GLOBAL VALUE CHAINS: SURVEYING DRIVERS, MEASURES AND IMPACTS

João Amador

Sónia Cabral

Banco de Portugal
EUROSYSTEM

Global Value Chains:
Surveying Drivers, Measures and Impacts[*]

João Amador

Banco de Portugal

Nova School of Business and Economics

Sónia Cabral

Banco de Portugal

January 2014

Abstract

The production of most goods and services is nowadays vertically fragmented across different countries. This paper surveys the growing empirical literature on global value chains (GVCs), acknowledged as the current paradigm for the international organisation of production. The paper starts by discussing the driving forces behind the significant expansion of GVCs in recent decades. Next, it surveys the indicators used to measure this phenomenon, accounting for their different scope and required datasets. Finally, the impacts of GVCs on trade flows, productivity and labour market developments, as well as some policy implications, are reviewed.

Keywords: International trade, Global Value Chains, Globalisation, Survey

JEL Codes: F60

1   Introduction

"The cross-border flows of goods, investment, services, know-how and people associated with international production networks – call it "supply chain trade" for short – has transformed the world." Richard Baldwin (in Baldwin (2012*b*)).

The rise of *Global Value Chains* (GVCs) has dramatically changed the organisation of world production of goods and services in recent decades, producing a deep and lasting impact on international trade and investment patterns and affecting competitiveness and macroeconomic developments. International production sharing has always been part of international trade as countries import manufactured goods to be incorporated in their exports (see Yeats (1998) for a discussion). However, the reduction of transport and communication costs, the acceleration of technological progress and the removal of political and economic barriers to trade exponentiated the opportunities for international fragmentation of production. Nowadays, GVCs are probably the most prominent feature of globalisation.

Baldwin (2006) examines the major transformations of international trade over the last century as a sequence of two unbundlings. Until the late XIX century, factories had an integrated production structure, where parts and components were produced either sequentially or in different contiguous units located near consumers. Afterwards, the spatial unbundling of production and consumption, i.e., the "first unbundling", was made possible by the great reduction in transport costs originating in steam power. Production was dispersed internationally, generating trade in final products, but it was still clustered locally to minimise coordination costs. Nowadays this model was replaced by a new paradigm based on a international network of individual and autonomous suppliers specialising in specific phases of the production process located in different countries. The spatial unbundling of production stages previously clustered in factories and offices, i.e., the "second unbundling", benefited from the sharp fall of communication and coordination costs and radically changed the nature of international trade and investment.

The networks that operate GVCs are highly complex, involving manufacturing, logistics, transportation and other services firms, as well as customs agents and other public authorities. At present, supply-chain trade is a complex process determined by international differences in production and unbundling costs, with technology shaping the way in which the different stages of production are internationally linked. Baldwin and Venables (2013) introduce the concepts of "spiders" (production processes where multiple parts and components are assembled in no particular order) and "snakes" (processes whose sequencing is dictated by engineering and where goods move in a sequential way from upstream to downstream stages with value being added along the way) as two benchmarks, but most international

production processes are a intricate mixture of the two. An extreme form of international fragmentation of production, designated as "factoryless goods producers", was documented recently for the US economy (see Bernard and Fort (2013)). These firms are formally classified in the wholesale sector in official statistics, but they perform pre-production activities, such as design and engineering, and exert control over the production of manufactured goods. All this complexity and the potentially different scales of analysis make it virtually impossible to define, measure and map GVCs in a single way. Therefore, the economic literature has evolved along different strands of research, using different concepts, methods and terminologies. A general definition, adapted from the Global Value Chain Initiative at Duke University, states that *"A global value chain describes the full range of activities undertaken to bring a product or service from its conception to its end use and how these activities are distributed over geographic space and across international borders."* (in DFAIT (2011)).

International trade literature has labelled this phenomenon using a wide set of terms: "vertical specialisation", "outsourcing", "offshoring", "internationalisation of production", "international production sharing", "disintegration of production", "multi-stage production", "intra-product specialisation", "production relocation", "slicing up the value chain", "international segmentation of production", etc. Nevertheless, international trade theorists tend to call it "fragmentation", a term originally proposed by Jones and Kierzkowski (1990). In parallel, the concept of middle products was introduced in the early eighties by Sanyal and Jones (1982) to incorporate the notion that all internationally traded goods incorporate some domestic value-added either through manufacturing and assembly processes or just through local transportation and retailing services.

The various terms relating to GVCs are usually used interchangeably in the literature. However, as discussed in Molnar et al. (2007), offshoring, outsourcing and internationalisation of production are slightly different concepts that overlap only partially. Outsourcing refers to the purchase of goods and services that were previously produced inside the firm. The firm providing the intermediate inputs can be located inside the home country (domestic outsourcing) or outside (international outsourcing). Offshoring refers to the purchase abroad of goods and services previously produced inside the purchasing firm. Thus, it includes not only international outsourcing, but also international insourcing, with the foreign affiliates exporting to their domestic parent firms. The internationalisation of production refers to the establishment of affiliates abroad. These affiliates may export back to the parent company (international insourcing) or provide goods and services to home and foreign markets. The goods and services produced by affiliates need not have been previously produced inside the parent firm. Sturgeon (2001) discusses in detail a set of terms and concepts associated with global economic integration in three dimensions (organisational scale, geographic scale and types of productive actors), distinguishing between value chains and production networks.

However, following most of the literature, we will use the various terms labelling GVCs interchangeably in this paper.

When the analysis turns to the economic consequences of GVCs, the complexity is even larger and theoretically challenging. The pervasiveness of GVCs on the world economy brought obvious impacts on trade and labour markets but also on broader issues like inequality, poverty and the environment. At present, even the measures that usually inform the policy-debate like export growth, bilateral trade balances, export market shares or real exchange rates need to be redefined in order to disentangle the domestic and foreign value-added actually embodied in exports.

In theoretical terms, the organisation of production along GVCs tends to follow the classical determinants of comparative advantage. Important contributions to the theory of international fragmentation of production and trade in intermediate products using Ricardian and Heckscher-Ohlin type models include the works of Arndt (1997), Venables (1999), Yi (2003), Jones and Kierzkowski (2001, 2005), Deardorff (2001a, 2005), Kohler (2004a,b), Markusen (2006) and Baldwin and Robert-Nicoud (2014), among many others. Nevertheless, there is still no comprehensive theoretical model to fit the specificities of GVCs. Grossman and Rossi-Hansberg (2006, 2008) propose a formal model of trade in tasks where offshoring acts as technological progress and originates a positive productivity effect that can generate gains for all domestic factors. Arndt and Kierzkowski (2001) and Antràs and Rossi-Hansberg (2009) offer reviews of this literature. Another branch of the literature on fragmentation focuses on the organisational choices of individual firms, their boundaries and incomplete-contracting, as in the works of McLaren (2000), Antràs (2003, 2005), Antràs and Helpman (2004) and Grossman and Helpman (2005). Spencer (2005) and Helpman (2006) provide useful reviews of this recent theoretical literature.

This paper surveys different strands of the empirical literature on GVCs, which is expanding fast and in various directions. The main goal is to provide a conceptual and interpretational framework, focusing on drivers, measures and, partially, on the impacts of this phenomenon. The remaining of the paper is organised as follows. Section 2 discusses the main drivers underlying the significant expansion of GVCs in the last decades. Section 3 surveys the different methodologies used in the literature to map and measure GVCs. Section 4 discusses the impacts of GVCs on trade flows, productivity and labour market developments and shortly debates the implications for policy-making. Finally, section 5 presents some concluding remarks.

2 Drivers of Global Value Chains

As discussed in Hillberry (2011), it is difficult to separate the drivers of the increase in international trade from those with a specific impact on the fragmentation of production. Nevertheless, declining transport, information and communication costs, the sharp increase in technological progress and lower political and economic barriers to trade are pointed out as the main drivers of GVCs in the last two decades. In addition, the liberalisation of capital flows has contributed to the expansion of foreign direct investment (FDI) flows, with multinational corporations as key players in operationalising GVCs. Data constraints have limited the empirical assessment of these drivers, while important inter-linkages make it difficult to disentangle the respective individual effects (Figure 1).

Hillberry (2011) finds that more readily available air transport and the integration in the world economy of new countries in Eastern Europe and East Asia may have been important sources of growth in international production fragmentation. Arvis et al. (2013) synthesise work done at the OECD on cost factors across the entire trade chain, namely "behind the border", "crossing the border", and "beyond the border" cost factors. The authors highlight the strong interactions and complementarities between all these components of trade costs, which are magnified by the increasing prevalence of GVCs. In addition, WTO (2008) examines the phenomena of international fragmentation of production and highlights the importance of two main factors as driving this process: the decline of international trade

Figure 1: Schematic illustration of the main drivers of GVCs
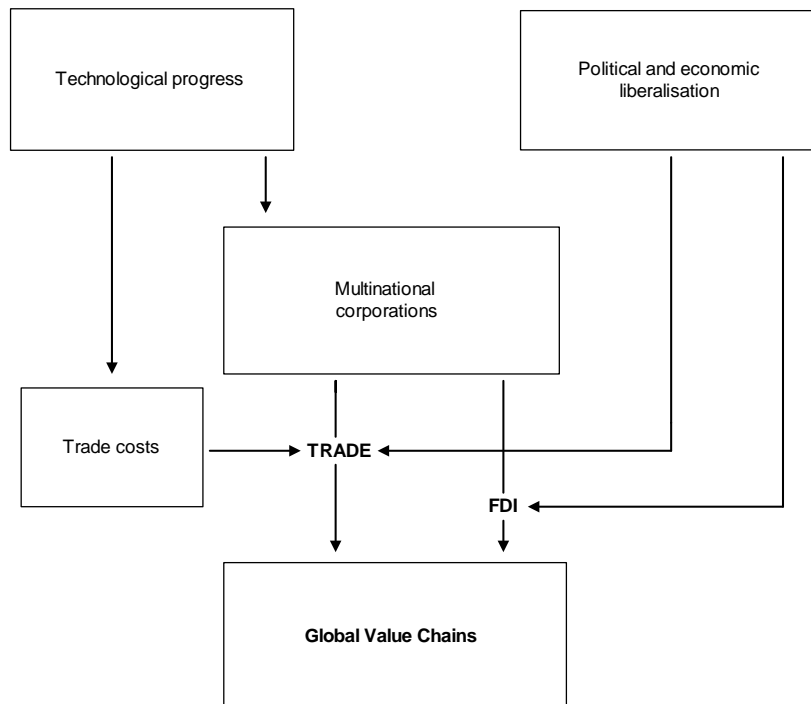
costs (including the reduction in tariff rates, lower transportation and communication costs and the reduction in the time required to exchange goods) and the lower managerial costs of offshoring (including searching costs and costs of monitoring and coordinating foreign activities), mostly reflecting advances in telecommunications technology. Finally, Baldwin (2012*a*) provides an interesting framework for the understanding of global supply chains, putting them into an historical perspective and discussing factors likely to affect their future evolution, namely the trade-off between specialisation gains and coordination costs. This section provides a broad discussion of the main drivers of GVCs that have been referred in the literature.

2.1 Technological progress and trade costs

Technological progress is one key driver of the development of GVCs. Only technological progress makes it possible that parts and components produced in factories in different parts of the world perfectly combine in sophisticated final products. In addition, improved information, telecommunications and transportation technologies are key in the coordination of dispersed production activities and in the management of highly complex GVCs. As it has always been the case, major transformations in world production systems are mostly based on technological breakthroughs. As discussed in Blinder (2006), the available technology, especially in transportation, information and communications, largely determines what can be traded internationally and what cannot.

Deardorff (2001*b*) discusses the important role of services in the emergence of the international fragmentation of production. The operation of GVCs involves more services' inputs than trade in final goods only, thus the gains from GVCs are highly dependent on the availability of the adequate services at low cost. Significant technological improvements and the liberalisation of trade in services have contributed to lower their cost. Debaere et al. (2013) study the effect of services on offshoring in the manufacturing industry using firm-level data for Ireland from 2000 to 2004. They find that the greater availability of local services increases the ratio of imported intermediates to sales. This positive impact of services on offshoring differs by firm type, with domestic firms responding to changes in local services conditions and multinationals being less affected.

In recent decades, there was a sharp progress in information and communication technology (ICT) and a dramatic fall in telecommunication costs (Figure 2). These major transformations have enhanced the development of GVCs in the services sector itself. Amiti and Wei (2005) describe the main world trends in outsourcing of business services and computing and information services. The authors show that service outsourcing has been steadily increasing, though it is still at low levels. Abramovsky and Griffith (2006) examine how ICT

Figure 2: World indicators of information and communication technology (ICT)
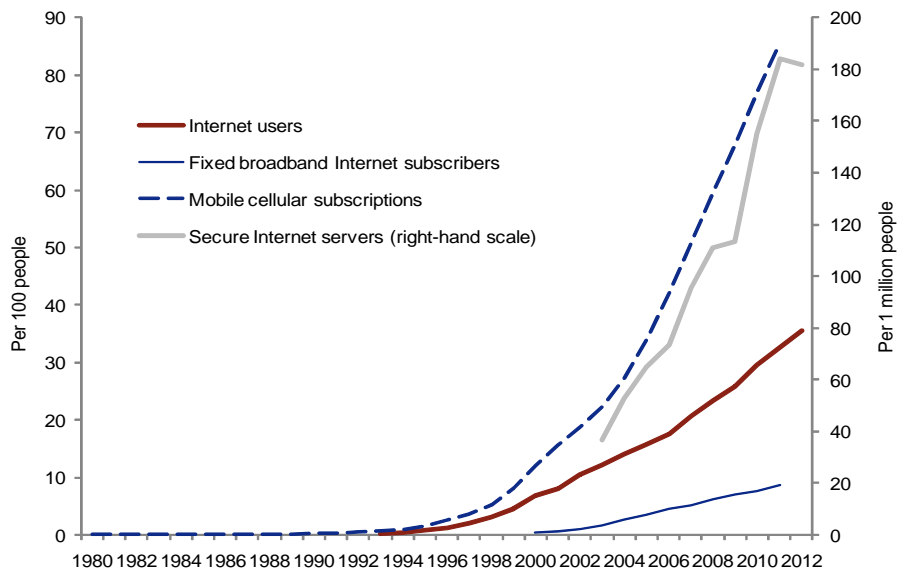
Source: World Bank - World Development Indicators (WDI).

affects the cost of offshoring services using firm-level data for the UK and find that it plays an important role in facilitating firms decision to purchase business services from abroad.

With the strong growth of international exchanges of electronically transmitted business services, sectors like financial services, computer and information services and other commercial and business services are increasingly traded internationally. Garner (2004) discusses the main economic, technological, and regulatory factors driving offshoring in the services sector and suggests four characteristics that make a service job more susceptible to offshoring: labour-intensive; information-based; codifiable; and high-transparency in the information. van Welsum and Vickery (2005) highlight the importance of ICT to service offshoring and they also consider four criteria that make a service occupation potentially offshorable: intensive use of ICT; producing an output that can be traded or transmitted via the Internet; highly codifiable knowledge content; and no face-to-face contact requirements. Their results suggest that around 20 per cent of total employment in Europe, the US, Canada and Australia could potentially be affected by the international outsourcing of services activities.

In this context, the concept of "offshorability" has emerged recently to designate the potential scope for offshoring of a given task. Several studies use data at a detailed occupational level to obtain information about the task content of work and related it to its offshorability, in the line of previous work on the impact of technological change (see, for instance, Autor et al. (2003)). Blinder (2009) uses occupational codes to construct an ordinal ranking of the potential offshorability of tasks, concluding that between 22 and 29 per cent of all US jobs are potentially offshorable. Jensen and Kletzer (2010) construct two different measures to

identify service activities that are potentially exposed to international trade (one based on the domestic geographic concentration and the other based on the task content of activities). They find a positive correlation between skill and potential tradability in the US. Blinder and Krueger (2013) discuss the concept and use survey techniques to develop different measures of offshorability, defined as the ability to perform the work from abroad. They find that around 25 per cent of US jobs are potentially offshorable and that offshorability is stronger in production work and in office and administrative tasks. Finally, Autor (2013) provides a comprehensive and interesting discussion of the main concepts and empirical methods associated with this task approach. The exact definition of an offshorable task is problematic but, as discussed therein, it ultimately depends on whether distance leads to a reduction in the quality of the task performed, not on its strict routine content.

As electronic communications progressively replace face-to-face interactions, the importance of geographical distance as a barrier for international service transactions declines. In fact, the great technological advances in communication networks with the availability of the global high-bandwidth network infrastructures have led to new types of business services trade, which take advantage of time zone differences between countries. The development of the Indian software industry or the rise of the call-centre service industry in Ireland are commonly cited as examples. Dettmer (2013) provides empirical evidence for the theoretical contributions of Marjit (2007) and Kikuchi and Iwasa (2010), which propose models of international trade that capture the role of time zone differences. She finds that time zones are a driving force of business services trade by allowing for continuous operations when a proper division of labour is feasible and countries are connected to electronic communications infrastructures.

The important technical innovations in transportation technology in recent decades play also a key role in the development of GVCs. As discussed in DFAIT (2011), the growth of GVCs may be less influenced by the costs of transportation in a traditional sense, and more by the increased speed and reliability of transportation, as the maintenance of an efficient international supply of inputs puts a premium on the timeliness of deliveries. This argument is also supported by evidence that a growing share of trade in intermediate inputs is being transported by air, a fast but relatively expensive mode of transportation. As discussed in Hummels (2007), there has been a rapid technological change in air shipping over the last decades, including improvements in avionics, wing design, materials, and most importantly the adoption of jet aircraft engines which are faster, more fuel efficient and reliable. Hummels and Schaur (2013) study firms' transport choices between the use of air and ocean cargo and conclude that trade in parts and components is specially time-sensitive. These results suggests a link between the decline in the relative cost of rapid transportation and the growth in worldwide fragmentation of production. Nordas (2006) examines the relevance of

time as a competitive factor and concludes that effective transport and logistics services, and trade facilitation leading to simpler customs procedures have a positive effect on trade and on the probability of entering an international supply chain.

