. These two countries are also main markets for US transport equipment, with US export shares amounting to 40% for Canada and 15% for Mexico.

4.2.3 Geographical evolution of trade structures over the crisis

While the crisis had a huge impact on all major economies, the faster recovery of countries like China has greatly affected its main trading partners. This section looks at the changes in exports from 2007 to 2010 and analyses the changes in trade by partner.

4.2.3.1 Exports

Figure 4.2.3 presents data on changes in the exports of the EU-12, EU-15, Japan and the US by trading partner as a percentage of total trade in 2007. As mentioned above, the industries 'Chemicals, chemical products and man-made fibres' as well as 'Electrical and optical equipment' have recovered faster than the other two industries. Especially the EU-12 exhibits strong trade growth in both industries. The high demand for multimedia equipment and other electronic devices led to an increase in exports in 'Electrical and optical equipment' of almost 25%, even during the crisis. Trade with other EU-12 countries has risen more strongly than trade with EU-15 countries. In both fast-growing industries, Russia has disproportionately increased its market share relative to its importance in 2007. The EU-15, of course, has the lion's share of the absolute increase.

The chemical industry is the only one that has recovered very well in the US, with exports growing fastest in the BRII and China (relative to the region's importance in 2007). The picture looks quite similar for Japan, where the rapid recovery of China and Korea has played a major role in the increase in exports, while the shares of the US and EU-27 have even decreased. The EU-15 has grown slowest in the industry with a three-year growth rate of around 4%.

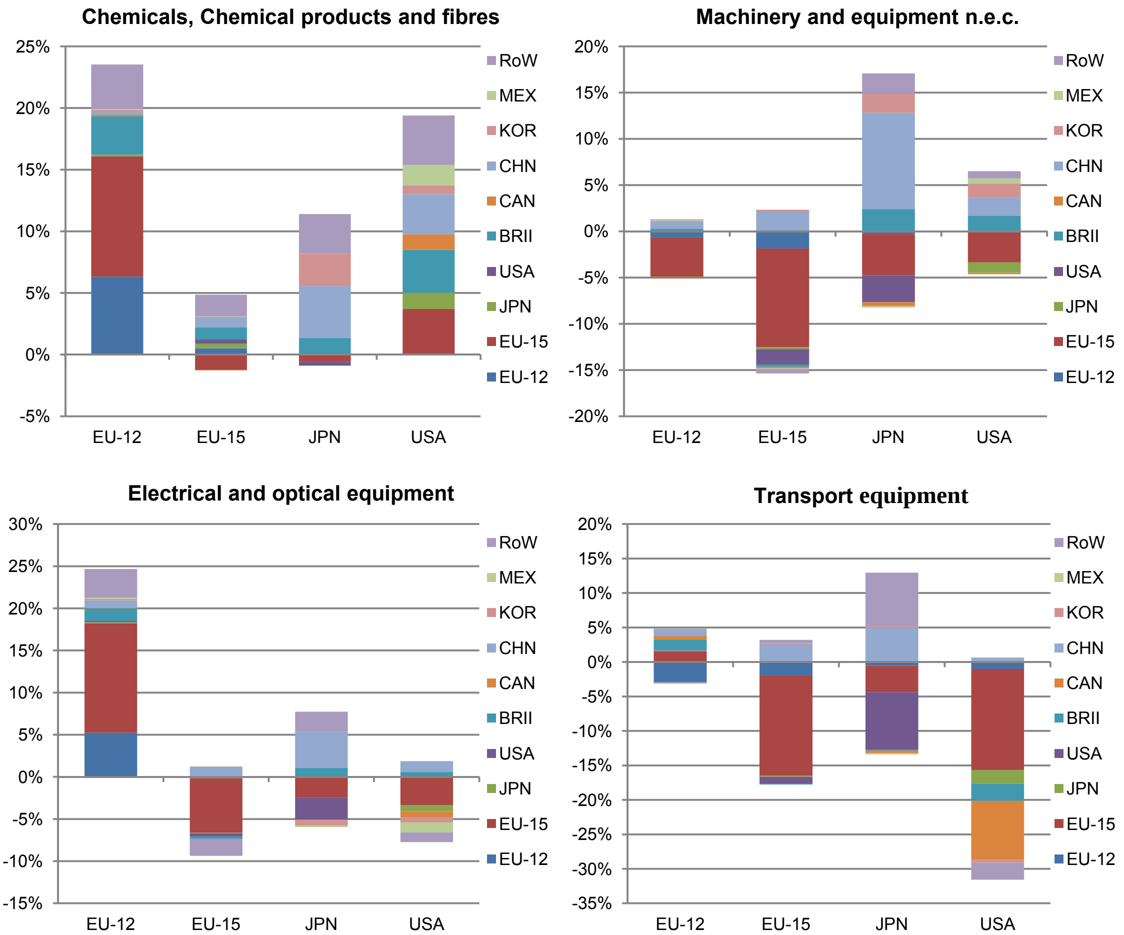
The reduction in demand in the EU-15 has heavily impacted the exports of all reporter countries in 'Machinery and equipment'. Also the drop in exports to the US has played a major role for the EU-15 and Japan. The EU-15 has experienced a drastic export reduction of -13.0%, followed by the EU-12 with -3.8%. Largely because of the geographical struc-

[41] Mostly likely due to confidentiality issues, US export data in 2009 and 2010 are missing for the product '880240 - Aeroplanes and other aircraft, of an unladen weight exceeding 15,000 kg' for some partner countries. The product was thus excluded in the subsequent analysis for exports of all countries, in order to avoid distortions.

ture of trade, Japanese (+8.8%) and US firms (+1.9%) could capitalise more on the relatively good recovery in China, Korea and the BRII. In the industry 'Electrical and optical equipment', again the EU-15 exhibits the strongest slump in trade (-8.1%), mainly due to the drop in intra-EU-15 trade. China is the only country where the EU-15 could increase its trade. For Japan, the increase in exports to China, BRII and the rest of the world more than offsets the rather strong trade decrease with the EU-15 and the US, resulting in an overall export growth of 1.8%. The US experienced a decrease in exports of around -5.9%, which was fairly equally distributed among the major trading partners. Again, only exports to China and BRII rose.

Figure 4.2.3

Changes in exports by partner as percentage of total trade 2007 (2007–10)

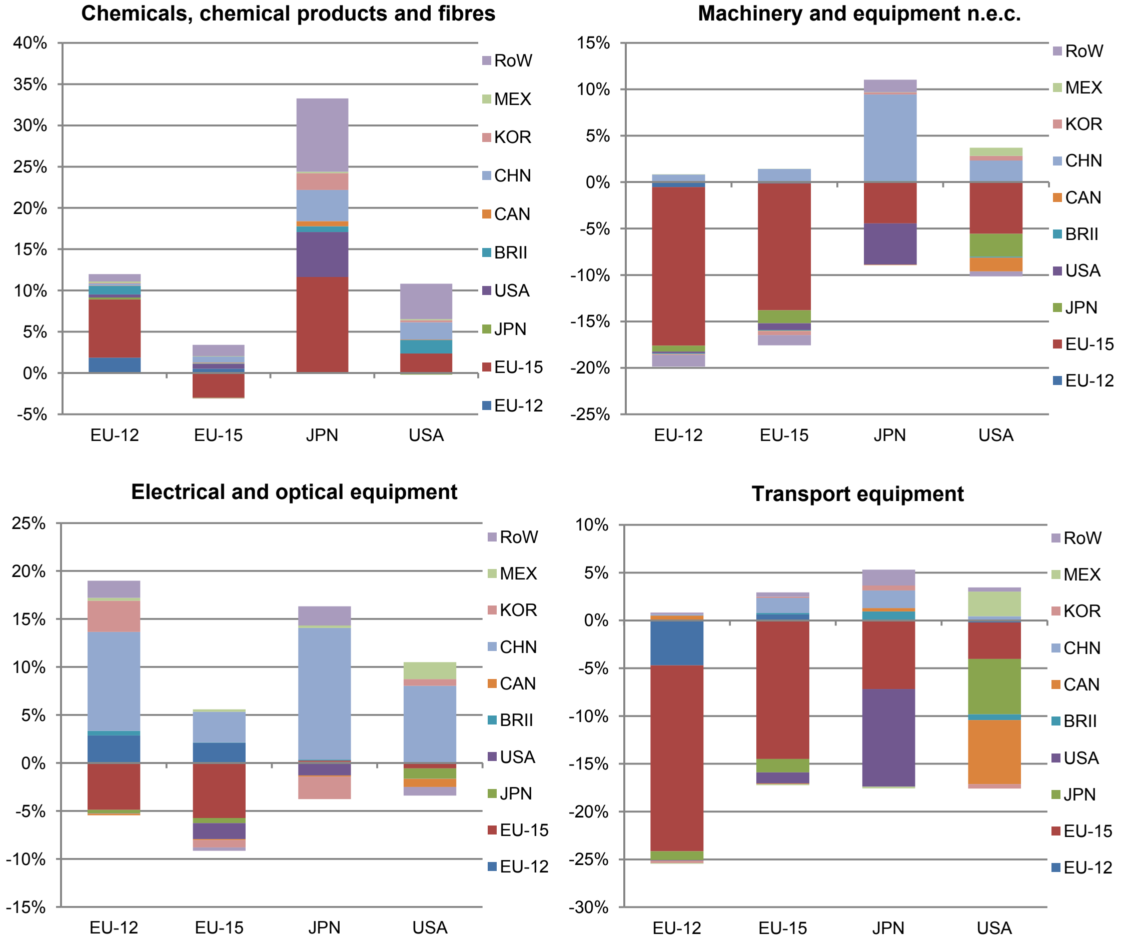


Source: UN Comtrade; authors' calculations.

Outstanding is the fall in exports of 'Transport equipment' in the US. The reduction in trade amounts to up to 57% of the 2007 trade value for Japan and even 67% for the EU-27. This huge slump is largely explained by a reduction in trade of large motor vehicles for personal transportation (>2500cc). In the EU-12 and Japan, exports of transport equipment have reached similar levels as in 2007. Japan, however, experienced a major shift in its exports away from the US and also the EU-15 market to China and South East Asian countries. The EU-15 is still suffering from a big reduction in intra-EU trade, resulting in a level of exports that in 2010 was 24% less than in 2007.

Figure 4.2.4

Changes in imports (2007–10) as percentage of total imports in industry in 2007



Source: UN Comtrade; authors' calculations

4.2.3.2 Imports

In all the advanced economies considered, imports in the chemical industry in 2010 reached or surpassed the levels of 2007. Especially Japan has dramatically increased its imports, with those from the EU-15 rising by 34% and from the US by 25% relative to the initial trade values with these partners. Imports from the EU-15 and the EU-12 have risen for all reporters considered, apart from the EU-15 itself.

Imports in the industry 'Electrical and optical equipment' are the most striking example of rising imports from China. Not only have exports to China increased (in all cases but one), but so have imports from China. Relative to the imports from China in 2007, they had increased by 59% for the EU-12, 19% for the EU-15, 39% for Japan and 25% for the US. This is outstanding in the face of the crisis. Also imports from the EU-12 have risen quite substantially for all reporters. While the EU-12 is not a major trading partner of Japan and the US, and thus the levels are quite low, intra-EU-12 trade increased by 30% and imports from the EU-15 by 24%.

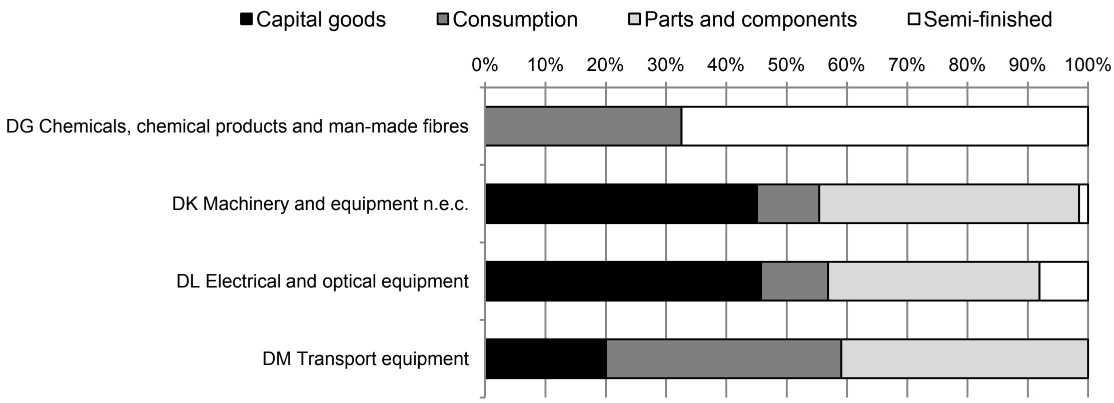
The two industries 'Machinery and equipment n.e.c.' and 'Transport equipment' are both characterised by a harsh decrease in imports from the EU-15, Japan and the US. Imports from the EU-15 decreased in most countries by more than 20%. As the EU-15 is a major trading partner of all the reporters considered, this leads to a huge effect with respect to total imports in these industries. In relative terms, other major advanced economies mostly performed no better. In 'Transport equipment', Japan's imports from the US plummeted by 25% (DK) and 28% (DM). EU-27 imports from the US, however, remained comparatively stable, at -11% (DK) and -16% (DM).

4.2.4 Trade by product use categories

This section goes deeper in analysing trade during the crisis and adds another layer. Decomposing the imports of an industry into trade in parts and components, semi-finished products, consumption and capital goods allows a more detailed look at vertical changes in trade.

Figure 4.2.5

Decomposition of EU-27 imports by use categories (2010)



Source: UN Comtrade; authors' calculations.

Figure 4.2.5 provides an overview of the composition of imports into the EU-27 for each industry. Trade in parts and components is a major portion of total trade in the industries 'Machinery and equipment n.e.c.' (43%), 'Electrical and optical equipment' (35%) and 'Transport equipment' (41%). Particularly in 'Machinery and equipment n.e.c.', trade in parts and components was strongly increasing before the crisis, with an annual rate of

19%, exceeding the growth in consumption goods (9%) and capital goods (16%). In the chemical industry, parts and components trade does not play a role and semi-finished products are the dominant trade element, with 67% of total imports.

The composition looks similar for EU-27 exports, albeit with slightly lower shares of capital and consumption goods.

Figure 4.2.6 shows the development of EU-27 imports by use categories. In most industries there was a sharper decrease in imports of semi-finished products and parts and components than of consumption goods. There are two factors behind this strong decrease in intermediate products. The first argument is that, as countries become more vertically specialised, the processing of a good in various production stages is likely to involve a number of countries. For this reason, trade declines not only by the value of the finished product, but also by the value of all the intermediate trade flows that went into creating it (see Yi, 2009; Bergoeing et al., 2004).

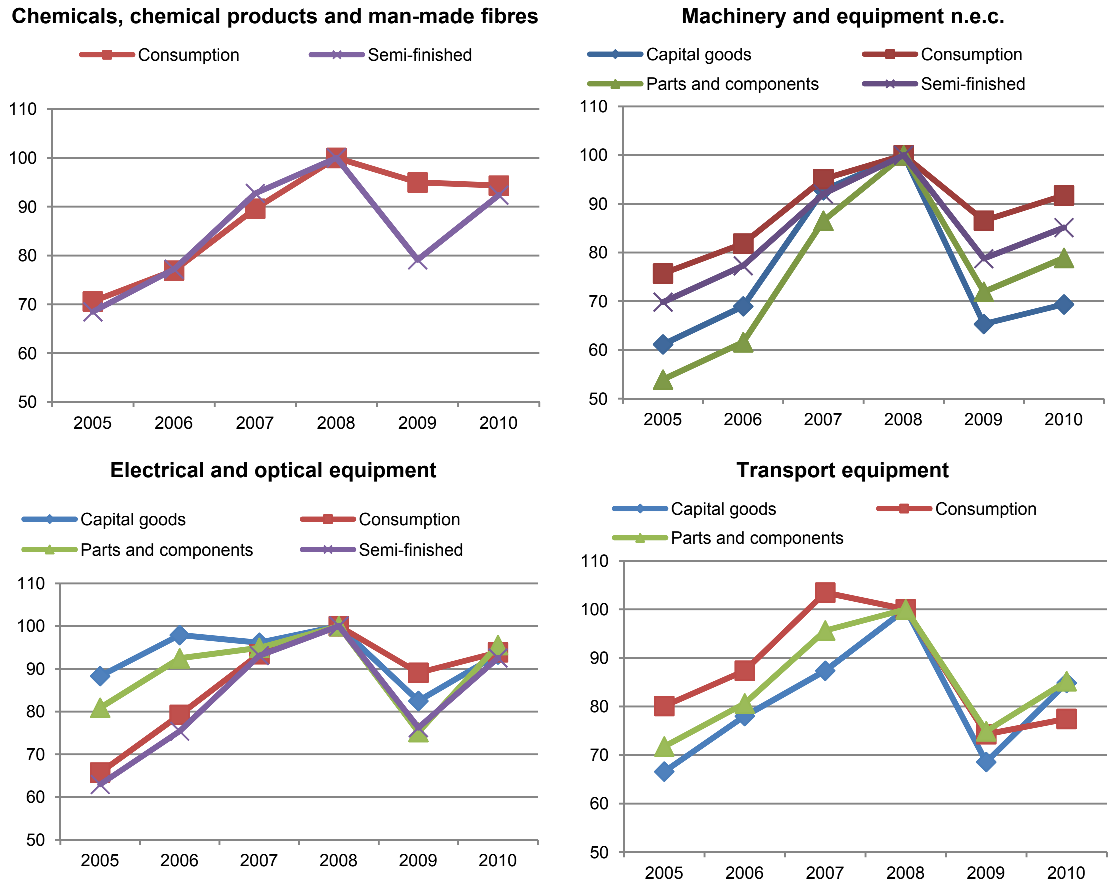
Following Alessandria et al. (2011), the inventory management of firms is another reason for the downturn in intermediate product trade during crisis periods. As a reaction to the demand shock, retailers and manufacturers not only reduce their orders by the amount of the demand shock, but also decrease their inventories in response. This decrease in inventories was observable in aggregate statistics during the crisis. Along the supply chain, each supplier now faces not only the first demand shock from the customer, but also the inventory effect, increased at each production stage. The effects are thus aggravated further up the supply chain from end-consumer to raw materials supplier, as can be seen in Figure 4.2.7 (Altomonte et al., 2012). The more complex the supply chains, and the more they are spread across countries, the more this so called 'bullwhip' or 'Forrester effect' (Forrester, 1961) is observable in international trade patterns. In the industry 'Transport equipment', there is not a stronger decline in intermediates than in consumption goods. This is partly explained by the just-in-time production, leading to minimal inventories and therefore a small bullwhip effect.

In a next step, the geographical component will be added and EU-27 trade will be analysed with respect to the partner countries and use category. The trade developments before the crisis (2005–07) will be compared with those during the crisis (2008–10). In order to do so, annual changes in imports are calculated for the EU-27, for each industry, use category and partner.

Before the crisis, EU-27 imports of semi-finished chemical products from countries close to the technological frontier had increased a lot faster than imports of consumption goods. The opposite was true of trade with the EU-12, where trade in consumption goods increased most. This indicates that the EU-12 countries had strengthened their role as a final producer of chemical products.

Figure 4.2.6

Development of EU-27 imports by use categories (2008=100)



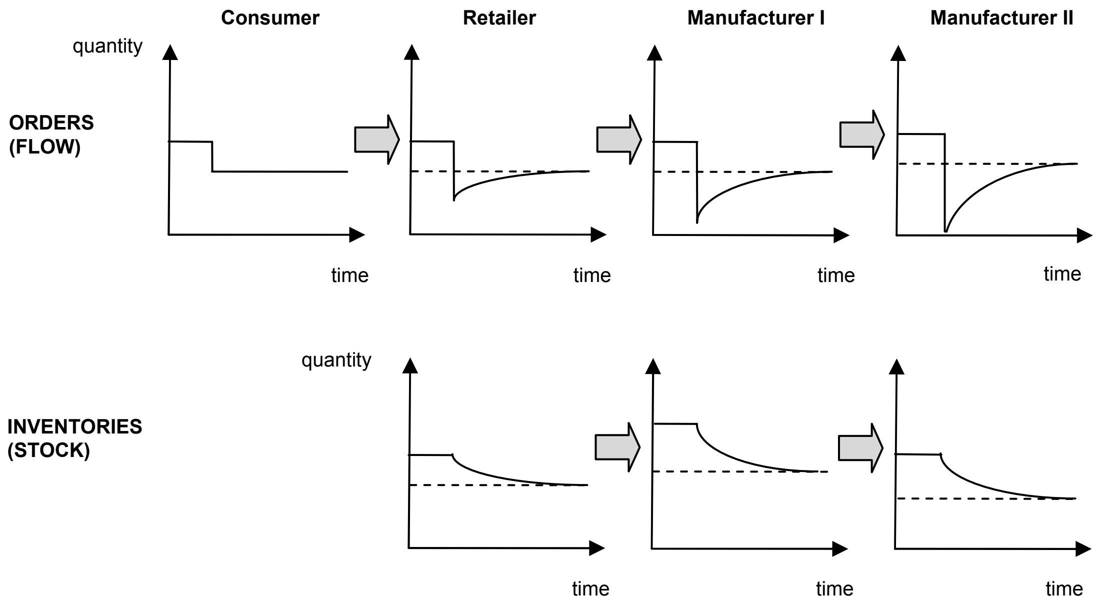
Source: UN Comtrade; authors' calculations.

'Machinery and equipment n.e.c.' registered the strongest growth rates in imports of parts and components. The annual growth rates between 2005 and 2007 are impressive, reaching 62% for China, 47% for Japan, 43% for Korea, 26% for the EU-12 and 20% for imports from the EU-15. The US role in the EU-27 production networks has been decreasing relatively speaking, as imports of parts and components grew by 'only' 10%. During the crisis, imports of parts and components and semi-finished products exhibited larger drops than those of consumption goods. Also trade in capital goods dropped significantly, as firms prolonged their investments. Along the geographical dimension, imports fell similarly in the EU-27, the US and Japan – mostly by 10–20%, while imports from China overall increased slightly.

Looking at the industry 'Electrical and optical equipment', Japan's traditional image as a major figure in this market is beginning to crumble. Even before the crisis, EU-27 imports of capital goods and parts and components fell by 8% annually. This trend continued during the crisis, with the largest drop in parts and components trade (17%). In contrast, the importance of the EU-12, China and Korea rose significantly before the crisis, and the former two partners even increased their trade levels during the crisis. By use category, again parts and components dropped very heavily in 2009, compared to consumption goods.

Figure 4.2.7

The bullwhip effect[42]



Source: Adapted from Altomonte et al. (2011).

