

HOW DO WE UNDERSTAND PARTICIPATION IN GLOBAL VALUE CHAINS? A STRUCTURED REVIEW OF THE LITERATURE

Filippo Bontadini

Amrita Saha

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CONTACT US

OFCE
10 place de Catalogne | 75014 Paris | France
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Filippo Bontadini and Amrita Saha,

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ABOUT THE AUTHORS

Filippo Bontadini, Department of Business and Management, LUISS University, SciencesPo-OFCE,
SPRU – University of Sussex

Email Address: fbontadini@luiss.it

Amrita Saha, Institute of Development Studies

Email Address: a.saha@ids.ac.uk

ABSTRACT

How do we understand participation in Global Value Chains (GVCs)? Despite its important methodological and theoretical implications, the literature has not come to a definitive answer to this question. We aim to contribute towards understanding this as follows. First, we undertake a structured review of the literature, asking how GVC participation can be conceptualised. Second, we systematise conceptual issues and empirical approaches to quantitatively explore the impact of GVCs both at the firm and sector level. Third, we generate descriptive evidence on GVC participation over time. Fourth, taking stock on the conceptual debate on the definition of GVC participation, we focus on how micro-level data can be used to identify firms that are fully integrated in GVCs as those that import and export intermediate and capital goods, distinguishing these from those which engage in traditional arm's length trade. Finally, we motivate an understanding of GVC participation as 'linking into GVCs', as a treatment to which certain firms are exposed and review possible relevant outcome variables to capture the impact of linking into GVCs. These are based on firms' value added and productivity, changes in their export portfolio and their position in trade networks.

KEYWORDS

GVCs ; importing ; exporting ; buyer-supplier.

JEL

F14 ; L25 ; O19.

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Filippo Bontadini

Department of Business and Management – LUISS University
SciencesPo – OFCE
SPRU – University of Sussex
fbontadini@luiss.it

Amrita Saha

Institute of Development Studies
a.saha@ids.ac.uk

Abstract

How do we understand participation in *Global Value Chains* (GVCs)? Despite its important methodological and theoretical implications, the literature has not come to a definitive answer to this question. We aim to contribute towards understanding this as follows. First, we undertake a structured review of the literature, asking how GVC participation can be conceptualised. Second, we systematise conceptual issues and empirical approaches to quantitatively explore the impact of GVCs both at the firm and sector level. Third, we generate descriptive evidence on GVC participation over time. Fourth, taking stock on the conceptual debate on the definition of GVC participation, we focus on how micro-level data can be used to identify firms that are fully integrated in GVCs as those that import and export intermediate and capital goods, distinguishing these from those which engage in traditional arm's length trade. Finally, we motivate an understanding of GVC participation as 'linking into GVCs', as a treatment to which certain firms are exposed and review possible relevant outcome variables to capture the impact of linking into GVCs. These are based on firms' value added and productivity, changes in their export portfolio and their position in trade networks.

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JEL classification: F14 ; L25 ; O19.

1. Introduction

Production has been increasingly fragmented across countries, with trade in intermediate goods representing a large share of total trade (Baldwin and Lopez-gonzalez, 2014; Baldwin and Robert-Nicoud, 2014) - leading to the emergence of Global Value Chains (GVCs). A long-standing literature on GVCs (e.g. Gereffi, 1994; Gereffi, Humphrey and Sturgeon, 2005; Giuliani, Pietrobelli and Rabellotti, 2005; Banga, 2014; Bernard, Moxnes and Ulltveit-Moe, 2014) is underlined by the idea of firms participating in GVCs, driving economic development by offering new specialisation opportunities (Baldwin, 2011), favouring technology transfer (Blalock and Veloso, 2007) and providing firms (especially) in developing countries with the opportunity to upgrade by moving towards new and higher value added activities (Gereffi, Humphrey and Sturgeon, 2005; Giuliani, Pietrobelli and Rabellotti, 2005; Pahl & Timmer, 2019). Despite these significant advances in examining GVCs, there is much less clarity on two key aspects. First, what is GVC participation, how it differs from trade as usual, and how it can be measured appropriately. A significant challenge in this also derives from the fact that it depends on the level of analysis, i.e. countries, sectors or firms. Despite different methodological approaches, to the best of our knowledge, there is no clear alignment in the literature on this.

In this paper, we review the range of literature that has touched upon the issue of participation in GVCs and its impact on countries' performance. Broadly speaking, this literature can be categorised into three streams. First, the "traditional" literature on GVCs has examined issues of governance and upgrading (Gereffi, 1994; Gereffi, Humphrey & Sturgeon, 2005; Humphrey & Schmitz, 2002; Pietrobelli & Rabellotti, 2010; Kaplinsky, 2013; Morris, Kaplinsky & Kaplan, 2012; Kaplinsky & Farooki, 2010; Jodie-Anne Keane, 2012). Second, the macro-level empirical literature has developed a range of measures to examine aggregated participation in GVCs (see De Backer & Miroudot, 2013 and Johnson, 2017 and more recently Borin & Mancini, 2019, for a thorough review of the technical aspects of this) using Inter-Country Input-Output (I-O) tables.¹ Third, a more recent literature captures firm-level participation in GVCs, by matching heterogeneous buyers and suppliers (Sugita, Teshima & Seira, 2015; Tybout, Jinkins, Yi Xu & Eaton, 2016; Eaton, Eslava, Kugler and Tybout, 2007; Bernard et al., 2014). The third one is characterised by its use of transaction-level data to study how heterogeneous firms perform in terms of exports and how buyers and suppliers match with each other (Melitz, 2003; Eaton *et al.*, 2007; Eslava, Fieler and Xu, 2015). Within this strand, the importance of trust within buyer-supplier relationships, as well differences in the nature of relationships have drawn attention (Macchiavello and Morjariay, 2014; Giovannetti, Marvasi and Sanfilippo, 2015; Brancati, Brancati and Maresca, 2017), bridging the transaction level literature and the case study based literature on GVCs.

An exhausting review of these three strands of literature is beyond the scope of this paper, but the issue of how GVCs participation is captured, is common to all of them. Case studies naturally lend themselves to a much higher degree of nuance in their empirical analysis, in contrast to both country- and firm-level trade data that face the significant challenge of inferring GVC participation from data sources that are not designed for this end. To give an example of this challenge, we can think of the export of intermediate products, e.g. electronic components, from Japan to China to produce a smart phone sold in Europe. Most sources of trade data, especially at the firm-level, only allow to observe the export of components from Japan to China, remaining silent as to whether the destination is also the location of final consumption. Inter country I-O data in contrast allow to observe the whole production chain but offer no clear indication as to what it takes for trade to be considered as GVC participation. To go back to our example, electronic components may in fact end up in Europe, be re-imported into Japan or remain in China, embodied in the finished smart phone. Are all these considered as GVC participation? How many borders does a product need to cross in order to be set apart from trade as usual? While different research streams have provided different answers, it fundamentally depends on the specific research question to be addressed.

This is not a mere conceptual issue, but has important bearing for policies, since GVCs have attracted considerable attention over the past decades (World Bank 2019, 2020, OECD, WTO & UNCTAD, 2013).

¹ The main insight of this strand of work highlights the interdependence of countries and sectors, tracing value added as it flows from origin to completion countries, netting out double counting of value added as products are exported and reimported along the different production stages (Koopman, Wang, & Wei, 2014; Los, Timmer, & de Vries, 2015).

It has been argued that GVCs offer countries a new and quicker way to industrialise and shift their productive structure towards higher value added products, by specialising in a segment of the value chain, rather than having to develop the capabilities necessary to build the whole chain domestically (Baldwin 2011, Banga 2014). In light of this growing policy interest, it is important to have a clear understand of what one means by GVC participation and how this is measured. The literature on I-O has made some significant advances in understanding GVCs, while the firm-level literature is at a more embryonic stage, still struggling to accurately measure GVC participation and its effects on firms' performance.

To fill this gap, we conduct a structured review of the literature on participation in GVCs² that use either I-O or transaction level data and that provide (i) a clear definition of GVCs and (ii) measures of participation in GVCs. The inclusion/exclusion criteria for the literature include a scan of each paper's introduction and methodology to determine how participation in GVCs is captured. We specifically focused on papers that provided a clear definition of how firms or countries engage in GVCs and its empirical application. Our inclusion criteria are as follows: (i). for the macro papers, a definition of GVC participation or features of the GVC (length etc.). (ii). for the micro papers, an explicit mention of GVC or buyer-supplier trade and a definition and methodological application of it.³ The application of strictly defined inclusion/exclusion criteria gave us 37 contributions published between 2001 and 2019. This is a fairly small sample of relevant contributions; it is however not surprising given our rather restrictive inclusion criteria that we only consider papers that suggest a novel conceptual understanding and empirical approach to GVC participation. There are of course countless contributions that then use these approaches to explore specific issues concerning GVCs, while we do mention many of these, they are not the focus of our review.

The remainder of this document is structured as follows: in section 2, we review the main conceptual issues around the definition of GVC participation and the implications for empirical research both at the macro and micro-level. Section 3 discusses the literature that has used I-O data and methodology to grapple with these issues. Section 4 shifts focus to the growing micro-level literature that has more recently started to use transaction level data to study GVC participation. Section 5 summarizes the discussion on understanding GVC participation, suggests an approach to measure it and its impact at the micro level. Section 6 concludes the paper.

2. Conceptual issues on global value chains

In order to understand participation in GVCs, it is crucial to have a definition of GVCs, both as a theoretical concept and its application to available data. Kaplinsky and Morris (2000) define GVCs as the “full range of activities which are required to bring a product or service from conception, through the different phases of production, delivery to final consumers and final disposal after use” (p.4). As globalisation has brought about a decline in barriers in flows of goods, capital, technology and (to a lesser extent and especially for skilled workers) labour, the different stages of production have been scattered geographically, making value chains global. These phenomena have led to a change in the nature of trade from an exchange of finished products to a more complex exchange of intermediate goods along the production process. Baldwin (2011) refers to this fragmentation of production, as a consequence of ICT technologies and a general reduction of barriers to trade, as the “second unbundling”, the first one being the increase in trade of final goods that followed the steam engine and the industrial revolution.

In order to study how this second unbundling is affecting countries' economic performance it is important to distinguish trade in GVCs from “traditional” trade that is the outcome of the first unbundling. In order to do this, trade transactions can be qualified according to different criteria, as outlined in **Table 1**.

² Our search strategy was to extract relevant papers from Google Scholar. We scanned through each paper's introduction and methodology section (for empirical papers) to determine underlying framing of linking into GVCs. Using this criteria led to the exclusion of papers that do not meet either: (i) an underlying definition of linking/participation in GVCs; and (ii) informative of conceptual or methodological issues in relation to the linkages. This yielded 37 papers, 17 of which rely on input-output methodology, of which 23 include firm-level analysis.

³ This criterion ruled out all theoretical papers that provide a model of Linking into GVCs without providing a discussion of this that can be brought to the data.

First, the kind of product being traded offers clues as to whether the transaction is happening within a GVC or as regular trade. Commodities, intermediate and capital goods are more likely to be traded within GVCs. On the other hand, retailers make it possible for final products to also be part of GVCs, for example the transaction that brings a smart phone from China to Germany when it is finally purchased is also, arguably, part of a GVC. Second, the origin of a product and whether it has been produced domestically or not is also important in understanding whether trade is taking place within a GVC. Third, the destination of a product is equally revealing of its GVC status, by asking the following: is a product satisfying final or intermediate demand? Is this demand foreign or domestic? For example, is a component exported to China for assembly into a smart phone part of a GVC even if it is then reimported into Japan or even if it remains in China to be consumed as a smart phone purchased by a Chinese resident? This leads us to the fourth criterion: what is the definition of “global” in global value chains? In other terms: how fragmented does a value chain need to be in order to be considered global?