Ocean shipping, which represents the major transportation mode in world trade, underwent also important technological changes in the last decades, which can be linked to the rise of GVCs. As examined in Hummels (2007), the growth of open registry shipping, scale effects from increased trade volumes, and the introduction of containerisation contributed to shorter transportation time. Open registry shipping is the practice of registering ships under flags of convenience to reduce regulatory and manning costs. An increasing amount of ocean shipping is done under flags of convenience with lower vessel operating cost than traditional flag shippers. In addition, the development of containerised transport allowed cost reductions in cargo handling, increasing cargo transshipment and inducing the creation of hub ports that take advantage of increasing returns to scale in maritime transport (see Clark et al. (2004)).

Information and communication technology have also led to improved logistic services that facilitate the timely and efficient exchange of intermediate goods. Using the example stated in Hillberry (2011), global positioning systems, along with efficient telecommunications and information technology, allow firms to better track and schedule their shipments of goods. In this context, benefiting from their strategic geographical location and adequate infrastructures, some regions became core distribution and logistics hubs of GVCs. These elements allowed regions or countries to lower the cost of doing business (including trade-related domestic regulations and procedures), increasing the international competitiveness of domestic firms. Feenstra et al. (2002) and Feenstra and Hanson (2004) study the role of Hong Kong in the distribution of China's exports, adding value to the goods through sorting, packaging, testing, marketing and matching suppliers and customers. Additionally, Kimura (2006) discusses the importance of service link costs for connecting production blocks in the development of efficient international production and distribution networks in East Asia. Young (1999) argues that the movement of goods through hubs like Hong Kong and the Netherlands is driven not only by transport considerations, but also by their role in the processing and marketing of the goods.

Finally, the strong increase of trade associated with the development of GVCs during the 90's coincides with a period of historically low oil prices (Figure 3). Although there is little empirical evidence linking these two factors, a low oil price scenario should impact positively on the costs of doing trade. In fact, transport costs are important for trade and energy is an input to transportation that is difficult to substitute. Bridgman (2008) presents a vertical specialisation trade model with an energy-using transportation sector. In the simulated model, trade growth slows from 1974 to 1985 as the increase in oil prices led to higher transport costs that offset the decline in tariffs. However, higher oil prices during the 2000s

Figure 3: World vertical specialisation activities and oil prices
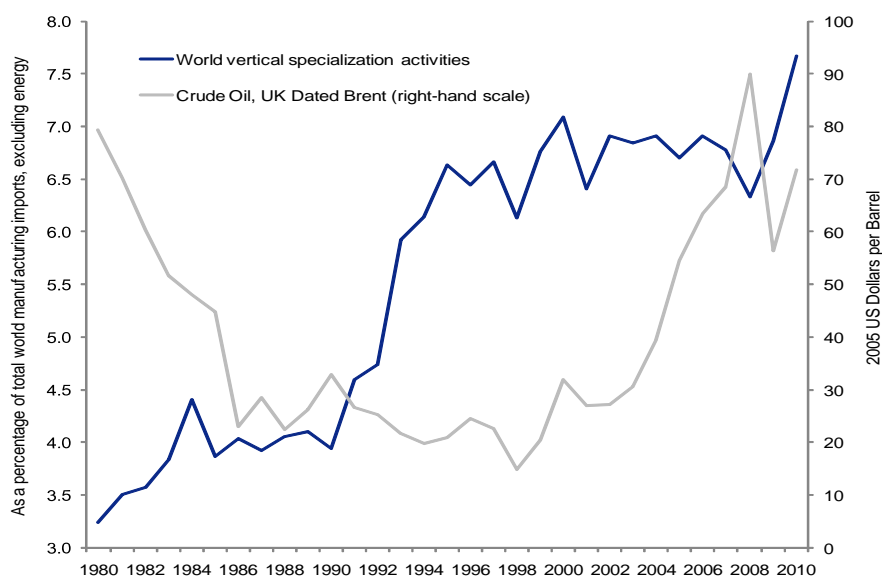
Sources: IMF - International Financial Statistics (IFS) and authors' calculations.
Note: The measure of vertical specialisation activities is computed as the "excess" imports of an intermediate good for a country with very high exports of a related output good (see Amador and Cabral (2009)).

did not lead to a decline in international trade because there was a simultaneous increase of productivity in the transportation sector.

2.2 Economic and trade liberalisation

The fall in political and economic barriers has been an important driver of trade, in general, and of GVCs, in particular (Figure 4). As discussed in Baldwin (2012*b*), at present supply-chain trade is very regionalised, supported by a combination of regional trade agreements, bilateral investment treaties and unilateral reforms by developing countries, mostly accomplished outside the World Trade Organisation (WTO). As a result, the global production network is organised around three major regional blocks in Europe, in Asia and in North America. Nevertheless, WTO members reached a comprehensive trade agreement in December 2013, the "Bali Package", aimed at lowering global trade barriers. It involves an effort to simplify the procedures for doing business across borders, including an agreement on trade facilitation, and to improve market access for least-developed countries.

The political and economical liberalisation in Europe is vividly illustrated by the successive enlargements of the European Union (EU) towards Central and Eastern European countries. This fact brought such economies into the European Common Market and created an intense net of international trade linkages, including important GVCs. Kaminski and Ng (2005) investigate network trade in ten Central and Eastern European countries until 2002, providing a detailed analysis of the evolution of network trade in these countries over time. They show

Figure 4: Global economic and trade liberalisation
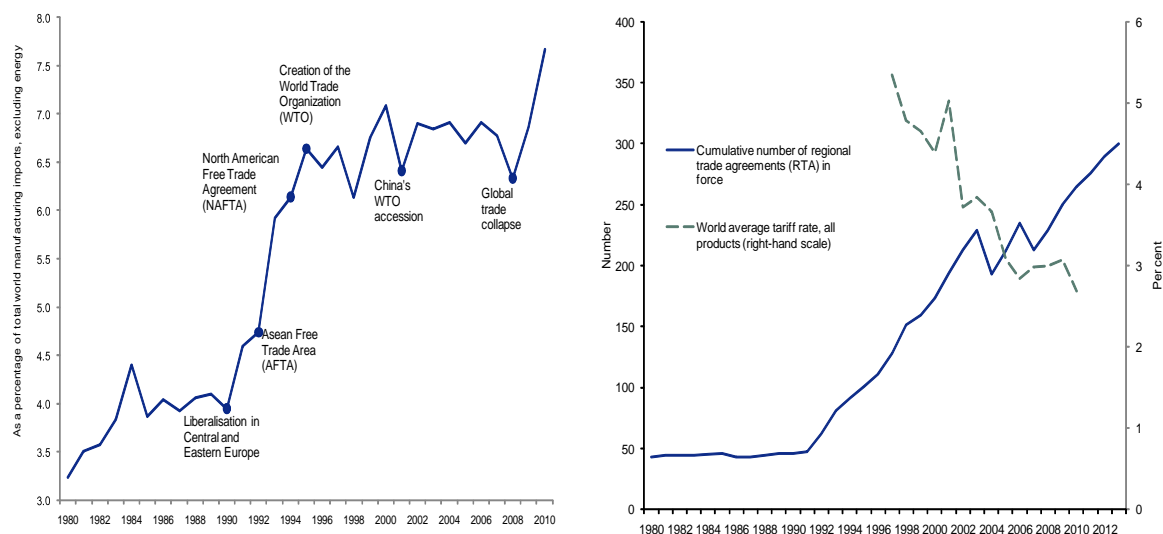
(a) A timeline of main trade events

(b) Trade agreements and tariffs

Sources: World Trade Organisation (WTO) for the RTA data, World Bank - World Development Indicators (WDI) for the tariff rate data and authors' calculations.
Notes: Measure of vertical specialisation activities computed as the "excess" imports of an intermediate good for a country with very high exports of a related output good (see Amador and Cabral (2009). Cumulative number of regional trade agreements (RTA) in force by date of entry into force. Weighted mean applied tariff as the average of effectively applied rates weighted by the product import shares of each partner country.

that it underwent important changes: there has been a shift from simple assembly operations to processing and local production of parts; these network firms, operating through mostly EU-based networks of production and distribution, have begun expanding beyond EU markets. They also conclude that the largest recipients of FDI in the 1990s (Hungary, the Czech Republic and Slovakia) have also experienced the fastest growth in network trade, an issue that we will return to in the next subsection. Marin (2006) uses survey data on German and Austrian firms investment projects in Eastern Europe from 1990 to 2001 to document the pattern of intra-firm trade among these countries and the emergence of some of the Eastern European countries as new players in the international division of production. Behar and Freund (2011) use international trade data in parts and components to examine how fragmentation in Europe has evolved and discuss how the process of EU integration may have facilitated the volume and increasing complexity of intra-EU trade in intermediates products.

An essential element of the movement towards trade liberalisation was the accession of China to the WTO in 2001. Zhao (2005) provides a detailed description of the process of China's external liberalisation over the last decades, examining the reforms leading to the accession to the WTO. Athukorala (2009) investigates how China's emergence as a major trading nation is affecting the export performance of other East Asian countries, in a context of increased global production sharing. He concludes that China's rapid integration into global production networks as a major assembly centre has created new opportunities for the other

East Asian countries to engage in various segments of the value chain in line with their comparative advantage. In fact, in geographical terms, the international fragmentation of production has been largely reported in emerging market economies in East Asia. Kimura and Ando (2005) examine the mechanics of international networks in East Asia using highly disaggregated international trade data and micro-data for Japanese multinational firms. The authors find evidence of active trade of parts and components in a complex combination of intra-firm and arm's-length transactions and suggest that the policy environment in East Asia was important in fostering these activities. Kimura and Obashi (2011) provide a recent and detailed review of production networks in East Asia, discussing their structure, the conditions of their existence and their implications. In addition, Escaith and Inomata (2011) examine the conjunction of technical, institutional and political changes that led to the emergence of production and trade networks in East Asia.

In general, applied tariffs in Asia are low and still decreasing but vary among sectors. The importance of trade on semi-processed products in Asian trade is reflected in the fact that tariffs on these products are the lowest. Additionally, several regional trading agreements among Asian countries have also contributed to accentuate regional integration and the development of GVCs in the region. One of the best known trade agreements is the Association of Southeast Asian Nations (ASEAN) Free Trade Area (AFTA). The AFTA agreement was signed in 1992 and now comprises the ten countries of the ASEAN (Indonesia, Malaysia, the Philippines, Singapore, Thailand, Brunei, Myanmar, Cambodia, Laos, and Vietnam). These efforts of economic integration were reinforced with the formation of the ASEAN Economic Community (AEC) in 2003, which aims at creating a single market and production base among ASEAN countries (see Chia (2013) for a detailed discussion on the evolution of ASEAN economic integration). As examined in Athukorala (2011), network trade strengthened economic interdependence in Asia, with China playing a key role as a centre of final assembly. The rise of China as a major player in the organisation of production in Asia, replacing to some extent Japan and the US, is also highlighted by Kalra (2010). Krapohl and Fink (2013) study different paths of regional integration and show, that for ASEAN countries, it worked as part of an export-promoting development strategy dependent on major economic partners outside the regional organisation, namely the US, Japan and China.

One of the most debated regional trade agreements is the North American Free Trade Agreement (NAFTA) between the United States, Canada, and Mexico that entered into force in 1994. As discussed in Gruben (2001), evidence on the direct causal impact of NAFTA on the substantial growth of plants operating under the Mexican's *maquiladora* program is difficult to disentangle from other non-NAFTA factors. However, under NAFTA there was a substantial increase in cross-border trade and FDI flows and a deepening of production-sharing in North-America.

Finally, Orefice and Rocha (2013) confirm the positive two-way relation between production networks trade and deeper trade agreements. On the one hand, signing deeper agreements stimulates the creation of production networks by facilitating trade among potential members of a supply chain. The impact of deep integration is higher for trade in automobile parts and information and technology products compared with textiles products. On the other hand, countries already involved in international fragmentation of production are more willing to sign deeper preferential trade agreements with their partners. The probability of signing deeper agreements is higher for country pairs involved in North-South production sharing and for countries in the Asian region.

2.3 FDI flows and intra-firm trade

As highlighted in Figure 1, FDI flows are also linked to the expansion of GVCs. Liberalisation and deregulation contributed strongly to the growth of FDI flows that accelerated markedly since the 90's (Figure 5). Productivity differences play a key role in firms' decisions to offshore parts of the production process and whether to do so through FDI or via arm's-length trade. In fact, as multinational firms adopt the new paradigm of production and become prominent players in international trade, GVCs are increasingly associated with FDI flows, with subsidiaries providing inputs to their parent firms. In this case, trade in intermediate goods takes the form of intra-firm transactions with production stages located in different countries, i.e., vertical production networks in multinationals.

Figure 5: World vertical specialisation activities and FDI flows
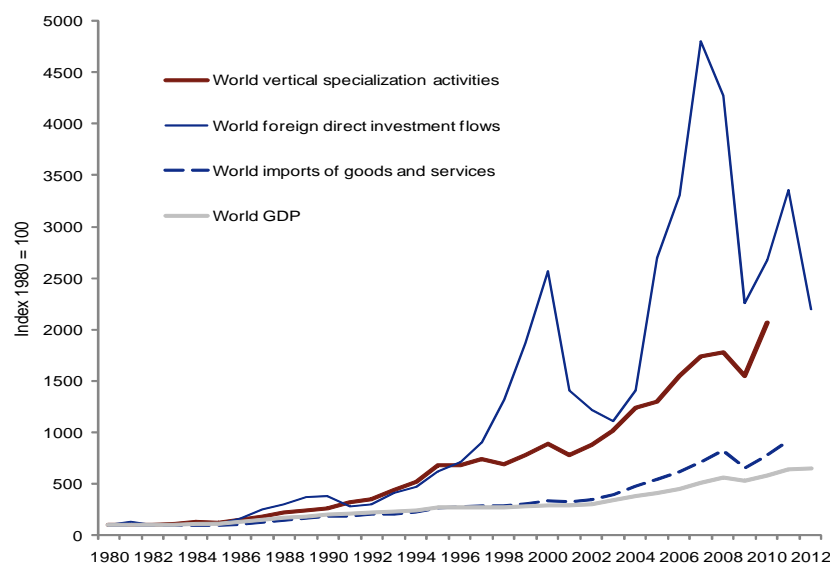
Sources: World Bank - World Development Indicators (WDI) and authors' calculations.
Note: The measure of vertical specialisation activities is computed as the "excess" imports of an intermediate good for a country with very high exports of a related output good (see Amador and Cabral (2009)).

Traditionally, vertical FDI is motivated by cross-country differences in relative factor abundance. In this framework, firms locate production facilities in foreign countries to take advantage of factor-cost differentials in specific stages of production, which are different in factor proportions and geographically separable. This reasoning explains why a firm from a skill-abundant country establish an affiliate in a low-wage country. However, empirical evidence for the US shows that intra-firm trade is concentrated in capital-intensive industries and is mostly between capital-abundant countries (Antràs (2003)). These patterns of intra-firm trade led to new theoretical work on the boundaries of the firm and a new strand of the empirical literature focused on the integration strategies of multinational corporations, and the consequent intra-firm trade, and on the choices of firms between different international outsourcing modes.

Some articles use intra-firm trade data aggregated by product and country of origin of the imported inputs. For the US, Yeaple (2006) find that the share of intra-firm imports tends to be higher in more capital and R&D-intensive industries. Nunn and Trefler (2008, 2013) use product-level data on US intra-firm and arm's-length imports and also find that vertical integration is increasing in the share of non-contractible inputs provided by US parent firm. They also conclude that intra-firm trade is larger where these headquarter inputs are important and productivity is high. Bernard, Jensen, Redding and Schott (2010) provide evidence on the impact of several interactions of country and product characteristics in the shares of US intra-firm trade. They find that intra-firm trade is high for products with low levels of contractibility sourced from countries with weak governance, for skill-intensive products from skill-scarce countries, and for capital-intensive products from capital-abundant countries.

Other studies use firm-level data to analyse the firms' choices between intra-firm and arm's-length trade, but the evidence is still scarce and has produced mixed results. Kohler and Smolka (2012) find a productivity ranking across different sourcing strategies of Spanish firms, in line with the predictions of the model of Antràs and Helpman (2004). Firms who choose vertical integration tend to be more productive than those who rely on arm's-length transactions, and firms who offshore are generally more productive than those who source their inputs domestically. Using a sample of Japanese firms, Tomiura (2007) also concludes that FDI firms are more productive than foreign outsourcers and exporters, which in turn are more productive than domestic firms. Using data on French firms, Corcos et al. (2013) find that intra-firm trade is more likely in capital- and skill-intensive firms, in more productive firms, and from countries with well-functioning judicial institutions. On the contrary, Jabbour (2012) examines the offshoring strategies of French manufacturing firms and finds that those more productive tend outsource through arm's-length transactions, while less productive firms integrate vertically. Defever and Toubal (2013) use detailed data on imports of French multinationals and also find that the most productive multinationals import through a

foreign unrelated supplier while the least productive import their intermediate inputs from a foreign related party.