Finally, the industry 'Transport equipment' shows a significant drop in imports of consumption goods from the US (-32%), Japan (-21%) and Korea (-26%), exceeding intra-EU-27 changes by far (-12%). On the other hand, overseas production network linkages remained rather stable, while imports of parts and components from the EU-15 dropped by 11%.

4.3 A decomposition of the trade collapse

In a final step, shifts in trade to different products or markets are investigated. Changes in total trade of a country between 2007 and 2010 will be decomposed into three effects. The first one considers only changes in the value of products, which were already traded with the partner in the past. The second effect includes changes due to new or vanishing export markets for the products the country is trading. The final effect represents changes due to newly traded products or products the reporter country does not trade anymore.

42 In certain cases, the order flow variable can even become negative. One example is the mass cancellation of orders to Boeing by the China's General Administration of Civil Aviation (CAAC) which has likely led to a negative order number in 2009 (Carson, 2009).

Table 4.2.3

EU-27 imports by partner, industry and use category: import share of partner in 2007, annual growth 2005–07 and 2008–10 (in %)

			Partner																							
Rep	NACE	Use category	EU-12			EU-15			JPN			USA			BRII			CHN			KOR			RoW		
			sh07	05-07	08-10	sh07	05-07	08-10	sh07	05-07	08-10	sh07	05-07	08-10	sh07	05-07	08-10	sh07	05-07	08-10	sh07	05-07	08-10	sh07	05-07	08-10
EU-27	DG	Consumption (33%)	3.3	30	10	76.4	11	-6	1.1	5	-8	8.2	8	6	0.5	10	24	1.1	25	2	0.3	59	-50	9.0	16	5
		Semi-finished (67%)	3.4	21	-7	67.0	14	-5	2.1	10	-3	9.0	15	-4	2.9	27	-5	2.1	23	4	0.5	18	0	13.0	20	0
	DK	Capital goods (45%)	5.2	26	-8	63.6	19	-21	6.3	14	-21	5.6	15	-18	0.8	28	-16	7.1	46	-4	1.5	30	-26	10.0	22	-18
		Consumption (10%)	14.4	22	-2	48.1	6	-10	1.5	-1	-6	3.1	9	-13	0.3	-6	17	20.9	16	5	2.2	3	1	9.5	18	-4
		Parts and components (43%)	8.8	26	-15	60.0	20	-15	6.7	47	-12	7.3	10	-8	1.2	29	-14	5.7	62	0	0.9	43	-11	9.4	28	-6
		Semi-finished (1%)	15.5	19	-17	55.0	11	-10	2.4	12	0	2.9	13	-12	1.3	16	-22	13.3	22	4	0.4	0	7	9.2	17	-2
	DL	Capital goods (46%)	6.8	11	4	42.8	2	-9	4.5	-8	-6	10.5	12	-11	1.0	15	1	19.6	11	7	3.2	-11	-22	11.6	0	-1
		Consumption (11%)	18.9	47	4	34.9	10	-9	3.0	3	-10	6.2	6	2	0.6	0	-15	17.6	26	-3	2.8	34	-11	15.9	7	-1
		Parts and components (35%)	7.0	19	-2	42.2	6	-6	5.5	-8	-17	7.7	-2	-9	0.8	18	-2	13.5	20	10	4.6	23	10	18.6	7	-2
		Semi-finished (8%)	17.7	21	-4	47.8	17	-8	2.8	23	-1	3.4	11	-3	1.1	24	-7	12.8	24	3	1.1	46	10	13.2	22	1
	DM	Capital goods (20%)	4.7	30	-15	67.7	18	-13	1.5	23	-12	10.7	-5	-20	1.1	29	28	1.5	23	46	2.3	-1	16	10.5	1	-12
		Consumption (39%)	9.4	34	0	71.2	10	-14	7.6	7	-21	3.5	29	-32	0.5	13	6	0.5	26	-9	3.1	4	-26	4.2	19	-3
		Parts and components (41%)	12.8	20	-4	66.7	13	-11	3.2	9	-6	8.4	10	-1	1.1	16	-10	1.3	26	6	0.6	48	11	6.0	18	-7

Note: The first (grey) column for each country is the share of this partner in EU-27 imports in this category in 2007. The second column is the annual growth rate in 2005–07 and the third column is the growth rate for 2008–10.

DG: Chemicals, chemical products and man-made fibres, DK: Machinery and equipment n.e.c., DL: Electrical and optical equipment, DM: Transport equipment.

Source: UN Comtrade; authors' calculations.

This analysis starts from the total trade value v_t of a country at time *t*

$$\Delta v_t = \sum_{n \in N_t} \sum_{c \in C_{nt}} v_{cnt}$$

where *n* stands for a product of the set N_t which includes all the products the reporter is trading at time *t*. *c* denotes a partner country of the set C_{nt}. This set C_{nt} includes all countries with which the reporter is trading the product at time *t*.
The overall change in trade between time *t* and *t-1* is simply given by

$$\Delta v_t = \sum_{n \in N_t} \sum_{c \in C_{nt}} v_{cnt} - \sum_{n \in N_{t-1}} \sum_{c \in C_{nt-1}} v_{cnt-1}$$

This total change in trade Δv_t can now be further decomposed:

$$\Delta v_t = \Delta v_t^s + \Delta v_t^m + \Delta v_t^p - \Delta v_t^w - \Delta v_t^q$$

The change in surviving varieties is denoted by Δv_t^s, Δv_t^m which represents trade with new markets, and Δv_t^p – trade in new products. By analogy, changes in trade due to vanishing markets is denoted by Δv_t^w and reduction in trade due to vanishing products by Δv_t^q.

Surviving varieties Δv_t^s are thus defined as varieties which were traded in both periods (here denoted as 0 and 1) between the reporter and the partner country.

$$\Delta v_t^s = \sum_{\substack{n \in N_1 \\ n \in N_0}} \sum_{\substack{c \in C_{n1} \\ c \in C_{n0}}} v_{cn1} - \sum_{\substack{n \in N_1 \\ n \in N_0}} \sum_{\substack{c \in C_{n1} \\ c \in C_{n0}}} v_{cn0}$$

If a country trades a variety that it is already trading with other countries, but now with a new partner, this counts as a new export market, Δv_t^m.

$$\Delta v_t^m = \sum_{\substack{n \in N_1 \\ n \in N_0}} \sum_{\substack{c \in C_{n1} \\ c \notin C_{n0}}} v_{cn1}$$

Consequently, trade in a variety that was previously not traded at all by the country counts as trade in new products, Δv_t^p.

$$\Delta v_t^p = \sum_{\substack{n \in N_1 \\ n \notin N_0}} \sum_{c \in C_{n1}} v_{cn1}$$

Contrariwise, a variety that is not traded anymore with a partner but is still traded with other countries counts as vanishing export markets, Δv_t^w.

$$\Delta \mathrm{v}_\mathrm{t}^\mathrm{w} = \sum_{\substack{\mathrm{n} \in \mathrm{N}_1 \\ \mathrm{n} \in \mathrm{N}_0}} \sum_{\substack{\mathrm{c} \notin \mathrm{C}_{\mathrm{n}1} \\ \mathrm{c} \in \mathrm{C}_{\mathrm{n}0}}} \mathrm{v}_{\mathrm{cn}0}$$

Finally if this product is not traded with any country anymore, this falls under the category of vanishing products, Δv_t^q.

$$\Delta v_t^q = \sum_{\substack{n \notin N_1 \\ n \in N_0}} \sum_{c \in C_{n0}} v_{cn0}$$

Altogether these changes are equal to the total change in trade, Δv_t. The disaggregation is used to investigate changes in imports and exports during the crisis. For the analysis again Comtrade trade data at the HS 6-digit level are used. The year 2007, before the crisis, is compared with 2010, the last available year.

Table 4.3.1

Changes in export 2007–10 relative to 2007

NACE	Reporter	Surviving varieties	New markets	Vanishing markets	New products	Vanishing products
DG	EU-12	21.7%	4.1%	-2.3%	0.0%	0.0%
	EU-15	3.5%	0.3%	-0.3%	0.0%	0.0%
	JPN	10.7%	0.7%	-1.0%	0.1%	0.0%
	USA	17.1%	1.3%	-1.4%	2.5%	-0.1%
DK	EU-12	-3.8%	1.6%	-1.6%	0.0%	0.0%
	EU-15	-13.0%	0.3%	-0.3%	0.0%	0.0%
	JPN	9.6%	0.8%	-1.5%	0.0%	0.0%
	USA	1.7%	1.1%	-1.0%	0.0%	0.0%
DL	EU-12	24.4%	0.6%	-0.3%	0.0%	0.0%
	EU-15	-8.2%	0.1%	-0.1%	0.0%	0.0%
	JPN	1.7%	0.4%	-0.4%	0.0%	0.0%
	USA	-6.1%	0.5%	-0.3%	0.0%	0.0%
DM	EU-12	1.0%	2.5%	-1.7%	0.0%	0.0%
	EU-15	-14.7%	0.9%	-0.7%	0.0%	0.0%
	JPN	-0.2%	0.4%	-0.6%	0.0%	-0.1%
	USA	-24.7%	0.7%	-6.5%	0.0%	-0.4%

Note: DG: Chemicals, chemical products and man-made fibres, DK: Machinery and equipment n.e.c., DL: Electrical and optical equipment, DM: Transport equipment.

Source: UN Comtrade; authors' calculations.

The estimates show the expected result: that most of the changes during the crisis occurred in the category of surviving varieties (Tables 4.3.1 and 4.3.2). At least at this product and reporter disaggregation level, most of the changes happen in this segment. An important observation is that there are still a lot of changes going on in export markets of the EU-12. In the last 10 years, trade levels of the EU-12 have been rapidly catching up with the level of economies closer to the technological frontier. Still there are rather large shifts in export markets observable. The US is a region with a larger change in vanishing markets – this is mostly related to trade in medium-sized aeroplanes and parts of helicopters and aeroplanes.

Finally, a look at the two categories 'new products' and 'vanishing products' reveals that there is little change going on – even in the face of the crisis. Just two chemicals, which are used mostly for fertilisers and were not exported in 2007, stand out from US exports.

The results of a more detailed decomposition by industry and use category can be found in the appendix (Table A.4.2.2 to Table A.4.2.5). A new insight from the further decomposition is that the partly substantial changes along the extensive margin in the industry ‘Transport equipment’ happened mainly in the category of capital goods.

Table 4.3.2

Changes in import 2007–10 relative to 2007

NACE	Reporter	Surviving varieties	New markets	Vanishing markets	New products	Vanishing products
DG	EU-12	11.6%	1.2%	-0.8%	0.0%	0.0%
	EU-15	0.1%	0.6%	-0.4%	0.0%	0.0%
	JPN	33.3%	1.6%	-1.6%	0.0%	-0.1%
	USA	10.7%	1.3%	-1.3%	0.0%	0.0%
DK	EU-12	-18.6%	0.5%	-0.8%	0.0%	0.0%
	EU-15	-16.2%	0.2%	-0.1%	0.0%	0.0%
	JPN	2.7%	0.7%	-1.2%	0.0%	0.0%
	USA	-6.4%	0.4%	-0.5%	0.0%	0.0%
DL	EU-12	13.6%	0.2%	-0.3%	0.0%	0.0%
	EU-15	-3.6%	0.1%	0.0%	0.0%	0.0%
	JPN	12.6%	0.2%	-0.2%	0.0%	0.0%
	USA	7.1%	0.1%	-0.1%	0.0%	0.0%
DM	EU-12	-25.8%	2.2%	-1.0%	0.0%	0.0%
	EU-15	-14.4%	0.6%	-0.5%	0.0%	0.0%
	JPN	-12.3%	2.0%	-1.9%	0.0%	0.0%
	USA	-14.3%	0.5%	-0.3%	0.0%	-0.1%

Note: DG: Chemicals, chemical products and man-made fibres, DK: Machinery and equipment n.e.c., DL: Electrical and optical equipment, DM: Transport equipment.

Source: UN Comtrade; authors’ calculations.

5. Impact of long-term and crisis-related value chain dynamics on the competitiveness of EU firms and their internationalisation

5.1 Introduction

This contribution investigates the relocation of production activities to locations abroad (referred to as offshoring in the text) in European manufacturing. At the end of the 1990s and the start of the new millennium, the antecedents and consequences of the relocation of production capacities to foreign countries were discussed intensely in public and academic debates (e.g. Barba Navaretti and Falzoni, 2004; Egger and Egger, 2003, 2006; Mucchielli and Saucier, 1997; Pennings and Sleuwaegen, 2000). Many well-known European manufacturing companies made use of production offshoring strategies. The aim in most cases was to improve their cost position, in particular in the new EU Member States, and partly also to support market penetration (Kinkel et al., 2007; Kinkel and Maloca, 2009). However, the risks and difficulties of developing production in low-wage countries were frequently underestimated, resulting in medium-term adaptation strategies and sometimes even backshoring activities (Kinkel and Maloca, 2009). Nevertheless, for many years production relocations held a firm place in the standard repertoire of the most popular cost-reduction measures in European industry.

In the current Euro crisis, the question arises of how manufacturing companies act in the offshoring arena in times of high economic uncertainty. Companies' behaviour in the global economic crisis of 2008/09 can act as a reference for how industrial relocation strategies are influenced by external economic shocks. When looking at the offshoring intensity of the German manufacturing industry over a timeframe from 1995 to 2006, it can be shown that in times of economic difficulties, relocation activities have usually increased, due to increased competitive pressure (Kinkel and Maloca, 2009).

Against that background, this section investigates the following questions: Which types of European manufacturing firms are offshoring production activities? What are the main destination countries for offshoring? How is offshoring related to innovation and company performance? What are the short-term and long-term trends in offshoring? Has the 2008/09 economic crisis altered or even arrested the trend towards stronger fragmentation of firms' global production chains? Or have companies, on the contrary, become more active again in order to get a better grip on their cost base at a time when production volumes are falling?

5.1.1 Key questions

With the dataset based on the European Manufacturing Survey (EMS) surveys of 2006 and 2009 described in detail below, the following **key questions** can be answered:

- How many and which European manufacturing companies have relocated parts of their production to foreign locations? Which types of firms are more likely to offshore? Is offshoring a phenomenon that is restricted to large firms, or do SMEs also offshore some of their activities?
- What are the preferred target countries for production relocations of European manufacturing companies? What are the motives for production relocations in these countries? How is offshoring related to framework conditions in different locations?
- Has the propensity of firms to offshore production activities changed in recent years? Of particular interest is whether offshoring has decreased or increased due to the 2008/09 economic recession.
- How is offshoring related to R&D, innovation, company performance, and the production processes of firms? Does offshoring hollow out firms and endanger their long-term competitiveness, or does it help firms to become more flexible and productive?

5.2 Database

The European Manufacturing Survey (EMS) investigates product, process, service and organisational innovation in the European manufacturing sectors. In contrast to the Community Innovation Survey (CIS), EMS is more focused on technology diffusion and organisational innovation than on product innovation. EMS is organised by a consortium of research institutes and universities coordinated by the Fraunhofer Institute for Systems and Innovation Research (ISI), and takes place every three years. This section presents results on European companies' production relocation activities. It exploits evidence from the last EMS round, conducted in the middle of 2009, which covers companies' production offshoring activities from 2007 to the middle of 2009; at least in the second half of the timeframe (around mid-2008 to mid-2009) such activities would have been decided at the start of the 2008/09 economic crisis. These findings are compared with the results of the previous EMS round of 2006, which covers production offshoring activities from the middle of 2004 to the middle of 2006 – way before the signs of a crisis could be detected on the economic horizon.

In the context of this chapter, offshoring firms are firms that have moved parts of production to their own or independent firms abroad. Hence, offshoring includes foreign direct investments flows, but also the purchase from contractors abroad of goods previously produced by the firm domestically.

Box 5.2.1

The European Manufacturing Survey

The European Manufacturing Survey (EMS) investigates technological and non-technological innovation in European industry. It focuses on fields such as technical modernisation of value-adding processes, the introduction of innovative organisational concepts, including international offshoring and outsourcing of production and R&D activities, and new business models for complementing the product portfolio with innovative services. The questions on these indicators have been agreed upon in the EMS consortium and are surveyed in all the participating countries. Additionally, some countries ask questions on specific topics. The underlying idea of the question design is to have a common core of questions asked consistently over several survey rounds; to modify other common questions in a survey round in order to correspond to actual trends, problems and topics; and to provide space for some country- or project-specific topics.

In most countries, EMS is carried out as a paper-based survey at company level. In order to prepare for multinational analyses, the national data undergo a joint harmonisation procedure.

The latest survey – EMS 2009 – was carried out successfully in 13 countries. Thanks to the cooperation of the EMS partners, information on the utilisation of innovative organisation and technology concepts in the generation of products and services, as well as performance indicators such as productivity, flexibility and quality could be gathered for more than 3,500 companies from the manufacturing sector in these countries.

The dataset employed in this report was compiled using those country surveys that included questions on the companies' production relocation behaviour, conducted in nine European countries. It includes the Austrian, Croatian, German, Dutch, Slovenian, Spanish and Swiss datasets collected in 2009 and 2006. The Danish and Finnish datasets are only available for the 2009 round, as the respective partners joined the EMS network after 2006. While most partners sent out their questionnaires by mail, the Finnish and Danish data were collected using an online questionnaire. Those asked to fill in the questionnaires were the production managers or CEOs of the manufacturing firms contacted.

This report focuses on actual trends and developments in production relocation activities of European manufacturing companies in the following industrial sectors: chemicals/chemical products (NACE 24), machinery and equipment (NACE 29), electrical and optical equipment (NACE 30–33) and transport equipment (NACE 34–35).

Table 5.2.1 gives an overview of the sample, broken down by sector, firm size and country distribution for the EMS surveys 2006 and 2009.

Table 5.2.1

Sample of surveyed firms, by firm size, country and sector, 2006 and 2009

	2006		2009	
Firm size	N	%	N	%
Up to 49	435	29.96	476	33.36
50 to 249	669	46.07	663	46.46
250 and more	348	23.97	288	20.18
Sector	N	%	N	%
Chemicals/chemical products [(a)]	170	11.71	180	12.61
Machinery & equipment [(b)]	617	42.49	628	44.01
Electrical & optical equipment [(c)]	537	36.98	507	35.53
Transport equipment [(d)]	128	8.82	112	7.85
Country	N	%	N	%
Germany	847	58.33	635	44.5
Austria	89	6.13	102	7.15
Switzerland	299	20.59	303	21.23
Netherlands	89	6.13	116	8.13
Denmark			143	10.02
Croatia	40	2.75	24	1.68
Finland			42	2.94
Spain	56	3.86	32	2.24
Slovenia	32	2.2	30	2.1
Total	1452		1427	

Note: (a) NACE 24, (b) NACE 29, (c) NACE 30–33, (d) NACE 34–35.

Source: European Manufacturing Survey 2006, 2009

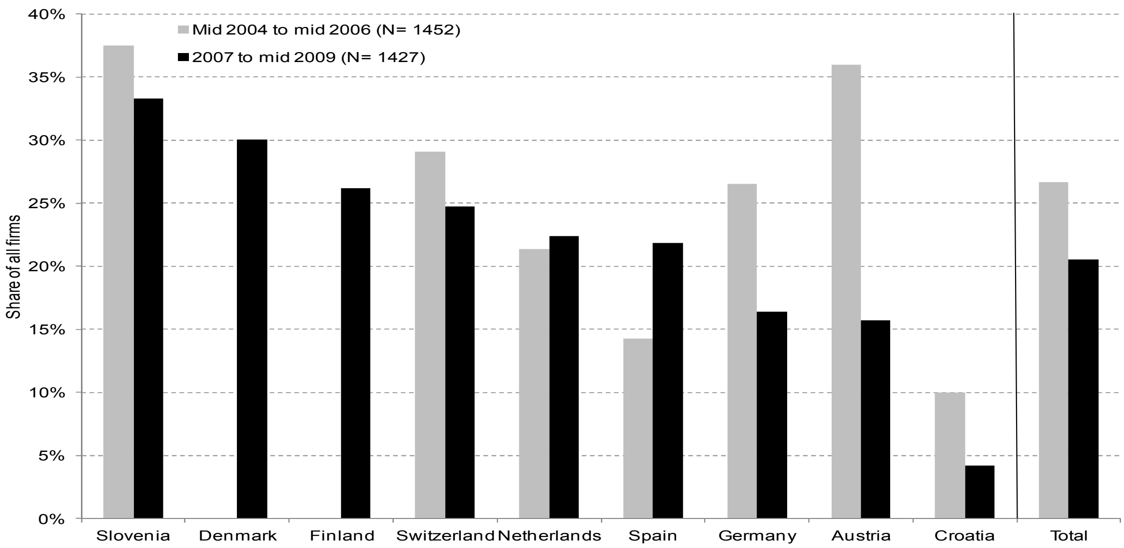
5.3 *Frequency of production offshoring*

5.3.1 Production offshoring by country

The results clearly show that the offshoring of production activities has been an important strategy for modernising production in all the countries surveyed. However, some differences as regards the degree of offshoring can be found (Figure 5.3.1). Slovenia and Denmark rank first and second, with around a third of manufacturing companies pursuing production offshoring activities in the survey period, from 2007 to the middle of 2009.[43] The Slovenian sample, however, is small, and results may have been influenced by some very active firms. Finland and Switzerland follow in third and fourth places, with 26% and 25% of offshoring companies. Spain and the Netherlands take midfield ranks in a European comparison – both countries have around 22% of manufacturing companies that relocated production facilities abroad in the survey timeframe. Germany and Austria follow next – some way behind: both countries had around 16% of manufacturing companies that pursued offshoring activities between 2007 and the middle of 2009. Croatia is last in the rankings of the surveyed countries as regards production offshoring.

Figure 5.3.1

Share of companies undertaking production relocation abroad, by country



Source: European Manufacturing Survey 2006, 2009.

The level of offshoring observed for the different countries does not necessarily mirror their labour cost position in a European comparison (Figure 5.3.2). Among the countries with the highest share of production relocations are some with quite high hourly labour costs (Denmark or Finland), but also one with a quite moderate labour cost level (Slovenia). Conversely, some countries with high hourly labour costs (Germany or Austria) were rather restrained in undertaking production relocations between 2007 and the middle of 2009.