Table 1 – Criteria for GVC participation

Criteria	Possible configurations		
<i>Kind</i>	Finished		
	Intermediate		
	Capital		
<i>Origin</i>	Domestic		
	Foreign		
<i>Destination</i>	Final Foreign		Final Domestic
	Intermediate Foreign		Intermediate Domestic
<i>Globalisation</i>	One-off Export	Export and re-export	Export and re-import
	One-off Import	Import and export	Import and re-export

Broadly speaking, GVC participation is trade that is part of any value chain that crosses at least one border before the final stage: this only excludes products that are entirely produced within a country’s border and are exported only in their final form as a one off transaction. However, as we discuss later, this is not always the approach that the literature has taken. Classifying trade transactions based on the criteria from Table 1 requires, from an empirical point of view, observing the whole production process from start to finish. This raises different, though related, challenges depending on the level of analysis. At the macro level, it is necessary to link final consumption of trade flows with the countries and sectors originating them. While standard trade statistics do not allow this, I-O analysis has proven extremely useful to trace value added along value chains, across countries and sectors.

At the micro level, researchers cannot rely on inter-country input-output data. In order to track down firms’ and sectors’ final markets and upstream chains, the scholarship has traditionally relied on in-depth case studies, focusing on one country or sector at the time conducting interviews with relatively small samples of firms. It is only recently that administrative data on firms’ import and export transactions have become increasingly available. These data usually cover the universe, or the majority, of transactions but they do not offer information on the origin or final destination of products that are traded. It is therefore crucial to understand how such data can be used to identify firms that are part of a GVC and to study their behaviour and performance.

3. The literature on GVCs based on input-output analysis

In this section we review the existing literature that has used input-output methodologies to study GVCs with ICIO tables, in three main parts. First, we look at the contributions that have focused on measuring countries’ participation in GVCs, and how to distinguish this from traditional trade. Second, we discuss a different approach to GVC that focuses on the degree of fragmentation of production in GVCs. Third, the literature that has conceptualised GVC as a production network, rather than a sequence of production stages, in which countries have different positions that can be characterised based on their connections.

Finally, we provide an empirical illustration of how GVCs have become more interconnected over time and the significant heterogeneity across services and manufacturing.

3.1. Countries GVC participation

There have been considerable efforts in using input-output methodology to unpack different portions of value added that is embodied in countries' gross exports, in order to identify countries GVC participation. Some thorough reviews of the technical differences already exist (De Backer and Miroudot, 2013; Johnson, 2017 and Borin and Mancini, 2019), we aim here to highlight different conceptual understanding of GVC participation and the measures that stem from them.

Backward GVC participation is defined in terms of foreign value added content in a country's export, while *forward GVC participation* is determined by a country's export used by importing countries to export to third countries. Initially proposed by Hummels, Ishii & Kei-Mu (2001), Koopman, Wang & Wei (2010) compare backward and forward GVC participation indexes to the total export of a country to give a comprehensive picture of participation in GVCs. However, this appears to be a relatively conservative measure of backward and forward participation, since it only captures intermediate goods or services that cross at least two borders. In this approach, domestic value added (DVA) that is exported to a foreign country and processed there into final goods is not considered as part of GVCs. To give an example, Mexican engines exported to the United States are counted as forward participation only if the final car is exported to a third country; they are not captured by this measure if the car is sold on the U.S. market.

GVC participation sets the focus on value added going through a country, another way of looking at GVC participation of a country consists in unpacking its gross exports identifying the origin the value added embodied in exports flows. Hummels et al. (2001) refer to the latter as vertical specialisation (VS) and Koopman et al. (2014) provide an accounting framework which allows for the disaggregation of the entire value added in a countries' export, distinguishing different kinds of double counting. The authors argue that a country's gross export may be affected by foreign value added originating in third countries: for example, China's exports that rely heavily on the import of intermediate products, which would fall into the backward GVC participation as defined above. Another kind of double counting concerns a country's own value added that is exported as intermediates to produce final goods, to be reimported and consumed domestically – like U.S. intermediate products exported to Mexico just to be reimported as final goods to be consumed on the U.S. market.

From a conceptual point of view it is important to distinguish between forward GVC participation and domestic value added (DVA) content of a country's export. The key difference is that the former only includes value added that is exported to satisfy foreign *intermediate* demand that contributes to third countries' export, while DVA refers to gross export, after netting out foreign value added embodied in it (Boring and Mancini 2019). To go back to our previous example of Mexican engines exported to the US, these would be included in DVA measures as long as the final product is not reimported into Mexico to satisfy domestic demand, while forward participation would include them only if the finished products was sold to a third country, i.e. neither Mexico nor the US. Forward participation is a relevant measure to capture the degree of integration of a given country or industry in GVCs, while domestic value added captures the portion of a country's gross export that comes from its domestic economy and thus remunerates domestic labour and capital (Kowalski *et al.*, 2015).

To summarise, there are different approaches that can be used to study a country's (or sector's) GVC participation and to unpack the value added content of its gross exports. It is not our goal to prescribe which one is the most appropriate, as this will depend crucially on the research question at hand, but it is paramount to have a clear understanding of what each measure represents.

Finally, it is also worth highlighting that this literature has overwhelmingly taken the approach to consider that value added needs to cross at least two boarders in order for this to be considered as GVC participation. This means that using the "globalisation" criterion as set out in Table 1, the I-O based literature considers GVC participation as "Export and re-export" or "Import and export" (Borin and Mancini, 2019). It should however be borne in mind that this is neither the case for the traditional GVC literature nor, as we discuss in section 4, for the emerging literature using firm-level data.

3.2. Fragmentation of production

The measures of GVC participation discussed in the previous section focus on a given country-industry; a different approach consists of looking at the number of countries and sectors that contribute to the production of a finished product. In this approach the focus of the analysis does not lie with the extent to which a country-industry is integrated in GVCs but rather on the degree of fragmentation of production that leads to the shipment of a final good in a given country-industry. To give an example, while the approaches discussed in the previous section look at how much value added is imported and exported by the German automotive sector, this other stream of literature looks at how many countries and industries contribute to the completion of a car exported as a finished good from Germany.

Looking at GVCs from this standpoint, Los et al., (2015) identify the country of completion of a given good and then trace back the value added along the different stages of the production process. Building on this, they put forward a measure of GVC income, i.e. the income generated by final demand of a product along its value chain. This approach also draws attention to the length of a GVC, which Fally (2012) computes by calculating recursively the average number of stages involved in the production of a given good, weighted by the value added in each stage. Tightly related to the length of a GVC, is the position of a given country-industry in a GVC. Antras, Chor, Fally, and Hillberry (2012) propose a measure of upstreamness of production, looking at the number of stages upstream and more recently, Antràs and Chor (2017) measure upstreamness as the share that final demand accounts for in a sector's output, also taking into account higher orders, i.e. how much of the product a sector sells to other sectors is then sold to final demand and so on. Downstreamness is computed in the same way but looking at value added, i.e. remuneration of primary factors, as a share of total output in the same recursive way as upstreamness.

This shift in focus from countries' GVCs participation to the fragmentation of production in GVCs is also important when one wants to measure productivity in a given country industry. In particular, Garbellini and Wirkierman (2014) argue that labour productivity should take into account all value added and labour involved along the value chain of any given final good, rather than only measuring labour's input at the industry level. This approach allows identifying whether an increase in productivity of a given segment of a chain is the result of the offshoring of some activities, without any improvement in the overall value chain productivity. In our example, if low-productivity stages of production in the German automotive industry are offshored to other countries, say Poland, this may lead to an apparent increase in productivity in Germany's car manufacturing that is simply the result of offshoring rather than an improvement in the way German cars are produced along the value chain.

3.3. GVC as networks

One should not be misled by the term GVCs in thinking that production takes place as a sequence of stages through which value added flows one after the other until it reaches final demand. Kaplinsky and Morris (2016) distinguish between additive GVCs in which production stages flow from one into the other and vertically specialised GVCs, where production is fragmented in several sub-processes that can take place at the same time in different place with the lead firm in the value chain providing coordination of the different tasks. It is thus possible that more than one production stage take place at once and interdependences among them are more complex than a sequential process. In this respect, production can be depicted more accurately as a network where final output is the result of the aggregation of value added coming from different industries and countries (Zhu *et al.*, 2015).

A general definition of a network is a collection of nodes that are connected by links (Fagiolo, Reyes and Schiavo, 2010). This can be depicted as a matrix in which nodes are lined along both rows and columns (such matrix in network analysis is called an adjacency matrix) and each element of the matrix represents the link (also called edge) connecting every two nodes. The simplest networks are binary and undirected, i.e. with an adjacency matrix populated by either 1 or 0, signalling the existence or not of a link between any pair of nodes. The Leontieff Inverse derived from input-output tables is also a (square) matrix, but it provides richer information, including both the strength and direction of links, such networks are referred to as weighted and directed. Hence, the literature has studied GVCs through the lens of network analysis focusing not only on the degree of participation of each country and industry to such networks, but also to the position and quality of participation.

A first attempt at qualifying differences in positions in GVCs of different countries was made in the seminal work of Baldwin and Lopez-Gonzalez (2015). Interestingly, while the authors understand GVCs in terms of production networks, they do not rely on an explicit network analysis framework. They simplify inter-country input-output tables by only looking at nodes that account for more than 0.3% of total value added flows and identify clusters of countries that trade intensively among each other. With this approach they identify three main clusters of countries, which they refer to as factories: Europe, America and Asia. Within each factory they then highlight countries that are important trade partners for all other countries, i.e. Germany, the US and China for the three factories, respectively, which they refer to as headquarters. They show that while most countries trade intensively with other countries within the same factory, headquarters have strong linkages also outside of their factory.

Making explicit reference to network analysis Amador and Cabral (2017) confirm the existence of such hubs and also show that trade in value added networks have changed over time. First, networks have become increasingly denser with headquarter economies becoming increasingly connected to their respective factory economies. Second, they have become more asymmetric, with economies gravitating around headquarter economies becoming increasingly dependent and, third, they have become increasingly interconnected, as globalisation has expanded.

In a more recent contribution Amador, Cabral, Mastrandrea, & Ruzzenenti, (2018) use inter-country input-output tables to construct a weighted and directed network. They then rely on two centrality measures: (i) the total value of direct outgoing and incoming connections of a node and (ii) the Kleinberg measure, which computes a node's centrality by looking at the value of the connections of its neighbours. Theoretically speaking, the above is a similar approach Baldwin and Lopez-Gonzalez (2015), but it relies on formalised measures of network centrality that the authors use to identify key countries, specifically Germany, the US, China and Japan, and qualify the roles that each plays. They find in particular that the US acts as a provider of value added to the rest of the world economy, while it is of much smaller importance in terms of consumption of foreign value added. Germany in contrast is important both as provider and consumer of value added, which reflects the high degree of integration among European countries though the majority of value added flows involve Germany directly. The Asian factory is in contrast characterised by more indirect relationships, where Japan and China are key actors in GVCs that involve more than one country.