A complementary strand of research studies the organisation of international sourcing strategies within multinational networks. Alfaro and Charlton (2009) use a global firm-level dataset that establishes the location, ownership, and activity of more than 650,000 multinational subsidiaries at a high level of sectoral disaggregation. They find that the number of vertical multinational subsidiaries is larger than commonly thought, even within developed countries. Many of the foreign subsidiaries in the same two-digit industry as their parents are located in four-digit sectors that produce highly specialised inputs close to their parents' final good. The authors named these subsidiaries unveiled at higher levels of disaggregation "intra-industry vertical FDI" and found that a large proportion of these firms are located in high-skill countries.

This pattern of intra-industry North-North vertical FDI is interpreted as reflecting multinationals' decision to own the stages of production closest to their own. Engemann and Lindemann (2013) also find that German multinationals tend to locate affiliates that produce goods positioned at later stages of the production process in more productive countries. Hanson et al. (2005) use firm-level data on US multinationals to examine trade in intermediate goods between parent firms and foreign affiliates. They conclude that imports of inputs from the affiliates are higher in host countries with lower trade costs, lower wages for less-skilled labour and lower corporate income tax rates. In the same vein, Borga and Zeile (2004) examine the propensity of foreign affiliates to import intermediate goods from their US parent companies, relating it to several firm, industry and country characteristics. Their results also point to a vertical specialisation between more technologically advanced activities performed by the parent and lower-skilled activities performed by the affiliate. Tanaka (2011) uses panel data on Japanese and US multinationals and finds that unskilled-labour abundance in foreign countries has a significantly positive impact on offshore production by Japanese firms but it has no significant effect on foreign affiliate sales to US multinationals.

3   Mapping and measuring Global Value Chains

The empirical trade literature suggests a range of methods and data sources to map and measure GVCs at the sectoral level. Three main methodological approaches have been used: international trade statistics on parts and components; customs statistics on processing trade; international trade data combined with input-output (I-O) tables. Figure 6 presents a timeline of the main articles in each methodological approach, each one to be detailed in the next three subsections. The research on GVCs using firm-level data has emerged more recently,

Figure 6: Measuring GVCs using sector-level data - Timeline of main research
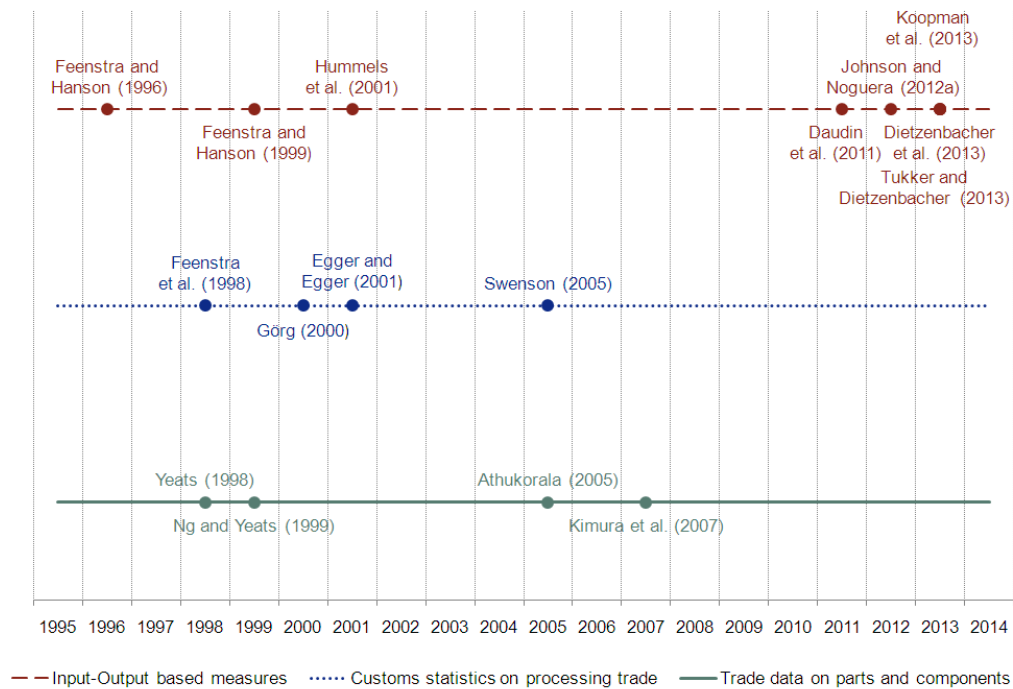
following different methodologies and using both qualitative surveys and international trade data. Major micro-level studies of GVCs are surveyed in subsection 3.4.

Figure 7 illustrates the strengths and caveats of the strands of research that map and measure GVCs. The first dimension in the figure (*x-axis*) corresponds to the complexity of data required to compute the measure; the second dimension (*y-axis*) stands for the accuracy of the resulting quantification, i.e., to what extent the measure truly captures the characteristics of GVCs; the third dimension (size of the circle) represents the coverage of the measure, i.e., to what extent the information content of the measure encompasses the worldwide dimension of GVCs. For the purpose of ordering, each dimension is measured from 1 to 5, such that higher values mean more complex data needed, a more accurate final measure, and higher global coverage, respectively.

Figure 7: Summary of main strands of the empirical research on GVCs
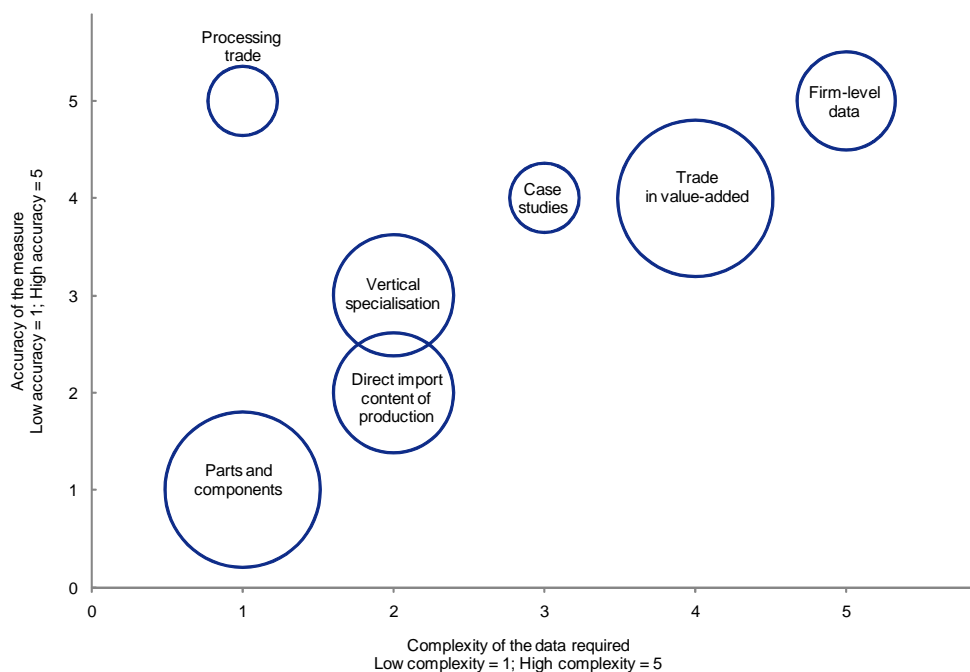
Notes: The size of the circles represents the coverage of each measure relatively to the real size of the GVCs phenomenon in the world economy. Larger circles stand for higher coverage.

3.1 International trade data on parts and components

The first and simplest methodological approach makes use of international trade statistics to measure fragmentation by comparing trade in goods classified as parts and components with trade in final products. In fact, even if trade in intermediate goods as a whole has not risen much faster than trade in final goods, data shows that trade in parts and components has been more dynamic than that of trade in final goods until mid-2000s (see Athukorala and Yamashita (2006) and Jones et al. (2005) for a review). The main advantage of this approach is the high coverage and low complexity of the data and its comparability across countries, allowing the identification of specific trading partner relationships. A drawback is the low accuracy of the measure and the fact that it relies heavily on the product classification of trade statistics. Typically, the parts and components aggregate is obtained from the Standard International Trade Classification (SITC) at the most detailed level and tends to include products belonging to SITC 7 (Machinery and transport equipment) and SITC 8 (Miscellaneous manufactured articles).

This type of analysis was initiated with the works of Yeats (1998) and Ng and Yeats (1999) and has been used extensively afterwards. Several papers focus on specific regions or countries and make use of this type of detailed trade data to analyse the international fragmentation of production. Understandably, the focus is put on East Asia and China's recent ex-

periences. Athukorala (2005) use trade data on parts and components to examine the international product fragmentation and its implications for global and regional trade patterns in East Asia. He finds that the degree of dependence of East Asia on this new form of international specialisation is proportionately larger than that of North America and Europe. Gaulier et al. (2007) use a detailed bilateral trade database with information on unit values and also conclude that the emergence of the Chinese economy has intensified the international segmentation of production processes among Asian partners. Orefice and Rocha (2013) use import values of parts and components in the period 1980-2007 for a set of 200 countries as a proxy of production networks trade in their study of the relation between GVCs and trade agreements.

Other authors have used this method to measure the importance of fragmentation in specific industries in particular countries or geographical areas. Lall et al. (2004) study of the electronics and automotive sectors in East Asia and Latin America. They show that electronics is fragmenting faster worldwide than the car industry, in particular in East Asia where electronics networks are more advanced. Kimura et al. (2007) examine patterns of international trade in machinery parts and components in East Asia and Europe and conclude that the theory of fragmentation is well suited for explaining the mechanics of international networks in East Asia. Sturgeon and Memedovic (2010) examine patterns of final and intermediate goods trade at the country level and find a growing involvement of developing countries in GVCs. The authors also trace GVC development in the three industries (electronics, automobiles and motorcycles, and apparel and footwear) and find evidence of deepening economic integration overall, especially since 2001, but with strong differences across the three industries. The electronics industry has driven intermediate goods trade the most, being the only of the three industries where intermediate goods trade rose more than trade in final goods.

3.2   Customs statistics on processing trade

The second methodological sectoral approach relies on the analysis of customs statistics. These statistics include information on trade associated with customs arrangements in which tariff exemptions or reductions are granted in accordance to the domestic input content of imported goods. The US Offshore Assembly Programme and the EU Processing Trade datasets are examples of such data, which have been used in a number of empirical studies to obtain a narrow measure of international fragmentation. Outward (inward) processing trade is considered a narrow measure of fragmentation because it captures only the cases where components or materials are exported (imported) for processing abroad (internally) and then reimported (reexported).

Swenson (2005) analyses the US offshore assembly program between 1980 and 2000 and concludes that these operations grew strongly in that period. Swenson (2007) uses the same dataset to examine how competition and production persistence influence US firms outsourcing decisions and finds that sunk costs have a large effect on assembly location choices. Swenson (2013) also use product-country level data from the US offshore assembly program to examine the incomplete pass-through of production and trade costs to outsourcing import prices. Yeats (1998) uses data on offshore assembly processing as a second source of information on international production sharing. The author shows that, outside the machinery and transport equipment group, production sharing seems to be also a key factor in the manufacture of textiles and clothing, leather goods, footwear and other labour intensive manufactures. Clark (2006) examines data on the use of offshore assembly provisions in the US tariff code and concludes that firms tend to shift the simple assembly operations to unskilled-labour abundant countries. Feenstra et al. (1998) also find that the US content of imports of apparel and machinery and of transportation equipment from industrial countries, made through the US offshore assembly program, is characterised by relatively intense use of skilled-labour.

Görg (2000) uses Eurostat data to show that there was an increase in US inward processing trade in EU countries, in particular in the periphery and in the leather and textiles sectors. Moreover, Baldone et al. (2001) conclude that outward processing trade represents a significant share of trade between the EU15 and Central Europe in the textile and apparel industry. According to Helg and Tajoli (2005), Germany has a higher propensity to use outward processing trade than Italy, especially towards Central and Eastern Europe, and it appears to be concentrated in a few specific sectors. Baldone et al. (2007) also observe that EU processing trade tends to be concentrated in a few industries and regions, while Egger and Egger (2001) find that outward processing trade in the EU is stronger in import-competing industries, which correspond to the EU low-skilled intensive industries. They also show that outward processing in EU manufacturing grew at the relatively rapid pace in the period 1995-1997. Similarly, Egger and Egger (2005) observe that outward processing trade in the EU grew significantly between 1988 and 1999, in particular with Central and Eastern European countries.

Processing trade accounts also for a significant share of the total manufactured exports of some developing countries. Lemoine and Ünal Kesenci (2002, 2004) and Gaulier et al. (2005) use detailed data from China's customs statistics on processing trade and conclude that the preferential treatment granted to international processing activities has fostered production sharing between China and its neighbours and strengthened regional economic integration in East Asia.

3.3 Input-output based measures

3.3.1 Classical input-output matrices and the import content of production and exports

Most of the initial systematic evidence on international fragmentation of production focuses on the imported input shares of gross output, total inputs or exports. Typically, such measures use information from classical I-O tables, sometimes complemented with import penetration statistics computed from trade data. The accuracy of the measurement of fragmentation depends crucially on the product breakdown available. A very detailed product classification assures that the characteristics of the production chain are identified and tracked properly, i.e., that a given product is indeed an intermediate good used in the production of another product. However, such data is typically unavailable, making accurate cross-country and/or time-series analysis more difficult to implement. Therefore, the identification of countries with important fragmentation activities and the assessment of its main trends has usually been carried out at a relatively aggregate product breakdown. I-O tables tend to provide the most appropriate source of sectoral information, as they allow a cross-industry and time analysis, even if they are available only for some countries on a comparable basis and are not updated regularly.

Traditionally, two different types of measures based on classical I-O data have been implemented in the empirical trade literature (see Hijzen (2005) for a discussion). The first type of measure focuses on the foreign content of domestic production as it considers the share of (direct) imported inputs in production or in total inputs. This measure is originally due to Feenstra and Hanson (1996) and has been used widely afterwards in different formats (see Horgos (2009) for a detailed analysis of the design of this type of indices). Feenstra and Hanson (1999) distinguish between broad and narrow definitions of outsourcing. The broad definition considers the value of intermediate goods that each manufacturing industry purchases from all the remaining ones. The narrow definition of outsourcing is obtained by considering only the inputs that are purchased from the same industry of the good being produced. More recently, Feenstra and Jensen (2012) use firm-level data on imports and production to improve the classical I-O sectoral estimates of imported inputs. In fact, because I-O data on imported inputs at the sectoral level are not available for the US, the empirical research has mostly relied on the "proportionality" or "import comparability" assumption, i.e., each sector is assumed to import each input in the same proportion as its economy-wide use of that input (see Winkler and Milberg (2012) for a discussion).

Most of the studies using this measure find a steady increase of international outsourcing of material inputs over time. Campa and Goldberg (1997) find an increase of the share of imported inputs in production in the US, UK and Canada, but not in Japan. Hijzen (2005) shows that international outsourcing has steadily increased since the early eighties in the

UK, while significant differences persist across industries. Egger et al. (2001) and Egger and Egger (2003) provide evidence of a significant growth of Austrian outsourcing to Central and Eastern European countries from 1990 to 1998, reflecting the decline of trade barriers and the low wages prevailing there.

The second I-O based measure of fragmentation focuses on the (direct and indirect) import content of exports and it was initially formulated by Hummels et al. (1998) and Hummels et al. (2001), which labelled it "vertical specialisation". This measure captures situations where the production is carried out in at least two countries and that the goods cross at least twice the international borders. In comparison with the first I-O based measure, which refers to the direct imported input share of gross output, this measure is narrower as it adds the condition that some of the resulting output must be exported. Conversely, it can be argued that the measure proposed by Hummels et al. (2001) broader as it considers also the imported inputs used indirectly in the production of the goods exported. Hummels et al. (2001) find that vertical specialisation activities accounted for 21 per cent of the exports of ten OECD and four emerging market countries in 1990 and grew almost 30 per cent between 1970 and 1990.

Chen et al. (2005) updates the analysis presented in Hummels et al. (2001) by using more recent I-O tables, finding also that trade in vertical specialised goods has increased over time. Other studies have applied this methodology, in some cases with minor changes from the original formulation, and found an increase of vertical specialisation activities. Some examples are Amador and Cabral (2008) for Portugal, Minondo and Rubert (2002) for Spain, Breda et al. (2008) for Italy and six other EU countries, Zhang and Sun (2007) for China, and Chen and Chang (2006) for Taiwan and South Korea.

China's processing trade regime raises additional challenges to the measurement of the foreign content of exports, because it invalidates the Hummels et al. (2001) assumption that imported inputs are used evenly in production for domestic sales and for exports. Koopman et al. (2012) start from the Hummels et al. (2001) formulation and develop a general framework for estimating the foreign and domestic content in exports when processing exports are pervasive, applying it to Chinese data. Dean et al. (2011) also estimate the vertical specialisation of Chinese merchandise exports, adjusting for the importance of Chinese processing imports. Chen et al. (2012) measure the domestic value-added generated by Chinese exports estimating distinct I-O coefficients for processing exports, non-processing exports, and products for domestic use. In the same vein, Upward et al. (2013) use imports of intermediate inputs and exports at the firm-transaction level to estimate foreign and domestic value-added of Chinese exports, taking into account processing trade. As imported inputs are used more intensively in production of processing exports, these works show that accounting for processing trade leads to a higher estimate of the foreign content of exports.

Amador and Cabral (2009) propose a relative measure of vertical specialisation-based trade that combines information from product detailed and country generic I-O matrices with international trade data. If a country has a simultaneous high export share of a product and a high import share of a related intermediate good used in its production, then this "excess" of intermediate imports is used as a proxy of trade related to vertical specialisation activities. The strength of this measure is its ability to produce results for a large sample of countries with a detailed product breakdown over more than four decades. However, the estimated levels of vertical specialisation-based trade must be interpreted in relative terms and as proxies. The article finds a substantial increase of vertical specialisation activities in high-tech products in East Asia over the last two decades. This is the measure used to illustrated the evolution of GVCs in Figures 3 to 5.