43 SI, HR and ES show rather small absolute numbers of offshoring companies in the EMS samples of 2006 and 2009.

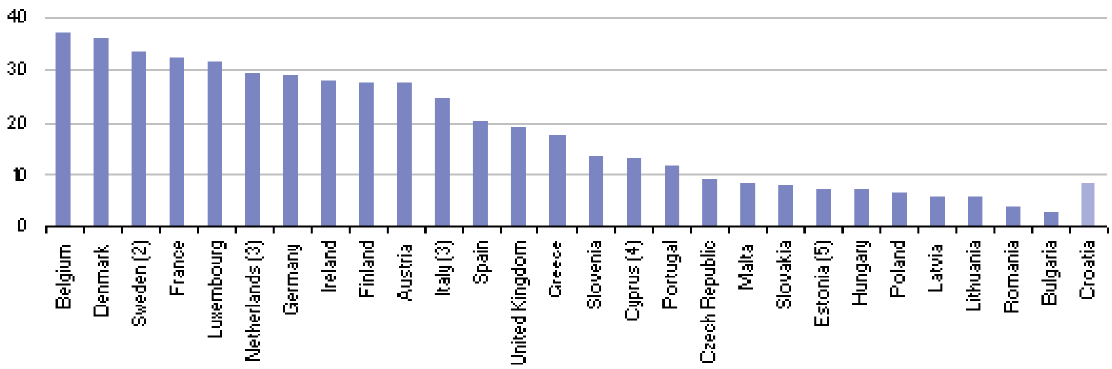
These insights indicate that labour cost arbitrage is not the only factor when it comes to explaining the different offshoring levels of European countries: other motives might also play an important role (cf. Section 5.5 on offshoring motives). Besides the absolute level of labour cost, labour cost dynamics in recent years could also be a decisive factor for firms' offshoring intensity, which might explain the high offshoring level of Slovenian companies, for example. Additionally, earlier offshoring levels and their dynamics over time have to be accounted for when it comes to explaining the actual offshoring intensity of European manufacturing industry.

When comparing production offshoring in the period from 2007 to the middle of 2009 and in the previous period (mid-2004 to mid-2006), one sees a significant decline in almost all countries surveyed. The sharpest cutback can be observed in Austria, with 20 percentage points (from 36% to 16%), followed by Germany with a drop of 10 percentage points (from 26% to 16%). Croatia's drop in its production relocation level is – at 6 percentage points – rather moderate, but coming from a previously low absolute level of 10% of companies that offshored, this equals a relative decline of around 60%.

Slovenia and Switzerland indicate a moderate decrease by 4 percentage points each. Denmark and Finland have only data for 2009. The Netherlands shows a comparable production relocation level in both surveyed periods, as the low increase of 1 percentage point is statistically not significant.

Figure 5.3.2

Average hourly labour costs in the business sector, 2009



(1) Enterprises with ten or more persons employed, NACE Rev .2 Sections B to N. – (2) NACE Rev. 1.1 Sections C to K 2007. – (3) 2008. – NACE Rev. 1.1 Sections C to K, 2008. – (5) All enterprises.

Source: Eurostat (online data codies: ic_an_costh_r2 and ic_an_costh)

Spain is the only country that saw the production offshoring activities of its manufacturing companies increase (by 8 percentage points – from 14% to 22%). This might be explained by a catching-up strategy of Spanish companies in emerging economies, e.g. in China and Asia. This will be explored in detail in Section 5.4, which focuses on target regions.

Overall, the data suggest that the 2008/09 economic crisis was associated with a decrease in offshoring activities in almost all the countries surveyed. The total sample of all surveyed countries shows a decrease in the production offshoring intensity – from 27% in the period 2004–06 to 21% in the period 2007 to mid-2009 (Figure 5.3.1). European manufacturing companies seem to have maintained production at home and utilised capacities at their existing locations, rather than look for new offshoring ventures abroad.

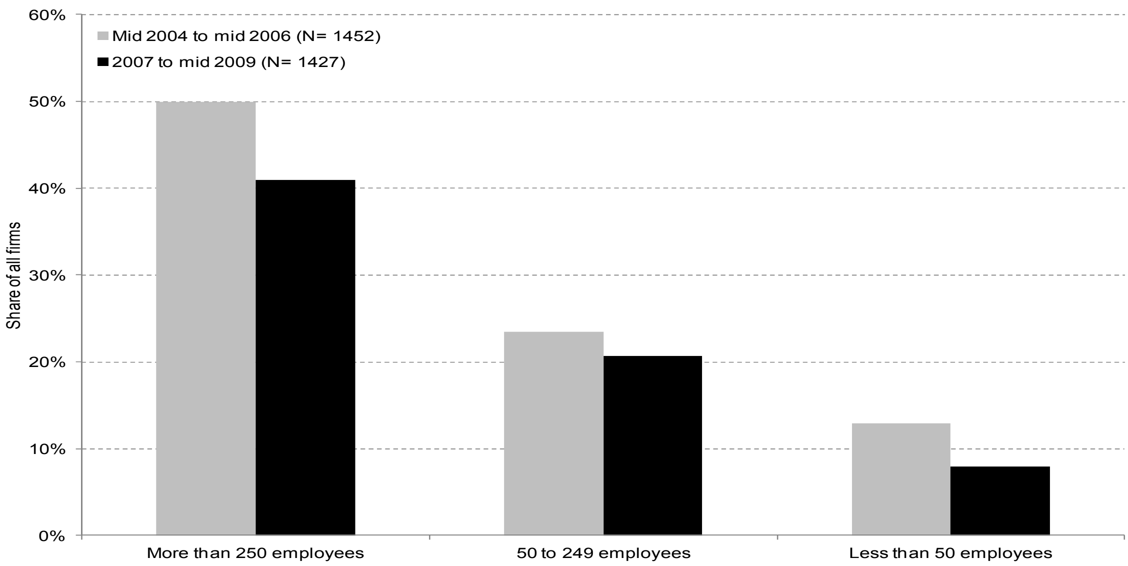
5.3.2 Production offshoring by company size

When looking at firms of different sizes, significant differences in the level of production relocations can be found (Figure 5.3.3). As might be expected, particularly larger firms (with more than 250 employees) have relocated parts of their production abroad (41%), whereas the figure is significantly lower for medium-sized firms (50–249 employees: 21%) and small firms (49 and fewer employees: 8%).

The decrease in offshoring intensity that is observed for the whole sample can be found across all company size categories. In companies with more than 250 employees, the share of offshoring firms dropped by 9 percentage points, compared to 2 percentage points for firms with 50–249 employees, and 5 percentage points for businesses with fewer than 50 employees. In relative terms, the sharpest cutback can be observed in small companies with fewer than 50 employees: a relative drop of 38% (from 13% to 8%) from the previous timeframe. This relative margin is lowest in medium-sized firms (50–249 employees) with a decline of 12% (from 24% to 21%).

Figure 5.3.3

Share of companies undertaking production relocation abroad, by company size



Source: European Manufacturing Survey 2006, 2009.

The analysis therefore shows that the decline in production relocation activities in the course of the economic crisis is observable for firms of all sizes, with a slight tendency to be higher among small and large firms. Particularly these companies seem to have been cautious about making sure that their existing production sites were utilised to sufficient capacity during the 2008/09 economic crisis. In large companies, this strategy can be explained by the offshore locations that already existed in various countries, which offered opportunities to produce in low-wage countries or close to foreign customers in the main markets, if required. In small companies their size restrictions might have them reluctant to split up production further in times of declining sales. Medium-sized companies seem to have been 'sandwiched' in between, so that some of them still sought additional opportunities for low-cost or in-market production, even when global sales were significantly down.

5.3.3 Production offshoring by sector

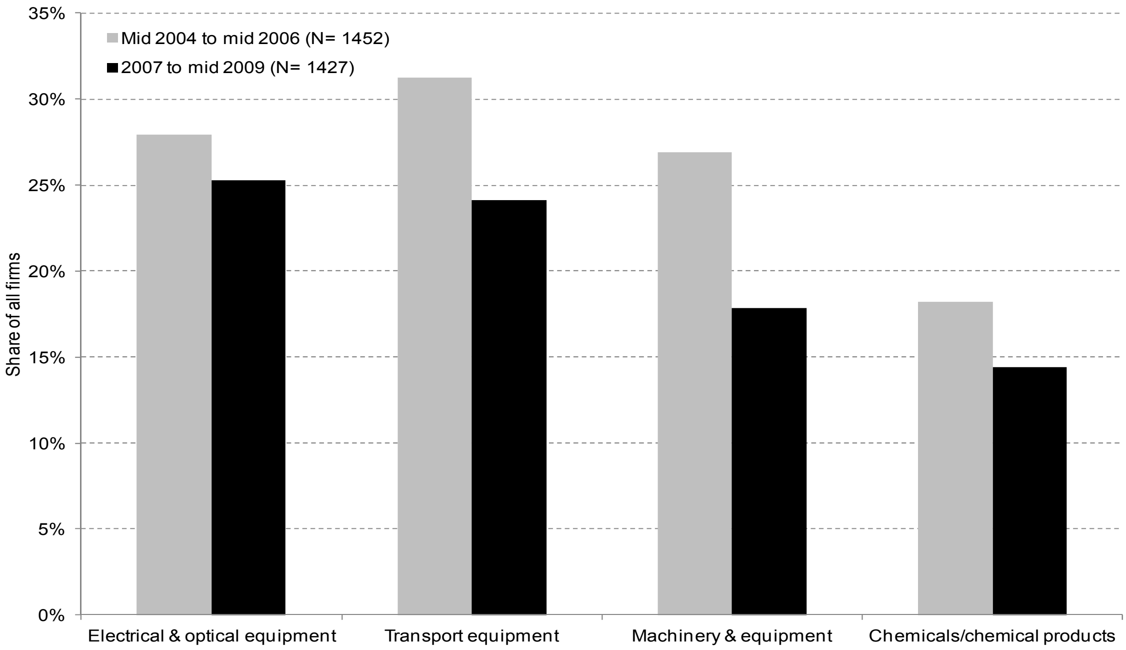
A differentiation by industry reveals sector-specific differences in relocation behaviour (Figure 5.3.4). Enterprises in the electrical and optical equipment industry (25%) and automotive and transport equipment manufacturers and their suppliers (24%) are particularly active in production relocations, ranking first and second. Following in third and fourth place, respectively, machinery and equipment manufacturers (18%) and the chemical industry (14%) tend to have had a markedly lower propensity for production relocation activities from 2007 to the middle of 2009. Reasons for the sector-specific offshoring levels are discussed in the following paragraphs, which also look at the dynamics over time.

Compared to the relocation level in the previous observation period – from mid-2004 to mid-2006 – particularly significant falls of around 9 percentage points and 7 percentage points can be observed in the machinery and equipment and the transport equipment industries, respectively. These dynamics equal high relative drops of 34% and 23%, respectively, in these sectors from their previous offshoring levels. The strong decline in orders and sales in 2008/09 seems to have had a dampening effect on production relocations abroad, in particular in the mechanical engineering industry and among automotive manufacturers, including their suppliers.

In the chemical industry, the decline of companies' offshoring activities was rather moderate in absolute terms (minus 4 percentage points). But compared to the relatively low offshoring level in the previous period (18%) this still equates to a relative drop of 21%. Due to the high capital intensity, a high degree of process integration and low labour intensity of its production processes, the chemical industry has traditionally been quite reserved in its production relocation strategies. At the dawn of the 2008/09 economic crisis, companies in the chemical sector seem to have been in particular focused on keeping and utilising their existing production capacities at their home bases.

Figure 5.3.4

Share of companies undertaking production relocation abroad, by sector



Source: European Manufacturing Survey 2006, 2009.

By contrast, a relatively small decrease (3 percentage points) in propensity to relocate can be observed in the electrical and optical industry. Here, competitive and cost pressures due to manufacturing processes characterised by medium-complex products, medium batch sizes and a relatively high labour intensity, along with strong foreign competition, appear to be so strong that, even with sales expectations significantly down, companies still looked for opportunities to save with production in low-wage countries.

Box 5.3.1

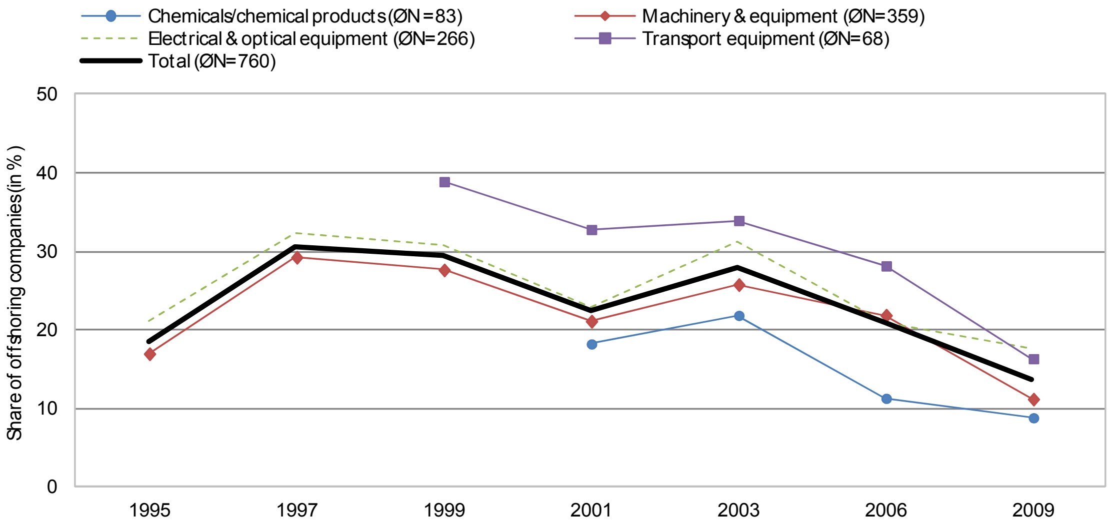
Changes in offshoring in the German manufacturing sector in the long run

The German dataset of the European Manufacturing Survey (EMS) allows a detailed look at the development of offshoring since 1995. In each survey those companies surveyed were asked if they had relocated production activities abroad in the previous two years. Data for the two sectors ‘machinery and equipment’ and ‘electrical and optical equipment’ are available back to 1995. Data for the transport equipment sector is available from 1999. Data for manufacturers of chemicals and chemical products are available from 2001. In Figure 5.3.5 below, the black line labelled ‘Total’ represents the average for all sectors surveyed in the respective time frame. In a strict sense, this line is not comparable for the different datasets from before 1999, in 1999 itself and for 2001 and after, as the datasets each represent a different scope of surveyed sectors. But because the vast majority of respondent companies belong to the two sectors ‘machinery and equipment’ and ‘electrical and optical equipment’ (which both date back to 1995), the addition of the other two sectors (which have smaller numbers of respondent companies) does not change the overall picture significantly. The average number of firms reporting offshoring over the period surveyed is reported in brackets in Figure 5.3.5.

Overall it can be seen that offshoring developed largely parallel in the different sectors of the German manufacturing industry. In years when the number of offshoring firms went down, this pattern could be observed in all sectors surveyed. Conversely, in years when the offshoring intensity rose, it did so across the sectors. No significant sectoral front-runner behaviour, catching-up processes or leapfrogging can be observed in offshoring intensity. Over all sectors surveyed, there was a decline in the intensity of production offshoring from the end of the 1990s' with an upswing in the survey period 2003, due to the imminent enlargement of the EU in Central and Eastern Europe. Since then, the share of offshoring firms in the surveyed sectors of German manufacturing industry has gone down from almost 30% to less than 15% in 2009. Within six years, the production offshoring frequency of those German manufacturing sectors surveyed was thus halved. The dominant pattern behind the 'parallel waves' is the development of the whole German manufacturing economy. Whenever Germany went through hard times with regard to economic growth (end of the 1990s and after reunion, from 2001 to 2003) the relocation intensity of German manufacturing rose to make more intensive use of cost-reduction potentials in low-wage countries. Whenever the German economy was growing well (reunion at the start of the new century and from 2004 to 2007), there was less production offshoring by German manufacturing companies. The only significant exception to this pattern was the global economic crisis of 2008/09, when German companies reduced their offshoring activities in order to make better use of capacity at their existing home plants.

Figure 5.3.5

Time series analysis of the share of companies that offshored production activities in selected German manufacturing sectors



Source: German Manufacturing Survey 1995, 1997, 1999, 2001, 2003, 2006, 2009.

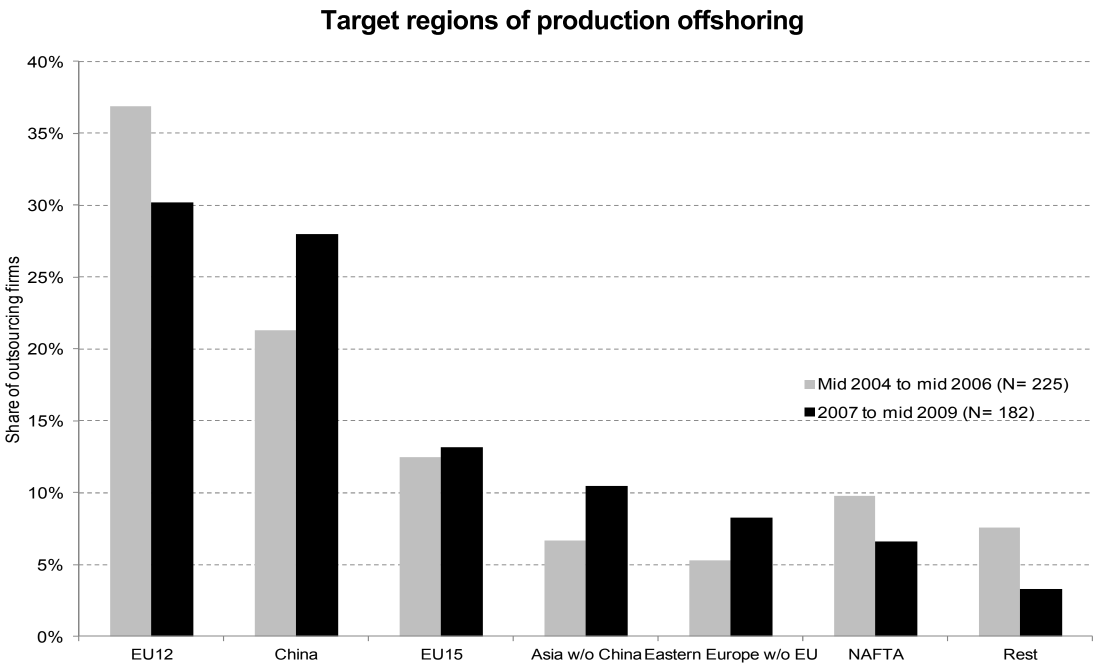
There is also a stable picture of which sectors make more intensive use of production offshoring activities. Since 1999, the transport equipment sector has shown the highest offshoring intensity. By contrast, manufacturers of chemicals and chemical products are – across all the periods surveyed – most reluctant to undertake offshoring. The only 'small' exception to this parallel pattern is the electrical and optical equipment industry, which declined least in offshoring intensity after 2006 and became the most offshoring-intensive sector in 2009 for the first time (albeit by only 1 percentage point ahead of the transport equipment sector). But over all the surveyed years, the transport equipment sector can be regarded as the most offshoring-intensive sector, followed by the electrical and optical equipment industry, the machinery and equipment industry, and finally the chemical industry.

5.4 *Target regions of production offshoring*

5.4.1 General trends in production offshoring destinations

According to the data, in the recent period (from 2007 to mid-2009) the EU-12 Member States remained the preferred target region for production relocations, accounting for 30% of all valid responses from the offshoring companies surveyed (Figure 5.4.1). Compared to the previous period (mid-2004 to mid-2006), this level dropped by 7 percentage points, or 18 per cent in relative terms. When the number of offshoring firms is related to all surveyed companies, including non-offshoring firms (Figure 5.4.2), it becomes obvious that the share of all surveyed companies that offshored production activities to the EU-12 dropped sharply, from 10% of all companies to 6% of all companies (37% in relative terms). One of the reasons for these new EU Member States becoming less attractive could be the sharp rise in wages in some industrial regions of Poland, the Czech Republic, Hungary and Slovakia in the period under survey, from mid-2004 to mid-2009.[44]

Figure 5.4.1



Note: The frequency of each location is related to all offshoring firms.

Source: European Manufacturing Survey 2006, 2009.

China is the second most attractive destination, with 28% of all valid responses. In contrast to the EU-12, China has become significantly more attractive – by 7 percentage points, compared to the previous period. Due to China's rising attractiveness, the total share of relocations to there among all companies surveyed stayed stable at 6%, despite the overall declining offshoring frequency.

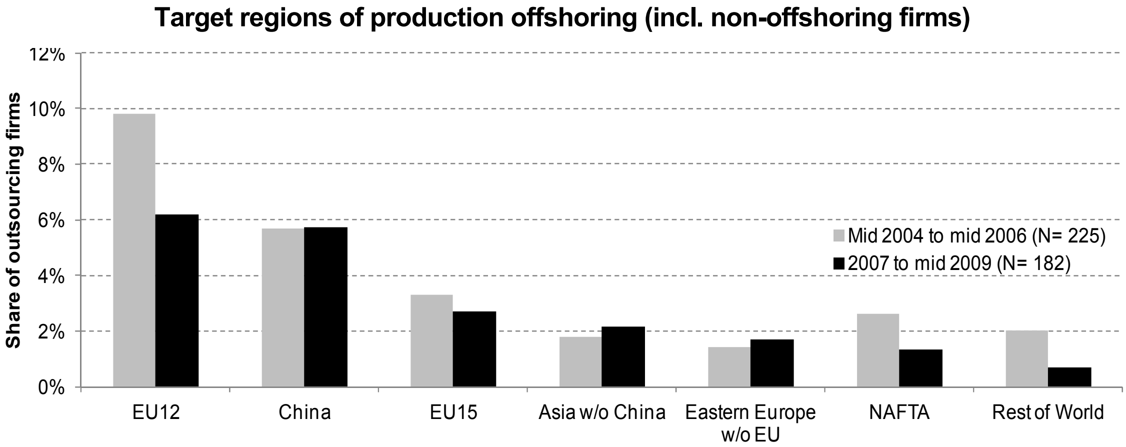
44 In Germany, 33% of all companies that backshored previously offshored production capacities to Germany between 2007 and mid-2009, offered increased labour costs as a driving motive (Kinkel and Maloca, 2010).

It is notable that in particular small and medium-sized companies intensified relocation to China (from 6% to 15% and from 20 to 33%, respectively, of their offshoring activities), while the relocation level of large firms (with 250 and more employees) to China remained stable at 27%. China is no longer an attractive relocation destination just for large companies, but increasingly also for small and medium-sized enterprises (SMEs).

Relocations to the EU-15 Member States remained stable at around 13% of all offshoring firms. The EU-15 countries are still the third most attractive region for relocations of European manufacturing companies.

Ranked fourth and fifth, the other Asian countries (10%) and non-EU Eastern Europe (8%) have both become more attractive, showing an increase of 3 percentage points each. When the number of offshoring firms is related to all companies surveyed (including non-offshoring ones), it becomes obvious that these countries were the only ones with an absolute increase in inward relocation activities by European companies surveyed, compared to the previous period (mid-2004 – mid-2006), before the economic recession.

Figure 5.4.2



Note: The frequency of each location is related to all offshoring and non-offshoring firms.

Source: European Manufacturing Survey 2006, 2009.