3.4. The evolution of GVCs as networks, an empirical illustration

In order to illustrate how networks can help understand GVCs and to identify countries' different positions within such networks, we provide an empirical application using data on trade in value added. In particular, we explore how value added is being exported among countries both at the aggregate level and focusing on selected sectors. To maximise the coverage of countries, we use data from the OECD's inter country I-O tables; all the figures presented in the paper use the TiVA indicator DVA in gross export computed by the OECD, following thus Koopman, Wang, & Wei, (2014). It should be noted that this is a mere descriptive exercise aiming to draw out some key facts and differences across sectors and countries.

First, we compare DVA flows among countries for all sectors. *Figures 1a* and *1b* in the Appendix illustrate the network of flows in 1995 and 2010, respectively. We do this by producing circle networks linking each country with export flows. The thickness of the edge is the size of value added in gross export traded between two countries. Each pair of vertices in the network is linked by two edges creating ellipses, for which the upper edge corresponds to value added flowing from the edge on the left to the one on the right and vice versa, for the lower edge. For instance, in 1995 (*Figure 1a*), we observe that the United States was trading value added with Japan, visible in the large ellipse in the graph, for which the upper line corresponds to value added exported by Japan to the United States and the lower line to value added exported from the United States to Japan. Other main trading partners for the United States are Canada and Mexico. We see in the upper part of the graph that European countries are already highly integrated in 1995, with dense exchanges in value added among Germany, France, UK, Italy, and at the bottom of the graph, the Netherlands. When we turn to value added in gross export in 2010 (*Figure 1b*), we observe an intensification of the exchange across all countries. However, the most significant change is the emergence of China, in the upper right corner of the graph, as a new major trading hub, a fact highlighted by many other contributions too (Baldwin and Lopez-gonzalez, 2014; Amador and Cabral, 2017; Amador *et al.*, 2018).

China is exporting significantly to the United States, Japan and Korea, from which it also imports a significant amount. The ellipsis between the United States and Japan has lost importance now, while the exchanges with Mexico and Canada have gained relevance, which is consistent with the signature of the NAFTA in 1994.

Next, we try to assess whether there are significant changes in trade patterns across sectors. We focus in particular on manufacturing and service sectors. *Figures 2a* and *2b* in the Appendix illustrate trade flows for the textile sector for the years 1995 and 2010, respectively. We have seen in the two previous figures that China only emerged, at the aggregate level in the period between 1995 and 2010. Concerning the trade in value added in the textile sector, we see that China in 1995 was already a large exporter of value added in textiles, mainly exporting to Japan and the United States. Italy was also a large actor in this sector, exporting value added to the United States and to Germany. The United States was a large importer from China, Italy, South Korea, India, and Indonesia. We also see that the United States was trading with Canada and Mexico, though these linkages seem much less important compared to the aggregated trade flows in *Figure 1a* and *1b*. In 2010, we observe a striking shift, with most of the value added concentrated in China. Italy is now a minor actor, while China is catering to Europe, Japan and the United States. This pattern is well in line with China's access to the international market, joining WTO in 2001 and the expiration of the Multi-Fibre Arrangement in 2004.

Among the manufacturing sector, the textile industry is relatively low-tech. We explore whether such stark changes in trade patterns have taken place in other more technology intensive sectors. We focus on electrical equipment in 1995 and 2010 again, in *Figures 3a* and *3b* in the Appendix. In the first period, we observe that Japan was exporting a large amount of value added in gross export to the United States, which in turn was trading with a range of partners, such as Canada, the UK, Europe, and Mexico. During this period, China is essentially absent from the picture, though we observe a weak linkage of import from Japan. By 2010, the situation has radically changed: most trade has been diverted to China, which in 2010 is the main destination market for Korea, Japan, and Taiwan, while it exports to the United States. It is worth stressing that such linkages should not be interpreted as sequential stages of production, but rather as intra-industry trade, i.e. exchanges of value added taking place in the same sector. By 2010, China has gained its place as a main manufacturer in the world and therefore imported the largest share of the equipment traded across countries, especially in East Asia. This finding is consistent with Baldwin and Lopez-Gonzalez (2015) who show that trade in GVCs is still concentrated in broad geographic areas with a headquarter economy, China in this case, importing value added from geographically close partners and exporting to other large farther away economies, like the United States.

We find therefore clear evidence of the emergence of China in the trade of goods in value added. This is particularly stark in the export of low-tech products, such as textile and the import of more high-tech products such as electric equipment. The United States remains a large importer and exporter and we clearly see the emergence of China in trade in value added. Aggregating across sectors, we see a general increase of exchange in value added among countries; we also observe however an increase in concentration of value added between 1995-2010: for example exports from China in the textile sector has soared, while Italy has lost its place as the main exporter of value added in the textile sector. We also observe a shift in trade in value added in other sectors, like electric equipment. This sector was heavily concentrated in 1995 with the United States as the main destination of value added in export, but in 2010, China has become the main importer, and exporter, of value added in trade in the electric equipment sector (Gale Raj-Reichert, 2020).

Manufactured goods have long been considered more tradable than services, this is now changing as services gain a larger place in trade flows (Anderson, Borchert, Mottow & Yotov, 2013; Guerrieri & Meliciani, 2005) and GVCs in services are now emerging (Hernandez, Mulder, Fernandez-Stark, Sauvé, López Giral & Muñoz Navia, 2014; Gereffi & Fernandez-Stark, 2010). This is because while services are indeed being traded directly, they are also an input to manufacturing activities (Meliciani & Savona, 2014; Guerrieri & Meliciani, 2005), being thus exported indirectly. The input-output based approach allows tracing value added back to the originating industry and therefore gives useful insights on trade in services too.

We explore geographic distribution of services looking at at two service sectors that are intensive in knowledge and contribute to the production process and are thus more likely to engage in export of intermediate, rather than final, services. *Figures 4a* and *4b* in the Appendix depict the network of value added in export in financial and insurance services and *Figures 5a* and *5b* look at research and design (R&D)

and business services in 1995 and 2010, respectively. Concerning financial services, we observe the United States to again be a central player in this sector, exporting value added to several countries: Japan, Germany, France, UK, and Canada. Switzerland is also exporting value added, mainly European countries such as Germany, Italy, UK and, outside of Europe, Japan. The largest linkage in financial services is the export of value added from the UK to the United States. In 2010, we observe a significant concentration of trade in this sector. The United States remains the main destination and the UK seems to have acquired an even more important role in the exchange of value added as largest exporter. Interestingly, we also observe the emergence of Ireland in the financial sector, importing value added from the United States and exporting to the UK, which is in line with the financialisation that Ireland has undergone in recent years, taking advantage of its membership to the European Single Market.

When we turn to R&D and business services, we observe a rather tight exchange of value added among European countries at top of the graph and the Netherlands at the bottom of the graph. These linkages seem stronger than in the other sectors, this can be explained by the fact that while Europe is a very integrated region the value added that is produced in the region itself is mainly originated in knowledge intensive business services, regardless of the final products embodied in which it is exported. Germany, France, UK, Italy, and the Netherlands exchange a large amount of value added in R&D and business services, though this may be embodied in all sorts of final goods or services. This sector is among those we have examined that undergo the smallest changes. In 2010 the main linkages remain unchanged, we just detect the emergence of a link between the US and Ireland, which again can be explained by Ireland leveraging its EU membership to attract investments in many R&D intensive activities. It is however interesting to note how the linkages between the US and Japan seem to fade, hinting at a shift in the R&D activities participating to GVCs going through the US.

In conclusion, we have shown that while the emergence of developing countries and China in particular, characterise trade in value added in the manufacturing sectors, this seems to be less the case concerning knowledge intensive services, which still seem to be largely produced and consumed by high-income economies. It is worth mentioning however, that this does not mean that value added in services is not traded in developing economies, but simply that it is neither produced nor consumed there. For example, design services of smartphones produce value added in the United States, which is exported to China where the phones are assembled to be re-exported to meet the UK final demand. The input-output approach used to compute TiVA data reallocates the value added in design services produced in the United States and consumed in UK as a link between these two countries, “by-passing” the intermediate segments of production.

The advantage of this methodological approach is that the I-O coefficients computed in this way take into account both direct and indirect linkages among sectors across countries and now provide a good coverage of value added traded across sectors and countries, deploying I-O techniques that are the result of a well-established literature. The drawback of this approach is, however, that it only allows analysis at the sector level. One could then argue that GVCs concern inter-firm relationships, which are rich in heterogeneity that we cannot observe. In recent years an increasing amount of firm and transaction level data has become available for different countries, spurring a literature on buyer-supplier relationships, which we explore in the next section.

4. The literature on buyer-supplier relationship and firm level import-export behaviour.

The literature reviewed in the previous section focuses on countries and sectors' using I-O methodology. The advantage of this approach is that it takes into account both direct and indirect linkages among sectors across countries. However, I-O tables are usually available at the sector level, especially when we consider ICIO, while one could argue that GVCs are ultimately the outcome of firm-to-firm interactions and their specific features. Moreover, this high level of aggregation inevitably masks significant heterogeneity both at the product and firm level.

In recent years an increasing amount of firm and transaction level data has become available for different countries, spurring a literature on buyer-supplier relationships. The emerging literature relying on these newly

available data sources has initially focused on how buyer and suppliers match in the first place, i.e. whether buyer and supplier's characteristic affect this process through assortative matching (Eaton *et al.*, 2007; Bernard *et al.*, 2011; Bernard, Moxnes and Ulltveit-Moe, 2014; Blum, Claro and Horstmann, 2014; Sugita *et al.*, 2015),⁴ building on Melitz's (2003) seminal work on firm heterogeneity. Within this broad literature, we focus particularly on the contributions that have looked at the relationship between firms. We review the most relevant contributions using firm- or transaction-level data to study GVCs, in terms of buyer-supplier transactions.

It is important to note the change in the conceptual understanding of GVC participation that is necessary for micro level analysis. While in sector- and country-level literature reviewed in the previous section, GVC trade involves value added crossing at least two borders, the micro-level literature can only rely on observations of trade flows between buyers and suppliers across one border. Part of this literature has therefore examined offshoring of production stages from one country to another, which can be detected through the export of intermediates. A second strand of work has adopted a more stringent definition of GVC trade, implying that firms must be both importing and exporting. Finally, other contributions have looked at the relationship between buyers and suppliers, adding to the evidence on a topic that has been explored largely through qualitative evidence. In this section, we review the work on these three separate, though related, strands of enquiry, emphasising conceptual understanding and empirical approach to GVCs of each contribution.

4.1. Offshoring.

Access to ample administrative data from customs in recent years has made it possible to link firm level data on production with information on firms' transactions. A growing literature on import and its impact on firms' performance has thus developed. While this is a large strand of work, which looks mainly at productivity and labour market outcomes (Bas and Strauss-Kahn, 2015; Bustos, 2015; Autor, Dorn and Hanson, 2016), we focus on the aspects that are most related to the conceptualisation of GVCs.

The concept of offshoring, i.e. sourcing intermediate products and/or services from abroad, is tightly related to backward participation. One of the main challenges to empirically observe such transactions is that import of inputs, as a result of offshoring, often involves imports from subsidiaries under the same ownership, which is important to distinguish from market-based transactions. Tackling precisely this issue, Halpern, Koren and Szeidl, (2015) combine tax and customs data for Hungary to study the impact of imports on firms' productivity. Their data allow distinguishing between domestic and foreign owned firms, and they rely on input-output coefficients to estimate the domestic input shares, while using import data to observe imported input. They find that if a firm imports all input varieties, they'd see their productivity increase by 22%; half of this increase is explained by simply switching from domestic to foreign suppliers. They also find that foreign-owned companies have lower import costs and use imported inputs more effectively.