In a different framework, recent studies use classical I-O data to measure of the average position of an industry in the production line. Antràs et al. (2012) measure the average distance of an industry from final use, which they named industry upstreamness, using US I-O tables. They also compute a summary measure of the average upstreamness of exports at the country-level, as a weighted average of the industry upstreamness values. An equivalent measure of industry upstreamness was proposed by Fally (2012) based on the notion that industries selling a disproportionate share of their output to relatively upstream industries should be relatively upstream themselves. Fally (2012) also develops a measure of the number of production stages embodied in an industry's output. Antràs and Chor (2013) propose two related measures of the average position of an industry in the value chain to capture the downstreamness of an industry in production processes. The first measure of downstreamness is the ratio of aggregate direct use to aggregate total use of an industry as an input and the second one is the reciprocal of the measure of industry upstreamness defined in Antràs et al. (2012). The authors show that the optimal pattern of ownership along an international value chain depends on the relative position (upstream versus downstream) of each supplier and on whether production stages are sequential complements or substitutes.

3.3.2 Global input-output matrices and trade in value-added

As GVCs spread worldwide, the concept of "country of origin" becomes increasingly difficult to apply. A country may stand as a large exporter of a specific good without adding much value to it (see, for instance, Dedrick et al. (2010) for a case study of Apple's iPod value chain). Hence, the analysis of an industry export potential and competitiveness needs to take into account its integration in a GVC and the role of trade in intermediate inputs. As a result, the analysis of gross trade flows needs to be complemented with the analysis of trade in value-added, where gross export flows are decomposed in domestic and foreign

value-added fully tracking down the original source country of the foreign value-added.

The need for better and complementary metrics on the contribution of trade to each nation's value-added, income and employment requires world I-O tables with information on all bilateral exchanges of intermediate inputs. This has led to several projects to build such matrices and some have already produced interesting results. A recent special issue of the *Economic Systems Research* provides a very useful and detailed description of several global multi-regional I-O databases currently available (see Tukker and Dietzenbacher (2013) for an introduction to this special issue and the papers therein). Table 1 summarises some features of the main global I-O matrices that have been used in the empirical research on GVCs.

The availability of global I-O matrices led to the development of methodological contributions suggesting more general metrics of GVCs. Several recent articles generalise the vertical specialisation concept of Hummels et al. (2001) and capture different dimensions of value-added embedded in trade. The first studies on the measurement of the value-added of trade in a international I-O framework were those of Johnson and Noguera (2012*a*), Daudin et al. (2011) and Koopman et al. (2013), using the Global Trade Analysis Project (GTAP) database.

Johnson and Noguera (2012*a*) define exports of value-added as the amount of value-added produced in a given source country that is embodied in final goods absorbed in a particular destination and compute the ratio to gross exports (VAX ratio) for 2004. Johnson and Noguera (2012*b*) extends this work linking data on bilateral trade, production, and input use at the sector-level for 42 countries from 1970 to 2009. Johnson and Noguera (2012*c*) use these data to analyse how changes in fragmentation over time are related to proximity. In a similar conceptual framework, Daudin et al. (2011) reallocate the value-added contained in trade in final goods to each country that has participated in its production, using the GTAP database for 1997, 2001, and 2004. They compute the share of imported inputs in exports (VS as in Hummels et al. (2001)), the share of exports used as inputs in exports of other countries (VS1) and the domestic content of imports ($VS1^\star$), i.e., exports that are embedded in re-imported goods. Furthermore, Koopman et al. (2013) provide an unified framework that integrates the several existing measures in the literature in block matrix formulation. They fully decompose gross exports into value-added components and connect official gross statistics to value-added measures of trade. Using this framework, it is possible to completely breakdown gross exports into its domestic and foreign content and further decompose domestic value-added into exports that end up in the direct importer, return from abroad to the exporting country, and indirect exports sent to third countries.

In parallel, Foster-McGregor and Stehrer (2013) and Stehrer (2012) discuss the different concepts associated with trade in value-added and the potential of the World Input-Output

Table 1: Summary of the main global Input-Output databases used in GVCs analysis

	Geographical coverage	Sector breakdown	Time span	Methodological reference
GTAP (Global Trade Analysis Project)	129 countries	57 sectors	1997, 2001, 2004, 2007	Aguiar and Walmsley (2012)
WIOD (World Input-Output Database)	40 countries	35 sectors	1995-2009	Dietzenbacher et al. (2013)
OECD-WTO TiVA (Trade in Value Added)	57 countries	18 sectors	1995, 2000, 2005, 2008, 2009	OECD and WTO (2012)
UNCTAD-Eora GVC Database	187 countries	25 to 500 sectors	1990-2010	UNCTAD (2013*a*)
IDE-JETRO (Institute of Developing Economies - Japan External Trade Organisation)	10 countries	76 industries	1975, 1980, 1985, 1990, 1995, 2000	Meng et al. (2013)

Database (WIOD) database to understand GVCs, as it quantifies the value-added embodied in the goods and services traded internationally. This data make it possible to study the implications of fragmentation on a wide range of issues and some articles were published recently. Since its release, the WIOD was used to derive new measures of competitiveness that take into account the value-added content of trade (Timmer et al. (2013)), to examine the link between international outsourcing and the skill-structure of labour demand (Foster-McGregor et al. (2013)), to decompose the value-added and factor content of trade into its foreign and domestic components (Stehrer et al. (2012)), to study the trends in factor income distributions in GVCs, decomposing domestic value-added into income for capital, low-, medium- and high-skilled labour (Timmer et al. (2012)), among others.

The OECD-WTO Trade in Value Added (TiVA) database was made public more recently and has been mostly used in policy-oriented studies. OECD (2013) summarises the main evidence and policy implications of the OECD's work on GVCs, including trade and investment policies targeted to GVCs. In addition, the OECD produced also several comparable country notes including indicators on the relevance of value-added trade and the participation in GVCs. Other recent exploratory analysis with the OECD-WTO TiVA database include Newby (2013) for Finland, Duprez and Dresse (2013) for Belgium and Beaudreau (2013), which studies the relative specialisation of countries using Balassa-type indicators of revealed comparative advantage calculated in valued-added terms. Baldwin and Lopez-Gonzalez (2013) use both the WIOD database and the OECD-WTO TiVA databases to provide a detailed portrait of the evolution of GVCs between 1995 and 2009.

Finally, a recent collaborative effort between the United Nations Conference on Trade and Development (UNCTAD) and the Eora project[1] has resulted in a multi-regional I-O time series dataset on embodied value-added in trade (the UNCTAD-Eora GVC database). Combining several primary data sources and using interpolation and estimation techniques, a continuous database for the period 1990-2010 with expanded country-coverage was produced. This database is used in the 2013 World Investment Report (UNCTAD (2013*b*)), which offers a general picture of GVCs in the global economy, examines the crossed links between world investment and trade through international production networks and analyses their contributions and risks for global and sustainable development.

3.4 Firm-level data

Empirical studies of GVCs using firm-level data are still relatively scarce but expanding rapidly. However, the available empirical articles do not adopt a common methodology. Some articles rely on qualitative survey data (typically answers pertaining to the international relocation of some activities), while others make use of international firm-level trade data to quantify the relevance of offshoring.

A related literature examines the international transfer of production activities within multi-national firms, thus focusing only on this specific group of firms. Several of these studies use the relative importance of activities in the affiliates as a measure of offshoring. The share of affiliate employment in total multinational's employment is used, for instance, by Head and Ries (2002) for Japanese multinationals, by Hansson (2005) for Swedish multinationals, by Ebenstein et al. (2013) and Ottaviano et al. (2013) for the US, and by Becker et al. (2013) for German multinationals. However, these measures capture only partially the offshoring activities of multinational firms, as they exclude all their arm's-length relations.

3.4.1 International trade data

In most micro-level studies, data on imports of intermediates is used to obtain a quantification of the relevance of imported inputs in the productive process of each firm. The literature presents several alternatives for the computation of these ratios, with differences in terms of the specific variables used in the numerator and the denominator, as well as on the denomination (nominal or real data), the type of transactions (intra-firm and/or arm's-length) and the type of products considered.

In the numerator, most studies use a measure of imports of inputs in real terms but there are different ways of deflating the nominal values. Imports of intermediate goods can be deflated

---

[1]See http://www.worldmrio.com/ for further information and access to the Eora MRIO Database and Lenzen et al. (2013) for a detailed methodological description.

using industry-level price deflators, as in Hijzen et al. (2010) for Japan, using official import price deflators, as in Amiti and Konings (2007) for Indonesia and Kasahara and Rodrigue (2008) for Chile, or using a standard consumer price indices, as in Görg et al. (2008) for Ireland. On the contrary, McCann (2011) uses the euro amount of inputs sourced from abroad in its measure of foreign outsourcing intensity of Irish manufacturing firms.

In general, studies use all imports of inputs, including both intra-firm and arm's-length. However, some studies differentiate these two types of transactions as they are expected to have distinct causes and consequences. For instance, Hijzen et al. (2010) considers two different measures of offshoring for Japanese firms, one of overall offshoring (intra-firm and arm's-length offshoring) and another of intra-firm offshoring.

The greater difference between the measures computed in the various studies relates to the types of products that are considered as imported inputs. The first distinction is to include only materials or both materials and services inputs. Görg and Hanley (2005a) and Görg et al. (2008) use data on Irish firms and break down intermediate inputs into two groups: raw materials and components (referred to as materials) and services inputs. In their case, services inputs include contracted-out services, such as consultancy, maintenance, security, cleaning, and catering, but do not include other indirect costs such as rents and interest payments.

Even considering only studies on materials' offshoring, distinct options still exist: to include only parts and components (defined according to some standard sectoral classification) or imports of all materials (including raw materials). Hijzen et al. (2010) compute two different measures of offshoring. One that includes imports of products, parts, and components and another that includes purchases of any kind (including raw materials) but only from the firm's own foreign affiliates. McCann (2011) includes "Raw Materials, Materials for repairs, Materials purchased for the production of capital goods by your enterprise for your own use, Packaging, Office supplies". Lo Turco and Maggioni (2012) use firm imports of non-energy material intermediates from all sectors together with the imports of finished goods from the firm's own sector. Biscourp and Kramarz (2007) for France and Mion and Zhu (2013) for Belgium compute two measures of offshoring using detailed firm-level import data for the manufacturing industry: offshoring of finished goods and offshoring of intermediate goods, both by broad geographic origins. Finished goods are defined as products that correspond to the same 3-digit code of the main activity of the firm, while the other imports of the firm are defined as imports of intermediate goods.

An additional aspect on the measurement of outsourcing at the firm-level was introduced by Hummels et al. (2013) based on the notions of "broad and narrow offshoring" defined by Feenstra and Hanson (1999). The point for Hummels et al. (2013) is to guarantee that ob-

served firm's imports are inputs into production and also that they are potentially substitutes for labour within the firms. The article considers only manufacturing firms and distinguishes between narrow and broad measures of offshoring at the firm-level. Broad offshoring is the total value of imports of goods by a given manufacturing firm and narrow offshoring stands for the sum of imports in the same Harmonised System 4-digit (HS4) category as goods sold by the firm (there is no substantial impact in the results if HS2 is used instead). Therefore, imports of raw materials are included in broad offshoring, but are omitted from narrow offshoring.

As for the denominator of the offshoring intensity of a firm, variables used comprise total inputs, material purchases, sales, wage bill, value-added and gross output. The indicators of international outsourcing intensity of Irish electronics firms are computed by Görg and Hanley (2005a) as ratios of imported inputs to total inputs, to measure the importance of imported intermediates in the production process. Amiti and Konings (2007) also use the share of imported inputs to total inputs in some specifications of their study. Hummels et al. (2013) use both total material purchases and gross output as denominators in their measures of broad and narrow offshoring for Danish firms. The total wage bill was first used as denominator in a measure of outsourcing by Girma and Görg (2004) in their study of the impact of outsourcing on productivity, though they do not distinguish between domestic and foreign outsourcing. McCann (2011) computes the foreign outsourcing intensity relative to the firm's wage bill, as outsourcing can be seen as a substitute for inhouse production. Görg et al. (2008) also calculate their international outsourcing indicator relative to the plant's total wage bill, computing a measure of foreign outsourcing relative to total inputs as a robustness check. Finally, Hijzen et al. (2010) use real value-added in the denominator of their measures of offshoring intensity of Japanese firms, while Biscourp and Kramarz (2007) and Mion and Zhu (2013) use total sales.

3.4.2 Survey data

The existence of cross-country firm-level survey data covering several years is very rare. One reason for the non-availability of such data relates with the national regulations on statistical confidentiality, as well as different national criteria for collecting and recording the information. Nevertheless, such data is vital to obtain solid and comparable econometric evidence.

A promising avenue is the indirect sharing of information, as national authorities run similar econometric codes and provide researchers with their estimated output. One example of these efforts is the International Study Group on Exports and Productivity (ISGEP) that used comparable micro-level panel data for 14 countries and a set of identically specified empiri-

cal models to investigate the relationship between exports and productivity (ISGEP (2008)). Another example is Competitiveness Research Network (CompNet) established in 2011 with participants from European central banks, as well as from a number of international organisations.[2] In parallel, the European statistical authorities are building sample-based comparable firm-level databases that can also help fill this gap of information.

Recent surveys have been conducted with a special focus on the internationalisation of production of the firms. In most of these surveys, only qualitative information on the offshoring status of each firm is available. In addition, these surveys are typically one-shot, i.e., they do not allow an analysis of the dynamics of offshoring activities. However, they still offer a potential avenue for empirically validating the predictions of different theories associated with the international fragmentation of production. Antràs (2013) discusses in detail four firm-level datasets that have been used to test the empirical relevance of the property-rights theory of the international organisation of production and suggests some avenues for future research in this area. In the remaining of this section, we briefly refer some of the main firm-level survey databases that have been used to empirically study GVCs.

Altomonte and Aquilante (2012) describe the EU-EFIGE/Bruegel-UniCredit dataset (in short the EFIGE dataset), a database collected within the EFIGE project (European Firms in a Global Economy) that consists of a representative sample for the manufacturing industry in seven European countries (Germany, France, Italy, Spain, United Kingdom, Austria, Hungary). The survey questionnaire contains both qualitative and quantitative data on firms' characteristics and activities, split into six sections providing information on: structure of the firm; workforce; investment, technological innovation and R&D; internationalisation; finance; market and pricing. All questions concern the year 2008, but some questions ask information for 2009 and previous years. Navaretti et al. (2011) use the EFIGE dataset to examine the internationalisation of production of European firms. The dataset includes the average share of firm turnover from three different modes: importing foreign inputs and components for use in domestic production; international outsourcing, which implies setting up specific arm's-length agreements with foreign firms; and carrying out own production through FDI. Veugelers et al. (2013) examine GVCs in Europe, defining GVC-involved firms as those that simultaneously import components, maintain production activities located abroad and export their goods. They find that only a few firms are intensively involved in GVCs, but these few firms tend to be larger, more trade-intensive, more innovative and more productive.

For Japan, Ito et al. (2011) and Tomiura et al. (2013) use the Research Institute of Economy, Trade and Industry (RIETI) survey of corporate offshore activities by manufacturing firms.

---

[2]See `http://www.ecb.europa.eu/home/html/researcher_compnet.en.html` for further details and access to the research conducted within the network and ECB (2013) for a summary the main findings of the CompNet after one year of existence.

The RIETI survey covers both offshoring of production activities and offshoring of services, including detailed information on what kind of tasks are offshored to which geographical destinations. The survey also distinguishes three types of suppliers in offshoring: offshore subsidiaries owned by the offshoring firm, offshore subsidiaries owned by other Japanese firms and foreign suppliers. Although quantitative data on how much each firm offshored are not available, the survey includes information on the status of offshoring five years ago as a retrospective question, thus allowing to make some comparative statics analysis.

Another survey with qualitative data on offshoring is the Survey on Manufacturing Firms (*Indagine sulle Imprese Manifatturiere*) for Italy. This is a large survey of Italian firms administered every three years by the commercial bank Unicredit-Capitalia. Antonietti and Antonioli (2011) use data from this survey covering the period 1995–2003 to study the effects of cross-border relocation of production on the skill composition of Italian manufacturing firms. Crinò (2010*a*) also uses this survey to examine the effects of service offshoring on the level and skill structure of domestic employment. The author constructs two different qualitative indicators: a variable taking the value of one if the firm offshored any type of services and a variable taking the value of one only if the firm offshored business services (imports of transportation services account for the difference between the two measures).

Some recent studies on the mode of internationalisation of French international groups use intra-firm imports from the firm-level survey on the foreign activities of French industrial multinationals carried out by the French Ministry of the Economy in 1999 (*Enquête sur les Échanges Internationaux Intra-Groupe*). For each import transaction of each firm covered by the survey, there is information on the value, the classification of the imported product, the country of origin as well as the mode of governance of the transaction. The modes of governance in this database include vertical integration or vertical FDI (measured by the share imported from an affiliated firm), partnership (measured by the share imported from a partner) and international outsourcing (the share imported from a third independent party). Examples of studies using this dataset are Defever and Toubal (2013), Jabbour (2012) and Corcos et al. (2013), which examine the offshoring choices of French manufacturing firms.