Compared to the relocation intensity of the previous period, the NAFTA region and other regions around the world play a less important role. Relocations to NAFTA dropped by 3 percentage points (to 7%), while other regions around the world dropped by 5 percentage points (to 3%). The reduced attractiveness of the NAFTA countries at the start of the 2008/09 economic crisis can be explained by reduced sales, particularly in the USA, which was hit first by the effects of the financial crisis on the 'real economy'.

Overall, based on the increased relative importance of Asian countries and China, as well as the EU-12 countries becoming less attractive, it can be concluded that companies more often prefer *farshoring* to Asian countries and less often *nearshoring* to the closer EU-12 countries. As a result, *intra-EU-27* production relocations decreased in relative terms from 49% to 43% of all target countries, whereas *extra-EU-27* relocation activities gained in relative terms – from 51% to 57%. If the number of offshoring firms is related to all surveyed companies, including non-offshoring ones, the decline in the *intra-EU-27* production relocations of 4 percentage points (from 13% of all surveyed companies in the period from mid-2004 to mid-2006 to 9% in the period from 2007 to mid-2009) was twice as large as the decline in the *extra-EU-27* relocations of 2 percentage points (from 14% to 12% of all surveyed companies).

5.4.2 Patterns of target regions by offshoring country, company size and industry sector

Beyond these findings at the aggregate level, further common patterns, as well as disparities of preferred target regions by offshoring countries, company size and industry sectors, have been identified.

5.4.2.1 By offshoring countries

Detailed analyses show that relocation activities by Austrian companies show different patterns compared to enterprises based in other European countries surveyed. Austrian companies are, in particular, more strongly focused on the EU-12 countries than are firms from other countries. With a level of 60% between 2007 and the middle of 2009, Austrian firms' offshoring activities to the EU-12 remained considerably above the average of all surveyed countries (30%) – despite a slight decline of 3 percentage points compared to the previous period. The reasons for this behaviour can be found in different inter-linkages between Austria and the EU-12 countries, in terms of geographical and cultural proximity, as well as a long experience of many Austrian firms in doing business in that region. Moreover, FDI is an important driver of these patterns.

In opposition to the general trend of an increasing share of relocation activities targeting Asia and China, enterprises from the Netherlands, Slovenia and Croatia have considerably reduced their activities in this region since the previous period. While the share of relocations from the Netherlands fell for both Asia (21 percentage points, to 29%) and China (13 percentage points, to 29%), the share of relocations to Eastern Europe rose significantly – from 0% to 14% in 2009. Similar behaviour is recognisable for Slovenian and Croatian companies: offshoring activities targeting Asia decreased by over 13 percentage points (to 25%) between the earlier and the later period, while relocations to Eastern Europe rose by 25 percentage points (to 63%).

Some reasons for this against-the-trend 'turning' from the *farshore* Asian countries to the more *nearshore* Eastern European countries might lie in the specific motivation patterns of companies from the Netherlands and Slovenia/Croatia. In Dutch companies, proximity to customers (12%) and expansion of markets (15%) rank significantly lower as relocation motives than in other countries, and had lost in significance since the previous survey period (by 9 percentage points and 11 percentage points, respectively; cf. Section 5.5). With the relative rise in cost-related motives compared to customer and market-oriented motives among Dutch companies, the offshoring trend away from Asia and towards the EU-12 could be explained, at least partially. For Slovenian and Croatian companies, however, the expansion of markets (64%) and proximity to customers (55%) are far more important as offshoring motives than in other countries. Thus, firms from these countries seem to intend to improve their customer and market-access potentials in the EU-12 through relocation activities targeted there.

On the contrary, companies from Spain, Denmark and Switzerland are ‘going with the trend’ and have performed above-average relocations to Asia. In these countries, almost every second offshoring activity was targeted at Asia between 2007 and the middle of 2009.

A first group of Asian-oriented relocation strategies includes Spanish companies, which are offshoring exclusively to China. Compared to the previous period, the share of Spanish offshoring activities to China increased considerably – by over 36 percentage points to 50%. This high growth in the Spanish offshoring share to China and a 17 percentage point increase in the NAFTA region in the same timeframe have mainly been at the expense of decreasing production relocations to the EU-12 (26 percentage points less), Eastern Europe and the Rest of the World (each 14 percentage points less).

The second group of Asian-oriented countries is offshoring primarily to China. Examples include Denmark, with 37%, and Germany, with 28% of production relocation activities targeting China. These countries are offshoring eight out of ten relocation activities in Asia at China, whereas the remaining two out of ten relocation activities are targeted at other Asian countries.

A third group of countries has increasingly started to shift offshoring activities towards Asian countries other than China. However, offshoring shares to China have basically remained unchanged in relation to the previous period. Examples of this group include Austria and Switzerland. The share of Austrian relocation activities targeting other Asian countries rose significantly (10 percentage points) while Swiss relocation activities rose by over 17 percentage points in the surveyed timeframe. For both Austria and Switzerland, the figure for offshoring activities towards Asian countries other than China accounts for nearly 50% of total relocation activities to the Asian region.

5.4.2.2 By company size

Compared to the previous period (mid-2004 to mid-2006), the share of small enterprises (with fewer than 50 employees) relocating to the EU-27 and EU-12 remained virtually unchanged. With 69% of all relocation activities targeting the EU-27, including 42% targeting the EU-12, small enterprises rank significantly above the average, in relation to their medium-sized and larger counterparts. But the figures for relocation to Asia and China paint a different picture: small enterprises show significantly below-average shares – with 23% to Asia and 15% to China. Taken as a whole, these findings can be construed as *favouring nearshore over farshore* relocations.

This behaviour is in line with learning-based explanation models of internationalisation processes, assuming that especially SMEs internationalise like 'rings in water' (Johanson and Vahlne, 1977; 1990). In particular, at times of high uncertainty – as at the start of the 2008/09 economic crisis – small firms with a lack of dedicated planning resources tend to concentrate their activities in culturally and physically 'close' countries. Such nearshore activities are assumed to be less risky and less complex, as well as more predictable, understandable and manageable in the first place.

A detailed analysis of relocation activities towards China shows that larger enterprises (250 employees and more) have not followed the overall growing trend and remain static at 27%. Instead, offshoring to other Asian countries has become more important for large companies, increasing by over 7 percentage points to 14%. By contrast, in the same timeframe (2007 to mid-2009), SMEs' offshoring to Asia rose – largely to China. China's share among offshoring firms is around seven out of ten for small enterprises and as high as nine out of ten for medium-sized enterprises. The reasons for this development might lie in the first-mover ability of larger enterprises to build up and develop advanced strategies to exploit labour cost advantages in other Asian countries – as well as a higher importance of market expansion and proximity to key customers as offshoring motivations (see Section 5.5).

Further findings show that medium-sized enterprises (50–250 employees) seem to have adapted their regional offshoring habits – from being quite similar to those of small enterprises in the earlier period, to being closer to the strategies of larger corporations in the later period. Their relocation activities to the EU-12 dropped significantly – from 41% in the earlier period to 30% in the period from 2007 to mid-2009. In parallel, medium-sized companies performed an increasing share of production relocations to Asia, especially China. This could well be related either to stronger global competition and associated higher cost pressure or to a higher motivation to get closer to key customers.

5.4.2.3 By industry sector

Differentiating target regions by industry reveals several sector-specific differences, as well as similarities in relocation behaviour. The analysis clearly shows that *manufacturers of chemical products* are still relocating at an above-average rate to Western Europe (EU-15). Despite a slight decrease of 5 percentage points (to 35%) in the timeframe from 2007 to mid-2009, relocations targeting the EU-15 remained at a significantly higher level than in other industries (around 10%). By contrast, although chemical companies' relocations to the EU-12 increased by 5 percentage points (15%), a significant gap remains relative to other industries (25% to 40% of relocations to the EU-12). A comparatively high capital intensity and low labour intensity, as well as a higher relevance of proximity to previously offshored production facilities (see Section 5.5) seem to lead to differentiated production relocation strategies on the part of chemical firms. Their focus lies on utilising existing capacities at their home bases, particularly in Western Europe, while growing Asian demand seems increasingly be served by local Chinese production.

The general trend of reduced offshoring activities towards the EU-12 (see Section 5.4.1) is, to a large extent, directly attributable to the fact that production relocations by *manufacturers of electrical and optical equipment* to this region declined significantly, by 12 percentage points (to 25%) in the later period. Additionally, electrical and optical equipment manufacturers increased their relocation activities towards Asian countries other than China by 8 percentage points, to 16% in the surveyed period from 2007 to mid-2009, while their relocation share to China remained almost stable. In contrast, the gains of the other surveyed sectors in Asia can be exclusively attributed to rising offshoring activities in China. The strong foreign competition and the relatively high labour intensity of the European electrical and optical industry can be used to explain this trend of an onward shift in production relocation activities. In terms of offshoring decisions, even regions with already lower labour costs than in Western Europe (EU-15), such as the EU-12 and China, seem increasingly to be competing with countries with even lower labour costs, such as other Asian countries or Eastern Europe.

Offshoring activities conducted by *manufacturers of transport equipment* show significant increases in Eastern European countries (13 percentage points) and China (16 percentage points) – both to 20%. These figures, combined with decreases of 9 percentage points in NAFTA and 20 percentage points in the Rest of the World, account for the highest shift in target destinations for relocation activities by any industry surveyed. The transport equipment industry seems to have shifted its focus on prospective high-growing markets, based on the rising relevance of specific motives (proximity to important customers, labour costs) discussed in the following section.

5.5 Main motives for production offshoring

5.5.1 Overall relevance of motives for production offshoring

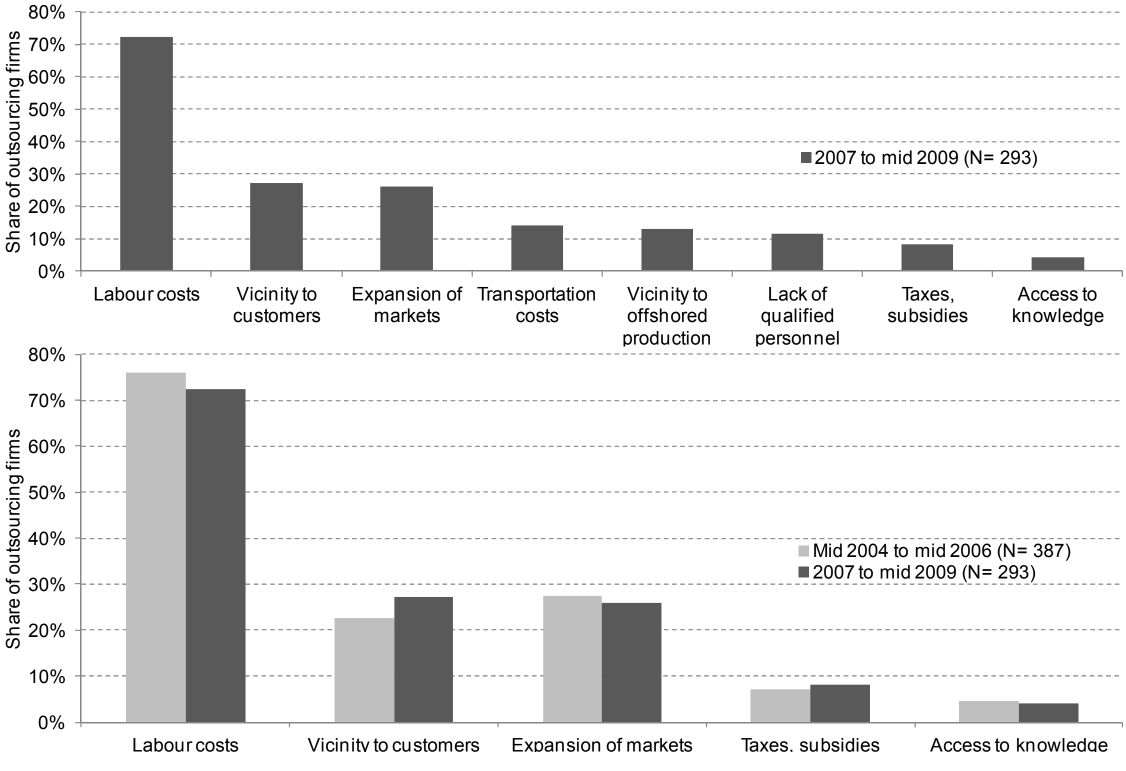
According to the data, cost reduction is the dominant motive for relocating production activities abroad. Labour costs are stated as the most frequent factor triggering relocation activities – offered by 72% of offshoring companies. Compared to the previous survey, this factor has decreased slightly, by 4 percentage points (but this is not statistically significant) (Figure 5.5.1).

The least relevant motives for production offshoring are a better access to knowledge and taxes and subsidies in the target country. Hence, policy measures to attract foreign-owned production activities with subsidies do not seem to be a very promising strategy. It has been shown that in most cases it is not a single factor – despite the paramount importance of labour cost savings – but a whole bundle of motives that makes locations attractive. This is clearly indicated by the high number of multiple answers as shown in Figure 5.5.1.

In second and third place for relocation motives, with around 27% of nominations, are customer and market-oriented motives. Compared to the previous survey (before 2007), the proximity of the production location to key customers abroad has gained in importance (4 percentage points), while the expansion of markets in the destination country has stagnated. In this context, it should be noted that the motive of proximity to key customers reflects not only proactive strategies on the part of the companies, but suppliers are often requested directly by major customers with production sites abroad to produce close to them.

Figure 5.5.1

Main motives for production relocations



Note: Multiple answers allowed.

Source: European Manufacturing Survey 2006, 2009.

More or less equally important – with around 13% of responses – are transportation costs, proximity to already relocated production capacities, and lack of qualified personnel at current company locations. These three motives could not be measured in the previous survey. Transportation costs are particularly a motive for relocation when the customers in the destination country or in bridge markets are supplied directly by the foreign production site. For the offshoring mode of an 'extended workbench', with a high level of re-imports to the home country or to European markets, transportation costs might even be a negative factor.

The relevance of a lack of qualified personnel for production relocations abroad is also rather low. It appears that the growing shortage of qualified personnel in some specialities in Europe has not yet had a major impact on the production relocation decisions of manufacturing companies. But it should be noted that this appraisal was made at the start of the 2008/09 economic crisis, when lack of qualified personnel was not the most pressing problem, due to rapidly dropping sales. In times of greater economic prosperity in Europe, this factor might become (again) more relevant, due to the demographic change in many European countries.

Further motives like taxes, duties and subsidies (8%) and access to knowledge (4%) have seen a modest increase or decrease (by 1 percentage point) compared to the previous period and continue to have a minor impact on whether production is offshored or not. This is good news for European and national fiscal policy, as tax conditions do not seem to be a major driving factor in companies' production offshoring activities.

5.5.2 Specific advantages of offshoring destinations

Some motives for production relocations are closely related to the target countries of these activities. The relationship between motives and offshoring destinations may therefore help to understand the specific advantages of various offshoring locations. To identify and relate bundles of motives to the target countries, a probit regression model is estimated, given as

$$Y^{*} = X'\beta + \varepsilon$$

where Y^{*} can be viewed as an indicator for whether the latent dependent variable Y – the probability to offshore – is positive

$$Y = 1_{\{Y^{*}>0\}} = \begin{cases} 1 \text{ if } Y^{*} > 0 \text{ i.e. } X'\beta + \varepsilon > 0 \\ 0 \qquad\qquad\qquad \text{otherwise} \end{cases}$$

with X' denoting the vector of binary explanatory variables and β being the parameter reflecting the marginal effect of a discrete change in the probability to offshore for the explanatory variables. ε is the error term, which is assumed to be of zero mean and with a standard deviation of σ^2.

This probit model relates the motives for offshoring activities as explanatory variables X' at the firm level with the dependent variable 'probability of offshoring production activities by region of destination' *Y* reflecting the decision of this firm to offshore to a specific target region in the periods from mid-2004 to mid-2006 and from 2007 to mid-2009. The possible reasons for production offshoring are labour costs, expansion of markets, proximity to important customers, access to knowledge, taxes, levies and subsidies, lack of qualified personnel, transportation costs, and proximity to offshored production. Marginal effects at the mean of the independent variables (sample means) are reported. Table 5.5.1 lists the significance levels and the resulting marginal effects.

The results show significant patterns between destination countries and different motives. When companies strive to reduce *labour costs* via relocation of production activities abroad, the EU-12, China and other Asian countries are significantly preferred target regions. If the cost motive is present, the probability that a firm offshores production to the EU-12 increases by 27%. Offshoring to Eastern Europe, the EU-15 Member States and to countries from the Rest of the World also shows a significant and positive correlation with the cost motive, but the coefficients are very small (below 0.03), so that the relationship is weak.

The main difference between Asian countries and the EU-12 with respect to the motives, however, is that the labour cost motive is paired with market expansion motives in the case of Asian countries, but not in the case of the EU-12. The market expansion and proximity to customers motives increase the probability of offshoring to Asia by 5% and 2%, but decrease the probability of offshoring to the EU-12 and EU-15 countries.

The fact that the markets in the EU-12 and Eastern Europe can more easily be supplied with exports from the home country might account for the lack of market and customer incentives in these countries. In addition, the negative coefficient of the EU-12 countries for market expansion motives might be explained by their rapidly shrinking market prospects at the start of the 2008/09 economic crisis.

The EU-15 Member States also show a weak positive correlation with the reduction in transportation costs as a major offshoring motive; in combination with even tight labour cost advantages of some EU-15 countries, this might add up to an attractive *total cost* position for relocating production capacities there instead of serving these countries via exports.

The target locations of Western Europe and North America are named as sources of access to new knowledge slightly more often than are other countries. This might serve as an indicator that technological competences for (basic) innovations and new product and process development (NPPD) are still predominantly located in Western Europe and North American company sites. By contrast, the negative (but not significant) coefficients of Asian and Chinese destinations might be triggered by a sense on the part of companies that access to and protection of knowledge in these countries is not easy to organise.

5.6 Characteristics of offshoring firms

In the following, the characteristics of offshoring firms are further investigated using a multivariate analysis. This will help to give a better understanding of which firms offshore and which do not. The analysis reports the strength of the relationship between the explanatory variables reflecting the characteristics of offshoring firms and the dependent variable, which is a firm's probability of offshoring. The results show how a change in an individual explanatory variable triggers a change in the dependent variable. In particular, this analysis gives insight into how innovation and the technological capabilities of firms vary between offshoring and non-offshoring firms and into the relationship between offshoring and innovation as one important source for the competitiveness of firms.

A probit regression model is estimated to analyse the linkages between firm characteristics and the manufacturing firm's probability of offshoring production activities. As before, the probit model is given as

$$Y^* = X'\beta + \varepsilon$$

where Y^* can be viewed as an indicator for whether the latent dependent variable *Y* – the probability of offshoring – is positive

$$Y = 1_{\{Y^*>0\}} = \begin{cases} 1 \text{ if } Y^* > 0 \text{ i.e. } X'\beta + \varepsilon > 0 \\ 0 \qquad\qquad\qquad \text{otherwise} \end{cases}$$

with *X'* denoting the vector of binary explanatory variables and *β* being the parameter reflecting the marginal effect of a discrete change in the probability to offshore for the explanatory variables. ε is the error term, which is assumed to be of zero mean and with a standard deviation of σ^2. This probit model relates firm characteristics on the offshoring decision as explanatory variables *X'* at the firm level with the dependent variable 'probability of offshoring production activities' *Y* reflecting the decision of this firm to offshore to a specific target region in the periods from 2003 to 2006 and from 2007 to 2009. The explanatory variables account for firm characteristics, notably productivity, R&D and innovation efforts and outcomes, export orientation, the requirements of the product development process, the batch size (i.e. the average number of similar products produced in one batch) and complexity of the products and the position in the supply chain (whether the firm is a supplier to other firms or not). Given that the previous results also suggested that the decision to offshore depends on firm size, its sector affiliation and its home country, these determinants are included as control variables in the model. A dummy variable is introduced to control for the year, e.g. whether the production activity was offshored from mid-2007 to mid-2009 or in the period before (2003 to 2006). A negative marginal effect is expected here, since a declining share of offshoring firms is observed, as described above. Again, marginal effects at the mean of the independent variables (sample means) are reported. The coefficients report the change in the probability of offshoring in each explanatory, continuous variable and a discrete change in the probability to offshore for binary variables.

See Table B.5.6.1 in the appendix for a detailed description of the variables applied. The aim of the probit regression is to assess the relationship between specific firm characteristics as explanatory variables on the offshoring decision as a dependent variable, allowing for a differentiation of offshoring firms from those not having offshored in the periods from 2003 to 2006 and from 2007 to 2009.

The results of the probit regression first confirm a positive relationship between *firm size*, *revenue per employee* (which may be regarded as a measure of labour productivity) and offshoring, holding all other factors constant. Moreover, there is a positive and significant, although very small, relationship between *exports* and offshoring. This is in line with the literature on foreign direct investment, which stresses the fact that large and more productive firms choose to go abroad and points to complementarities between exports and FDI (Markusen, 2002). Firms that are suppliers to other firms have a lower propensity to offshore than firms that predominantly supply to final demand, which is not surprising given the fact that suppliers may follow their customers abroad with production activities.

Innovation efforts of the firm are captured by R&D intensity, as well as innovation outcomes. An increase in a firm's R&D expenditure as a share of turnover is associated with a significantly lower probability of offshoring production activities, though the coefficient is very small. Innovation output of a firm, as reflected by new products introduced within the last three years, exhibits a positive relationship with the probability of offshoring. A firm that has introduced a new product to the firm within the last three years shows a 5% higher probability of offshoring than a firm without a product innovation. This result points to the fact that offshoring is not only a passive reaction to rising wage costs, but has to be seen in the wider context of the international expansion of firms.

Moreover, a relationship between offshoring and the characteristics of the production process of the firm can be observed. As far as the batch size (the average number of similar products produced in one batch) is concerned, single-unit production exhibits a lower marginal effect on offshoring than medium batch production. Large batch production, on the other hand, seems to positively influence the probability of offshoring, though the effect is rather small. It is not only the big batch that is offshored, but also the simple products and products developed for a standard programme: the product complexity influences the probability of offshoring, insofar as complex products have a negative impact on the offshoring probability. In detail, the probability to offshore decreases by 5% if the firm produces complex products as opposed to medium-complex products. The offshoring probability also increases by 6% if the firm develops products for a standard programme, as opposed to development according to customers' specifications. Complex products and individual development processes require skilled staff and several different service inputs, which are better available at home than in emerging markets. Firms with simple products are more likely to offshore than are firms with medium-complex products, though this relationship is not significant. For these types of products, offshoring might be attractive due to lower labour costs in the destination region, which are mainly emerging markets. Lower labour costs, which are the most frequently mentioned motive for offshoring, then lead to improvements in the firm’s productivity measures. Overall, this implies that firms specialise in rather individual and sophisticated production activities with small and medium batch sizes produced at home. The relocation of ‘standardised’ production of simple products and production processes characterised by large batch sizes allows the home-base plants to concentrate on rather complex production processes and products, thus increasing the revenue per employee.