Antràs, Fort and Tintelnot (2017) also point out that offshoring, which they refer to as global sourcing, exhibits complementarities across source markets. They provide a theoretical model explaining this and test this hypothesis with U.S. census data and the U.S. Longitudinal Business Database with transaction data from firms with at least one manufacturing plant between 1997 and 2007. They show that the decision to import has a range of connections and complementarities within firms' production function, rather than impacting their productivity through only one channel.

Beyond these complementarities, Bøler, Moxnes and Ulltveit-Moe, (2015) look at the intersection between offshoring, economic performance, and R&D expenditure. They use a tax credit for R&D activities in Norway in 2002 to examine this nexus and detect a positive effect of a reduction of R&D cost not only on R&D activities, but also on import. Their model explains how reducing import cost increases firms' productivity and, through this, returns to R&D costs.

The contributions we have discussed here build on the long-standing literature on the complementarity between import and export, but have one clear limitation when it comes to looking at GVCs: they only

⁴ While all these contributions look at how buyers and suppliers match with each other, none of them uses a GVC framework or discusses how one could distinguish GVC trade from traditional arms' length trade. For this reasons they do not meet the inclusion criteria for our literature review.

look at importing activities. Conceptually speaking the emergence of GVCs entails a broader set of activities than just importing inputs. As we saw at the macro-level, GVC participation in the I-O literature is understood as involving the crossing of at least two borders; this happens either through importing to export (backward participation) or exporting products to firms that will re-export them themselves (forward participation). At the micro level, it is very challenging to observe forward participation, while there are some contributions that have been looking at backward participation, understood as firms that are both importers and exporters.

4.2. Importing and exporting.

Importing and exporting are two complementary activities that often signal a firms' participation in GVCs. On a theoretical level, it is rather straightforward to explain why firms that engage in export might also engage in import. First, gaining access to global markets often involves fixed costs and the ability of firms to withstand stronger competition; this suggests that only the most productive or competitive companies will be able to gain access to global markets. This self-selection argument applies to exporting as much as importing, so firms that are able to do the former are also likely to do the latter. Second, access to global demand through export will make enduring the cost of sourcing inputs from abroad more affordable and vice-versa (Johnson, 2017). In this section we review some key contributions that have studied the behaviour of firms that both import and export and that are most likely to be participating to GVCs.

Jensen, Bernard and Schott (2009) define firms that engage in import, export, and trade with at least one subsidiary as most globally engaged (MGE). The authors find that MGE firms account for 80% of total U.S. trade. Besides MGE companies, much attention has been devoted to processing trade, understood as transactions in which firms import inputs (sometimes enjoying duties exemption) with the sole aim of re-exporting, (when firms do enjoy duties exemption, sales in the domestic market is often forbidden). This approach allows identifying a clear sample of firms that solely engage in import and export activity with no (or minimal) interaction with the domestic market, like it is the case in Grossi Cajal, (2016) who looks at Bangladeshi firms that import and export. While these firms are clearly participating to GVCs, such an approach leaves out firms that do not engage in pure processing trade and may be using foreign inputs to sell on both the domestic and international market and would still be participating in GVCs.

Dai, Maitra and Yu, (2016) look at Chinese data and find that firms engaging in processing trade do not seem to show the higher productivity levels usually associated with export status. Using data from the Chinese National Bureau of Statistics from 2000 to 2005, the authors examine firms with at least 8 employees, combining balance sheet information, ownership, and customs reports. An interesting finding from this evidence is that trade processing arrangements amount to subsidising low productivity firms to gain access to global markets. Poncet and Starosta de Waldemar (2013) also look at export data (albeit at the municipality level, rather than at the firm level) and find that export upgrading has no impact on economic growth when it comes from processing trade activities.

Finally, Kee and Tang, (2015) also use Chinese data to study domestic value added (DVA), which they estimate through firms' financial statements and the special case of processing export where all output is by definition export. They find that foreign direct investment and lower input tariffs have second (and higher) order effects, making it easier for firms to import, produce at lower costs, and make input available to other Chinese firms too, thereby increasing the country's DVA share in output. Interestingly, they use this micro evidence to match existing macro evidence, showing how China's share in GVC participation increased over time.

Methodologically speaking, Kee and Tang, (2015) make an important accomplishment by looking at DVA without relying on input-output coefficients that vary only across sectors and not across firms. However, one can rarely observe information on firms' production function, input intensities in particular, of products sold on the domestic market. As a consequence, researchers must either assume that export and domestic sales share the same use of inputs or rely on input-output coefficients and assume that all products share the same technology.

Choosing the latter option, Goldberg, Kumar Khandelwal, Pavcnik, & Topalova, (2010) make a seminal contribution in this strand of literature. They look at the impact of trade liberalisation, the subsequent access to new imported intermediates for Indian firms, and its effect on the extensive

margin of export of firms. They use I-O coefficients in order to infer information on the technology used by exporters, i.e. how much of each import goes into which export. This approach implies that all firms use inputs in the same proportion. An additional challenge of using domestic I-O is that these are rarely compiled every year.⁵ In this particular case, the paper looks at the impact of a one-off event (import liberalisation) for which I-O tables are available, but this may be a challenge for analyses looking at long-term effects.

Boehm et al. (2016) use the Indian Annual Survey of Industries (ASI) dataset, which provides information on plant level input and output of firms to build an I-O matrix. The approach used in this paper captures first order connections, which means that all indirect linkages among firms remain unobserved. However, the main objective of Boehm et al.'s (2016) analysis is to explain the introduction of new goods, based on firms input portfolio, which makes knowing where the inputs are coming from and how they are allocated across the firms' less relevant.

The above-mentioned contributions have not referred to the concept of participating in GVCs explicitly, but rather looked at the import and export activities of firms. Baldwin and Yan (2014), in contrast, look at Canadian firms that import and export intermediated goods to explicitly identify GVC participation, as well as exiting GVCs, and GVC participation's effect on productivity trajectories of firms. They find that more productive firms tend to self-select into GVCs, and that the same firms also tend to experience an increase in size and an improvement in productivity.

Baldwin and Yan, (2014) also find different patterns across industries: firms in high-tech sectors tend to participate more in GVCs and benefit more from trade (both import and export) with high-wage countries, which suggests that these firms import higher quality intermediate goods and learn from exporting. Companies in lower-technology industries in contrast tend to benefit from GVC participation by gaining access to inputs from low-wage countries. Based on this evidence, the authors conclude that for Canada, GVC participation may be more profitable if it is with other high-wage and high-tech economies, while little is to be gained from more trade with emerging low-wage markets.

Concerning developing countries, Winkler and Farole (2015) look at a firm level database on companies from South Africa, Namibia, and Swaziland, and proxy GVC participation as exporting and importing of intermediates, like most contributions reviewed in this section. The authors study the effect of these two measures on labour productivity and find a positive association for firms in Namibia and South Africa, though not for Swaziland. The results are explained based on Swaziland's economy, which lacks infrastructure and investment capacity to turn GVC participation into increases in labour productivity. Another finding from the analysis is the relationship between GVC participation and increased productivity explained by firms' size, skill, and agglomeration that are positively correlated with the benefits from GVC participation.

The contributions we have reviewed so far proxy GVC participation with import and export of intermediate goods. This approach overlooks the qualitative differences between trade in an arm's length relationship compared to trade in GVCs, which often entails relational aspects and exchange of information and knowledge (Gereffi, Humphrey and Sturgeon, 2005).

However, the most accurate way of exploring these issues in a quantitative setting would require access to large surveys with relevant questions addressing the qualitative features of firms' trade relationships. At the moment, there are not many statistical surveys that explicitly cover GVCs participation and its qualitatively different aspects. A significant exception is the Italian survey on manufacturers (MET), which includes questions on buyer-supplier relationships, such as whether the relationship is a long-term one or on an occasional basis, ownership linkages, and suppliers' involvement in the conception of the final product.

Based on the qualitative literature and specifically the contributions by Humphrey and Schmitz (2002) and Gereffi et al. (2005), Brancati, Brancati and Maresca, (2017) exploit the MET dataset to distinguish different types of GVC governance. Firms that have a short-term relationship with no involvement in the conception

⁵ This is particularly true for domestic and highly disaggregate input-output tables, inter-country I-O are now available for a considerable set of years, but they are rather aggregate and arguably not well suited for firm level analysis.

of the final product are considered to be trading under market-based (or arm's length) GVC governance. Companies that have a long-term relationship but no involvement in the conception of the final product are in hierarchical GVC governance, while those that have both a long-term relationship and involvement in the conception of the final product are in relational GVC governance. Based on this taxonomy, Brancati et al., (2017) find that firms in relational governance are more likely to engage in innovative activities and showed higher resilience to the 2008 financial crisis. To the best of our knowledge, the MET dataset used by Brancati et al., (2017) is the only statistical survey that directly tackles GVC participation with a focus on different modes of GVC participation, and has been used in a few other contributions to further explore these issues.

Giovannetti, Marvasi and Sanfilippo, (2015) use the 2011 wave of the MET dataset and focus on small Italian suppliers, finding that being part of a supply chain makes suppliers more likely to gain access to international markets, specifically at the intensive margin of trade, while no effect is detected on the likelihood of expanding the number of markets served. Giovannetti and Marvasi (2016) also rely on the MET data and study Tuscan companies in 2011 both in terms of their position (i.e. upstreamness vs. downstreamness) in GVCs and their governance, distinguishing between market relationships, relational, and hierarchical in a similar way as Brancati et al. (2017). Interestingly, the analysis finds that Tuscan firms in hierarchical value chains are more productive than those in market-based ones. Once controlling for self-selection, however, there is no significant effect of governance on firm's productivity, though being a buyer and an exporter does have a positive effect on productivity.

Finally, Todeva and Rakhmatullin (2016) propose a methodology to study GVC participation and its impact on firms' performance, but this approach relies on bespoke data that are collected ad hoc and are therefore of lesser interest to our purpose here. The authors also provide an example of the high level of detail required in the data collection for the pharmaceutical sector. As we have shown, the different kinds of relationships that are established between buyers and suppliers are rarely addressed in a quantitative setting, arguably for lack of suitable data sources. We devote the next section to exploring the literature that has engaged with the importance of buyer-supplier relationships through administrative data at the micro level as this kind of data is becoming increasingly available, though it often does not explicitly provide information on GVC governance.

4.3. The value of relationships.

Monarch and Schmidt-Eisenlohr (2015) study the value of relationships in international trade and the effect of learning processes. Drawing from U.S. customs' data, they use buyer-supplier-product combinations to identify trade relationships. The authors also look at the age of the relationship, computed as the number of consecutive years in which two firms trade with each other. Although the value of such relationships is unobserved, the authors infer it from firm behaviour based on whether buyers and suppliers already know each other due to prior trade, assuming thus that as the relationship's duration increases, so does its value. A range of empirical findings are presented:

- The largest number of relationships are new; however new-, medium-, and long-term relationships contribute equally to trade flows in terms of value.
- Undifferentiated products are traded within long-lasting relationships, while the opposite is true for shorter relationships. This is because the authors define undifferentiated products as having spot prices, hence the lack of incentives for looking for new suppliers.
- Failure to provide products of sufficient quality may be more prevalent in differentiated products, which explains why relationships in these goods tend to last for shorter periods of time.
- Larger firms tend to engage in longer relationships. Longer relationships are very relevant at the product level as well, i.e. looking at buyer-supplier-product matches. 43.9% of new products are bought by buyers from exporters already providing another product category, implying that buyers tend to attribute value to already existing relationships with known exporters when it comes to sourcing a new product.
- Institutions in the destination country also play a role, especially concerning contract enforceability and relational contracts, to which many of the papers in this section are also linked.