4 Impacts of Global Value Chains

As stated in previous sections, GVCs stand as the present paradigm in world production and their effects span over multiple dimensions. In this section, we review the empirical research on the impacts of GVCs, organised around three main topics: trade flows, employment and wages, and productivity. The section concludes with a brief discussion of some policy implications of GVCs.

4.1 Trade flows

One of the significant economic trends of the last decades is the strong growth of international trade flows. World trade volume of goods and services exhibited an average annual growth of around 6 per cent over the period 1970-2005, well above the real growth rate of world GDP of around 3.5 per cent. One of the reasons that has been put forward to explain this sharp growth of international trade is the emergence of GVCs (see Yi (2003) and Jones et al. (2005)). As production is fragmented into different stages, which are then executed in distinct plants, often located in different countries, more intermediate goods circulate between countries.

The pervasiveness of GVCs poses substantial challenges to the WTO multilateral trading system, as its principles are based on the existence of localised production within nations and not on internationally fragmented production systems. Dhar (2013) discusses in detail several options for redefining the WTO program given the emergence of GVCs. The author analyses three main policy areas aimed at fostering the growth of GVCs: trade facilitation measures, an equitable investment regime, and effective disciplines for curbing non-tariff barriers. Baldwin (2011) highlights the role of regionalism on the development of GVCs, comprising deep regional trade agreements (RTAs), bilateral investment treaties (BITs) and unilateral reforms, and its impact on the WTO's global trade governance.

The rapid internationalisation of production and the subsequent changes in global trade patterns have also raised questions in terms of the participation of new countries in these flows as well as on the role of geographical and gravity variables. Hanson (2012) discusses the changes in international trade associated with the integration of low- and middle-income countries into the global economy and the growth of South-South trade as GVCs deepen and trade in intermediate inputs increases. Exports of low- and middle-income countries are concentrated in a relatively small number of products (hyper-specialisation) and seem capable of progressing rapidly up the sophistication ladder. As for geography, Baldwin and Taglioni (2011) show how the standard gravity model performs poorly when it is applied to bilateral flows where parts and components trade is important. As gross trade flows deviate from value-added flows, the correct estimation of the standard gravity equation is harder and, thus, better procedures are needed.

The international outsourcing of production and firms' networks are also reflected in new empirical firm-level regularities that are not easily reconciled with traditional multi-product models of trade. Bernard, Beveren and Vandenbussche (2010) and Bernard et al. (2012) find that a significant fraction of firms' exports in Belgium is made of goods that are not produced by the firm, labeled as "carry-along trade" (CAT). In addition, the share of CAT in total exports rises with firm productivity. Bernard et al. (2012) also introduce a new framework to

identify the mechanics and motivations underlying CAT, highlighting the importance of heterogenous distribution costs at the firm-level and demand-side complementarities between firms' products. Damijan et al. (2013) show that a large fraction of firm-level trade flows in Slovenia consists of simultaneous imports and exports of identical products, which they label "pass-on trade" (POT) and can be seen as a subset of CAT. In fact, CAT is related to total (domestic and international) outsourcing of products, while POT refers only to international outsourcing of products that have been passed-on to exports. They also find that the share of POT is increasing in firm size, product diversification, multinational status as well as firm productivity and profitability.

The international fragmentation of production is also closely related to the expansion of intra-industry trade (IIT). In empirical terms, trade resulting from the international fragmentation of production can be classified either as inter-industry trade or as IIT. At a highly disaggregated product breakdown level, intermediate goods and the relevant finished products in the production chain tend to be classified in distinct product categories and these flows are considered inter-industry trade. However, at a more aggregate level intermediate and final goods are more likely to be classified in the same category and regarded as vertical intra-industry trade (see Jones et al. (2002) for a discussion on the link between fragmentation and IIT). Ando (2006) studies the evolution of machinery trade in East Asia in the 1990s and concludes that the strong increase in vertical intra-industry trade was largely due to the expansion of back-and-forth transactions between vertically specialised production processes, rather than to trade in quality-differentiated goods. In the same vein, Wakasugi (2007) examines the expansion of trade in East Asia and concludes that it has been accompanied by a drastic increase in the proportion of vertical intra-industry trade induced by the international fragmentation of production.

4.2 Employment and wages

Numerous empirical studies have focused on the potential adverse effects of offshoring on the labour markets of developed countries, stemming from fears of significant job losses. The public media in the US and Europe often claims that offshoring corporate activities to developing countries reduces operations and employment at home (see Mankiw and Swagel (2006) for a discussion). Over the last decades, most developed countries witnessed a shift in labour demand towards more-skilled workers, with an increase in wage and employment inequality. Skill-biased technological change and GVCs are commonly seen as the two main factors behind this evolution (see Chusseau et al. (2008) for a review of this debate). Feenstra and Hanson (2003) review earlier empirical work on the effects of trade in intermediate inputs and technological change on wages, most of which uses industry-level data, while

Harrison et al. (2011) survey more recent empirical work on offshoring and wage inequality, most of which uses firm-level or matched worker-firm data. Finally, Crinò (2009) reviews the empirical literature on the effects of offshoring and foreign activities of multinational firms on the labour markets of developed countries.

International outsourcing tends to have a negative impact on the relative demand for low-skilled labour in developed countries. Studies using industry level measures of offshoring, combined or not with information on individual wages, to evaluate its impact on relative labour demand are numerous and cover a wide range of countries. The seminal works of Feenstra and Hanson (1996) and Feenstra and Hanson (1999) conclude that the rise of outsourcing accounts for a significant part of the increase in the relative demand for skilled-labour in US manufacturing industries during the eighties. Using a similar approach, Geishecker (2006) finds that the significant growth of international outsourcing during the 1990s was an explanation for the observed decline in relative demand for manual workers in German manufacturing. Geishecker and Görg (2008) combine information on individual wages with industry-level measures of international outsourcing and find evidence of a significant negative (positive) effect of international outsourcing on the real wage of low-skilled (high-skilled) workers in this country. For the UK, Hijzen et al. (2005) find that international outsourcing equally had a strong negative impact on the demand for unskilled-labour and Hijzen (2007) concludes that skill-biased technological change is the major driving force of wage inequality but that international outsourcing also contributed significantly. Using a combination of worker and industry-level data, Hsieh and Woo (2005) examine how off-shoring to China affects the relative wages and employment of skilled workers in Hong Kong, finding evidence of strong and persistent relative demand shifts favouring skilled workers. Geishecker et al. (2010) use worker-level data on wages and comparable measures of outsourcing at the industry-level to study the impact of international outsourcing on individual wages for Germany, UK and Denmark, discussing the potential impact of distinct labour market institutions. However, they find small and similar effects of outsourcing in the three countries.

Other studies use similar methodologies but focus on the impact of services' offshoring. Crinò (2010*b*) studies the effects of services' offshoring on white-collar employment, using an industry-level measure combined with disaggregated occupational data for the US. The article finds that service' offshoring is skill-biased, i.e., it increases employment in more skilled occupations relative to less skilled ones and concludes that, within each skill group, service offshoring penalises tradable occupations relatively to non-tradable ones. Geishecker and Görg (2013) use worker-level data combined with sectoral data to study the impact of services' offshoring on individual wages for the UK, finding small but non-negligible effects on wage inequality. The authors conclude that services' offshoring negatively affects

the real wage of low- and medium-skilled individuals, but has a positive effect on the real wages of skilled workers. For Japan, Agnese (2012) differentiates the effects of services and materials offshoring on the employment shares of seven broad skill groups, concluding that the various types of offshoring affect occupations differently, depending on their degree of complementarity. In particular, services' offshoring has a positive effect on the employment share of highly-skilled workers, especially professional and technical workers, while materials offshoring tends to benefit production workers more.

There are fewer empirical works using firm-level measures of offshoring to assess its impact on the relative labour demand of skilled and unskilled workers. Antonietti and Antonioli (2011) study how the international outsourcing of production impacts the skill structure of employment within Italian manufacturing firms. Their results point to a potential skill-bias effect of production offshoring, driven by a fall in the demand for unskilled workers. Crinò (2010a) studies the effects of services' offshoring on the level and skill composition of domestic employment of Italian firms. The article concludes that services' offshoring has no effect on the level of employment but changes its composition in favour of high skilled workers. The results of Tomiura et al. (2013) for Japan also suggest that offshoring is related with a shift in the composition of employment towards high skills even within non-production workers, as the share of skilled non-production workers is significantly higher in offshoring firms. Mion and Zhu (2013), using Belgian manufacturing firm-level data, also find evidence that offshoring of both finished and intermediate goods, specially to China, tends to foster skill upgrading. Crinò (2012) examines the effect of imported inputs on the relative demand for high-skill labour using firm-level data for 27 transition countries. The author finds that imported inputs increase the relative demand for high-skill labour as importing firms engage in high-skill intensive activities. Hummels et al. (2013) use a matched worker-firm data for Denmark to estimate how offshoring and exporting affect individual wages by skill, concluding that offshoring tends to increase the wages of high-skilled workers and decrease the wages of low-skilled workers.

As for firm-level studies on the impact of technological change on skill composition and wage inequality, some articles use the content of tasks to examine the impact of offshoring and find that offshoring tends to shift labour demand towards non-routine tasks. Using plant-level data for German multinationals, Becker et al. (2013) provide evidence that offshoring is related to onshore skill-upgrading. They find that offshore employment within multinationals in both manufacturing and services is associated with a shift towards more non-routine and more interactive tasks and towards highly educated workers. Baumgarten et al. (2013) link individual-level data with industry-level offshoring measures for the German manufacturing industry, taking into account the interaction between tasks and skills. They find that within-industry changes in offshoring have only modest negative effects on wages but, allowing for

labour mobility across sectors, the cross-industry negative wage effects of offshoring are substantial and depend strongly on the task profile of workers, even within skill groups. Namely, a high degree of personal interactivity and, specially, of non-routine content play a mitigating role for the negative wage effect of offshoring. Ebenstein et al. (2013) merge worker-level data on wages with industry-level data on offshoring employment of US multinationals and conclude that the impact of offshoring depends both on the location of the offshore activities and on the routineness of the tasks performed. For instance, the increase of offshore employment in low-income locations is associated with wage reductions for routine workers, but the opposite happens with offshore activity in high-income locations. However, the effects of offshoring are always stronger in occupations classified as more routine. They also find stronger effects of offshore activities on domestic wages from 1997 to 2002 than before.

Other recent works that study the polarisation of employment and wages make use of the content of tasks to compute measures of potential offshoring ("offshorability") of job tasks. Firpo et al. (2011) compute five indexes of task content to capture the potential effect of technological change and offshorability on occupational wages and find that the latter was an important element behind the polarisation of US wages since the nineties. Using data on local US labour markets, Autor and Dorn (2013) find that offshorability does not play a major role in explaining trends in employment and wage polarisation at this level of aggregation. Goos et al. (2011) compute a measure of offshorability of occupations using counts of news reports from the European Restructuring Monitor and find evidence of a small but significant role of offshoring in the polarisation of employment in Europe. In a different vein, Criscuolo and Garicano (2010) compute a direct measure of the offshorability of tasks using legal licensing requirements for the UK, finding that wages and employment of occupations subject to formal licensing are positively related to offshoring in these services.

A less studied issue relates to the overall effect of offshoring on the level of employment. Using industry-level data for 17 OECD countries, Hijzen and Swaim (2007) find that offshoring has no effect or a slight positive effect on sectoral employment. Falk and Wolfmayr (2008) use I-O tables for five EU countries (Austria, Finland, Germany, Italy and the Netherlands) and find a small negative impact of services outsourcing to low-wage countries on employment of the non-manufacturing sector. For the manufacturing sector, the outsourcing of intermediate materials to low-wage countries also appears to have a relatively small negative impact on the demand for labour. Cadarso et al. (2008) use detailed I-O tables for Spanish manufacturing industry and find a negative effect of outsourcing to Central and Eastern European countries on employment in medium–high-tech sectors, but no clear effect in low-tech sectors. Michel and Rycx (2012) find that materials and services offshoring has no significant impact on total employment in Belgium using industry-level data from 1995 to 2003.

The small magnitude of the effects obtained at the industry-level can hide differences in labour demand for different skill categories (as stated above) and differences at the level of the individual firms. Görg and Hanley (2005*b*) use plant-level data for the Irish electronics sector to examine the effect of international outsourcing on labour demand of the outsourcing plant and find that it decreases labour demand in the short-run. In addition, they find stronger negative effects from outsourcing of materials than of services. The results of Gomez et al. (2013) for Canada suggest that the offshoring of business services is not likely to have a large negative impact on employment. Lo Turco and Maggioni (2012) use balanced panel of Italian manufacturing firms and find a negative effect of imports of intermediates from low-income countries on the conditional labour demand of firms, specially in firms involved in traditional activities.

Using a sample of German firms, Moser et al. (2009) find a positive effect of an increase in the share of foreign intermediate inputs on the employment level of the offshoring plant. Desai et al. (2009) also find evidence of complementarity between the domestic and foreign operations of US manufacturing firms: an increase in foreign operations is associated with greater domestic investment, wages and employment growth. Harrison and McMillan (2011) use firm-level data on US multinationals to measure the impact of changes in foreign affiliates' wages on domestic employment. They find that the link between offshoring and domestic employment depends on both the type and location of foreign affiliates. In general, offshoring to low-wage countries substitutes for domestic employment but for firms that export to affiliates located in low-income (high-income) countries for further processing, domestic and foreign labour are complements (substitutes). Wagner (2011) uses combined data from matched regular surveys and a special purpose survey on relocation to investigate the causal effect of offshoring on the performance of German manufacturing firms. He concludes that offshoring has a small negative impact on employment in offshoring firms, but finds no evidence for a causal effect on the wage per employee, the proxy variable for human capital intensity.

Recently, Ottaviano et al. (2013) study the impact of both offshoring and immigration on the employment of native workers in the US manufacturing industry. They find that easier offshoring has a significant negative effect on the employment shares of native workers but not on their employment levels. The fact that offshoring does not have a significant impact on the levels of employment of natives is consistent with the existence of a positive productivity effect. Wright (2013) also finds evidence of a productivity effect in the US labour market as offshoring to China resulted in a small increase of total employment, with a decline in the share of low-skill workers.

Finally, Sethupathy (2013) uses firm-level data and two events in Mexico as a natural experiment to identify the impact of an exogenous decline in the marginal cost of offshoring to this

country. The article finds that, in comparison to the firms unlikely to take advantage of the new offshoring opportunity, US firms that already offshored to Mexico reinforced this option, increased their operating profits per domestic worker and their average domestic wages, without further reductions on their US employment level.

4.3 Productivity

GVCs affect firm-level productivity mainly because they allow firms to benefit from gains from specialisation, making a more efficient use of production factors. However, the empirical evidence on the relation between offshoring and productivity is still limited (see Olsen (2006) for a survey).

Studies that explored this link using industry-level data tend to conclude that offshoring positively affects productivity. Amiti and Wei (2009) estimate the effects of offshoring on productivity in US manufacturing industries, concluding that service offshoring has a significant positive effect on productivity. Offshoring of material inputs also has a positive effect on productivity, but the magnitude is smaller. Similar findings where obtained by Winkler (2010) for Germany using input-output data for 1995-2006. Crinò (2008) uses comparable data for nine European countries and finds that service offshoring exerts positive and economically large effects on domestic productivity. Egger and Egger (2006) analyse how offshoring affects the productivity of low-skilled workers employed in the EU manufacturing sector. They find a negative marginal effect on productivity in the short run, but the impact becomes positive and significant in the long run. Schworer (2013) combines industry-level data on offshoring from the WIOD with firm-level data for nine European countries between 1995 and 2008 and finds that offshoring of services and of non-core manufacturing activities contributed to an increase in productivity, whereas no significant effect is found for offshoring of core manufacturing activities. He finds also evidence of additional productivity gains for multinational firms.

Available studies using firm-level data to analyse this issue are still scarce and have so far reported mixed results. Görg and Hanley (2005a) examine the effect of international outsourcing on productivity at the plant-level in the electronics industry in Ireland. They find that total international outsourcing increases plant-level productivity, but this effect only holds for plants with low export intensities. When distinguishing between offshoring of services and materials, they find that the positive impact on productivity is limited to materials outsourcing. Görg et al. (2008) investigate the impact of international outsourcing on productivity with plant-level data for Irish manufacturing, finding that being more embedded in international markets leads to larger productivity gains from outsourcing. McCann (2011) also finds that an increase in outsourcing intensity leads to productivity gains for foreign

owned firms and for indigenous exporters in Ireland. On the contrary, being an outsourcer matters strongly for Irish firms that are not exporting, while for exporters and foreign affiliates, productivity increases are much lower. Using a dataset of Japanese firms, Ito et al. (2011) find productivity gains in the firms offshoring both manufacturing and service tasks, but not in the firms offshoring only either manufacturing or service tasks. These results suggest that the level of firms' engagement in offshoring is more important for productivity than whether or not firms engage in offshoring at all. Hijzen et al. (2010) also use firm-level data for the Japanese manufacturing industries and find that intra-firm offshoring has generally a positive effect on productivity of the offshoring firm, while arm's-length offshoring does not.

Kasahara and Rodrigue (2008) find evidence of a positive impact of imported intermediates on the productivity of Chilean manufacturing plants. Morrison Paul and Yasar (2009) evaluate the productivity and input composition effects of domestic and foreign outsourcing for Turkish textile and apparel manufacturing plants. They find that higher shares of imported materials and subcontracted inputs are associated with higher productivity. The results also reveal both self-selection of more productive plants into outsourcing and increased relative productivity after beginning to outsource. Fariñas and Martín-Marcos (2010) also find evidence consistent with self-selection of the most productive firms into international outsourcing in a sample of Spanish manufacturing firms. Their results also suggest that foreign outsourcing has a positive impact on total factor productivity growth at the firm-level. Jabbour (2010) find positive effects of offshoring on productivity and profitability of French manufacturing firms, but only in the case of international outsourcing to developing countries. For Germany, Wagner (2011) concludes that offshoring firms were already larger, more productive, more human capital intensive, and with a higher share of exports in total sales before they started offshoring, which point to self-selection of better firms into offshoring. However, he finds mild evidence of a positive causal effect of offshoring on firm-level productivity, but this effect is very small.