The results clearly show that there is a strong relationship between a firm’s size and sector affiliation and the probability that it will offshore production abroad. Not surprising, the probability of offshoring increases with the size of the firm. Firms that belong to the machinery and equipment, electrical and optical equipment and transport equipment sectors reveal higher probabilities of offshoring than those in the chemicals and chemical products sector.

Table 5.5.1

Probit regression results for destination region, by reasons for offshoring, 2006 and 2009

Production relocation: Reasons	**Marginal effects**						
	Asia	**China only**	**EU-15**	**EU-12**	**North America**	**Eastern Europe**	**ROW**
Labour costs	0.150 ***	0.114 ***	0.026 ***	0.268 ***	-0.004 ***	0.032 ***	0.013 ***
Expansion of markets	0.049 ***	0.040 ***	-0.012 *	-0.010 ***	0.021 ***	0.004	0.006
Proximity to important customers	0.020 **	0.012 **	0.000	-0.003	0.088 ***	0.003	0.006
Access to knowledge	-0.009	-0.010 *	0.054 **	0.001	0.023 **		0.029 **
Taxes, levies, subsidies	-0.007	-0.006	0.007	0.012	0.031 ***	0.008	0.009
Lack of qualified personnel	0.003	0.000	0.027	-0.002	0.005	0.010	
Transportation costs	0.027 *	0.009	0.065 **	-0.007	-0.003 *		0.015 *
Proximity to offshored production	0.000	-0.002	0.001	0.002	0.019 **	0.000	0.000

Note: (*) dF/dx is for discrete change of dummy variable from 0 to 1. The independent variables reflect the answers to the question in the EMS of 2006 and 2009: 'Has your firm offshored parts of production or parts of R&D to foreign locations or foreign companies or backshored them to your factory from abroad since 2007? How has this been organised? Please indicate the reasons.' Difference in means of the independent variables significantly diverge from zero, probability values of 10% (*), 5% (**) or 1% (***).

Source: European Manufacturing Survey 2006, 2009.

The probit results confirm that not only do sector and firm size do more to explain the probability of offshoring than a firm's characteristics, but so does the firm's home country. Being a Dutch, Danish or Swiss firm has a significant positive effect on offshoring (as compared to being a German firm). Being an Austrian, Finnish, Spanish or Slovenian/ Croatian firm makes no significant difference to the probability of offshoring than being a German one.

Table 5.6.1

Probit regression on the probability of being an offshoring firm, 2006–09

Propensity to offshore production	**Coefficient**	**Sig.**	**Std.err.**	**Coefficient**	**Sig.**	**Std.err.**
General						
Size (log function of number of employees)	0.101	***	0.007	0.094	***	0.007
log revenue per employee	0.041	***	0.015	0.050	***	0.016
Export share (% of turnover)	0.001	***	0.000	0.001	***	0.000
Intermediate supplier*	-0.037	*	0.019	-0.035	*	0.020
Innovation						
Share of R&D expenditure (% of turnover)	-0.004	**	0.002	-0.005	***	0.002
Product innovator (new to firm innovation)*	0.053	**	0.021	0.050	**	0.022
Share with product innovations (% of turnover)	-0.001	**	0.001	-0.001	*	0.001
Product complexity (a)						
Simple products*	0.035		0.037	0.040		0.038
Complex products*	-0.046	**	0.020	-0.044	**	0.020
Batch size (b)						
Single-unit production*	-0.020		0.022	-0.032		0.022
Large batch*	0.068	**	0.029	0.040		0.029
Product development (c)						
According to customers' specification*	-0.007		0.020	-0.009		0.020
Standard programme*	0.064	**	0.031	0.064	**	0.031
No product development*	-0.069		0.039	-0.088	***	0.038
Sector (d)						
Machinery and equipment*	0.169	***	0.037	0.161	***	0.037
Electrical and optical equipment*	0.224	***	0.039	0.216	***	0.039
Transport equipment*	0.178	***	0.055	0.154	***	0.056
Country (e)						
AT*	0.031		0.037			
CH*	0.064	***	0.025			
NL*	0.142	***	0.046			
DK*	0.088		0.072			
HR & SI*	-0.057		0.038			
FI*	0.033		0.074			
ES*	-0.033		0.046			
Product market regulation				-0.071		0.046
Sample Size	2,476			2,359		
Pseudo R2	0.1502			0.1416		

Note: (*) dF/dx is for discrete change of dummy variable from 0 to 1. Reference groups: [(a)] medium complexity, [(b)] medium batch, [(c)] basic programme with alternative, [(d)] chemicals and chemical products, [(e)] Germany. Difference in means of the independent variables significantly diverge from zero, probability values of 10% (*), 5% (**) or 1% (***).

Source: European Manufacturing Survey 2006, 2009

To test the relationship between regulation in the home country and offshoring, a variable that measures product market regulation (PMR) at the country level, proposed by the OECD (Wölfl et al., 2009), has been introduced into the regression. This variable captures various aspects of regulation, such as barriers to trade and investment, state control or barriers to entrepreneurship, in one single number for each country.[45] A rising value of PMR indicates a higher level of product market regulation in a country. Values for PMR are available for 1998, 2003 and 2008. The dataset for EMS 2006 has been extended with the values for 2003, the data for 2009 with the values for 2008. To avoid undesired effects from collinearity, country dummies are removed from the regression when the PMR variable is employed.

Table 5.6.2

Probit regression on the probability of being an offshoring firm, 2009

Propensity to offshore production	Coefficient	Sig.	Std.err.	Coefficient	Sig.	Std.err.
General						
Size (log function of number of employees)	0.066	***	0.011	0.063	***	0.011
log revenue per employee	0.011		0.019	0.006		0.020
Export rate	0.001	***	0.000	0.001	***	0.000
Intermediate supplier*	0.065	**	0.029	0.034		0.028
Experience (offshoring between 1999 and 2006)	0.430	***	0.038	0.437	***	0.038
Innovation						
Share of R&D expenditure (% of turnover)	-0.003		0.002	-0.003		0.002
Product innovator (new to firm innovation)*	0.021		0.030	0.019		0.031
Share with product innovations (% of turnover)	-0.001		0.001	-0.001		0.001
Product complexity (a)						
Simple products*	0.038		0.053	0.040		0.055
Complex products*	-0.015		0.026	-0.021		0.027
Batch size (b)						
Single-unit production*	-0.033		0.029	-0.033		0.029
Large batch*	-0.012		0.037	-0.034		0.035
Product development (c)						
According to customers' specification*	-0.037		0.026	-0.041		0.027
Standard programme*	0.015		0.038	0.000		0.037
No product development*	-0.028		0.055	-0.019		0.058
Sector (d)						
Machinery and equipment*	0.022		0.045	0.020		0.045
Electrical and optical equipment*	0.092	**	0.048	0.095	**	0.049
Transport equipment*	0.040		0.063	0.034		0.064
Country (e)						
AT*	-0.023		0.045			
CH*	0.118	***	0.041			
NL*	0.172	***	0.067			
DK*	0.089		0.074			
HR & SI*	-0.012		0.065			
FI*	0.193	**	0.113			
ES*	0.152	*	0.103			
Product market regulation				-0.373	***	0.094
Sample Size	1,169			1,121		
Pseudo R2	0.323			0.3165		

Note: (*) dF/dx is for discrete change of dummy variable from 0 to 1. Reference groups: (a) medium complexity, (b) medium batch, (c) basic programme with alternative, (d) chemicals and chemical products, (e) Germany. Difference in means of the independent variables significantly diverge from zero, probability values of 10% (*), 5% (**) or 1% (***).

Source: European Manufacturing Survey 2009.

45 The variable is not available for Croatia and Slovenia, which reduces the number of observations in the regression.

The results indicate that the level of PMR is not significantly related to the offshoring decision of firms. In other words, product market regulation, as captured by the PMR variable, is not a reason for firms to relocate production activities.

The model presented above is extended in Table 5.6.2 with a variable that captures the firm's previous experience with offshoring production activities in the period 1999 to 2006. This variable is only available for observations in the period 2007 to mid-2009.

The results for this extended model indicate that previous offshoring experience can explain offshoring today to a considerable degree: if a firm had experience of offshoring in the period 1999–2006, the probability of its offshoring in the period 2007 to mid-2009 increases by 45%. Furthermore, the firm's export share on turnover and its position as a supplier in the supply chain are positively related to the probability of its offshoring. This may indicate that intermediate suppliers – firms that supply other firms rather than final demand – have a special incentive to offshore, because they are required to follow their clients to locations abroad with production.

Another change can be observed for the role of product market regulation. The variable is highly significant for the period 2007 to mid-2009, which was not the case in the previous period. The relationship between product market regulation and offshoring, however, is not a positive one where high regulatory burdens may force firms to offshore; on the contrary, the relationship is inverse, which indicates that high regulatory burdens may rather act as an obstacle to offshoring. This may be explained by the inclusion of observations from Finland and Denmark, two countries with a high propensity for production offshoring, but low values for the product market regulation indicator.

5.7 Offshoring of support business functions

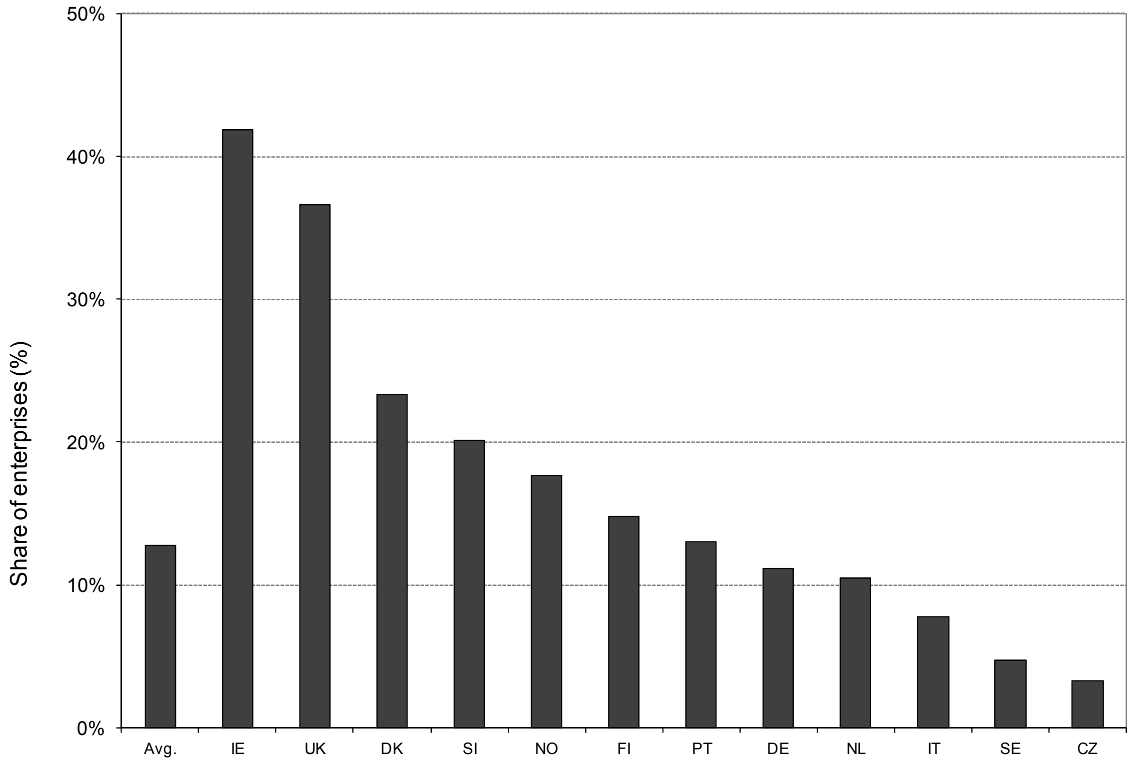
In addition to the analysis of offshoring of production activities in manufacturing, a closer look at the offshoring of *support business functions* provides further insights. Support business functions are required in order to enable or facilitate the production of the firm's main products. The output of the support business functions is usually not intended directly for the market. Eurostat's recently published results of the first large-scale survey of offshoring activities in 2001–06 in 13 European countries (Alajääskö, 2009) shed some light on the offshoring of support business functions in manufacturing and service sectors. The results refer to firms (with at least 100 employees) which carried out international offshoring activities during the period 2001–06. The data cover firms in 11 EU Member States (the Czech Republic, Denmark, Finland, Germany, Ireland, Italy, the Netherlands, Portugal, Slovenia, Sweden and the United Kingdom) and Norway.

Alajääskö (2009) distinguishes six types of support business functions: a) *distribution and logistics*, b) *marketing, sales and after-sales services*, c) *ICT services*, d) *administration and management*, e) *engineering and related technical services*, and f) r*esearch and development*. See Appendix A for a detailed list of activities included in each category.

Though manufacturing firms overall tend to offshore more frequently than service firms, this differential becomes smaller when looking at the offshoring of support functions (see Figure 5.7.1). Around 13% of all European manufacturing firms relocated support functions abroad. This is less than the share of firms that have relocated production activities to locations abroad. The share is highest in Ireland and the UK, and lowest in Sweden and the Czech Republic. Interestingly, knowledge-intensive business services (KIBS) as a specific part of the service sector tend to offshore support services more often than do manufacturing firms.

Figure 5.7.1

Offshoring support functions: Share of manufacturing enterprises having offshored support functions, by country (%), 2001–06



Source: Eurostat (2009).

However, there is a difference in the tendency to relocate distinct support functions, with *distribution*, *logistics*, *marketing* and *sales* being the most frequently offshored activities. In detail, 4% of the firms offshored each of distribution, logistics, marketing, sales or after-sales services; 3% of offshoring firms relocated ICT services and telecommunications; and another 3% administrative and management functions. Manufacturing firms tend to focus relocation activities rather on their core functions, with 17% offshoring their production, as compared to 13% relocating support functions.

It is important to point out that *knowledge-intensive support business functions* most closely related to the production process (engineering, as well as R&D) are less often sourced internationally by manufacturing firms than are other support business functions. In general, 2% of all firms sourced R&D functions and 3% engineering functions. The biggest share of R&D and engineering functions was offshored to the EU-27 (55% in both cases). The share of manufacturing firms having offshored R&D is higher than the share of service firms.

6. SUMMARY

This study provides an overview of the ongoing tendencies in the process of internationalising production, since 1995 and over the period of the recent crisis. As outlined in Section 2 there is no single approach that allows the many facets of this phenomenon to be captured at the various levels of aggregation: from single firm decisions to overall industry-level patterns and macroeconomic consequences. Therefore, various approaches have been used to analyse this internationalisation process and to highlight some of the main aspects. Based on the recently compiled world input-output tables from the WIOD project, ongoing trends in vertical specialisation patterns for the EU countries have been documented, as they relate to other major economies. Generally, one finds that, for the EU, the integration process since 1995 has considerably intensified the internationalisation of production within Europe – and the particular role the EU-12 countries play in this respect. But also the rise of China as a major partner is well documented. An important finding is that, in the initial phase of the ongoing crisis, there was a tendency to less integration, which manifested itself in the resurgence of domestic rather than foreign sourcing. (Importantly, the only foreign country that has continued to increase its share in the EU sourcing structures has been China.) Though this phenomenon of 'backshoring' might be caused by particular industries that have been most affected by the crisis, it might also be indicative of a rupture in the trend towards more offshoring and 'farshoring'. Albeit to varying degrees, the trends seem to be similar for all four sectors that have been studied in more detail.

The economic and financial crisis that broke in 2008 was accompanied by a great fall in foreign trade volumes; actually, the extent of trade collapse was greater than the decline in output. Thus international trade can be regarded as one of the great 'victims' of the world crisis. At the same time, it was also one of the channels through which the crisis was transmitted between countries. In summing up the empirical literature to date on the role of international production linkages in the trade crisis, it is clear that the results are not fully compatible; this can be attributed partly to the different approaches and different methodologies, datasets and time horizons used. However, it seems obvious that production chains in the first phase of the crisis had an amplifying effect in terms of the decrease in international trade (this is now referred to as the 'bullwhip effect'). On the other hand, there is a certain stabilising effect created by value chains, at least in the slightly longer run. This may be caused by the reversal of the bullwhip effect, as well as by the fact that companies inside the value chain helped each other (e.g. through providing trade finance). As for the changing role of the internationalisation of production due to the impact of the crisis: it is obvious that the internationalisation of production is here to stay, but consolidation tendencies are ubiquitous.

The more detailed analysis in Section 4 shows that the great trade collapse was digested quite differently in the major economies of the world. China's continued growth had a positive effect on other countries in the region, like Japan, whose exports recovered a lot faster than those of the US and the EU-27. But also the EU-27 and the US profited from the China effect, as exports to the country continued to rise even in the years of the crisis. Even more surprisingly, imports from China also rose for all major economies in this critical period. Firms maintained their sourcing connections with Chinese firms, while imports from almost all other major trading partners fell.

As regards particular industries, the chemical industry did fairly well during the crisis, with trade levels that dropped less than those of the other industries. By 2010, trade in the industry had already surpassed the levels of 2007 in the economies considered. 'Machinery' and 'Transport equipment' were worst hit by the crisis, as they produce above all larger capital and consumption goods, whose demand is more cyclical. Especially trade in aeroplanes, larger cars (>1500cc), small trucks and road tractors for semi-trailers decreased significantly all over the world.

The analysis by use category documents the fact that trade in parts and components and semi-finished products experienced a larger drop than trade in consumption goods. One line of argument that tries to explain this finding relates to the increase in the vertical specialisation of countries. As more and more countries get involved in the production process of a single good, trade declines 'not only by the value of the finished product, but also by the value of all the intermediate trade flows that went into creating it' (Yi, 2009). An additional explanation originates in the inventory management of firms. When faced with a demand shock, retailers not only reduce their orders by the amount of the demand shock, but also their inventory stocks. This effect is then aggravated, the further up the supply chain one moves – from retailer to manufacturer and provider of raw materials.

Finally the decomposition analysis of trade reveals that most of the changes in trade happened in the category of 'surviving varieties', products which were traded in both periods with the partner, i.e. on the intensive margin. Only the EU-12 countries, which are still further away from the technological frontier but are rapidly catching up in trade levels, exhibited notable shifts in their export markets during the crisis.

As outlined in the survey of literature in Section 2, the focus on industry-level data, using trade statistics or a combination of this plus detailed input-output tables, might hide aspects of this internationalisation process which can be seen only at the level of firms. Section 5 therefore investigated offshoring – the relocation of production activities to locations abroad – by European firms using a large firm-level dataset. It covers the periods mid-2004 to mid-2006 and 2007 to mid-2009.

The data indicate that the share of offshoring firms decreased across most countries, sectors and firm sizes between the periods 2004/06 and 2007/09. This may indicate that firms focus on the utilisation of their activities at home in times of (upcoming) economic crisis. However, there is also evidence from German data that the current decrease in offshoring intensity is part of a larger trend which started back in 2003. This is good news for politicians, who fear the negative effects that offshoring may have on domestic employment in Europe.

The main target regions of offshoring by European firms are the EU-12, China, the EU-15 and other Asian locations excluding China. Despite a general decrease in the share of offshoring firms, *farshoring* to Asia and China, in particular, has increased. By contrast, *nearshoring* to the EU-12 has become less attractive, though this is still the most important target region. An explanation for this shift may be an increase in labour costs in the EU-12, coupled with geographical proximity, which allows firms to serve these markets from their home countries.

The dominant motive for production offshoring is the wish to reduce labour costs, stated by nearly three-quarters of all offshoring firms, followed (at some considerable distance) by proximity to customers and market expansion. Expected labour cost reductions explain offshoring to the EU-12, Asia and China, in particular. However, in contrast to the EU-12, where the offshoring decision is dominated solely by potential labour cost savings, customer and market expansion motives are also significantly related to offshoring activities to Asia and China.

Firms that have offshored production activities are characterised by a larger firm size and greater revenue per employee, a standard programme of less complex products, but a higher probability of introducing new products to the market. The simple formula ‘the more innovation, the less offshoring’ therefore does not hold true in the light of the empirical results. Instead, the need for complex and individual solutions may be a significant ‘glue’ to keep manufacturing in Europe. Producers of electrical and optical equipment seem to be continually forced to look for cost-saving potentials abroad, as they have a higher and hardly unchanged propensity to offshore production than do firms in the other three sectors included. Previous experience of production offshoring goes a long way towards determining production offshoring today. Product market regulation does not seem to be a push factor for firms to offshore production activities abroad.