Related to the last point, Macchiavello (2010) studies reputation acquisition in the wine market for Chilean exporters in the UK. He compiles a new dataset matching wine producers in Chile with UK retailers finding the following stylised facts:

- The age of the relationship has a positive effect on free-on-board (FOB) unit prices, which decline over time.
- The likelihood of a relationship breaking down increases with the age of the relationship.
- Concerning re-matching patterns: distributors involved in second relationships have longer lasting relationships and pay higher FOB unit prices.

In another contribution, Macchiavello and Morjaria (2014) look at the export of flowers from Kenya and focuses on the value of firm relationships in an environment where contracts are often not enforceable. Exploiting the existence of an auction market and a relational market for flowers from Kenya, the authors use customs data reporting buyers and suppliers for each transaction. Two features of the Kenyan setting are used. First, suppliers can choose whether to sell directly to their buyer or whether to sell their produce at public auctions. Second, a riot is used as an external supply shock to study which sale channel suppliers preferred. Given the very specific setting on which this paper relies, it is difficult to extract a generalizable methodology to study buyer-supplier relationships in GVCs. Nonetheless the authors offer compelling evidence of the importance for trade partners to establish trust, with the value of relationship increasing with age and find that this is even more so in a context of low-contract enforceability.

In the contribution we have mentioned above, Grossi Cajal (2016) focuses on the Bangladesh fashion industry, observing both import and export of firms. This is a particularly interesting setting in which to look at GVCs and input-output relationships at the firm level. She uses administrative data, exploiting an administrative procedure which allows firms to claim duty exception for inputs used for export, to trace which proportion of input goes into export. This feature of the data solves the issue of observing how firms allocate inputs across the several outputs they produce. The administrative data on export allows matching each exporter with their buyers, and relationships are defined as buyer-supplier combination. The data allow in fact to observe several of the criteria from Table 1: for each transaction the author can observe where it is coming from (the *origin* criterion), where it is going (the *destination* criterion) what product is being traded (the *kind* criterion). The author considers a relationship to be active if the two parties traded at least in one product category, as long as the buyer is purchasing a product category in which the supplier is active. The main goal is to look at the effect of quality and heterogeneity on search effort in buyers. From our perspective there are three main contributions that this paper makes that are relevant to study GVC participation at the firm level:

1. It measures quality as a demand shifter: goods of superior quality will be bought in larger quantity conditional on their price. To do this she builds on the theoretical model developed by Hottman, Redding & Weinstein (2014).
2. Empirically this quality measure is computed as the deviation of the supplier sales from the expected sales conditional on price, a wide range of control variables and buyer, product, and time fixed effects.
3. Moreover, a measure of exporters' heterogeneity, i.e. the standard deviation of the quality measure above, is constructed.

Grossi Cajal's (2016) paper looks specifically at buyer-supplier relationships, which are arguably part of a GVC, but it does not look at the kinds of relationships that are established; instead the different characteristics of buyers and suppliers are examined. In this respect, the literature has not departed much from the initial contributions we mentioned in sections above looking at heterogeneity and assortative matching.

5. Discussion

5.1 Distinguishing GVC participation from traditional trade in administrative data

After reviewing the literature above, we find that much of the literature on firm-level analysis of GVCs rely on administrative data, rather than self-collected datasets; this has two main advantages. First,

administrative data make it possible to match and directly observe buyer-supplier relationships; and second, they have a more contained cost. The main drawback of administrative data is that only the characteristics of one end of the transaction (either the importer or the exporter) can be fully observed, because the foreign party of the transaction is usually identified with its name and address, but rarely with a unique identifier, which makes matching with other datasets challenging.

From a more conceptual point of view, the papers reviewed understand GVC participation as buyer-supplier relationships in general. As a consequence, most of them do not distinguish between firms that are fully integrated in a GVC, i.e. importing and exporting, from those that simply export at arm's length, nor those who have developed a non-market relationship with their foreign buyers.

They also do not consider any of the conceptual issues discussed in Section 2. Jensen, Bernard and Schott (2009), Halpern, Koren and Szeidl (2015) and Macchiavello and Miquel-Florensa (2017) are three exceptions since they take into account ownership relationships; however, they do not go any further in characterising different kinds of arm's length relationships. This also explains why GVCs are rarely explicitly mentioned in these contributions and if so, only to indicate that the buyer-supplier relationships studied are part of a given production process.

It then appears that when comparing the micro-level methodologies with the I-O approaches, there is a trade-off between the level of aggregation (micro-level data allow studying actual inter-firm relationships) and the proportion of GVCs that can be included in the analysis (only inter-country I-O data allow investigating GVCs in their entirety). It is hard, and perhaps unnecessary, to identify the best approach. This choice is likely dictated by what one understands as participation in GVCs, the specific research question of interest and thus the relevant level of analysis. However, it can be useful to explore how the conceptual issues highlighted by the I-O methodology can inform empirical strategies to identify GVC participation at the firm level. This is important because it would allow retaining the micro-level and high granularity of the analysis, while integrating a more nuanced understanding of what is GVC participation.

As we have seen, the most common approach in the I-O literature is to focus on backward and forward participation. The analysis of the latter requires data on at least two countries and the ability to track value added flowing from the export of one country to the export of another. This seems a daunting endeavour to be achieved with firm-level data, given that administrative data only capture transactions across one border. Nevertheless, if we relax our requirement concerning value added crossing two borders and consider that a firm is joining a GVC through forward participation as long as it is exporting an intermediate good, i.e. a product or service not destined for final consumption, this still signals the fact that the production process crosses at least one border and may therefore be viewed as a GVC. Linking this back to the conceptual framework in Table 1, this would amount to overlooking the "globalisation" criterion, taking into account only the "kind" and "destination" criteria, which are usually easily identified in firm-level transaction data.

Relaxing the "globalisation" criterion also makes it easier to identify backward participation with firms that import and export intermediate products, relying thus on the "origin", "destination" and "kind" criteria from Table 1. This is a very similar approach to the contributions we have reviewed in section 3.2, although most of those do not explicitly focus on intermediate products and do not frame their analysis in terms of GVCs.

5.2 Linking into Global Value Chains

Once we have discussed how GVC participation is defined across macro and micro strands of literature and how it can be measured with data, a useful way of studying its impact on firms' performance is to understand it in terms of *linking into GVCs*, i.e. the moment in which GVC participation begins, conceptualising this as a treatment to which certain firms are exposed.

This raises the question, in turn, of self-selection issues (most productive or best performing firms are arguably more likely to enter GVCs) and the identification of treatment and control groups of firms. Relatedly to this, it is crucial to choose the appropriate control group. In the export and productivity

literature the treatment is export and the control group are non-exporting firms. Building on this, it would be relevant to compare the effect of joining a GVC (import for export and/or export of intermediates, as discussed above) with both non-exporting and exporting firms as control groups. This facilitates highlighting the relevance of joining a GVC compared not only to not trading abroad at all, but also from exporting in a traditional way.

There are several ways in which this issue can be dealt with and a review of these is well beyond the scope of this paper. However, an approach that would be very suitable to studying the effect of linking into GVCs is that of the event-study, as proposed by Alfaro-Urena, Manelici and Vasquez, (2018). The authors study the impact of becoming suppliers to a multinational company for Costa Rican firms, in other words they look at what happens to domestic firms that engage in domestic transactions with foreign owned companies that then export, which qualifies as a way of joining a GVC, although one with very restrictive criteria. In their event-study, they compare firms that become first-time suppliers to multinational corporations (MNC) with those that will also become one but haven't yet done so. In this way, they identify in future MNC suppliers a valid counterfactual that deals with the issue of self-selection.

5.3 Value added and export upgrading in GVCs

Once we have defined what it is to link into GVCs and how this can be studied as a treatment effect, another issue is the choice of a relevant outcome variable to understand the impact of linking into GVCs. The traditional literature on GVCs, based on qualitative studies, stresses the importance of upgrading, which Gereffi et al. (2005) and Sturgeon and Gereffi (2009) define in four ways: Product upgrading: what the firm produces; Process upgrading: how the firm produces; Functional upgrading: what is the role of the firm within the GVC? Value chain upgrading: has the firm moved to a whole other chain?

These definitions can be used to categorize new products and firm capabilities. In contrast, the quantitative and well-established literature on export and productivity tends to focus more on measures of productivity or profitability of the firm. As we have seen, measuring productivity of a firm in the context of GVCs can be misleading from a policy perspective, as the outsourcing of activities, i.e. the increase of import, may result in an increase of productivity that is achieved by reducing the labour costs and may yield ambiguous results at the more aggregate level (Garbellini & Wirkierman 2014). Therefore, it is important to try to devise a productivity measure that distinguishes between increases in value added per worker due to a reduction of the workers or an increase of the value added produced.

Another policy relevant approach, that is arguably closer to the idea of upgrading in GVCs as spelled out by the qualitative literature, is looking at firms' export portfolio. There is a large literature on export diversification and development and this is also conceptually close to the definition of product and value chain upgrading briefly discussed above. A challenge here is deciding if the introduction of any product is a form of upgrading or whether it is necessary to look at the type of products introduced for example breaking it down by raw material, intermediates, and final goods. Taking this approach, a firm producing textile fabric that starts to produce t-shirts is arguably upgrading, while a firm that was already producing t-shirts and includes in its export basket export of textile fabrics is simply diversifying without increasing its capabilities.

The economic complexity index provided by Hidalgo and Hausmann (2009) ⁶ can be of help in characterizing the kind of products that firms introduce in their export portfolio. The authors look at world trade flows as a network and use countries' export portfolios' diversification and goods' ubiquity in the network to construct an index, where high complexity scores are associated to goods produced by few countries (low ubiquity levels) that have a high level of diversification in their export portfolio (a wide range of capabilities). This measure's main weakness is that it does not reveal much about the firms' own

⁶ There is a lively and still on-going debate on what measures of economic sophistication are best suited, that we do not explore here (Hausmann and Hidalgo, 2011; Felipe et al., 2012; Cristelli, Tacchella and Pietronero, 2014; Daude, Nagengast and Perea, 2016)

contribution to the production process, revealing the importance of distinguishing processing trade involving very simple tasks (e.g. assembly) that add little value, from higher value added.

6. Conclusion

The literature reviewed in this paper studies GVCs using inter-country I-O tables and micro data with information on the buyer-supplier relationship. I-O tables facilitate the study of relationships between sectors and countries. The literature used these to look at countries' participation in GVCs and the degree to which the production of a final good or service is fragmented. Compared to traditional gross export measures, I-O analysis captures value added flows, excludes double counting effects and reallocates value added embodied in the export of a given industry but generated by a different one. The main limitation of this approach is the level of aggregation at which the analysis can be carried out. The inter-country input-output tables only cover some countries and highly aggregated sectors. National input-output tables are sometimes more disaggregated, mostly in high-income economies, but are usually not compiled for every year. Most importantly, national input-output tables only allow for the study of inter-sectoral linkages within one country, while we've seen that, by definition, participation in GVCs implies crossing multiple country borders. Moreover, even if input-output tables were available at a more disaggregated level, this empirical approach would still be unable to capture firm level effects of participating in GVCs.