4.4 Policy implications

The implications of GVCs for the way economists interpret macroeconomic developments and, ultimately, economic policy decisions are numerous. Firstly, the pervasiveness of GVCs has a relevant impact in the interpretation of global imbalances. Accounting for trade in intermediate parts and components and GVCs does not change the overall trade balance of an individual country with the rest of the world. Nevertheless, the consideration of GVCs implies the redistribution of trade surpluses and deficits across partner countries (see, for instance, OECD and WTO (2012) for a discussion). When bilateral trade balances are measured in gross terms, a deficit with an exporter of final goods(or a surplus of an exporter

of final products) can be overstated because it is affected by the value of inputs supplied to this exporter by third countries. Only the consideration of domestic and foreign value-added embodied exports allows for an accurate calculation of bilateral trade balances. In policy terms, under a scenario of persistent trade deficits, the pressure for rebalancing increases the risk of protectionist responses, which could hit countries at the end of the GVC on the basis of an inaccurate perception of the origin of trade imbalances.

Secondly, indicators like revealed comparative advantage and real effective exchange rates are affected by the measurement of trade in gross terms. The concept of "country of origin" is increasingly difficult to apply, as the various production operations are spread across the world. In fact, a country may stand as a large exporter of a specific good relatively to the world average without adding much value-added to it. As a result, the analysis of a country export potential and competitiveness needs to take into account its integration in a GVC and the role of trade in intermediate inputs. Timmer et al. (2013) propose a new competitiveness indicator that is defined as the income generated in a country by participating in global manufacturing production using the data from the WIOD. This metric, named by the authors "GVC income", measures the value that is added in the various stages of a GVC and, hence, it indicates to what extent a country can compete in terms of activities, rather than through the gross exports of manufacturing goods. Bems and Johnson (2012) propose a methodology for computing value-added real effective exchange rates and calculate this index for 42 countries from 1970-2009. They show that there are important differences between value-added and conventional real effective exchange rates.

Thirdly, GVCs have implications in terms of market access and trade disputes. In the current paradigm, competition is not between nations, but between firms, and involves both trade and investment. Competitiveness in a world of GVCs means access to competitive inputs and technology. Therefore, the optimum tariff structure in such a situation is flat and stable, as contractual arrangements within supply chains, especially between affiliated plants, tend to be long term. In addition, offshoring of elaborated parts and components can only take place in situations where intellectual property is respected. Moreover, from a macroeconomic perspective, beggar-thy-neighbour strategies can be misplaced. As stated above, domestic value-added is found both in exports and imports as some goods and services are intermediates shipped abroad whose value comes back to the domestic economy embodied in imports of foreign products. Therefore, exchange rate policies, tariffs, non-tariff barriers and other trade measures (e.g., anti-dumping rights) are likely to impact not only foreign producers but also domestic producers. Thus, as outlined in OECD et al. (2013), both the costs of trade and investment protectionism and the benefits of multilateral opening are higher in today's interconnected world than before.

Finally, recent experience shows that GVCs affect the magnitude and propagation of macroe-

conomic shocks. During the recent financial and economic crisis, the collapse in global trade was severe, synchronised across the world, and particularly pronounced for trade in capital and intermediate goods. Several transmission mechanisms were in play but GVCs appear to have had a central role in the transmission of what was initially a demand shock in some markets affected by a sharp credit shortage. Baldwin (2009) provide a useful discussion on the several causes of the trade collapse, as well as on its consequences and prospects for the future, and Bems et al. (2013) survey the recent literature on the causes of the collapse in international trade during the 2008-2009 global recession.

Bems et al. (2011) use a global bilateral input-output framework to study the role of vertical linkages and vertical specialisation in the 2008-2009 collapse of global trade and find that the contribution of intermediate goods to the total trade decline was significant. They also find that vertical specialisation trade fell by more than value-added trade, accounting for about one-third of the decline in total trade. Bridgman (2013) shows that the volatility of trade relative to GDP has increased over the last decades but does not find a major role for vertical specialisation. He calibrates a model of vertical specialisation trade and finds that vertical specialisation causes trade to fall more in recession but also increases the share of output that is traded, with no impact on volatility. Vertical specialisation increases trade volatility relatively to GDP by changing trade composition to more volatile sectors but the effect is found to be modest.

Anderton and Tewolde (2011) estimate a structural imports function which captures the different and time-varying import-intensities of the components of final expenditure. Their results suggest that the high import-intensity of exports at the country-level, resulting from the increasing role of global production chains, can explain a significant proportion of the decline in imports of OECD countries. The literature on the recent trade collapse points towards a wave effect because when there is a sudden drop in demand, firms delay orders and run down inventories and, hence, the fall in demand is amplified along the supply chain and can translate into a standstill for firms located upstream. Altomonte et al. (2012) use a very detailed transaction-level dataset on French firms and conclude that trade in intermediates was the main determinant of the magnitude of the recent trade collapse, highlighting the role for GVCs. The authors also find evidence that the adjustment in inventories seems to be the most important channel of transmission of this demand shock to trade. Using data for the US, Alessandria et al. (2011) also conclude that the magnified movements in international trade reflected a severe adjustment of inventory holdings of firms. Overall, the increasing importance of GVCs seems to be associated with a greater elasticity of trade with respect to changes in activity.

5 Concluding Remarks

Global value chains (GVCs) have deeply changed the paradigm of world production, affecting international trade and investment, labour market developments and the way policy-makers interpret trade policies and external competitiveness. The significant expansion of GVCs has been rooting on technological progress, the fall of political and economic barriers and, in parallel, the development of multinational corporations. These drivers are not expected to reverse in the near future.

The probability of a technological reversal that would limit the scope of GVCs looks minimal. In addition, although a major increase in economic barriers cannot be ruled out, such event seems unlikely. Given the strong interconnections between multinational corporations, domestic firms and capital markets, policies targeted at limiting the action of GVCs would have major disruptive effects in the economy. The significant disturbances on the global economy that resulted from temporary breaks in GVCs following natural disasters provide a vivid illustration. Furthermore, multinational corporations and business groups represent an important share of economic activity worldwide, posting high productivity levels and holding strong political influence.

In this context, the return to a pre-GVCs world seems like a low probability event. On the contrary, there is scope for further growth and deepening of GVCs, especially through an expansion of trade in services. In fact, many services, previously seen as non-tradable, are becoming increasingly important in world trade. Moreover, there is potential for further international trade liberalisation, especially in a multilateral dimension. Finally, developing countries are increasingly participating in different stages of GVCs and these links can play an important role in their economic development. GVCs can facilitate technology dissemination and skill building, thus enhancing the productive capacity of developing countries.

The rise in GVCs brought a permanent reshuffling of global comparative advantages, which are now identified in terms of intermediate goods and services or specific tasks in the value chain, rather than only in terms of final products. Reaping the benefits from international trade implies adjusting the productive structure to this changing reality and, hence, it requires ability to reallocate inputs between industries and to attract and sustain the operations of multinational firms. In most international markets, competition is now more intense than in the past. Firms try to generate value-added and sustain profits by developing new and innovative products and services, which are targeted for the world market. Nevertheless, this Schumpeterian environment goes hand in hand with a setup where information flows very rapidly, facilitating the access to new technologies and the imitation of products. Therefore, in this context, only a strategy based on investment in R&D and continuing innovation can prevail. In a world of GVCs, a flexible and educated labour force is crucial to ensure a rapid

and efficient reallocation of resources across sectors and the development of new products, tasks and technologies.

Notwithstanding the substantial work done in recent decades, there are still important research gaps in the empirical literature on GVCs. As for the main drivers of GVCs, little systematic work has been undertaken to estimate the actual contributions of transport and communication costs, technological progress and economic barriers to the development of GVCs, as well as their potential complementarities. In addition, the role of geographic and gravitational variables on GVCs has not been explored in depth. Trade literature has identified gravity as a key driver for international trade, thus a similar pattern can be expected to emerge for GVCs. The proper understanding of its drivers is crucial to predict shifts in the dynamics of GVCs, which, in turn, are important to forecast macroeconomic developments and to assess the role, if any, that policy can play in shaping GVCs.

In spite of the intense research over the last decades, the mapping and measurement of GVCs is still incomplete and several research strands may bring further valuable results. A large part of the empirical literature has based on Input-Output (I-O) matrices and aggregate trade data to map and measure GVCs across the world. The computation of global I-O matrices constitutes a big progress relatively to the use of national matrices but their time, sectoral and country coverage remains limited. In addition, although almost impossible to avoid, proportionality assumptions still hamper the accuracy of global I-O matrices. Therefore, a detailed historical mapping of GVCs covering a large number of countries and sectors is still missing. This research would be useful to understand the nature and time dynamics of GVCs, also interlinking with its drivers and impacts.

A major strand of research that is still underdeveloped is the use of firm-level data to examine GVCs. Micro-level measurement and analysis of GVCs allows controlling for firm heterogeneity and can give important insights on the widespread impacts of GVCs. Several measures can potentially be computed using firm-level databases but, for example, the assessment of the imported value-added of exports at the firm level is still not available. In addition, it is not possible to trace trade flows along GVCs at the micro-level, establishing the links between firms in the different countries and in different stages of the production process. Empirical research of GVCs at the firm-level is determined by the availability of information, so further micro-data disclosure and sharing would allow for some progress in this front. A set of stylised facts on GVCs based on micro-data for several countries could be obtained using internationally comparable databases and a common methodology.

This would set the stage for important policy results and facilitate the integration of GVCs in macroeconomic general equilibrium models. In fact, the correct response of policy-makers to the new paradigm in world production requires the accurate knowledge on the characteristics

of the firms, sectors and countries involved in GVCs, as well on the channels through which these networks are established. Although GVCs are complex phenomenon, it is essential that policy-analysis takes on board their impacts on the quantification and interpretation of traditional trade and competitiveness indicators and on the forecasting of macroeconomic developments.

References

Abramovsky, L. and Griffith, R. (2006), 'Outsourcing and offshoring of business services: How important is ICT?', *Journal of the European Economic Association* **4**(2-3), 594–601.

Agnese, P. (2012), 'Employment effects of offshoring across sectors and occupations in Japan', *Asian Economic Journal* **26**(4), 289–311.

Aguiar, A. H. and Walmsley, T. L. (2012), Regional input-output data, *in* A. A. Badri Narayanan and R. McDougall, eds, 'Global Trade, Assistance, and Production: The GTAP 8 Data Base', Center for Global Trade Analysis, Purdue University, chapter 7.

Alessandria, G., Kaboski, J. P. and Midrigan, V. (2011), 'US trade and inventory dynamics', *American Economic Review* **101**(3), 303–07.

Alfaro, L. and Charlton, A. (2009), 'Intra-industry foreign direct investment', *American Economic Review* **99**(5), 2096–2119.

Altomonte, C. and Aquilante, T. (2012), The EU-EFIGE/Bruegel-Unicredit dataset, Bruegel Working Paper 13, Bruegel.

Altomonte, C., Mauro, F. D., Ottaviano, G., Rungi, A. and Vicard, V. (2012), Global value chains during the great trade collapse: A bullwhip effect?, Working Paper 1412, European Central Bank.

Amador, J. and Cabral, S. (2008), 'Vertical specialization in Portuguese international trade', *Banco de Portugal Economic Bulletin* **Summer**, 91–107.

Amador, J. and Cabral, S. (2009), 'Vertical specialization across the world: A relative measure', *The North American Journal of Economics and Finance* **20**(3), 267–280.

Amiti, M. and Konings, J. (2007), 'Trade liberalization, intermediate inputs, and productivity: Evidence from Indonesia', *The American Economic Review* **97**(5), 1611–1638.

Amiti, M. and Wei, S.-J. (2005), 'Fear of service outsourcing: Is it justified?', *Economic Policy* **20**(42), 308–347.

Amiti, M. and Wei, S.-J. (2009), 'Service offshoring and productivity: Evidence from the US', *World Economy* **32**(2), 203–220.

Anderton, R. and Tewolde, T. (2011), 'The global financial crisis: Understanding the global trade downturn and recovery', *The World Economy* **34**, 741–763.

Ando, M. (2006), 'Fragmentation and vertical intra-industry trade in East Asia', *The North American Journal of Economics and Finance* **17**(3), 257–281.

Antonietti, R. and Antonioli, D. (2011), 'The impact of production offshoring on the skill composition of manufacturing firms: evidence from Italy', *International Review of Applied Economics* **25**(1), 87–105.

Antràs, P. (2003), 'Firms, contracts, and trade structure', *The Quarterly Journal of Economics* **118**(4), 1375–1418.

Antràs, P. (2005), 'Incomplete contracts and the product cycle', *American Economic Review* **95**(4), 1054–1073.

Antràs, P. (2013), 'Grossman-Hart (1986) goes global: Incomplete contracts, property rights, and the international organization of production', *Journal of Law, Economics, and Organization* (Forthcoming).

Antràs, P. and Chor, D. (2013), 'Organizing the global value chain', *Econometrica* **81**(6), 2127–2204.

Antràs, P., Chor, D., Fally, T. and Hillberry, R. (2012), 'Measuring the upstreamness of production and trade flows', *American Economic Review* **102**(3), 412–16.

Antràs, P. and Helpman, E. (2004), 'Global sourcing', *Journal of Political Economy* **112**(3), 552–580.

Antràs, P. and Rossi-Hansberg, E. (2009), 'Organizations and trade', *Annual Review of Economics* **1**(1), 43–64.

Arndt, S. W. (1997), 'Globalization and the open economy', *The North American Journal of Economics and Finance* **8**(1), 71–79.

Arndt, S. W. and Kierzkowski, H., eds (2001), *Fragmentation: New Production Patterns in the World Economy*, Oxford University Press, USA.

Arvis, J.-F., Duval, Y., Shepherd, B. and Utoktham, C. (2013), Trade costs in the developing world: 1995-2010, Policy Research Working Paper 6309, World Bank.

Athukorala, P.-c. (2005), 'Product fragmentation and trade patterns in East Asia', *Asian Economic Papers* **4**(3), 1–27.

Athukorala, P.-c. (2009), 'The rise of China and East Asian export performance: Is the crowding-out fear warranted?', *The World Economy* **32**(2), 234–266.

Athukorala, P.-c. (2011), 'Production networks and trade patterns in East Asia: Regionalization or globalization?', *Asian Economic Papers* **10**(1), 65–95.

Athukorala, P.-c. and Yamashita, N. (2006), 'Production fragmentation and trade integration: East Asia in a global context', *The North American Journal of Economics and Finance* **17**(3), 233–256.

Autor, D. H. (2013), 'The "task approach" to labor markets: an overview', *Journal for Labour Market Research* (Forthcoming).

Autor, D. H. and Dorn, D. (2013), 'The growth of low-skill service jobs and the polarization of the US labor market', *American Economic Review* **103**(5), 1553–1597.

Autor, D. H., Levy, F. and Murnane, R. J. (2003), 'The skill content of recent technological change: An empirical exploration', *The Quarterly Journal of Economics* **118**(4), 1279–1333.

Baldone, S., Sdogati, F. and Tajoli, L. (2001), 'Patterns and determinants of international fragmentation of production: Evidence from outward processing trade between the EU and Central Eastern European Countries', *Review of World Economics* **137**(1), 80–104.

Baldone, S., Sdogati, F. and Tajoli, L. (2007), 'On some effects of international fragmentation of production on comparative advantages, trade flows and the income of countries', *The World Economy* **30**(11), 1726–1769.

Baldwin, R. (2006), Globalisation: the great unbundling(s), Research paper of the project "Challenges of globalisation for Europe and Finland", September 2006, Secretariat of the Economic Council of Finland.

Baldwin, R. (2011), 21st century regionalism: Filling the gap between 21st century trade and 20th century trade rules, CEPR Policy Insight 56, Centre for Economic Policy Research.

Baldwin, R. (2012*a*), Global supply chains: Why they emerged, why they matter, and where they are going, CEPR Discussion Papers 9103, Centre for Economic Policy Research.

Baldwin, R. (2012*b*), WTO 2.0: Global governance of supply-chain trade, CEPR Policy Insight 64, Centre for Economic Policy Research.

Baldwin, R., ed. (2009), *The Great Trade Collapse: Causes, Consequences and Prospects*, Centre for Economic Policy Research (CEPR), VoxEU.org ebook.

Baldwin, R. and Lopez-Gonzalez, J. (2013), Supply-chain trade: A portrait of global patterns and several testable hypotheses, NBER Working Paper 18957, National Bureau of Economic Research.

Baldwin, R. and Robert-Nicoud, F. (2014), 'Trade-in-goods and trade-in-tasks: An integrating framework', *Journal of International Economics* **92**(1), 51–62.

Baldwin, R. and Taglioni, D. (2011), Gravity chains: Estimating bilateral trade flows when parts and components trade is important, NBER Working Paper 16672, National Bureau of Economic Research.

Baldwin, R. and Venables, A. J. (2013), 'Spiders and snakes: Offshoring and agglomeration in the global economy', *Journal of International Economics* **90**(2), 245–254.

Baumgarten, D., Geishecker, I. and Görg, H. (2013), 'Offshoring, tasks, and the skill-wage pattern', *European Economic Review* **61**, 132–152.