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Appendix Tables

Appendix Tables to Chapter 3.2

Table A.3.2.1

WIOD industry list

Nr.	Industry	Description
1	AtB	Agriculture, Hunting, Forestry and Fishing
2	C	Mining and Quarrying
3	15t16	Food, Beverages and Tobacco
4	17t18	Textiles and Textile Products
5	19	Leather, Leather and Footwear
6	20	Wood and Products of Wood and Cork
7	21t22	Pulp, Paper, Paper , Printing and Publishing
8	23	Coke, Refined Petroleum and Nuclear Fuel
9	24	Chemicals and Chemical Products
10	25	Rubber and Plastics
11	26	Other Non-Metallic Mineral
12	27t28	Basic Metals and Fabricated Metal
13	29	Machinery, Nec
14	30t33	Electrical and Optical Equipment
15	34t35	Transport Equipment
16	36t37	Manufacturing, Nec; Recycling
17	E	Electricity, Gas and Water Supply
18	F	Construction
19	50	Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel
20	51	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles
21	52	Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods
22	H	Hotels and Restaurants
23	60	Inland Transport
24	61	Water Transport
25	62	Air Transport
26	63	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies
27	64	Post and Telecommunications
28	J	Financial Intermediation
29	70	Real Estate Activities
30	71t74	Renting of Machinery and Equipment and Other Business Activities
31	L	Public Admin and Defence; Compulsory Social Security
32	M	Education
33	N	Health and Social Work
34	O	Other Community, Social and Personal Services
35	P	Private Households with Employed Persons

Table A.3.2.2

WIOD country list

Country	Group
AUS	ROW
AUT	EU-15
BEL	EU-15
BGR	EU-12
BRA	BRII
CAN	ROW
CHN	CHN
CYP	EU-12
CZE	EU-12
DEU	EU-15
DNK	EU-15
ESP	EU-15
EST	EU-12
FIN	EU-15
FRA	EU-15
GBR	EU-15
GRC	EU-15
HUN	EU-12
IDN	BRII
IND	BRII
IRL	EU-15
ITA	EU-15
JPN	JPN
KOR	KOR
LTU	EU-12
LUX	EU-15
LVA	EU-12
MEX	MEX
MLT	EU-12
NLD	EU-15
POL	EU-12
PRT	EU-15
ROU	EU-12
RUS	BRII
SVK	EU-12
SVN	EU-12
SWE	EU-15
TUR	ROW
TWN	ROW
USA	USA
ROW	ROW

Appendix Tables to Section 3.4

Table A.3.4.1

Linkages for chemicals (NACE 24, DG)

		Backward linkages					Forward linkages				
		1995	2000	2005	2007	2009	1995	2000	2005	2007	2009
EU-12	BRII	0.094	0.112	0.118	0.126	0.115	0.090	0.066	0.087	0.079	0.094
	CAN	0.003	0.005	0.006	0.006	0.004	0.006	0.007	0.009	0.007	0.008
	CHN	0.004	0.012	0.024	0.037	0.054	0.017	0.019	0.043	0.052	0.081
	EU-12	0.728	0.628	0.642	0.630	0.647	0.695	0.618	0.555	0.556	0.542
	EU-15	0.334	0.418	0.426	0.441	0.410	0.399	0.384	0.392	0.436	0.422
	JPN	0.012	0.016	0.014	0.014	0.012	0.019	0.016	0.018	0.017	0.017
	KOR	0.006	0.007	0.008	0.010	0.009	0.019	0.011	0.009	0.010	0.010
	MEX	0.001	0.002	0.002	0.002	0.002	0.003	0.005	0.006	0.006	0.005
	USA	0.029	0.045	0.033	0.033	0.032	0.062	0.076	0.079	0.069	0.052
	ROW	0.077	0.112	0.136	0.150	0.125	0.143	0.146	0.191	0.204	0.211
EU-15	BRII	0.020	0.024	0.033	0.041	0.036	0.039	0.040	0.048	0.055	0.061
	CAN	0.005	0.007	0.007	0.007	0.007	0.011	0.018	0.020	0.020	0.021
	CHN	0.006	0.014	0.022	0.033	0.050	0.023	0.041	0.071	0.094	0.154
	EU-12	0.012	0.014	0.020	0.026	0.027	0.034	0.044	0.060	0.073	0.071
	EU-15	0.854	0.871	0.879	0.886	0.895	0.822	0.719	0.664	0.651	0.594
	JPN	0.016	0.020	0.016	0.016	0.014	0.052	0.050	0.044	0.041	0.049
	KOR	0.004	0.006	0.007	0.008	0.006	0.018	0.019	0.023	0.025	0.023
	MEX	0.002	0.004	0.003	0.003	0.003	0.007	0.013	0.015	0.016	0.014
	USA	0.042	0.067	0.058	0.058	0.062	0.111	0.182	0.174	0.168	0.145
	ROW	0.073	0.107	0.127	0.146	0.133	0.183	0.177	0.210	0.229	0.240
JPN	BRII	0.011	0.014	0.026	0.036	0.030	0.020	0.015	0.021	0.028	0.025
	CAN	0.006	0.005	0.006	0.007	0.006	0.005	0.007	0.008	0.008	0.007
	CHN	0.007	0.015	0.038	0.059	0.066	0.040	0.077	0.174	0.256	0.324
	EU-12	0.001	0.001	0.002	0.003	0.003	0.002	0.003	0.007	0.009	0.008
	EU-15	0.041	0.046	0.069	0.081	0.077	0.052	0.060	0.074	0.087	0.067
	JPN	0.826	0.877	0.869	0.891	0.892	1.253	1.196	1.077	1.054	1.087
	KOR	0.009	0.012	0.018	0.021	0.014	0.042	0.045	0.076	0.089	0.077
	MEX	0.001	0.002	0.001	0.002	0.001	0.003	0.006	0.009	0.009	0.007
	USA	0.028	0.032	0.039	0.046	0.038	0.077	0.094	0.095	0.096	0.066
	ROW	0.054	0.082	0.168	0.222	0.179	0.113	0.110	0.144	0.169	0.149
USA	BRII	0.009	0.011	0.019	0.021	0.020	0.022	0.017	0.022	0.028	0.030
	CAN	0.029	0.036	0.046	0.045	0.038	0.043	0.057	0.055	0.052	0.050
	CHN	0.008	0.015	0.032	0.042	0.062	0.022	0.026	0.051	0.072	0.115
	EU-12	0.002	0.003	0.004	0.005	0.004	0.003	0.004	0.006	0.007	0.007
	EU-15	0.083	0.106	0.132	0.133	0.124	0.084	0.087	0.096	0.105	0.106
	JPN	0.032	0.028	0.024	0.021	0.018	0.046	0.032	0.030	0.030	0.031
	KOR	0.008	0.007	0.009	0.009	0.007	0.022	0.017	0.022	0.022	0.020
	MEX	0.009	0.013	0.015	0.014	0.012	0.028	0.046	0.046	0.047	0.043
	USA	0.791	0.817	0.794	0.766	0.697	0.968	0.873	0.789	0.783	0.670
	ROW	0.058	0.081	0.116	0.116	0.103	0.105	0.078	0.087	0.100	0.109

Source: WIOD; authors' calculations.

Table A.3.4.2

Linkages for machinery (NACE 29, DK)

		Backward linkages					Forward linkages				
		1995	2000	2005	2007	2009	1995	2000	2005	2007	2009
EU-12	BRII	0.053	0.046	0.050	0.056	0.038	0.036	0.030	0.044	0.049	0.050
	CAN	0.004	0.006	0.006	0.007	0.005	0.004	0.006	0.006	0.006	0.006
	CHN	0.006	0.017	0.040	0.072	0.095	0.007	0.009	0.028	0.048	0.077
	EU-12	0.770	0.667	0.685	0.659	0.713	0.584	0.353	0.263	0.230	0.267
	EU-15	0.398	0.502	0.552	0.596	0.486	0.273	0.359	0.428	0.448	0.415
	JPN	0.015	0.027	0.029	0.031	0.026	0.007	0.008	0.011	0.010	0.008
	KOR	0.007	0.009	0.015	0.021	0.021	0.004	0.005	0.008	0.012	0.013
	MEX	0.001	0.002	0.003	0.003	0.002	0.001	0.003	0.004	0.004	0.003
	USA	0.029	0.043	0.034	0.036	0.033	0.033	0.043	0.046	0.041	0.030
	ROW	0.058	0.095	0.126	0.143	0.100	0.065	0.080	0.108	0.124	0.127
EU-15	BRII	0.017	0.019	0.027	0.035	0.027	0.029	0.025	0.035	0.042	0.040
	CAN	0.006	0.007	0.006	0.008	0.006	0.007	0.011	0.009	0.008	0.008
	CHN	0.010	0.020	0.037	0.061	0.083	0.024	0.033	0.069	0.097	0.158
	EU-12	0.018	0.027	0.043	0.054	0.051	0.023	0.028	0.039	0.047	0.042
	EU-15	0.954	0.949	0.969	0.964	0.972	0.485	0.461	0.466	0.440	0.441
	JPN	0.025	0.031	0.023	0.025	0.021	0.015	0.016	0.015	0.014	0.012
	KOR	0.006	0.008	0.012	0.012	0.010	0.013	0.010	0.015	0.019	0.020
	MEX	0.002	0.004	0.003	0.004	0.003	0.003	0.005	0.005	0.005	0.004
	USA	0.040	0.054	0.039	0.041	0.038	0.059	0.076	0.068	0.060	0.045
	ROW	0.060	0.090	0.098	0.114	0.087	0.119	0.110	0.132	0.150	0.168
JPN	BRII	0.011	0.014	0.018	0.027	0.021	0.012	0.010	0.017	0.021	0.020
	CAN	0.005	0.004	0.005	0.006	0.004	0.004	0.007	0.006	0.006	0.005
	CHN	0.011	0.023	0.061	0.095	0.122	0.030	0.050	0.106	0.159	0.199
	EU-12	0.001	0.001	0.003	0.004	0.003	0.001	0.003	0.006	0.008	0.007
	EU-15	0.029	0.037	0.049	0.060	0.045	0.037	0.051	0.053	0.066	0.049
	JPN	1.054	1.038	1.009	1.032	1.103	0.362	0.375	0.353	0.356	0.354
	KOR	0.013	0.015	0.024	0.030	0.022	0.023	0.023	0.032	0.036	0.033
	MEX	0.001	0.002	0.002	0.003	0.002	0.002	0.003	0.004	0.005	0.004
	USA	0.030	0.041	0.036	0.043	0.032	0.055	0.069	0.062	0.060	0.040
	ROW	0.045	0.066	0.098	0.123	0.097	0.085	0.092	0.098	0.112	0.106
USA	BRII	0.014	0.017	0.026	0.028	0.020	0.012	0.010	0.014	0.018	0.022
	CAN	0.040	0.044	0.050	0.052	0.041	0.038	0.045	0.041	0.038	0.042
	CHN	0.019	0.027	0.066	0.092	0.113	0.013	0.017	0.041	0.067	0.101
	EU-12	0.003	0.004	0.006	0.007	0.005	0.002	0.003	0.005	0.006	0.006
	EU-15	0.087	0.090	0.106	0.105	0.076	0.056	0.062	0.063	0.067	0.067
	JPN	0.059	0.049	0.043	0.038	0.030	0.018	0.018	0.016	0.016	0.013
	KOR	0.014	0.014	0.018	0.018	0.016	0.016	0.012	0.017	0.022	0.021
	MEX	0.016	0.023	0.027	0.029	0.027	0.014	0.022	0.021	0.022	0.018
	USA	0.932	0.912	0.873	0.885	0.793	0.480	0.425	0.396	0.398	0.405
	ROW	0.058	0.072	0.088	0.094	0.062	0.074	0.062	0.079	0.103	0.124

Source: WIOD; authors' calculations.

Table A.3.4.3

Linkages for electrical and optical equipment (NACE 30–33, DL)

		Backward linkages					Forward linkages				
		1995	**2000**	**2005**	**2007**	**2009**	**1995**	**2000**	**2005**	**2007**	**2009**
EU-12	BRII	0.038	0.039	0.041	0.047	0.044	0.024	0.016	0.022	0.027	0.027
	CAN	0.004	0.007	0.008	0.010	0.008	0.004	0.008	0.006	0.006	0.006
	CHN	0.012	0.049	0.171	0.282	0.396	0.009	0.020	0.064	0.089	0.136
	EU-12	0.611	0.440	0.429	0.436	0.475	0.512	0.231	0.186	0.179	0.202
	EU-15	0.513	0.675	0.657	0.635	0.520	0.391	0.578	0.614	0.646	0.638
	JPN	0.030	0.076	0.074	0.078	0.061	0.007	0.014	0.014	0.014	0.012
	KOR	0.014	0.030	0.054	0.070	0.062	0.004	0.010	0.011	0.012	0.012
	MEX	0.001	0.006	0.005	0.006	0.005	0.001	0.007	0.012	0.009	0.007
	USA	0.054	0.097	0.064	0.063	0.055	0.043	0.096	0.070	0.057	0.046
	ROW	0.083	0.186	0.173	0.197	0.148	0.074	0.120	0.207	0.204	0.204
EU-15	BRII	0.015	0.018	0.025	0.033	0.031	0.020	0.018	0.025	0.030	0.032
	CAN	0.006	0.008	0.006	0.007	0.006	0.008	0.012	0.010	0.009	0.010
	CHN	0.017	0.034	0.075	0.119	0.155	0.024	0.051	0.104	0.134	0.220
	EU-12	0.015	0.027	0.043	0.057	0.059	0.027	0.045	0.067	0.077	0.066
	EU-15	0.820	0.817	0.843	0.831	0.861	0.597	0.542	0.587	0.569	0.555
	JPN	0.043	0.050	0.034	0.034	0.026	0.020	0.025	0.020	0.020	0.018
	KOR	0.012	0.018	0.024	0.023	0.017	0.011	0.017	0.020	0.019	0.019
	MEX	0.002	0.005	0.004	0.005	0.004	0.005	0.013	0.012	0.010	0.007
	USA	0.066	0.092	0.058	0.057	0.054	0.083	0.108	0.086	0.074	0.063
	ROW	0.082	0.114	0.108	0.121	0.095	0.146	0.163	0.170	0.208	0.260
JPN	BRII	0.009	0.012	0.017	0.024	0.020	0.009	0.009	0.016	0.020	0.021
	CAN	0.004	0.004	0.004	0.006	0.004	0.008	0.010	0.009	0.009	0.008
	CHN	0.015	0.028	0.080	0.122	0.164	0.044	0.079	0.251	0.365	0.473
	EU-12	0.001	0.001	0.003	0.004	0.003	0.002	0.007	0.015	0.021	0.016
	EU-15	0.029	0.038	0.046	0.056	0.045	0.078	0.095	0.103	0.112	0.083
	JPN	0.828	0.821	0.851	0.858	0.945	0.402	0.433	0.444	0.424	0.429
	KOR	0.016	0.019	0.028	0.035	0.025	0.028	0.041	0.056	0.054	0.044
	MEX	0.001	0.003	0.002	0.003	0.002	0.005	0.011	0.021	0.022	0.013
	USA	0.040	0.049	0.040	0.048	0.038	0.132	0.133	0.112	0.106	0.074
	ROW	0.051	0.080	0.111	0.131	0.105	0.131	0.141	0.178	0.208	0.201
USA	BRII	0.012	0.015	0.018	0.019	0.014	0.011	0.010	0.014	0.018	0.021
	CAN	0.028	0.034	0.028	0.030	0.020	0.032	0.032	0.029	0.027	0.026
	CHN	0.026	0.038	0.096	0.135	0.139	0.019	0.031	0.091	0.135	0.202
	EU-12	0.002	0.004	0.005	0.006	0.004	0.003	0.005	0.008	0.010	0.009
	EU-15	0.082	0.085	0.077	0.074	0.048	0.089	0.096	0.090	0.101	0.087
	JPN	0.080	0.059	0.038	0.034	0.020	0.037	0.034	0.031	0.034	0.030
	KOR	0.032	0.028	0.024	0.023	0.015	0.022	0.025	0.032	0.029	0.025
	MEX	0.022	0.035	0.031	0.037	0.027	0.035	0.065	0.041	0.038	0.028
	USA	0.791	0.762	0.615	0.621	0.510	0.539	0.453	0.407	0.398	0.406
	ROW	0.107	0.115	0.099	0.096	0.054	0.121	0.112	0.149	0.181	0.206

Source: WIOD; authors' calculations.

Table A.3.4.4

Linkages for transport equipment (NACE 34–35, DM)

		Backward linkages					Forward linkages				
		1995	**2000**	**2005**	**2007**	**2009**	**1995**	**2000**	**2005**	**2007**	**2009**
EU-12	BRII	0.054	0.043	0.044	0.049	0.039	0.044	0.031	0.031	0.043	0.046
	CAN	0.005	0.007	0.007	0.008	0.006	0.003	0.006	0.006	0.005	0.007
	CHN	0.007	0.023	0.046	0.081	0.108	0.006	0.006	0.015	0.032	0.054
	EU-12	0.793	0.635	0.623	0.586	0.663	0.294	0.144	0.117	0.113	0.115
	EU-15	0.533	0.783	0.769	0.776	0.637	0.215	0.397	0.433	0.420	0.386
	JPN	0.031	0.054	0.047	0.048	0.039	0.006	0.014	0.013	0.013	0.011
	KOR	0.015	0.020	0.024	0.038	0.033	0.002	0.003	0.005	0.006	0.006
	MEX	0.001	0.004	0.004	0.005	0.003	0.000	0.002	0.002	0.002	0.002
	USA	0.036	0.065	0.042	0.047	0.041	0.016	0.031	0.029	0.029	0.020
	ROW	0.058	0.092	0.113	0.135	0.106	0.076	0.101	0.115	0.109	0.120
EU-15	BRII	0.018	0.022	0.030	0.038	0.032	0.014	0.015	0.024	0.034	0.025
	CAN	0.008	0.010	0.009	0.011	0.009	0.005	0.010	0.008	0.007	0.007
	CHN	0.011	0.022	0.041	0.065	0.092	0.008	0.011	0.024	0.039	0.067
	EU-12	0.020	0.040	0.064	0.077	0.077	0.010	0.020	0.032	0.042	0.036
	EU-15	1.052	1.053	1.061	1.042	1.070	0.261	0.263	0.262	0.263	0.251
	JPN	0.043	0.050	0.043	0.043	0.037	0.025	0.023	0.021	0.019	0.015
	KOR	0.009	0.013	0.023	0.021	0.024	0.004	0.006	0.007	0.008	0.008
	MEX	0.003	0.005	0.005	0.007	0.006	0.002	0.005	0.005	0.004	0.004
	USA	0.051	0.077	0.060	0.066	0.062	0.043	0.070	0.053	0.047	0.040
	ROW	0.060	0.089	0.100	0.118	0.093	0.112	0.105	0.129	0.133	0.150
JPN	BRII	0.012	0.013	0.019	0.027	0.021	0.015	0.016	0.041	0.052	0.038
	CAN	0.005	0.005	0.006	0.006	0.005	0.007	0.016	0.014	0.016	0.014
	CHN	0.012	0.023	0.054	0.083	0.099	0.011	0.015	0.038	0.066	0.114
	EU-12	0.001	0.002	0.004	0.006	0.005	0.001	0.003	0.006	0.009	0.007
	EU-15	0.057	0.066	0.081	0.090	0.066	0.043	0.060	0.072	0.083	0.069
	JPN	1.003	0.994	0.936	0.910	0.977	0.298	0.281	0.232	0.216	0.243
	KOR	0.011	0.014	0.020	0.025	0.018	0.006	0.007	0.013	0.017	0.016
	MEX	0.001	0.003	0.003	0.004	0.003	0.002	0.005	0.006	0.009	0.005
	USA	0.040	0.042	0.041	0.049	0.036	0.083	0.113	0.100	0.108	0.084
	ROW	0.042	0.059	0.083	0.109	0.084	0.127	0.119	0.141	0.154	0.177
USA	BRII	0.015	0.019	0.028	0.029	0.022	0.005	0.006	0.008	0.012	0.013
	CAN	0.081	0.087	0.092	0.089	0.070	0.048	0.053	0.051	0.047	0.041
	CHN	0.021	0.030	0.073	0.102	0.137	0.004	0.005	0.014	0.032	0.058
	EU-12	0.003	0.004	0.008	0.009	0.007	0.001	0.002	0.002	0.004	0.004
	EU-15	0.113	0.128	0.142	0.143	0.116	0.036	0.052	0.051	0.063	0.064
	JPN	0.109	0.095	0.083	0.085	0.068	0.021	0.015	0.017	0.019	0.018
	KOR	0.020	0.020	0.029	0.029	0.026	0.005	0.004	0.005	0.007	0.006
	MEX	0.027	0.041	0.043	0.048	0.047	0.009	0.021	0.017	0.018	0.015
	USA	0.916	0.845	0.845	0.885	0.849	0.266	0.235	0.225	0.209	0.265
	ROW	0.065	0.072	0.089	0.097	0.072	0.065	0.055	0.058	0.076	0.109

Source: WIOD; authors' calculations.

Appendix Tables to Section 3.5

Table A.3.5.1

Vertical integration measures 1995–2009, NACE DG

		VS2 (total exports)					VS1				
		1995	**2000**	**2005**	**2007**	**2009**	**1995**	**2000**	**2005**	**2007**	**2009**
EU-12	BRII	3.9	4.6	4.7	5.0	4.6	5.4	6.6	6.5	6.7	6.2
	CAN	0.1	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.1
	CHN	0.2	0.5	1.0	1.5	2.2	0.1	0.3	0.6	0.9	1.4
	EU-12	76.8	70.4	69.2	67.6	69.3					
	EU-15	13.9	17.0	17.1	17.4	16.5	16.1	20.0	20.3	20.9	19.4
	JPN	0.5	0.6	0.6	0.6	0.5	0.2	0.3	0.3	0.3	0.2
	KOR	0.3	0.3	0.3	0.4	0.3	0.3	0.2	0.2	0.3	0.2
	MEX	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.0
	USA	1.2	1.8	1.3	1.3	1.3	1.0	1.4	0.9	0.8	0.9
	ROW	3.2	4.5	5.4	5.9	5.0	3.5	4.7	5.8	6.3	5.1
EU-15	BRII	0.9	1.0	1.4	1.7	1.5	1.0	1.2	1.5	1.8	1.6
	CAN	0.2	0.3	0.3	0.3	0.3	0.2	0.3	0.3	0.4	0.3
	CHN	0.3	0.6	0.9	1.3	2.1	0.2	0.5	0.7	1.0	1.6
	EU-12	0.5	0.6	0.8	1.1	1.1	0.6	0.8	1.1	1.4	1.5
	EU-15	92.0	88.8	87.6	86.0	86.0					
	JPN	0.7	0.8	0.7	0.7	0.6	0.6	0.7	0.5	0.5	0.4
	KOR	0.2	0.2	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2
	MEX	0.1	0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.1
	USA	1.9	2.9	2.4	2.4	2.6	2.0	3.2	2.7	2.7	3.1
	ROW	3.2	4.6	5.4	6.0	5.5	4.0	5.9	7.1	8.1	7.1
JPN	BRII	0.5	0.6	1.0	1.3	1.1	0.5	0.6	1.0	1.3	1.2
	CAN	0.2	0.2	0.2	0.3	0.2	0.3	0.3	0.3	0.3	0.3
	CHN	0.3	0.6	1.5	2.1	2.5	0.3	0.6	1.4	1.9	2.2
	EU-12	0.0	0.0	0.1	0.1	0.1					
	EU-15	1.8	1.9	2.6	3.0	2.9	1.7	1.9	2.5	2.9	2.9
	JPN	93.2	91.4	85.9	82.6	84.5	0.0	0.0	0.0	0.0	0.0
	KOR	0.4	0.5	0.7	0.7	0.5	0.4	0.6	0.9	1.0	0.6
	MEX	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.0	0.1	0.0
	USA	1.2	1.3	1.5	1.7	1.4	1.2	1.3	1.6	1.8	1.6
	ROW	2.3	3.4	6.4	8.1	6.7	3.0	4.5	9.3	12.4	9.5
USA	BRII	0.4	0.5	0.8	0.9	0.8	0.3	0.4	0.5	0.6	0.6
	CAN	1.3	1.5	1.8	1.8	1.6	1.8	2.2	2.7	2.6	2.2
	CHN	0.3	0.6	1.3	1.7	2.6	0.3	0.5	1.1	1.2	2.0
	EU-12	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
	EU-15	3.6	4.5	5.3	5.4	5.2	3.8	4.8	5.8	5.7	5.4
	JPN	1.4	1.2	1.0	0.9	0.7	1.2	1.0	0.8	0.7	0.6
	KOR	0.3	0.3	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.2
	MEX	0.4	0.5	0.6	0.6	0.5	0.6	0.8	0.9	0.9	0.8
	USA	89.7	87.4	84.0	83.6	83.6					
	ROW	2.5	3.4	4.7	4.7	4.3	3.1	4.2	5.9	5.8	5.0

Source: WIOD; authors' calculations.