This is a crucial shortcoming because there is now an established literature on firm heterogeneity showing that that firms producing the same product may vary greatly in their characteristics (Melitz, 2003) and thus benefit to different extents by linking into GVC. It is now possible to explore these aspects, thanks to the increasing availability of firm-level export data, which allows for matching buyers and suppliers. We reviewed some of the most relevant contributions in this strand of work in the second part of this document. Empirically speaking, the methodology of these papers is quite straightforward; they rely on either administrative data matching buyers and suppliers or ad hoc surveys from which they extract their main variables of interest – typically relationship duration, volume and values of trade, number of available suppliers, etc., The key shortcoming of this approach is that administrative data allows focusing only on a given segment instead of the GVC in its entirety.

There appears thus to be a trade-off between I-O methodologies and the firm-level trade literature. The former is compatible with a more nuanced theoretical understanding of GVCs and offers the opportunity to observe GVCs in their entirety but at highly aggregated levels of analysis. The latter on the other hand provides great level of detail but can only focus on a specific segment of GVCs and makes no distinction between trade as usual and trade in GVCs. This paper tries to overcome this trade-off by systematising the conceptual issues that ought to be considered in defining GVCs, reviewing both the I-O and micro-level literature and highlighting how the theoretical understanding put forward by the former can inform the empirical approach of the latter. This allows us to distinguish firms that are fully integrated in a GVC i.e. importing and exporting intermediate products, from those which simply export at arm's length.

Building on this, we argue for an understanding of GVC participation as '*linking into GVCs*', i.e. in terms of a treatment to which certain firms are exposed. We then suggest to study the impact of such treatment based on firm's position in trade networks, and the extent of their value added and the sophistication of their exports.

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Appendix

A. Supplementary Figures

Fig. 1a – Network of value added in gross export in 1995

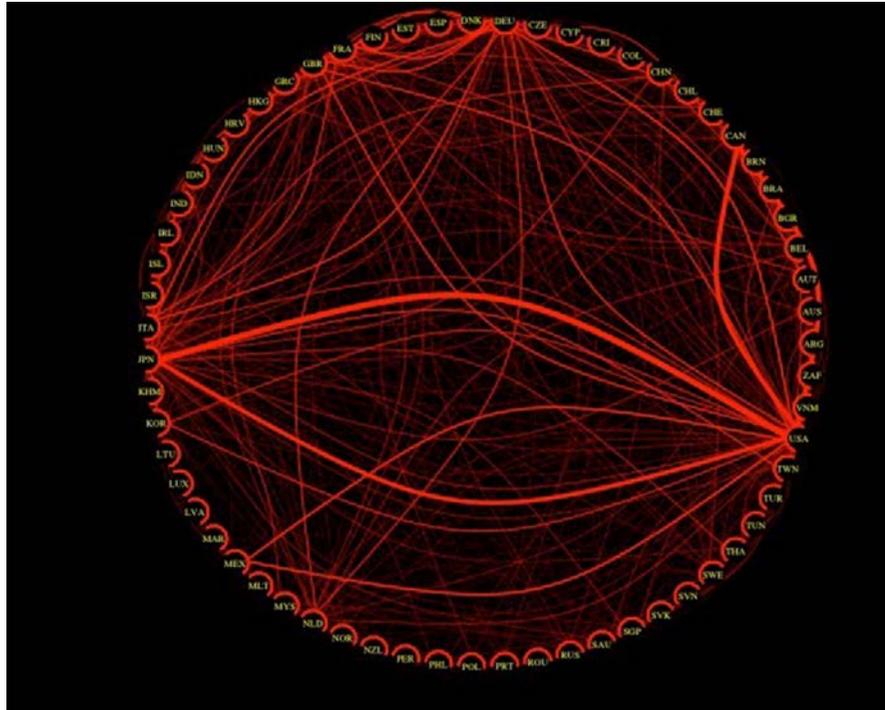
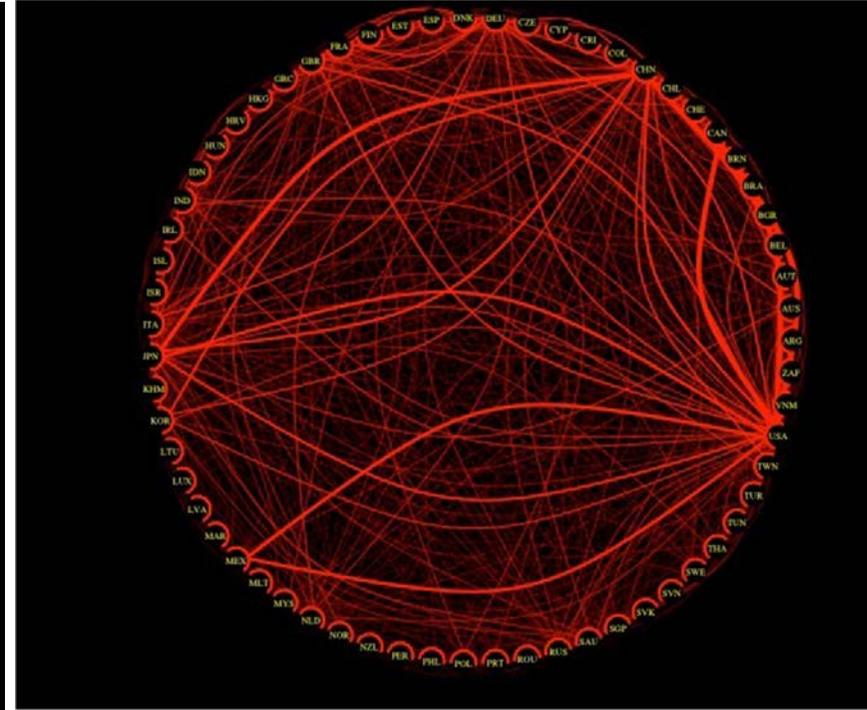


Fig. 1b – Network of value added in gross export in 2010



Source: Authors' own calculation based on TiVA data from OECD. Note: countries names are abbreviated using ISO3 codes and ordered alphabetically starting with Argentina (ARG) on the most right-hand side edge and moving anti-clockwise. The size of the link represents the strength of bilateral flows of value added.

Fig. 2a – Network of value added in gross export in textile in 1995

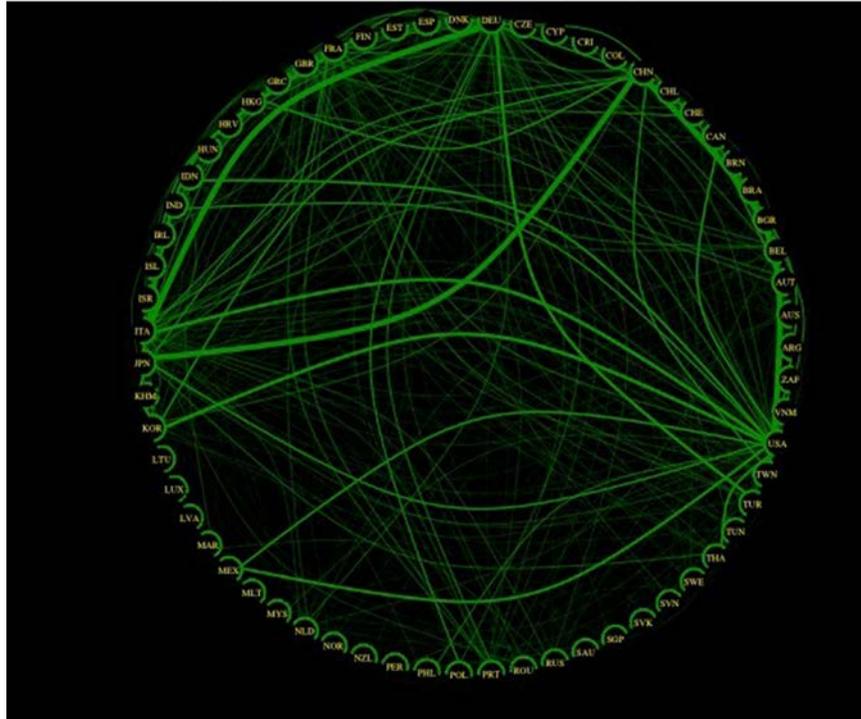
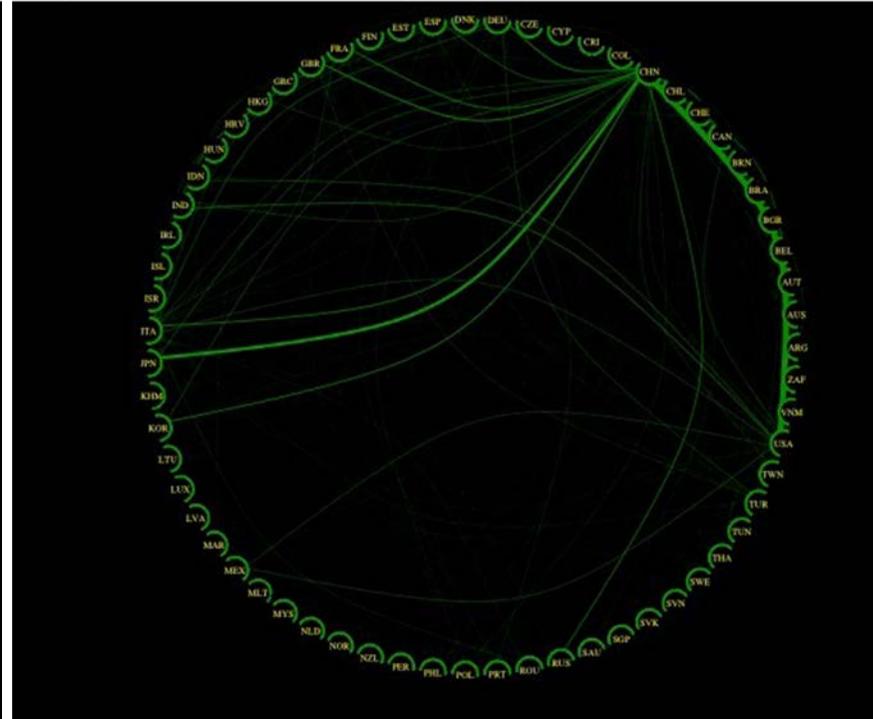


Fig. 2b – Network of value added in gross export in textile in 2010



Source: Authors' own calculation based on TiVA data from OECD. Note: countries names are abbreviated using ISO3 codes and ordered alphabetically starting with Argentina (ARG) on the most right-hand side edge and moving anti-clockwise. The size of the link represents the strength of bilateral flows of value added.