Beaudreau, B. C. (2013), 'What the OECD-WTO TiVA data tell us about comparative advantage and international trade in general', *The International Trade Journal* **27**(5), 465–481.

Becker, S. O., Ekholm, K. and Muendler, M.-A. (2013), 'Offshoring and the onshore composition of tasks and skills', *Journal of International Economics* **90**(1), 91–106.

Behar, A. and Freund, C. (2011), Factory Europe? Brainier but not Brawnier, FREIT Working Paper 312, Forum for Research in Empirical International Trade (FREIT).

Bems, R. and Johnson, R. C. (2012), Value-added exchange rates, NBER Working Paper 18498, National Bureau of Economic Research.

Bems, R., Johnson, R. C. and Yi, K.-M. (2011), 'Vertical linkages and the collapse of global trade', *American Economic Review* **101**(3), 308–12.

Bems, R., Johnson, R. C. and Yi, K.-M. (2013), 'The great trade collapse', *Annual Review of Economics* **5**(1), 375–400.

Bernard, A. B., Beveren, I. V. and Vandenbussche, H. (2010), Multi-product exporters, carry-along trade and the margins of trade, Working Paper Research 203, National Bank of Belgium.

Bernard, A. B., Blanchard, E. J., Beveren, I. V. and Vandenbussche, H. Y. (2012), Carry-along trade, NBER Working Paper 18246, National Bureau of Economic Research.

Bernard, A. B. and Fort, T. C. (2013), Factoryless goods producers in the US, NBER Working Paper 19396, National Bureau of Economic Research.

Bernard, A. B., Jensen, J. B., Redding, S. J. and Schott, P. K. (2010), 'Intrafirm trade and product contractibility', *American Economic Review* **100**(2), 444–448.

Biscourp, P. and Kramarz, F. (2007), 'Employment, skill structure and international trade: Firm-level evidence for France', *Journal of International Economics* **72**(1), 22–51.

Blinder, A. S. (2006), 'Offshoring: The next industrial revolution?', *Foreign Affairs* **85**(2), 113–128.

Blinder, A. S. (2009), 'How many US jobs might be offshorable?', *World Economics* **10**(2), 41–78.

Blinder, A. S. and Krueger, A. B. (2013), 'Alternative measures of offshorability: A survey approach', *Journal of Labor Economics* **31**(S1), S97 – S128.

Borga, M. and Zeile, W. J. (2004), International fragmentation of production and the intrafirm trade of U.S. multinational companies, BEA Working Papers 0013, Bureau of Economic Analysis.

Breda, E., Cappariello, R. and Zizza, R. (2008), Vertical specialization in Europe: Evidence from the import content of exports, Working Paper 682, Bank of Italy.

Bridgman, B. (2008), 'Energy prices and the expansion of world trade', *Review of Economic Dynamics* **11**(4), 904–916.

Bridgman, B. (2013), 'International supply chains and the volatility of trade', *Economic Inquiry* **51**(4), 2110–2124.

Cadarso, M. A., Gomez, N., Lopez, L. A. and Tobarra, M. A. (2008), 'The EU enlargement and the impact of outsourcing on industrial employment in Spain, 1993-2003', *Structural Change and Economic Dynamics* **19**(1), 95–108.

Campa, J. and Goldberg, L. S. (1997), 'The evolving external orientation of manufacturing: A profile of four countries', *Federal Reserve Bank of New York Economic Policy Review* **3**(2), 53–81.

Chen, H., Kondratowicz, M. and Yi, K.-M. (2005), 'Vertical specialization and three facts about US international trade', *The North American Journal of Economics and Finance* **16**(1), 35–59.

Chen, H.-Y. and Chang, Y.-M. (2006), 'Trade verticality and structural change in industries: The cases of Taiwan and South Korea', *Open Economies Review* **17**(3), 321–340.

Chen, X., Cheng, L. K., Fung, K., Lau, L. J., Sung, Y.-W., Zhu, K., Yang, C., Pei, J. and Duan, Y. (2012), 'Domestic value added and employment generated by Chinese exports: A quantitative estimation', *China Economic Review* **23**(4), 850–864.

Chia, S. Y. (2013), The ASEAN Economic Community: Progress, challenges, and prospects, ADBI Working Papers 440, Asian Development Bank Institute (ADBI).

Chusseau, N., Dumont, M. and Hellier, J. (2008), 'Explaining rising inequality: skill-biased technical change and North-South trade', *Journal of Economic Surveys* **22**(3), 409–457.

Clark, D. (2006), 'Country and industry-level determinants of vertical specialization-based trade', *International Economic Journal* **20**(2), 211–225.

Clark, X., Dollar, D. and Micco, A. (2004), 'Port efficiency, maritime transport costs, and bilateral trade', *Journal of Development Economics* **75**(2), 417–450.

Corcos, F., Irac, D. M., Mion, G. and Verdier, T. (2013), 'The determinants of intrafirm trade: Evidence from French firms', *Review of Economics and Statistics* **95**(3), 825–83.

Crinò, R. (2008), 'Service offshoring and productivity in Western Europe', *Economics Bulletin* **6**(35), 1–8.

Crinò, R. (2009), 'Offshoring, multinationals and labour market: A review of the empirical literature', *Journal of Economic Surveys* **23**(2), 197–249.

Crinò, R. (2010*a*), 'Employment effects of service offshoring: Evidence from matched firms', *Economics Letters* **107**(2), 253–256.

Crinò, R. (2010*b*), 'Service offshoring and white-collar employment', *Review of Economic Studies* **77**(2), 595–632.

Crinò, R. (2012), 'Imported inputs and skill upgrading', *Labour Economics* **19**(6), 957–969.

Criscuolo, C. and Garicano, L. (2010), 'Offshoring and wage inequality: Using occupational licensing as a shifter of offshoring costs', *American Economic Review* **100**(2), 439–43.

Damijan, J. P., Konings, J. and Polanec, S. (2013), 'Pass-on trade: why do firms simultaneously engage in two-way trade in the same varieties?', *Review of World Economics* **149**, 85–111.

Daudin, G., Rifflart, C. and Schweisguth, D. (2011), 'Who produces for whom in the world economy?', *Canadian Journal of Economics* **44**(4), 1403–1437.

Dean, J. M., Fung, K. C. and Wang, Z. (2011), 'Measuring vertical specialization: The case of China', *Review of International Economics* **19**(4), 609–625.

Deardorff, A. V. (2001*a*), 'Fragmentation in simple trade models', *The North American Journal of Economics and Finance* **12**(2), 121–137.

Deardorff, A. V. (2001*b*), 'International provision of trade services, trade, and fragmentation', *Review of International Economics* **9**(2), 233–248.

Deardorff, A. V. (2005), 'A trade theorist's take on skilled-labor outsourcing', *International Review of Economics & Finance* **14**(3), 259–271.

Debaere, P., Görg, H. and Raff, H. (2013), 'Greasing the wheels of international commerce: how services facilitate firms' international sourcing', *Canadian Journal of Economics* **46**(1), 78–102.

Dedrick, J., Kraemer, K. L. and Linden, G. (2010), 'Who profits from innovation in global value chains?: a study of the iPod and notebook PCs', *Industrial and Corporate Change* **19**(1), 81–116.

Defever, F. and Toubal, F. (2013), 'Productivity, relationship-specific inputs and the sourcing modes of multinationals', *Journal of Economic Behavior & Organization* **94**, 345–357.

Desai, M. A., Foley, C. F. and Hines, J. R. (2009), 'Domestic effects of the foreign activities of US multinationals', *American Economic Journal: Economic Policy* **1**(1), 181–203.

Dettmer, B. (2013), 'International service transactions: Is time a trade barrier in a connected world?', *International Economic Journal* (Forthcoming).

DFAIT (2011), The evolution of global value chains, *in* 'Canada's State of Trade: Trade and Investment Update - 2011', Department of Foreign Affairs and International Trade Canada (DFAIT), chapter 8, pp. 85–101.

Dhar, B. (2013), The future of the World Trade Organization, ADBI Working Papers 444, Asian Development Bank Institute (ADBI).

Dietzenbacher, E., Los, B., Stehrer, R., Timmer, M. and de Vries, G. (2013), 'The construction of world input-output tables in the WIOD project', *Economic Systems Research* **25**(1), 71–98.

Duprez, C. and Dresse, L. (2013), 'The Belgian economy in global value chains. An exploratory analysis', *National Bank of Belgium Economic Review* **September**, 7–21.

Ebenstein, A., Harrison, A., McMillan, M. and Phillips, S. (2013), 'Estimating the impact of trade and offshoring on American workers using the Current Population Surveys', *Review of Economics and Statistics* (Forthcoming).

ECB (2013), Competitiveness Research Network: First year results, Interim report, European Central Bank (ECB).

Egger, H. and Egger, P. (2001), 'Cross-border sourcing and outward processing in EU manufacturing', *The North American Journal of Economics and Finance* **12**(3), 243–256.

Egger, H. and Egger, P. (2003), 'Outsourcing and skill-specific employment in a small economy: Austria after the fall of the Iron Curtain', *Oxford Economic Papers* **55**(4), 625–643.

Egger, H. and Egger, P. (2005), 'The determinants of EU processing trade', *The World Economy* **28**(2), 147–168.

Egger, H. and Egger, P. (2006), 'International outsourcing and the productivity of low-skilled labor in the EU', *Economic Inquiry* **44**(1), 98–108.

Egger, P., Pfaffermayr, M. and Wolfmayr-Schnitzer, Y. (2001), 'The international fragmentation of Austrian manufacturing: The effects of outsourcing on productivity and wages', *The North American Journal of Economics and Finance* **12**(3), 257–272.

Engemann, M. and Lindemann, H. (2013), Testing the O-ring theory for FDI, Working Paper 24, Deutsche Bundesbank.

Escaith, H. and Inomata, S., eds (2011), *Trade patterns and global value chains in East Asia: From trade in goods to trade in tasks*, World Trade Organization (WTO) and Institute of Developing Economies (IDE-JETRO).

Falk, M. and Wolfmayr, Y. (2008), 'Services and materials outsourcing to low-wage countries and employment: Empirical evidence from EU countries', *Structural Change and Economic Dynamics* **19**(1), 38–52.

Fally, T. (2012), Production staging: Measurement and facts, FREIT Working Paper 359, Forum for Research in Empirical International Trade (FREIT).

Fariñas, J. C. and Martín-Marcos, A. (2010), 'Foreign sourcing and productivity: Evidence at the firm level', *The World Economy* **33**(3), 482–506.

Feenstra, R. C. and Hanson, G. H. (1996), 'Globalization, outsourcing, and wage inequality', *The American Economic Review* **86**(2), 240–45.

Feenstra, R. C. and Hanson, G. H. (1999), 'The impact of outsourcing and high-technology capital on wages: Estimates for the United States, 1979-1990', *The Quarterly Journal of Economics* **114**(3), 907–940.

Feenstra, R. C. and Hanson, G. H. (2003), Global production sharing and rising inequality: A survey of trade and wages, *in* E. K. Choi and J. Harrigan, eds, 'Handbook of International Trade', Blackwell Publishing, chapter 6, pp. 146–185.

Feenstra, R. C. and Hanson, G. H. (2004), 'Intermediaries in entrepôt trade: Hong Kong re-exports of Chinese goods', *Journal of Economics & Management Strategy* **13**(1), 3–35.

Feenstra, R. C., Hanson, G. H. and Lin, S. (2002), The value of information in international trade: Gains to outsourcing through Hong Kong, NBER Working Paper 9328, National Bureau of Economic Research.

Feenstra, R. C., Hanson, G. H. and Swenson, D. L. (1998), Offshore assembly from the United States: Production characteristics of the 9802 program, Working Paper 98-10, University of California, Davis, Department of Economics.

Feenstra, R. C. and Jensen, J. B. (2012), 'Evaluating estimates of materials offshoring from US manufacturing', *Economics Letters* **117**(1), 170–173.

Firpo, S., Fortin, N. M. and Lemieux, T. (2011), Occupational tasks and changes in the wage structure, IZA Discussion Papers 5542, Institute for the Study of Labor (IZA).

Foster-McGregor, N. and Stehrer, R. (2013), 'Value added content of trade: A comprehensive approach', *Economics Letters* **120**(2), 354–357.

Foster-McGregor, N., Stehrer, R. and Vries, G. (2013), 'Offshoring and the skill structure of labour demand', *Review of World Economics* **149**(4), 631–662.

Garner, C. A. (2004), 'Offshoring in the service sector: Economic impact and policy issues', *Federal Reserve Bank of Kansas City Economic Review* **Third Quarter**, 5–37.

Gaulier, G., Lemoine, F. and Ünal Kesenci, D. (2005), China's integration in East Asia: Production sharing, FDI and high-tech trade, Working Papers 2005-09, CEPII Research Center.

Gaulier, G., Lemoine, F. and Ünal Kesenci, D. (2007), 'China's emergence and the reorganization of trade flows in Asia', *China Economic Review* **18**(3), 209–243.

Geishecker, I. (2006), 'Does outsourcing to Central and Eastern Europe really threaten manual workers' jobs in Germany?', *The World Economy* **29**(5), 559–583.

Geishecker, I. and Görg, H. (2008), 'Winners and losers: a micro-level analysis of international outsourcing and wages', *Canadian Journal of Economics* **41**(1), 243–270.

Geishecker, I. and Görg, H. (2013), 'Services offshoring and wages: evidence from micro data', *Oxford Economic Papers* **65**(1), 124–146.

Geishecker, I., Görg, H. and Munch, J. (2010), 'Do labour market institutions matter? Micro-level wage effects of international outsourcing in three European countries', *Review of World Economics* **146**, 179–198.

Girma, S. and Görg, H. (2004), 'Outsourcing, foreign ownership, and productivity: Evidence from UK establishment-level data', *Review of International Economics* **12**(5), 817–832.

Gomez, R., Gunderson, M. and Morissette, R. (2013), 'Labour adjustment implications of service offshoring: Evidence from Canada', *British Journal of Industrial Relations* **51**(1), 148–173.

Goos, M., Manning, A. and Salomons, A. (2011), Explaining job polarization: the roles of technology, offshoring and institutions, Discussion Paper 11.34, Katholieke Universiteit Leuven, Center for Economic Studies.

Görg, H. (2000), 'Fragmentation and trade: US inward processing trade in the EU', *Weltwirtschaftliches Archiv* **127**(3), 403–422.

Görg, H. and Hanley, A. (2005*a*), 'International outsourcing and productivity: Evidence from the Irish electronics industry', *The North American Journal of Economics and Finance* **16**(2), 255–269.

Görg, H. and Hanley, A. (2005*b*), 'Labour demand effects of international outsourcing: Evidence from plant-level data', *International Review of Economics & Finance* **14**(3), 365–376.

Görg, H., Hanley, A. and Strobl, E. (2008), 'Productivity effects of international outsourcing: evidence from plant-level data', *Canadian Journal of Economics* **41**(2), 670–688.

Grossman, G. M. and Helpman, E. (2005), 'Outsourcing in a global economy', *Review of Economic Studies* **72**(1), 135–159.

Grossman, G. M. and Rossi-Hansberg, E. (2006), The rise of offshoring: it's not wine for cloth anymore, *in* 'The New Economic Geography: Effects and Policy Implications', Vol. Jackson Hole Conference, Federal Reserve Bank of Kansas City, pp. 59–102.

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

Gruben, W. C. (2001), 'Was NAFTA behind Mexico's high maquiladora growth?', *Federal Reserve Bank of Dallas Economic and Financial Policy Review* (Q III), 11–21.

Hanson, G. H. (2012), 'The rise of middle kingdoms: Emerging economies in global trade', *Journal of Economic Perspectives* **26**(2), 41–64.

Hanson, G. H., Mataloni, R. J. and Slaughter, M. J. (2005), 'Vertical production networks in multinational firms', *The Review of Economics and Statistics* **87**(4), 664–678.

Hansson, P. (2005), 'Skill upgrading and production transfer within Swedish multinationals', *Scandinavian Journal of Economics* **107**(4), 673–692.

Harrison, A., McLaren, J. and McMillan, M. (2011), 'Recent perspectives on trade and inequality', *Annual Review of Economics* **3**(1), 261–289.

Harrison, A. and McMillan, M. (2011), 'Offshoring jobs? Multinationals and U.S. manufacturing employment', *The Review of Economics and Statistics* **93**(3), 857–875.

Head, K. and Ries, J. (2002), 'Offshore production and skill upgrading by Japanese manufacturing firms', *Journal of International Economics* **58**(1), 81–105.

Helg, R. and Tajoli, L. (2005), 'Patterns of international fragmentation of production and the relative demand for labor', *The North American Journal of Economics and Finance* **16**(2), 233–254.

Helpman, E. (2006), 'Trade, FDI, and the organization of firms', *Journal of Economic Literature* **44**(3), 589–630.

Hijzen, A. (2005), 'A bird's eye view of international outsourcing: data, measurement and labour demand effects', *Économie internationale* **104**(4), 45–63.

Hijzen, A. (2007), 'International outsourcing, technological change, and wage inequality', *Review of International Economics* **15**(1), 188–205.

Hijzen, A., Görg, H. and Hine, R. C. (2005), 'International outsourcing and the skill structure of labour demand in the United Kingdom', *Economic Journal* **115**(506), 860–878.

Hijzen, A., Inui, T. and Todo, Y. (2010), 'Does offshoring pay? Firm-level evidence from Japan', *Economic Inquiry* **48**(4), 880–895.

Hijzen, A. and Swaim, P. (2007), 'Does offshoring reduce industry employment?', *National Institute Economic Review* **201**(1), 86–96.