Table A.3.5.2

Vertical integration measures 1995–2009, NACE DK

		VS2 (total exports)					VS1				
		1995	**2000**	**2005**	**2007**	**2009**	**1995**	**2000**	**2005**	**2007**	**2009**
EU-12	BRII	2.2	1.9	1.9	2.1	1.5	2.8	2.3	2.0	2.0	1.4
	CAN	0.2	0.2	0.2	0.3	0.2	0.1	0.2	0.2	0.2	0.1
	CHN	0.2	0.7	1.6	2.7	3.7	0.1	0.4	1.0	1.8	2.6
	EU-12	76.4	69.5	66.8	63.7	68.5					
	EU-15	16.5	20.5	21.4	22.4	19.0	19.2	24.2	25.9	27.8	22.6
	JPN	0.6	1.1	1.1	1.2	1.0	0.3	0.7	0.8	0.8	0.7
	KOR	0.3	0.4	0.6	0.8	0.8	0.3	0.3	0.4	0.7	0.7
	MEX	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.0
	USA	1.2	1.8	1.3	1.4	1.3	1.0	1.3	0.9	0.8	1.0
	ROW	2.4	3.9	4.9	5.4	3.9	2.3	3.6	5.1	5.6	3.8
EU-15	BRII	0.8	0.8	1.1	1.4	1.1	0.8	0.8	1.1	1.3	1.0
	CAN	0.3	0.3	0.2	0.3	0.2	0.3	0.3	0.3	0.4	0.3
	CHN	0.5	0.9	1.6	2.5	3.5	0.4	0.7	1.2	1.8	2.7
	EU-12	0.8	1.1	1.8	2.2	2.1	1.0	1.5	2.4	3.1	2.9
	EU-15	91.8	88.8	87.9	85.5	86.5					
	JPN	1.1	1.3	1.0	1.0	0.8	0.9	1.1	0.7	0.7	0.6
	KOR	0.3	0.4	0.5	0.5	0.4	0.2	0.3	0.4	0.4	0.3
	MEX	0.1	0.2	0.1	0.2	0.1	0.1	0.2	0.2	0.2	0.2
	USA	1.8	2.3	1.7	1.7	1.6	1.8	2.4	1.7	1.7	1.8
	ROW	2.7	3.9	4.1	4.7	3.6	3.2	4.7	5.1	6.0	4.3
JPN	BRII	0.5	0.6	0.8	1.1	0.8	0.5	0.6	0.7	1.0	0.8
	CAN	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	CHN	0.5	0.9	2.5	3.7	4.8	0.4	0.8	2.1	3.1	4.2
	EU-12	0.0	0.0	0.1	0.1	0.1					
	EU-15	1.2	1.6	2.0	2.4	1.8	1.1	1.4	1.6	1.8	1.3
	JPN	93.8	91.5	87.9	84.8	86.5	0.0	0.0	0.0	0.0	0.0
	KOR	0.5	0.6	1.0	1.2	0.9	0.6	0.7	1.0	1.2	0.8
	MEX	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1
	USA	1.3	1.7	1.5	1.7	1.2	1.3	1.7	1.5	1.7	1.3
	ROW	1.9	2.8	4.0	4.8	3.8	2.4	3.4	5.1	6.5	4.8
USA	BRII	0.6	0.7	1.1	1.2	0.9	0.6	0.7	0.9	0.9	0.7
	CAN	1.7	1.9	2.1	2.1	1.8	2.4	2.7	3.0	3.1	2.3
	CHN	0.8	1.2	2.8	3.8	5.1	0.7	0.9	2.2	2.8	3.7
	EU-12	0.1	0.2	0.3	0.3	0.2	0.1	0.1	0.2	0.2	0.1
	EU-15	3.7	3.9	4.5	4.4	3.4	3.8	3.8	4.2	4.0	2.9
	JPN	2.6	2.1	1.8	1.6	1.3	2.3	1.8	1.5	1.2	0.9
	KOR	0.6	0.6	0.8	0.8	0.7	0.6	0.5	0.6	0.6	0.5
	MEX	0.7	1.0	1.2	1.2	1.2	1.0	1.5	1.7	1.8	1.6
	USA	86.7	85.4	81.8	80.8	82.6					
	ROW	2.5	3.1	3.7	3.9	2.8	2.8	3.3	3.9	4.1	2.4

Source: WIOD; authors' calculations.

Table A.3.5.3

Vertical integration measures 1995–2009, NACE DL

		VS2 (total exports)					VS1				
		1995	2000	2005	2007	2009	1995	2000	2005	2007	2009
EU-12	BRII	1.5	1.4	1.5	1.6	1.5	1.9	1.6	1.3	1.3	1.3
	CAN	0.2	0.3	0.3	0.3	0.3	0.1	0.2	0.2	0.3	0.2
	CHN	0.5	1.8	6.2	9.6	13.7	0.3	1.4	5.7	8.5	12.8
	EU-12	70.2	56.6	55.0	52.6	55.1					
	EU-15	20.4	25.1	23.7	21.7	18.0	25.1	32.3	31.0	29.4	23.7
	JPN	1.2	2.8	2.7	2.7	2.1	0.7	2.1	2.1	2.1	1.4
	KOR	0.6	1.1	2.0	2.4	2.1	0.5	1.0	1.8	2.4	2.1
	MEX	0.1	0.2	0.2	0.2	0.2	0.0	0.2	0.2	0.1	0.1
	USA	2.1	3.6	2.3	2.2	1.9	1.8	2.6	1.7	1.3	1.4
	ROW	3.3	6.9	6.3	6.7	5.1	3.4	8.1	6.7	7.7	5.0
EU-15	BRII	0.7	0.7	1.1	1.3	1.3	0.7	0.7	1.0	1.3	1.2
	CAN	0.3	0.4	0.3	0.3	0.2	0.3	0.4	0.3	0.3	0.3
	CHN	0.7	1.4	3.2	4.9	6.3	0.6	1.2	2.6	3.7	5.0
	EU-12	0.7	1.1	1.8	2.3	2.4	0.8	1.6	2.6	3.4	3.5
	EU-15	88.6	84.6	84.1	81.3	81.8					
	JPN	1.9	2.1	1.4	1.4	1.1	1.6	1.7	1.0	1.0	0.7
	KOR	0.5	0.8	1.0	0.9	0.7	0.5	0.7	0.9	0.7	0.5
	MEX	0.1	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2
	USA	2.9	3.9	2.4	2.4	2.2	3.0	4.1	2.7	2.5	2.6
	ROW	3.6	4.8	4.5	5.0	3.9	4.2	5.9	5.3	6.0	4.4
JPN	BRII	0.4	0.5	0.7	1.0	0.8	0.4	0.5	0.6	0.8	0.7
	CAN	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	CHN	0.6	1.2	3.3	4.8	6.3	0.5	1.0	2.9	3.9	5.5
	EU-12	0.0	0.0	0.1	0.1	0.1					
	EU-15	1.2	1.6	1.9	2.2	1.7	1.1	1.2	1.2	1.4	1.1
	JPN	92.9	90.2	86.4	83.1	84.3	0.0	0.0	0.0	0.0	0.0
	KOR	0.7	0.8	1.2	1.4	1.0	0.7	0.8	1.1	1.4	0.9
	MEX	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1
	USA	1.7	2.1	1.6	1.9	1.5	1.7	2.0	1.6	1.9	1.6
	ROW	2.2	3.4	4.5	5.1	4.0	2.6	4.2	5.8	6.9	5.2
USA	BRII	0.5	0.6	0.9	0.9	0.7	0.4	0.5	0.5	0.6	0.4
	CAN	1.2	1.5	1.3	1.4	1.1	1.7	2.1	1.6	1.8	1.1
	CHN	1.1	1.6	4.6	6.3	7.3	0.9	1.3	3.3	4.3	4.6
	EU-12	0.1	0.2	0.2	0.3	0.2	0.1	0.2	0.1	0.1	0.1
	EU-15	3.5	3.6	3.6	3.5	2.5	3.2	3.1	2.6	2.3	1.6
	JPN	3.4	2.5	1.8	1.6	1.1	3.0	2.0	1.0	0.9	0.5
	KOR	1.4	1.2	1.1	1.1	0.8	1.4	1.2	0.7	0.6	0.4
	MEX	0.9	1.5	1.5	1.7	1.4	1.4	2.3	2.0	2.4	1.8
	USA	83.4	82.3	80.3	78.8	81.9					
	ROW	4.5	4.9	4.7	4.5	2.9	5.3	5.8	4.5	4.3	2.1

Source: WIOD; authors' calculations.

Table A.3.5.4

Vertical integration measures 1995–2009, NACE DM

		VS2 (total exports)					VS1				
		1995	**2000**	**2005**	**2007**	**2009**	**1995**	**2000**	**2005**	**2007**	**2009**
EU-12	BRII	2.0	1.5	1.6	1.7	1.4	2.7	1.9	1.6	1.6	1.3
	CAN	0.2	0.3	0.2	0.3	0.2	0.1	0.2	0.2	0.2	0.1
	CHN	0.3	0.8	1.6	2.8	3.8	0.1	0.5	1.1	1.8	2.7
	EU-12	72.4	61.8	61.5	59.1	64.0					
	EU-15	19.9	27.4	27.0	26.8	22.6	24.9	35.9	34.6	34.7	28.4
	JPN	1.2	1.9	1.7	1.7	1.4	0.8	1.4	1.2	1.2	1.0
	KOR	0.6	0.7	0.8	1.3	1.2	0.6	0.7	0.7	1.2	1.0
	MEX	0.0	0.1	0.1	0.2	0.1	0.0	0.1	0.1	0.1	0.1
	USA	1.3	2.3	1.5	1.6	1.5	1.1	1.8	1.0	0.9	1.1
	ROW	2.1	3.2	4.0	4.6	3.8	2.1	2.9	4.0	4.9	3.9
EU-15	BRII	0.7	0.8	1.1	1.4	1.2	0.9	0.9	1.2	1.5	1.2
	CAN	0.3	0.4	0.3	0.4	0.3	0.4	0.5	0.4	0.5	0.4
	CHN	0.5	0.8	1.5	2.3	3.3	0.4	0.7	1.3	1.8	2.8
	EU-12	0.8	1.5	2.4	2.8	2.8	1.1	2.3	3.6	4.4	4.3
	EU-15	91.1	87.6	86.1	83.8	84.4					
	JPN	1.7	1.9	1.6	1.5	1.4	1.5	1.7	1.4	1.3	1.1
	KOR	0.4	0.5	0.9	0.7	0.9	0.4	0.5	0.8	0.6	0.8
	MEX	0.1	0.2	0.2	0.3	0.2	0.1	0.3	0.3	0.4	0.3
	USA	2.0	2.9	2.2	2.4	2.2	2.3	3.4	2.6	2.7	2.8
	ROW	2.4	3.4	3.7	4.3	3.4	3.1	4.5	5.0	6.0	4.5
JPN	BRII	0.4	0.5	0.6	0.9	0.7	0.5	0.6	0.7	1.0	0.8
	CAN	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	CHN	0.4	0.8	1.8	2.8	3.3	0.4	0.8	1.9	2.6	3.3
	EU-12	0.0	0.1	0.1	0.2	0.2					
	EU-15	2.0	2.3	2.7	3.0	2.2	2.3	2.6	3.0	3.1	2.3
	JPN	93.8	92.2	89.4	86.7	88.7	0.0	0.0	0.0	0.0	0.0
	KOR	0.4	0.5	0.7	0.8	0.6	0.5	0.6	0.8	1.0	0.7
	MEX	0.0	0.1	0.1	0.1	0.1	0.0	0.2	0.1	0.2	0.1
	USA	1.4	1.4	1.4	1.6	1.2	1.7	1.7	1.7	1.9	1.5
	ROW	1.4	2.0	2.8	3.6	2.8	2.1	3.0	4.2	5.7	4.1
USA	BRII	0.6	0.7	1.0	1.0	0.8	0.6	0.7	0.9	0.9	0.6
	CAN	3.1	3.4	3.5	3.3	2.7	5.0	5.6	5.6	5.4	3.9
	CHN	0.8	1.1	2.8	3.7	5.2	0.7	0.9	2.3	2.9	4.2
	EU-12	0.1	0.2	0.3	0.3	0.3	0.1	0.1	0.2	0.2	0.2
	EU-15	4.3	4.9	5.4	5.3	4.4	4.6	5.0	5.4	5.3	4.3
	JPN	4.1	3.7	3.1	3.1	2.6	3.9	3.3	2.8	2.8	2.2
	KOR	0.7	0.8	1.1	1.1	1.0	0.8	0.7	0.9	0.9	0.8
	MEX	1.0	1.6	1.6	1.8	1.8	1.5	2.4	2.6	2.9	2.9
	USA	82.9	80.9	77.9	76.9	78.5					
	ROW	2.4	2.8	3.4	3.5	2.8	3.0	3.1	3.7	4.0	2.8

Source: WIOD; authors' calculations.

Appendix Tables to Section 3.6

Table A.3.6.1

Energy use (TJ) by unit of exports (USD million), 1995–2009

		Total exports					Final goods exports				
		1995	**2000**	**2005**	**2007**	**2009**	**1995**	**2000**	**2005**	**2007**	**2009**
EU-12	BRII	2.8	5.4	5.9	5.2	4.0	2.3	4.6	5.1	4.6	3.6
	CAN	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	CHN	0.2	0.4	1.0	1.3	1.4	0.2	0.4	1.0	1.3	1.4
	EU-12	47.7	57.0	37.6	25.1	25.9	39.4	47.4	32.2	21.3	22.4
	EU-15	2.5	3.4	2.8	2.5	1.9	2.4	3.4	2.7	2.4	1.8
	JPN	0.0	0.1	0.1	0.2	0.1	0.0	0.1	0.1	0.2	0.1
	KOR	0.1	0.2	0.2	0.3	0.3	0.1	0.2	0.2	0.3	0.4
	MEX	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.1
	USA	0.3	0.5	0.4	0.4	0.3	0.3	0.5	0.3	0.4	0.3
	ROW	0.2	0.4	0.3	0.3	0.2	0.2	0.4	0.3	0.3	0.2
EU-15	BRII	0.6	1.5	2.7	2.6	2.3	0.6	1.4	2.5	2.4	2.1
	CAN	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	CHN	0.3	0.4	0.6	0.8	0.8	0.3	0.4	0.7	0.8	0.9
	EU-12	0.4	0.7	0.7	0.6	0.6	0.4	0.8	0.7	0.6	0.6
	EU-15	13.5	17.2	14.1	10.9	9.5	11.4	14.8	12.3	9.6	8.5
	JPN	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	KOR	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.2
	MEX	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1
	USA	0.4	0.5	0.5	0.5	0.4	0.4	0.5	0.5	0.5	0.4
	ROW	0.2	0.3	0.3	0.3	0.2	0.1	0.3	0.3	0.3	0.2
JPN	BRII	0.5	1.2	1.9	2.2	2.0	0.4	1.1	1.7	1.9	1.6
	CAN	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	CHN	0.3	0.5	1.2	1.3	1.3	0.3	0.5	1.2	1.3	1.3
	EU-12	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.0
	EU-15	0.2	0.3	0.4	0.3	0.2	0.2	0.3	0.3	0.3	0.2
	JPN	8.0	9.7	12.2	14.1	12.5	6.5	8.0	9.6	10.8	8.7
	KOR	0.3	0.6	0.6	0.5	0.5	0.2	0.5	0.6	0.5	0.5
	MEX	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.1
	USA	0.3	0.4	0.4	0.4	0.3	0.3	0.4	0.4	0.4	0.3
	ROW	0.1	0.3	0.3	0.3	0.3	0.1	0.2	0.3	0.3	0.2
USA	BRII	0.3	0.8	1.4	1.2	1.0	0.3	0.9	1.4	1.2	1.0
	CAN	0.5	0.6	0.6	0.5	0.4	0.5	0.6	0.6	0.5	0.4
	CHN	0.3	0.4	0.8	0.9	0.8	0.4	0.4	0.9	0.9	0.9
	EU-12	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	EU-15	0.4	0.6	0.6	0.5	0.3	0.4	0.6	0.5	0.5	0.3
	JPN	0.1	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.1
	KOR	0.1	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2
	MEX	0.1	0.2	0.4	0.5	0.5	0.1	0.3	0.4	0.5	0.6
	USA	19.2	17.9	20.5	21.1	17.7	17.2	16.2	18.8	19.9	17.0
	ROW	0.1	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.1

Source: WIOD; authors' calculations.

Table A.3.6.2

Energy use (TJ) by unit of exports (USD million) in NACE DG, 1995–2009

		Total exports					Final goods exports				
		1995	**2000**	**2005**	**2007**	**2009**	**1995**	**2000**	**2005**	**2007**	**2009**
EU-12	BRII	3.6	9.1	11.1	10.4	9.2	3.6	9.1	11.1	10.4	9.2
	CAN	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	CHN	0.1	0.4	0.7	0.8	0.9	0.1	0.4	0.7	0.8	0.9
	EU-12	89.5	134.9	86.9	61.2	60.1	89.5	134.9	86.9	61.2	60.1
	EU-15	3.8	5.9	4.8	4.3	3.4	3.8	5.9	4.8	4.3	3.4
	JPN	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.2	0.1
	KOR	0.1	0.2	0.2	0.3	0.3	0.1	0.2	0.2	0.3	0.3
	MEX	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.1
	USA	0.4	0.9	0.6	0.6	0.5	0.4	0.9	0.6	0.6	0.5
	ROW	0.3	0.6	0.5	0.5	0.4	0.3	0.6	0.5	0.5	0.4
EU-15	BRII	0.7	1.9	3.3	3.2	3.1	0.7	1.9	3.3	3.2	3.1
	CAN	0.1	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.1
	CHN	0.2	0.4	0.6	0.7	0.8	0.2	0.4	0.6	0.7	0.8
	EU-12	0.5	0.9	0.8	0.7	0.7	0.5	0.9	0.8	0.7	0.7
	EU-15	22.7	27.4	19.3	16.6	15.6	22.7	27.4	19.3	16.6	15.6
	JPN	0.1	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2
	KOR	0.1	0.2	0.2	0.2	0.3	0.1	0.2	0.2	0.2	0.3
	MEX	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1
	USA	0.7	1.0	1.0	1.0	1.0	0.7	1.0	1.0	1.0	1.0
	ROW	0.2	0.5	0.5	0.4	0.4	0.2	0.5	0.5	0.4	0.4
JPN	BRII	0.6	1.8	3.6	3.6	3.1	0.6	1.8	3.6	3.6	3.1
	CAN	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	CHN	0.2	0.5	1.2	1.4	1.2	0.2	0.5	1.2	1.4	1.2
	EU-12	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1
	EU-15	0.5	0.6	0.7	0.7	0.6	0.5	0.6	0.7	0.7	0.6
	JPN	20.6	27.4	36.8	43.0	31.2	20.6	27.4	36.8	43.0	31.2
	KOR	0.3	0.9	1.2	1.1	1.0	0.3	0.9	1.2	1.1	1.0
	MEX	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.1
	USA	0.6	0.7	0.9	1.0	0.7	0.6	0.7	0.9	1.0	0.7
	ROW	0.2	0.4	0.6	0.6	0.5	0.2	0.4	0.6	0.6	0.5
USA	BRII	0.4	1.1	2.1	1.8	1.7	0.4	1.1	2.1	1.8	1.7
	CAN	0.8	1.2	1.3	1.0	0.8	0.8	1.2	1.3	1.0	0.8
	CHN	0.3	0.4	0.9	0.8	1.0	0.3	0.4	0.9	0.8	1.0
	EU-12	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.1
	EU-15	0.8	1.4	1.5	1.3	1.0	0.8	1.4	1.5	1.3	1.0
	JPN	0.2	0.3	0.3	0.3	0.2	0.2	0.3	0.3	0.3	0.2
	KOR	0.1	0.2	0.4	0.4	0.3	0.1	0.2	0.4	0.4	0.3
	MEX	0.2	0.3	0.6	0.5	0.6	0.2	0.3	0.6	0.5	0.6
	USA	43.9	45.6	47.2	41.8	37.0	43.9	45.6	47.2	41.8	37.0
	ROW	0.2	0.4	0.4	0.3	0.3	0.2	0.4	0.4	0.3	0.3

Source: WIOD; authors' calculations.

Table A.3.6.3

Energy use (TJ) by unit of exports (USD million) in NACE DK, 1995–2009

		Total exports					Final goods exports				
		1995	**2000**	**2005**	**2007**	**2009**	**1995**	**2000**	**2005**	**2007**	**2009**
EU-12	BRII	2.0	3.7	4.6	4.3	2.9	2.0	3.7	4.6	4.3	2.9
	CAN	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	CHN	0.2	0.4	0.9	1.2	1.2	0.2	0.4	0.9	1.2	1.2
	EU-12	32.1	36.1	20.6	14.7	15.4	32.1	36.1	20.6	14.7	15.4
	EU-15	2.5	3.5	3.1	2.7	2.1	2.5	3.5	3.1	2.7	2.1
	JPN	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.2	0.2	0.1
	KOR	0.1	0.2	0.2	0.3	0.4	0.1	0.2	0.2	0.3	0.4
	MEX	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.1
	USA	0.3	0.4	0.3	0.4	0.3	0.3	0.4	0.3	0.4	0.3
	ROW	0.2	0.4	0.4	0.4	0.2	0.2	0.4	0.4	0.4	0.2
EU-15	BRII	0.6	1.4	2.3	2.4	1.9	0.6	1.4	2.3	2.4	1.9
	CAN	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	CHN	0.3	0.4	0.8	1.0	1.1	0.3	0.4	0.8	1.0	1.1
	EU-12	0.5	0.9	0.9	0.8	0.7	0.5	0.9	0.9	0.8	0.7
	EU-15	6.7	8.0	6.1	5.0	4.7	6.7	8.0	6.1	5.0	4.7
	JPN	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	KOR	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.2
	MEX	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1
	USA	0.3	0.4	0.4	0.4	0.3	0.3	0.4	0.4	0.4	0.3
	ROW	0.2	0.3	0.3	0.3	0.2	0.2	0.3	0.3	0.3	0.2
JPN	BRII	0.5	1.1	1.7	2.0	1.6	0.5	1.1	1.7	2.0	1.6
	CAN	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	CHN	0.3	0.5	1.3	1.5	1.6	0.3	0.5	1.3	1.5	1.6
	EU-12	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.0
	EU-15	0.2	0.3	0.3	0.3	0.2	0.2	0.3	0.3	0.3	0.2
	JPN	5.0	5.7	6.3	7.2	6.0	5.0	5.7	6.3	7.2	6.0
	KOR	0.2	0.4	0.4	0.4	0.5	0.2	0.4	0.4	0.4	0.5
	MEX	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.1
	USA	0.3	0.3	0.3	0.4	0.2	0.3	0.3	0.3	0.4	0.2
	ROW	0.1	0.2	0.3	0.3	0.2	0.1	0.2	0.3	0.3	0.2
USA	BRII	0.5	1.3	2.2	1.9	1.3	0.5	1.3	2.2	1.9	1.3
	CAN	0.7	0.6	0.6	0.5	0.4	0.7	0.6	0.6	0.5	0.4
	CHN	0.5	0.6	1.4	1.5	1.5	0.5	0.6	1.4	1.5	1.5
	EU-12	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	EU-15	0.5	0.6	0.6	0.5	0.3	0.5	0.6	0.6	0.5	0.3
	JPN	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.1
	KOR	0.1	0.2	0.3	0.3	0.3	0.1	0.2	0.3	0.3	0.3
	MEX	0.2	0.3	0.5	0.6	0.7	0.2	0.3	0.5	0.6	0.7
	USA	11.3	10.6	10.5	10.8	9.0	11.3	10.6	10.5	10.8	9.0
	ROW	0.1	0.2	0.3	0.2	0.1	0.1	0.2	0.3	0.2	0.1

Source: WIOD; authors' calculations.