Fig. 3a – Network of value added in gross export in electric equipment in 1995

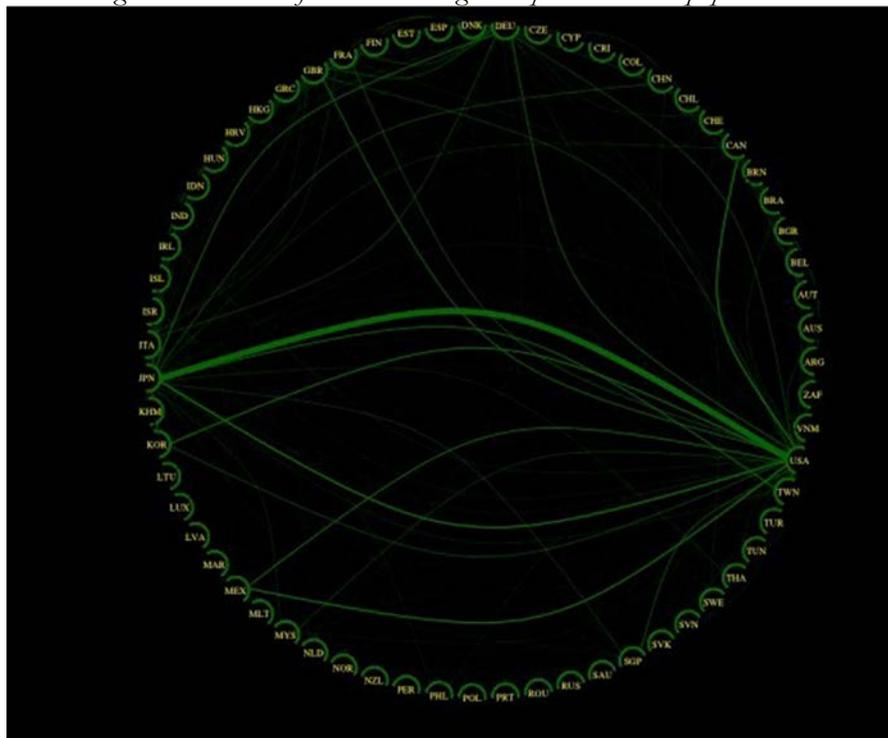
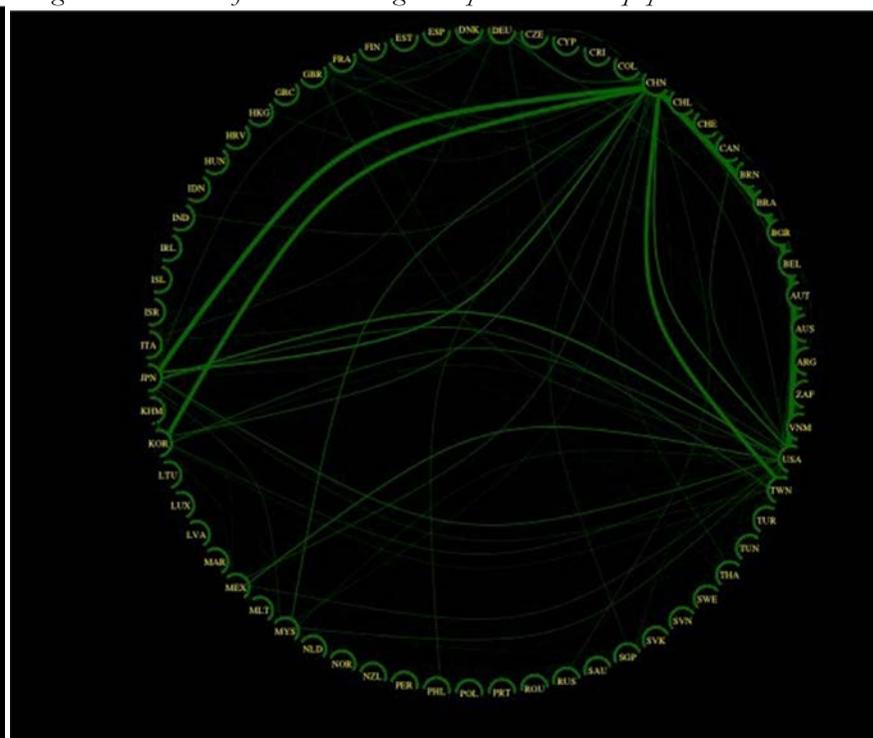


Fig. 3b – Network of value added in gross export in electric equipment in 2010



Source: Authors' own calculation based on TiVA data from OECD. Note: countries names are abbreviated using ISO3 codes and ordered alphabetically starting with Argentina (ARG) on the most right-hand side edge and moving anti-clockwise. The size of the link represents the strength of bilateral flows of value added.

Fig. 4a – Network of value added in gross export in financial and insurance services in 1995

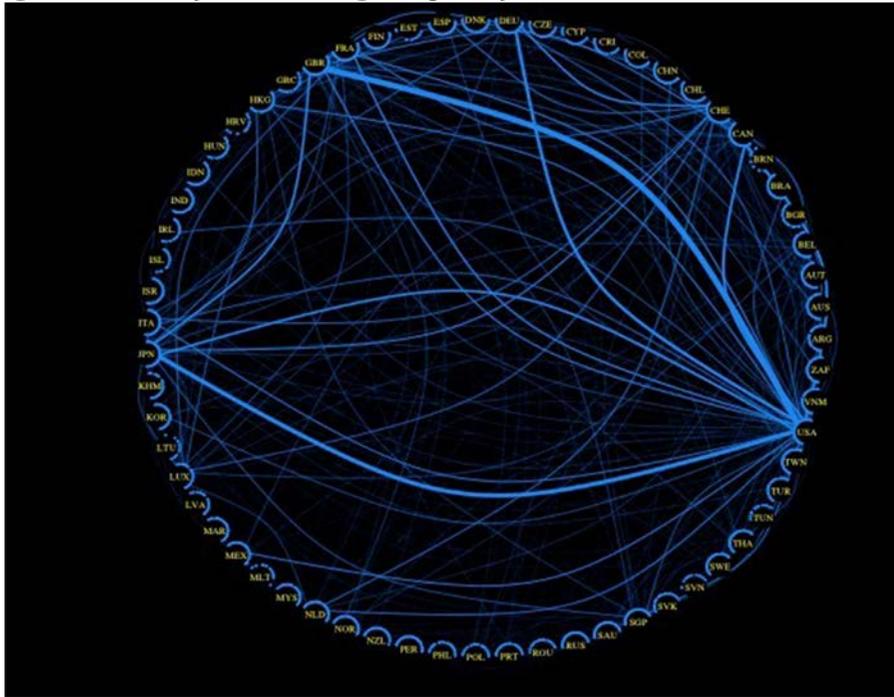
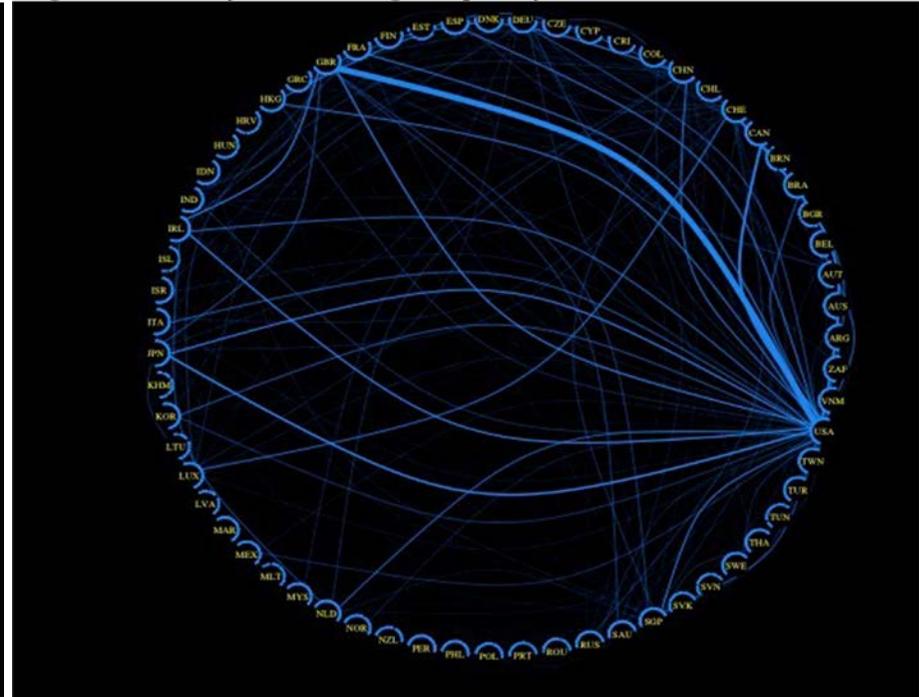


Fig. 4b – Network of value added in gross export in financial and insurance services in 2010



Source: Authors' own calculation based on TiVA data from OECD. Note: countries names are abbreviated using ISO3 codes and ordered alphabetically starting with Argentina (ARG) on the most right-hand side edge and moving anti-clockwise. The size of the link represents the strength of bilateral flows of value added.

Fig. 5a – Network of value added in gross export in R&D and business services in 1995

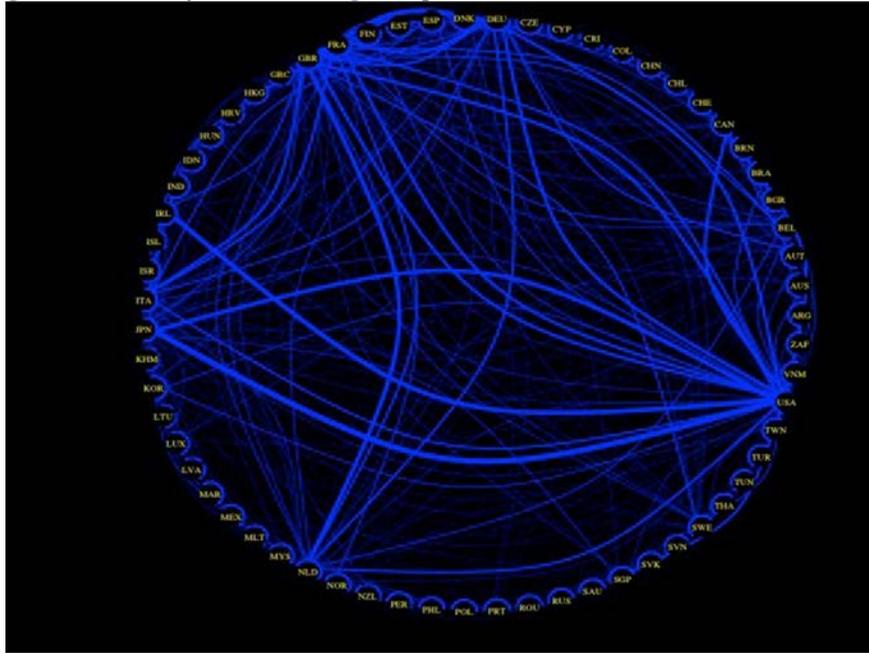
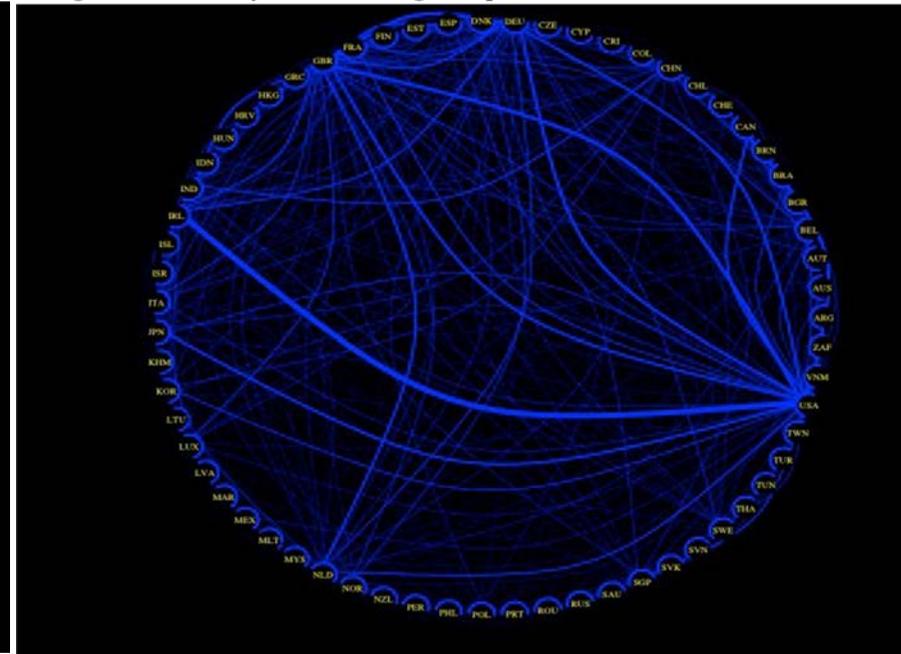


Fig. 5b – Network of value added in gross export in R&D and business services in 2010



Source: Authors' own calculation based on TiVA data from OECD. Note: countries names are abbreviated using ISO3 codes and ordered alphabetically starting with Argentina (ARG) on the most right-hand side edge and moving anti-clockwise. The size of the link represents the strength of bilateral flows of value added.