Hillberry, R. (2011), Causes of international production fragmentation: Some evidence, *in* A. Sydor, ed., 'Global Value Chains: Impacts and Implications', Department of Foreign Affairs and International Trade Canada (DFAIT), chapter 3, pp. 77–101.

Horgos, D. (2009), 'Labor market effects of international outsourcing: How measurement matters', *International Review of Economics & Finance* **18**(4), 611–623.

Hsieh, C.-T. and Woo, K. T. (2005), 'The impact of outsourcing to China on Hong Kong's labor market', *American Economic Review* **95**(5), 1673–1687.

Hummels, D. (2007), 'Transportation costs and international trade in the second era of globalization', *Journal of Economic Perspectives* **21**(3).

Hummels, D., Ishii, J. and Yi, K.-M. (2001), 'The nature and growth of vertical specialization in world trade', *Journal of International Economics* **54**(1), 75–96.

Hummels, D., Jøgensen, R., Munch, J. and Xiang, C. (2013), 'The wage effects of offshoring: Evidence from Danish matched worker-firm data', *The American Economic Review* (Forthcoming).

Hummels, D., Rapoport, D. and Yi, K.-M. (1998), 'Vertical specialization and the changing nature of world trade', *Federal Reserve Bank of New York Economic Policy Review* **4**(2), 79–99.

Hummels, D. and Schaur, G. (2013), 'Time as a trade barrier', *American Economic Review* **103**(7), 2935–2959.

ISGEP (2008), 'Understanding cross-country differences in exporter premia: Comparable evidence for 14 countries', *Review of World Economics* **144**(4), 596–635.

Ito, B., Tomiura, E. and Wakasugi, R. (2011), 'Offshore outsourcing and productivity: Evidence from Japanese firm-level data disaggregated by tasks', *Review of International Economics* **19**(3), 555–567.

Jabbour, L. (2010), 'Offshoring and firm performance: Evidence from French manufacturing industry', *World Economy* **33**(3), 507–524.

Jabbour, L. (2012), 'Slicing the value chain internationally: Empirical evidence on the offshoring strategy by French firms', *The World Economy* (Forthcoming).

Jensen, J. B. and Kletzer, L. G. (2010), Measuring tradable services and the task content of offshorable services jobs, *in* K. G. Abraham, J. R. Spletzer and M. Harper, eds, 'Labor in the New Economy', University of Chicago Press, chapter 8, pp. 309–335.

Johnson, R. C. and Noguera, G. (2012*a*), 'Accounting for intermediates: Production sharing and trade in value added', *Journal of International Economics* **86**(2), 224–236.

Johnson, R. C. and Noguera, G. (2012*b*), Fragmentation and trade in value added over four decades, NBER Working Paper 18186, National Bureau of Economic Research.

Johnson, R. C. and Noguera, G. (2012*c*), 'Proximity and production fragmentation', *American Economic Review* **102**(3), 407–11.

Jones, R. W. and Kierzkowski, H. (1990), The role of services in production and international trade: A theoretical framework, *in* R. W. Jones and A. Krueger, eds, 'The Political Economy of International Trade', Oxford, Basil Blackwell, chapter 3, pp. 31–48.

Jones, R. W. and Kierzkowski, H. (2001), A framework for fragmentation, *in* S. W. Arndt and H. Kierzkowski, eds, 'Fragmentation: New Production Patterns in the World Economy', Oxford University Press, USA, chapter 2, pp. 17–34.

Jones, R. W. and Kierzkowski, H. (2005), 'International fragmentation and the new economic geography', *The North American Journal of Economics and Finance* **16**(1), 1–10.

Jones, R. W., Kierzkowski, H. and Leonard, G. (2002), Fragmentation and intra-industry trade, *in* P.J.Lloyd and H.-H. Lee, eds, 'Frontiers of Research in Intra-Industry Trade', Palgrave-Macmillan, chapter 5, pp. 67–86.

Jones, R. W., Kierzkowski, H. and Lurong, C. (2005), 'What does the evidence tell us about fragmentation and outsourcing?', *International Review of Economics & Finance* **14**(3), 305–316.

Kalra, S. (2010), ASEAN: A chronicle of shifting trade exposure and regional integration, IMF Working Paper 10/119, International Monetary Fund (IMF).

Kaminski, B. and Ng, F. (2005), 'Production disintegration and integration of Central Europe into global markets', *International Review of Economics & Finance* **14**(3), 377–390.

Kasahara, H. and Rodrigue, J. (2008), 'Does the use of imported intermediates increase productivity? Plant-level evidence', *Journal of Development Economics* **87**(1), 106–118.

Kikuchi, T. and Iwasa, K. (2010), 'A simple model of service trade with time zone differences', *International Review of Economics & Finance* **19**(1), 75–80.

Kimura, F. (2006), 'International production and distribution networks in East Asia: Eighteen facts, mechanics, and policy implications', *Asian Economic Policy Review* **1**(2), 326–344.

Kimura, F. and Ando, M. (2005), 'Two-dimensional fragmentation in East Asia: Conceptual framework and empirics', *International Review of Economics & Finance* **14**(3), 317–348.

Kimura, F. and Obashi, A. (2011), Production networks in East Asia: What we know so far, ADBI Working Papers 320, Asian Development Bank Institute (ADBI).

Kimura, F., Takahashi, Y. and Hayakawa, K. (2007), 'Fragmentation and parts and components trade: Comparison between East Asia and Europe', *The North American Journal of Economics and Finance* **18**(1), 23–40.

Kohler, W. (2004*a*), 'Aspects of international fragmentation', *Review of International Economics* **12**(5), 793–816.

Kohler, W. (2004*b*), 'International outsourcing and factor prices with multistage production', *Economic Journal* **114**(494), C166–C185.

Kohler, W. and Smolka, M. (2012), Global sourcing: Evidence from Spanish firm-level data, *in* R. M. Stern, ed., 'Quantitative Analysis of Newly Evolving Patterns of International Trade', World Scientific Publishing, USA, chapter 4, pp. 139–193.

Koopman, R., Wang, Z. and Wei, S.-J. (2012), 'Estimating domestic content in exports when processing trade is pervasive', *Journal of Development Economics* **99**(1), 178– 89.

Koopman, R., Wang, Z. and Wei, S.-J. (2013), 'Tracing value-added and double counting in gross exports', *The American Economic Review* (Forthcoming).

Krapohl, S. and Fink, S. (2013), 'Different paths of regional integration: Trade networks and regional institution-building in Europe, Southeast Asia and Southern Africa', *Journal of Common Market Studies* **51**(3), 472–488.

Lall, S., Albaladejo, M. and Zhang, J. (2004), 'Mapping fragmentation: Electronics and automobiles in East Asia and Latin America', *Oxford Development Studies* **32**(3), 407–432.

Lemoine, F. and Ünal Kesenci, D. (2002), China in the international segmentation of production processes, Working Papers 2002-02, CEPII Research Center.

Lemoine, F. and Ünal Kesenci, D. (2004), 'Assembly trade and technology transfer: The case of China', *World Development* **32**(5), 829–850.

Lenzen, M., Moran, D., Kanemoto, K. and Geschke, A. (2013), 'Building EORA: A global multi-region input-output database at high country and sector resolution', *Economic Systems Research* **25**(1), 20–49.

Lo Turco, A. and Maggioni, D. (2012), 'Offshoring to high and low income countries and the labor demand. Evidence from Italian firms', *Review of International Economics* **20**(3), 636–653.

Mankiw, N. G. and Swagel, P. (2006), 'The politics and economics of offshore outsourcing', *Journal of Monetary Economics* **53**(5), 1027–1056.

Marin, D. (2006), 'A new international division of labor in Europe: Outsourcing and offshoring to Eastern Europe', *Journal of the European Economic Association* **4**(2-3), 612–622.

Marjit, S. (2007), 'Trade theory and the role of time zones', *International Review of Economics & Finance* **16**(2), 153–160.

Markusen, J. R. (2006), Modeling the offshoring of white-collar services: From comparative advantage to the new theories of trade and FDI, *in* L. Brainard and S. M. Collins, eds, 'Brookings Trade Forum 2005 - Offshoring White-Collar Work', The Brookings Institution, Washington, D.C., chapter 1, pp. 1–34.

McCann, F. (2011), 'The heterogeneous effect of international outsourcing on firm productivity', *Review of World Economics* **147**(1), 85–108.

McLaren, J. (2000), '"Globalization" and vertical structure', *The American Economic Review* **90**(5), 1239–1254.

Meng, B., Zhang, Y. and Inomata, S. (2013), 'Compilation and applications of IDE-JETRO's international input-output tables', *Economic Systems Research* **25**(1), 122–142.

Michel, B. and Rycx, F. (2012), 'Does offshoring of materials and business services affect employment? Evidence from a small open economy', *Applied Economics* **44**(2), 229–251.

Minondo, A. U.-E. and Rubert, G. A. (2002), 'La especializacion vertical en el comercio internacional de España', *Información Comercial Española, ICE: Revista de economía* (802), 117–128.

Mion, G. and Zhu, L. (2013), 'Import competition from and offshoring to China: A curse or blessing for firms?', *Journal of International Economics* **89**(1), 202–215.

Molnar, M., Pain, N. and Taglioni, D. (2007), The internationalisation of production, international outsourcing and employment in the OECD, OECD Economics Department Working Paper 561, Organisation for Economic Co-operation and Development (OECD).

Morrison Paul, C. J. and Yasar, M. (2009), 'Outsourcing, productivity, and input composition at the plant level', *Canadian Journal of Economics* **42**(2), 422–439.

Moser, C., Urban, D. M. and Weder di Mauro, B. (2009), Offshoring, firm performance and establishment-level employment: Identifying productivity and downsizing effects, CEPR Discussion Papers 7455, Centre for Economic Policy Research.

Navaretti, G. B., Bugamelli, M., Schivardi, F., Altomonte, C., Horgos, D. and Maggioni, D. (2011), The global operations of European firms - The second EFIGE policy report, Bruegel Blueprint 12, Bruegel.

Newby, E. (2013), 'Foreign trade statistics based on value added challenge the traditional picture of international trade', *Bank of Finland Bulletin* **4**, 65–77.

Ng, F. and Yeats, A. J. (1999), Production sharing in East Asia: Who does what for whom, and why?, Policy Research Working Paper Series 2197, The World Bank.

Nordas, H. K. (2006), 'Time as a trade barrier: Implications for low-income countries', *OECD Economic Studies* **2006**(1), 137–167.

Nunn, N. and Trefler, D. (2008), The boundaries of the multinational firm: An empirical analysis, *in* D. M. Elhanan Helpman and T. Verdier, eds, 'The Organization of Firms in a Global Economy', Harvard University Press, chapter 2, pp. 55–83.

Nunn, N. and Trefler, D. (2013), 'Incomplete contracts and the boundaries of the multinational firm', *Journal of Economic Behavior & Organization* **94**(1), 330–344.

OECD (2013), *Interconnected Economies: Benefiting from Global Value Chains*, Organisation for Economic Co-operation and Development (OECD).

OECD and WTO (2012), Trade in value-added: Concepts, methodologies and challenges, Joint OECD-WTO note, Organisation for Economic Co-operation and Development (OECD) and World Trade Organization (WTO).

OECD, WTO and UNCTAD (2013), Implication of global value chains for trade, investment, development and jobs, Joint report prepared for the G-20 Leaders Summit, Organisation for Economic Co-operation and Development (OECD), World Trade Organization (WTO) and United Nations Conference on Trade and Development (UNCTAD).

Olsen, K. B. (2006), Productivity impacts of offshoring and outsourcing: A review, OECD Science, Technology and Industry Working Paper 2006/1, Organisation for Economic Co-operation and Development (OECD).

Orefice, G. and Rocha, N. (2013), 'Deep integration and production networks: An empirical analysis', *The World Economy* (Forthcoming).

Ottaviano, G. I. P., Peri, G. and Wright, G. C. (2013), 'Immigration, offshoring, and American jobs', *American Economic Review* **103**(5), 1925–1959.

Sanyal, K. K. and Jones, R. W. (1982), 'The theory of trade in middle products', *The American Economic Review* **72**(1), 16–31.

Schworer, T. (2013), 'Offshoring, domestic outsourcing and productivity: Evidence for a number of European countries', *Review of World Economics* **149**, 131–149.

Sethupathy, G. (2013), 'Offshoring, wages, and employment: Theory and evidence', *European Economic Review* **62**, 73–97.

Spencer, B. (2005), 'International outsourcing and incomplete contracts', *Canadian Journal of Economics* **38**(4), 1107–1135.

Stehrer, R. (2012), Trade in value added and the value added in trade, WIOD Working Paper 8, World Input-Output Database (WIOD).

Stehrer, R., Foster, N. and de Vries, G. (2012), Value added and factors in trade: A comprehensive approach, WIOD Working Paper 7, World Input-Output Database (WIOD).

Sturgeon, T. J. (2001), 'How do we define value chains and production networks?', *IDS Bulletin* **32**(3), 9–18.

Sturgeon, T. J. and Memedovic, O. (2010), Mapping global value chains: Intermediate goods trade and structural change in the world economy, Working Paper 05/2010, United Nations Industrial Development Organization (UNIDO).

Swenson, D. L. (2005), 'Overseas assembly and country sourcing choices', *Journal of International Economics* **66**(1), 107–130.

Swenson, D. L. (2007), 'Competition and the location of overseas assembly', *Canadian Journal of Economics* **40**(1), 155–175.

Swenson, D. L. (2013), 'The nature of outsourcing relationships: Evidence from OAP prices', *Economic Inquiry* **51**(1), 181–197.

Tanaka, K. (2011), 'Vertical foreign direct investment: Evidence from Japanese and U.S. multinational enterprises', *Japan and the World Economy* **23**(2), 97–111.

Timmer, M. P., Erumban, A. A., Los, B., Stehrer, R. and de Vries, G. (2012), Slicing up global value chains, WIOD Working Paper 12, World Input-Output Database (WIOD).

Timmer, M. P., Los, B., Stehrer, R. and de Vries, G. J. (2013), 'Fragmentation, incomes and jobs: an analysis of European competitiveness', *Economic Policy* **28**(76), 613–661.

Tomiura, E. (2007), 'Foreign outsourcing, exporting, and FDI: A productivity comparison at the firm level', *Journal of International Economics* **72**(1), 113–127.

Tomiura, E., Ito, B. and Wakasugi, R. (2013), 'Offshore outsourcing and non-production workers: Firm-level relationships disaggregated by skills and suppliers', *The World Economy* **36**(2), 180–193.

Tukker, A. and Dietzenbacher, E. (2013), 'Global multiregional input-output frameworks: An introduction and outlook', *Economic Systems Research* **25**(1), 1–19.

UNCTAD (2013*a*), Global value chains and development: Investment and value added trade in the global economy, Technical report, United Nations Conference on Trade and Development (UNCTAD).

UNCTAD (2013*b*), Global value chains: Investment and trade for development, *in* 'World Investment Report 2013 - Global Value Chains: Investment and Trade for Development', United Nations Conference on Trade and Development (UNCTAD), chapter 4, pp. 121–210.

Upward, R., Wang, Z. and Zheng, J. (2013), 'Weighing China's export basket: The domestic content and technology intensity of Chinese exports', *Journal of Comparative Economics* **41**(2), 527–543.

van Welsum, D. and Vickery, G. (2005), Potential offshoring of ICT-intensive using occupations, OECD Digital Economy Paper 91, Organisation for Economic Co-operation and Development (OECD).

Venables, A. J. (1999), 'Fragmentation and multinational production', *European Economic Review* **43**(4-6), 935–945.

Veugelers, R., Barbiero, F. and Blanga-Gubbay, M. (2013), Meeting the manufacturing firms involved in GVCs, *in* R. Veugelers, ed., 'Manufacturing Europe's Future', Bruegel, Bruegel Blueprint 21, chapter 5, pp. 107–138.

Wagner, J. (2011), 'Offshoring and firm performance: self-selection, effects on performance, or both?', *Review of World Economics* **147**, 217–247.

Wakasugi, R. (2007), 'Vertical intra-industry trade and economic integration in East Asia', *Asian Economic Papers* **6**(1), 26–39.

Winkler, D. (2010), 'Services offshoring and its impact on productivity and employment: Evidence from Germany, 1995–2006', *The World Economy* **33**(12), 1672–1701.

Winkler, D. and Milberg, W. (2012), 'Bias in the "proportionality assumption" used in the measurement of offshoring', *World Economics* **13**(4), 39–60.

Wright, G. C. (2013), 'Revisiting the employment impact of offshoring', *European Economic Review* (Forthcoming).

WTO (2008), Trade, the location of production and the industrial organization of firms, *in* 'World Trade Report 2008 - Trade in a Globalizing World', World Trade Organization (WTO), chapter D, pp. 81–122.

Yeaple, S. R. (2006), 'Offshoring, foreign direct investment, and the structure of U.S. trade', *Journal of the European Economic Association* **4**(2-3), 602–611.

Yeats, A. J. (1998), Just how big is global production sharing?, Policy Research Working Paper Series 1871, The World Bank.

Yi, K.-M. (2003), 'Can vertical specialization explain the growth of world trade?', *Journal of Political Economy* **111**(1), 52–102.

Young, A. (1999), Transport, processing and information: Value added and the circuitous movement of goods, mimeo, University of Chicago.

Zhang, X. and Sun, J. (2007), 'An analysis of China's global industrial competitive strength based on vertical specialization', *Frontiers of Economics in China* **2**(1), 57–73.

Zhao, M. (2005), External liberalization and the evolution of China's exchange system: an empirical approach, Research Working Paper 4, World Bank China Office.

WORKING PAPERS

2010