Table A.3.6.4

Energy use (TJ) by unit of exports (USD million) in NACE DL, 1995–2009

		Total exports					Final goods exports				
		1995	2000	2005	2007	2009	1995	2000	2005	2007	2009
EU-12	BRII	1.4	2.8	3.3	3.2	2.7	1.4	2.8	3.3	3.2	2.7
	CAN	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	CHN	0.3	0.9	2.7	3.5	4.0	0.3	0.9	2.7	3.5	4.0
	EU-12	20.7	18.8	10.8	7.8	8.4	20.7	18.8	10.8	7.8	8.4
	EU-15	2.5	3.5	2.7	2.2	1.8	2.5	3.5	2.7	2.2	1.8
	JPN	0.1	0.3	0.3	0.4	0.2	0.1	0.3	0.3	0.4	0.2
	KOR	0.1	0.3	0.5	0.6	0.8	0.1	0.3	0.5	0.6	0.8
	MEX	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1
	USA	0.4	0.6	0.5	0.5	0.4	0.4	0.6	0.5	0.5	0.4
	ROW	0.2	0.4	0.4	0.3	0.3	0.2	0.4	0.4	0.3	0.3
EU-15	BRII	0.5	1.2	2.0	2.1	1.9	0.5	1.2	2.0	2.1	1.9
	CAN	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	CHN	0.4	0.6	1.3	1.6	1.7	0.4	0.6	1.3	1.6	1.7
	EU-12	0.4	0.7	0.7	0.6	0.6	0.4	0.7	0.7	0.6	0.6
	EU-15	5.7	6.4	5.1	4.2	4.0	5.7	6.4	5.1	4.2	4.0
	JPN	0.1	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.1
	KOR	0.1	0.2	0.2	0.2	0.3	0.1	0.2	0.2	0.2	0.3
	MEX	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1
	USA	0.5	0.6	0.4	0.5	0.4	0.5	0.6	0.4	0.5	0.4
	ROW	0.2	0.3	0.3	0.3	0.2	0.2	0.3	0.3	0.3	0.2
JPN	BRII	0.4	0.9	1.5	1.7	1.5	0.4	0.9	1.5	1.7	1.5
	CAN	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.0
	CHN	0.4	0.5	1.5	1.7	1.8	0.4	0.5	1.5	1.7	1.8
	EU-12	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.0
	EU-15	0.2	0.3	0.3	0.3	0.2	0.2	0.3	0.3	0.3	0.2
	JPN	4.6	5.5	6.3	7.1	5.9	4.6	5.5	6.3	7.1	5.9
	KOR	0.2	0.4	0.4	0.5	0.5	0.2	0.4	0.4	0.5	0.5
	MEX	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.1
	USA	0.3	0.4	0.3	0.4	0.3	0.3	0.4	0.3	0.4	0.3
	ROW	0.1	0.2	0.2	0.3	0.2	0.1	0.2	0.2	0.3	0.2
USA	BRII	0.4	1.0	1.4	1.2	0.8	0.4	1.0	1.4	1.2	0.8
	CAN	0.4	0.5	0.4	0.3	0.2	0.4	0.5	0.4	0.3	0.2
	CHN	0.7	0.7	1.6	1.8	1.5	0.7	0.7	1.6	1.8	1.5
	EU-12	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.0
	EU-15	0.4	0.6	0.4	0.4	0.2	0.4	0.6	0.4	0.4	0.2
	JPN	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.1
	KOR	0.2	0.3	0.3	0.3	0.2	0.2	0.3	0.3	0.3	0.2
	MEX	0.2	0.3	0.4	0.5	0.5	0.2	0.3	0.4	0.5	0.5
	USA	9.5	7.6	6.1	6.5	4.4	9.5	7.6	6.1	6.5	4.4
	ROW	0.2	0.3	0.2	0.2	0.1	0.2	0.3	0.2	0.2	0.1

Source: WIOD; authors' calculations.

Table A.3.6.5

Energy use (TJ) by unit of exports (USD million) in NACE DM, 1995–2009

		Total exports					Final goods exports				
		1995	**2000**	**2005**	**2007**	**2009**	**1995**	**2000**	**2005**	**2007**	**2009**
EU-12	BRII	1.9	3.1	3.7	3.4	2.6	1.9	3.1	3.7	3.4	2.6
	CAN	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	CHN	0.2	0.5	0.9	1.2	1.3	0.2	0.5	0.9	1.2	1.3
	EU-12	26.9	25.7	15.7	10.8	11.9	26.9	25.7	15.7	10.8	11.9
	EU-15	2.8	4.2	3.3	2.8	2.2	2.8	4.2	3.3	2.8	2.2
	JPN	0.1	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2
	KOR	0.1	0.3	0.3	0.4	0.5	0.1	0.3	0.3	0.4	0.5
	MEX	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1
	USA	0.3	0.5	0.4	0.4	0.3	0.3	0.5	0.4	0.4	0.3
	ROW	0.2	0.3	0.3	0.3	0.2	0.2	0.3	0.3	0.3	0.2
EU-15	BRII	0.6	1.5	2.4	2.5	2.1	0.6	1.5	2.4	2.5	2.1
	CAN	0.1	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1
	CHN	0.3	0.5	0.8	1.0	1.1	0.3	0.5	0.8	1.0	1.1
	EU-12	0.6	1.1	1.0	0.9	0.9	0.6	1.1	1.0	0.9	0.9
	EU-15	7.0	8.2	6.2	5.1	4.9	7.0	8.2	6.2	5.1	4.9
	JPN	0.1	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.1
	KOR	0.1	0.2	0.2	0.2	0.4	0.1	0.2	0.2	0.2	0.4
	MEX	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1
	USA	0.4	0.6	0.5	0.5	0.4	0.4	0.6	0.5	0.5	0.4
	ROW	0.2	0.3	0.3	0.3	0.2	0.2	0.3	0.3	0.3	0.2
JPN	BRII	0.5	1.1	1.7	1.9	1.5	0.5	1.1	1.7	1.9	1.5
	CAN	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.0
	CHN	0.4	0.5	1.2	1.3	1.3	0.4	0.5	1.2	1.3	1.3
	EU-12	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1
	EU-15	0.3	0.4	0.4	0.3	0.2	0.3	0.4	0.4	0.3	0.2
	JPN	5.2	6.7	7.2	7.6	6.1	5.2	6.7	7.2	7.6	6.1
	KOR	0.2	0.4	0.4	0.4	0.4	0.2	0.4	0.4	0.4	0.4
	MEX	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.1
	USA	0.3	0.4	0.4	0.4	0.3	0.3	0.4	0.4	0.4	0.3
	ROW	0.1	0.2	0.2	0.3	0.2	0.1	0.2	0.2	0.3	0.2
USA	BRII	0.5	1.3	2.1	1.8	1.3	0.5	1.3	2.1	1.8	1.3
	CAN	0.8	0.8	0.7	0.6	0.4	0.8	0.8	0.7	0.6	0.4
	CHN	0.6	0.6	1.4	1.6	1.7	0.6	0.6	1.4	1.6	1.7
	EU-12	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.1
	EU-15	0.5	0.7	0.7	0.6	0.4	0.5	0.7	0.7	0.6	0.4
	JPN	0.3	0.3	0.3	0.4	0.2	0.3	0.3	0.3	0.4	0.2
	KOR	0.2	0.3	0.3	0.3	0.4	0.2	0.3	0.3	0.3	0.4
	MEX	0.2	0.4	0.6	0.7	0.9	0.2	0.4	0.6	0.7	0.9
	USA	10.2	9.4	9.3	9.6	8.6	10.2	9.4	9.3	9.6	8.6
	ROW	0.1	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.1

Source: WIOD; authors' calculations.

Appendix Tables to Section 4.2

Table A.4.2.1

Trade figures in USD billion

NACE	Reporter	2005	2006	2007	2008	2009	2010
				Exports			
DG	EU-12	23	27	35	45	36	43
	EU-15	549	609	713	780	675	738
	JPN	58	63	70	72	62	77
	USA	115	131	149	172	150	177
DK	EU-12	32	40	54	63	46	52
	EU-15	395	449	576	639	469	501
	JPN	88	95	122	134	88	133
	USA	95	107	125	138	108	127
DL	EU-12	64	81	104	128	109	130
	EU-15	582	658	626	644	513	576
	JPN	175	180	169	174	137	172
	USA	170	188	190	192	156	179
DM	EU-12	58	73	97	112	88	98
	EU-15	540	589	683	704	500	583
	JPN	150	169	190	207	138	189
	USA	124	145	162	168	86	112
				Imports			
DG	EU-12	42	50	63	77	61	70
	EU-15	466	517	611	658	558	613
	JPN	38	41	45	54	48	60
	USA	132	144	155	176	149	172
DK	EU-12	40	48	66	77	51	53
	EU-15	265	296	398	436	309	334
	JPN	23	26	34	37	28	34
	USA	120	134	163	167	128	152
DL	EU-12	72	91	114	133	106	129
	EU-15	604	677	679	700	562	655
	JPN	107	115	111	116	96	125
	USA	353	387	386	388	338	414
DM	EU-12	48	60	83	93	54	63
	EU-15	493	545	627	637	482	537
	JPN	23	25	28	29	21	25
	USA	245	263	269	248	172	231

DG: Chemicals, chemical products and man-made fibres, DK: Machinery and equipment n.e.c., DL: Electrical and optical equipment, DM: Transport equipment.

Source: UN Comtrade; authors' calculations.

Table A.4.2.2

Changes in 'DG: Chemicals, chemical products and man-made fibres' 'between 2007 and 2010, relative to 2007 (%)

flow	Reporter	Use category	Surviving varieties	New markets	Vanishing markets	New products	Vanishing products
Exports	EU-12	Consumption	49.1	0.5	-0.2	0.0	0.0
		Semi-finished	7.3	6.0	-3.5	0.0	0.0
	EU-15	Consumption	8.2	0.0	0.0	0.0	0.0
		Semi-finished	0.9	0.5	-0.4	0.0	0.0
	JPN	Consumption	-3.0	0.5	-0.7	0.6	0.0
		Semi-finished	12.6	0.8	-1.1	0.0	0.0
	USA	Consumption	24.1	0.4	-0.5	0.0	0.0
		Semi-finished	15.5	1.5	-1.6	3.0	-0.1
Imports	EU-12	Consumption	19.0	0.5	-0.1	0.0	0.0
		Semi-finished	7.9	1.6	-1.1	0.0	0.0
	EU-15	Consumption	3.6	0.1	0.0	0.0	0.0
		Semi-finished	-1.5	0.8	-0.6	0.0	0.0
	JPN	Consumption	68.7	0.3	-0.2	0.0	0.0
		Semi-finished	23.4	2.0	-1.9	0.0	-0.2
	USA	Consumption	17.4	0.9	-0.1	0.0	0.0
		Semi-finished	7.3	1.4	-2.0	0.0	0.0

Source: UN Comtrade; authors' calculations.

Table A.4.2.3

Changes in 'DK: Machinery and equipment n.e.c.' between 2007 and 2010, relative to 2007 (%)

flow	Reporter	Use category	Surviving varieties	New markets	Vanishing markets	New products	Vanishing products
Exports	EU-12	Capital goods	-3.2	2.8	-3.0	0.0	0.0
		Consumption	2.6	0.7	-0.3	0.0	0.0
		Parts and components	-6.7	0.5	-0.5	0.0	0.0
		Semi-finished	-7.6	0.3	-0.1	0.0	0.0
	EU-15	Capital goods	-17.3	0.3	-0.4	0.0	0.0
		Consumption	-19.6	0.1	-0.1	0.0	0.0
		Parts and components	-5.5	0.2	-0.2	0.0	0.0
		Semi-finished	-13.3	0.1	-0.1	0.0	0.0
	JPN	Capital goods	2.4	1.0	-2.0	0.0	0.0
		Consumption	1.4	0.7	-0.8	0.0	0.0
		Parts and components	23.1	0.4	-0.8	0.0	0.0
		Semi-finished	12.1	0.2	-0.2	0.0	0.0
	USA	Capital goods	5.2	1.8	-1.4	0.0	0.0
		Consumption	-9.8	0.8	-0.9	0.0	0.0
		Parts and components	-2.4	0.5	-0.5	0.0	0.0
		Semi-finished	-1.7	0.8	-0.8	0.0	0.0
Imports	EU-12	Capital goods	-28.9	0.5	-1.1	0.0	0.0
		Consumption	-15.5	0.7	-0.1	0.0	0.0
		Parts and components	-3.0	0.3	-0.4	0.0	0.0
		Semi-finished	-0.6	0.0	-0.1	0.0	0.0
	EU-15	Capital goods	-24.5	0.2	-0.2	0.0	0.0
		Consumption	-2.1	0.3	0.0	0.0	0.0
		Parts and components	-9.7	0.1	-0.1	0.0	0.0
		Semi-finished	-9.1	0.1	0.0	0.0	0.0
	JPN	Capital goods	-5.0	1.1	-2.1	0.0	0.0
		Consumption	29.4	1.0	-0.5	0.0	0.0
		Parts and components	2.6	0.2	-0.5	0.0	0.0
		Semi-finished	14.7	0.7	-0.2	0.0	0.0
	USA	Capital goods	-12.7	0.7	-0.8	0.0	0.0
		Consumption	-2.6	0.3	-0.3	0.0	0.0
		Parts and components	-1.8	0.2	-0.1	0.0	0.0
		Semi-finished	3.8	0.5	-0.3	0.0	0.0

Source: UN Comtrade; authors' calculations.

Table A.4.2.4

Changes in 'DL: Electrical and optical equipment' between 2007 and 2010, relative to 2007 (%)

flow	Reporter	Use category	Surviving varieties	New markets	Vanishing markets	New products	Vanishing products
Exports	EU-12	Capital goods	28.4	1.0	-0.5	0.0	0.0
		Consumption	44.2	0.5	-0.1	0.0	0.0
		Parts and components	22.5	0.3	-0.4	0.0	0.0
		Semi-finished	-6.1	0.2	-0.1	0.0	0.0
	EU-15	Capital goods	-7.8	0.2	-0.1	0.0	0.0
		Consumption	-3.4	0.1	-0.1	0.0	0.0
		Parts and components	-10.2	0.0	0.0	0.0	0.0
		Semi-finished	-6.2	0.0	-0.1	0.0	0.0
	JPN	Capital goods	3.5	0.9	-0.6	0.0	0.0
		Consumption	-32.6	0.6	-2.4	0.0	0.0
		Parts and components	2.1	0.2	-0.2	0.0	0.0
		Semi-finished	2.7	0.4	-0.2	0.0	0.0
	USA	Capital goods	-0.8	0.7	-0.4	0.0	0.0
		Consumption	12.4	0.5	-0.7	0.0	0.0
		Parts and components	-15.3	0.3	-0.1	0.0	0.0
		Semi-finished	5.0	0.4	-0.3	0.0	0.0
Imports	EU-12	Capital goods	4.3	0.4	-0.2	0.0	0.0
		Consumption	20.3	0.6	-1.3	0.0	0.0
		Parts and components	21.6	0.1	-0.1	0.0	0.0
		Semi-finished	6.9	0.2	-0.4	0.0	0.0
	EU-15	Capital goods	-3.9	0.1	0.0	0.0	0.0
		Consumption	-1.3	0.1	-0.1	0.0	0.0
		Parts and components	-4.3	0.0	0.0	0.0	0.0
		Semi-finished	-2.1	0.1	-0.1	0.0	0.0
	JPN	Capital goods	18.3	0.3	-0.3	0.0	0.0
		Consumption	72.6	0.6	-0.4	0.0	0.0
		Parts and components	-0.8	0.1	-0.1	0.0	0.0
		Semi-finished	8.3	0.2	-0.3	0.0	0.0
	USA	Capital goods	14.5	0.2	-0.1	0.0	0.0
		Consumption	-4.5	0.2	-0.1	0.0	0.0
		Parts and components	1.3	0.1	-0.2	0.0	0.0
		Semi-finished	-4.7	0.1	-0.1	0.0	0.0

Source: UN Comtrade; authors' calculations.

Table A.4.2.5

Changes in 'DM: Transport equipment' between 2007 and 2010, relative to 2007 (%)

flow	Reporter	Use category	Surviving varieties	New markets	Vanishing markets	New products	Vanishing products
Exports	EU-12	Capital goods	-5.9	14.7	-11.0	0.0	0.0
		Consumption	3.1	0.4	-0.2	0.0	0.0
		Parts and components	0.9	0.9	-0.3	0.0	0.0
	EU-15	Capital goods	-25.1	4.8	-3.5	0.0	0.0
		Consumption	-16.8	0.0	0.0	0.0	0.0
		Parts and components	-7.3	0.1	-0.1	0.0	0.0
	JPN	Capital goods	39.3	2.2	-3.4	0.0	-0.4
		Consumption	-18.3	0.0	-0.1	0.0	0.0
		Parts and components	19.9	0.1	-0.1	0.0	0.0
	USA	Capital goods	-3.4	3.0	-25.9	0.0	-2.3
		Consumption	-10.6	0.1	-0.5	0.0	0.0
		Parts and components	-39.2	0.1	-3.1	0.0	0.0
Imports	EU-12	Capital goods	-47.3	7.6	-3.1	0.0	0.0
		Consumption	-39.3	0.6	-0.4	0.0	0.0
		Parts and components	-3.3	0.2	-0.2	0.0	0.0
	EU-15	Capital goods	5.0	2.5	-2.7	0.0	0.0
		Consumption	-24.0	0.3	0.0	0.0	0.0
		Parts and components	-12.1	0.1	-0.1	0.0	0.0
	JPN	Capital goods	-23.5	10.2	-9.4	0.0	0.0
		Consumption	-12.2	0.2	-0.6	0.0	0.0
		Parts and components	-8.9	0.4	-0.3	0.0	0.0
	USA	Capital goods	-29.5	2.4	-1.3	0.0	-0.4
		Consumption	-15.7	0.2	0.0	0.0	0.0
		Parts and components	-5.8	0.1	-0.2	0.0	0.0

Source: UN Comtrade; authors' calculations.

Appendix A to Section 5

Support business functions, as classified by Eurostat (2008)

Distribution and logistics: Consists of transportation activities, warehousing and order processing.

Marketing, sales and after-sales services including help desks and call centres: Market research, advertising, direct marketing services (telemarketing), exhibitions, fairs and other marketing or sales services. Also including call-centre services and after-sales services such as help desks and other customer-support services.

ICT services: IT services and telecommunication. IT services consist of hardware and software consultancy, customised software data processing and database services, maintenance and repair, web-hosting, other computer-related and information services. Packaged software and hardware excluded.

Administrative and management functions: Support functions related to: Legal services, accounting, book-keeping and auditing, business management and consultancy, HR management (e.g. training and education, staff recruitment, provision of temporary personnel, payroll management, health and medical services), corporate financial and insurance services, also including procurement functions.

Engineering and related technical services: Engineering and related technical consultancy, technical testing, analysis and certification. Also including design services.

Research & Development: Research and experimental development.

Appendix B to Section 5

Table B.5.6.1

Definition of variables used for the probit regression on the probability of being an offshoring firm, 2006–09

Variable	Definition/Question in the EMS 2006/09	Code
Probability of being an *offshoring firm*	'Has your factory offshored parts of production to foreign locations resp. foreign companies or backshored them to your factory from abroad in the last two years?'	0: No, 1: Yes
Size (log function of number of employees)	Logarithm of number of employees (excl. temporary agency workers) in 2005/08	0 to 999999
log revenue per employee	Logarithm of annual turnover per employee in 2005/08	0 to 999999
Share of R&D expenditure (% of turnover)	Expenditure on R&D as share of turnover invested internally in your factory in 2005/08	0 to 100%
Product innovator (new to firm innovation)	'Has your factory introduced products since 2004/06 that were completely new to the factory, or incorporated major technical changes (not just minor modifications) (e.g. application of new materials, modifications in product function, altered mode of operation, etc.)?'	0: No, 1: Yes
Share of product innovations (% of turnover)	What share of turnover did these (newly introduced) products have in 2005/2008?	0 to 100%
Export share of turnover	'Please estimate where your factory has sold its products in 2006/08: Products sold to abroad, ca. %'	0 to 100%
Product complexity	'Which of the following characteristics do best describe your main product or line of products? *Production/assembly* (Please tick one box only)'	1: Simple products, 2: Products with medium complexity, 3: Complex products
Batch size	'Which of the following characteristics do best describe your main product or line of products? *Batch or lot size* (Please tick one box only)'	1: Single-unit production, 2: Small or medium batch/lot, 3: Large batch/lot
Product development	'Which of the following characteristics do best describe your main product or line of products? *Product development* (Please tick one box only)'	0: Does not exist in this factory, 1: Customers' specification, 2: Standardised basic programme into which customer-specific options are implemented, 3: Standard programme from which the customer can select
Position in supply chain	'With regards to your main line of products, is your factory predominantly a supplier of systems, components, or jobshops?	0: No supplier, 1: Supplier
Sector	Sector affiliation of enterprise being surveyed by EMS 2006/09 using NACE Rev. 1.1	1: Chemicals (NACE 24), 2: Machinery and equipment (29), 3: Electrics and electronics (30–33), 4: Transport equipment (34, 35)
Country	Country of origin of enterprise being surveyed by the EMS 2006/09	1: Germany, 2: Austria, 3: Switzerland, 4: Netherlands, 6: Denmark, 7: Croatia or Slovenia, 8: Finland, 9: Spain
Year 2009	Enterprise being surveyed by the EMS 2009	0: 2006, 1: 2009
Offshoring experience (1999 and 2006)	'Did your factory already, from 1999 to 2006, offshore parts of the production abroad?'	0: No, 1: Yes

Source: European Manufacturing Survey 2006, 2009.

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