B. Table A: GVCs based on input-output analysis

Authors	Year	Title	GVC definition	Data applicability	Relevance and limitations
Amador, Cabral, Mastrandrea and Ruzzenenti	2018	<i>Who's Who in Global Value Chains? A Weighted Network Approach</i>	GVCs as a weighted and directed	WIOD	The paper represents GVCs as a weighted and directed network. The structure of this network is studied in terms of different centrality measures, based on the number of connections of each element as well as the neighbours' connectedness. Germany, the US, China and Japan are found to be at the centre of dense clusters.
Johnson	2017	<i>Measuring Global Value Chains</i>	n.a.	n.a.	This paper explores the progress made in the literature both at the macro level, using Multi Regional Input Output (MRIO) tables, and the micro level using transaction level data.
Antràs and Chor	2017	<i>On the Measurement of Upstreamness and Downstreamness in Global Value Chains</i>	WIOD	1995-2011	This paper builds on the existing measures for upstreamness and downstreamness of GVCs. It applies these measures to WIOD and explores the correlation between these two measures and possible reasons explaining this.
Amador and Cabral	2017	<i>Networks of Value-added Trade</i>	Network analysis of trade in value added flows	WIOD	The authors explicitly conceptualise GVCs in terms of networks. They find these networks to become increasingly dense with headquarter economies gaining growing importance within their respective cluster.
Los, Timmer and de Vries	2016	<i>Tracing Value-Added and Double Counting in Gross Exports: Comment</i>	The authors provide an alternative approach to Koopman et al 2014 based on the hypothetical extraction method from the I-O literature to derive measures of value added in gross export.	n.a.	This paper is a direct response to Koopman et al 2014, providing a methodological alternative to disaggregating value added embodied in gross trade. Johnson 2017 also argues that this methodology is superior as it avoids treating export of intermediate goods twice, once in the Leontief global inverse and a second time in the export vector.
Los, Timmer and de Vries	2015	<i>How Global are Global Value Chains?</i>	Final Product Fragmentation	they use the world input-output database (WIOD). However these measures can be applied to any I-O.	The novelty of this approach is that it focuses on countries final good productions and traces value added contribution to this, distinguishing between sectors and countries of origin. Compared to Koopman et al the focus shifts here from the countries' integration to the production fragmentation.
Kowalski, Lopez Gonzalez, Ragoussis, and Ugarte	2015	<i>Participation of Developing Countries in Global Value Chains: implications for Trade and Trade-Related Policies</i>	Domestic Value Added	ICIO compiled by OECD	Domestic value added is the domestic contribution, in value added terms, that each sector makes to its country's export. This means that it doesn't include value added imported from other countries (backward participation) but it does include domestic value added contribution to other countries' export (forward participation) plus domestic value added consumed by other countries final demand or domestic production. So, this measure captures the part of value added exported that accrues domestic labour and capital.
Zhu, Puliga, Cerina, Chessa and Riccaboni	2015	<i>Global Value Trees</i>	GVC as production trees	WIOD	The paper understands GVCs as complex networks of production. They find that production networks can be better represented by tree topology rather than as chains of successive production steps.
Koopman Wang Wei	2014	<i>Tracing Value-Added and Double Counting in Gross Exports</i>	Building on the existing literature this paper provides an accounting framework to break up countries' exports in 9 components.	they integrate GTAP data and UN.COMTRADE and construct their own Inter-Country Input-Output dataset	This is a cornerstone in the literature on Input-Output techniques and GVC measurement. It provides a thorough discussion of how different segments of value added in trade can be accounted for. However, given that the main goal of the paper is to provide a methodology to slice up value added embodied in trade, the authors do not concern themselves with proposing a clear definition of what linking into GVCs, or GVC participation means.
Garbellini and Wirkierman	2014	<i>Productivity Accounting in Vertically (Hyper-)Integrated terms: Bridging the Gap between Theory and Empirics</i>	Value Chain Productivity	In the empirical exploration they use data from the Italian National Institute of Statistics (ISTAT) but again this methodology is applicable to any I-O.	in this application productivity is not measured as value added per labour within a given industry, but within a given value chain. This is to take into account that off-shoring is often used by firms to outsource activities which automatically yields an increase in productivity of the industry, but not necessarily of the value chain overall. This measure is however more relevant for macro-level analyses.
Banga	2014	<i>Linking into Global Value Chains Is not Sufficient: Do You export Domestic Value Added Contents</i>	Domestic Value Added Content	ICIO compiled by OECD	The merit of this paper is to point out that GVC participation is not necessarily beneficial, it proposes to take into account both backward and forward participation and compute a sort of trade balance based on these measures. However, backward and forward participation may be complementary and this approach may not provide an accurate view of countries benefits from GVC participation.
Baldwin and Lopez Gonzalez	2014	<i>Supply-chain Trade: A Portrait of Global Patterns and Several Testable Hypotheses</i>	Headquarter and factory economies in production networks	ICIO compiled by OECD and WIOD	The authors stress how flows in trade in value added can be understood as a network among different countries and sectors. They find that these clusters around three macro-regions: Europe, America and Asia. In each of these clusters there are headquarter (Germany, the US and China, respectively) with factory economies revolving around these.
Fally	2012	<i>Production Staging: Measurement and Facts</i>	Length of GVC	US input-output matrix - the measures can be applied to any I-O, though the US ones are particularly suitable because of the high level of disaggregation (6-digit).	This is an index of the number of production stages necessary for a final good to be produced, it traces the number of stages upstream from a given sector and country. Conceptually speaking it is not dissimilar to backward participation, except that this measure focuses on the number of stages, rather than the amount of value added
Antras, Chor, Fally, and Hillberry	2012	<i>Measuring the Upstreamness of Production and Trade Flows</i>	Upstreamness	They use both US I-O and other countries' I-O retrieved from the OECD STAN database.	This is an index of the number of production stages necessary separating a good from its final demand, it traces the number of stages downstream from a given sector and country. Conceptually speaking it is not dissimilar to forward participation, except that this measure focuses on the number of stages, rather than the amount of value added. It is essentially specular to Fally's contribution

Koopman, Powers, Wang and Wei	2010	<i>Give Credit where Credit Is Due: Tracing Value Added in Global Production Chains</i>	Forward and Backward participation	They use the inter-country input-output (ICIO) database. However these measures can be applied to any I-O.	These two measures are perhaps the most commonly used in the literature when it comes to study a country's integration in GVCs. Based on this it is important for us to define carefully whether "joining a GVC" is different from "participating" to it, although this is a conceptual rather than methodological issue.
Hummels Ishii & Kei-Mu	2001	<i>The nature and growth of vertical specialization in world trade</i>	Vertical Specialisation	They use the inter-country input-output (ICIO) database. However these measures can be applied to any I-O.	This is one of the very first contributions discussing the risk of double counting when using gross trade data and putting forward the idea of value added in exports, which they refer to a Vertical Specialisation (VS). Koopman et al (2014) show how this measure is still affected by double counting and have spurred a large literature trying to pin down different measures of value added embodied in countries' exports.

C. Table B: GVCs using firm level import-export behaviour

Authors	Year	Title	Definition of B-S	Relevance and limitations
Antràs, Fort and Tintelnot	2017	<i>The Margins of Global Sourcing: Theory and Evidence from U.S. Firms</i>	The paper does not observe buyer-supplier linkages directly, instead it looks at importing and complementarities across different import and their impact on firm performance	The paper is relevant as it explores sourcing strategies employed by firms joining a GVCs. However the definition of GVC participation consists of simply importing.
Baldwin and Yan	2014	<i>Global Value Chain Participation and the Productivity of Canadian Manufacturing Firms</i>	Firms that link into GVCs are defined as those that import intermediate goods and export either intermediate or final goods.	The authors explicitly address the issue of self-selection into GVCs and provide an interesting empirical application to deal with this. The paper also provides a clear definition of what GVC participation means.
Boehm Dhingra Morrow	2016	<i>Swimming Upstream: Input-output Linkages and the Direction of Product Adoption.</i>	The dataset provides information on firms purchases and sales at the plant level, which makes it close to an I-O matrix, though only at the first order (i.e. we just observe how much a plant is purchasing in input, but we don't know where these input really come from). There is no buyer-supplier relation here, but simply plant's input portfolio.	This is a very relevant paper, it by-passes the issue of matching buyers and suppliers and just looks at input-output relations at the firm level.
Bøler, Moxnes and Ulltveit-Moe	2015	<i>R&D, International Sourcing, and the Joint Impact on Firm Performance</i>	This paper doesn't look specifically at the relationship between buyers and suppliers, but at the effect of importing on R&D activity and its return for firms.	This paper looks not only at import but also at its relationship with R&D activity and the returns from it. However it doesn't explicitly look at GVC participation, but rather at import tout court.
Brancati, Brancati and Maresca	2017	<i>Global Value Chains, innovation and Performance: Firm-Level Evidence from the Great Recession</i>	The dataset the authors use in this paper is a survey (MET) administered by the Italy's National Institute of Statistics (ISTAT) that explicitly includes questions on firms' relationships with their buyers, which allows identifying firms that are part of a GVC.	The ISTAT data with the relevant information are part of a dataset called MET. The data include information only on the supplier's side of trade relationships. This means that it informs on how suppliers describe their trade relationships, but we do not observe every single trade relationship a supplier engages in.
Dai Maitra and Yu	2016	<i>Unexceptional Exporter Performance in China? The Role of Processing Trade</i>	This paper looks at firms that engage in trade, joint exporting and importing; do not focus specifically on buyer-supplier linkages, but look more in general at firms' performance, differentiating between processing and regular trade.	This paper explores the impact of processing trade, setting it aside from joint exporting and importing. This is important because it allows nuancing between different ways of GVC participation, emphasising the importance of linkages between firms linking into GVC and the domestic economy.
Defever Fischer Suedekum	2015	<i>Relational Contracts and Supplier Turnover in the Global Economy</i>	They use a subsample of new trade relationships of firm-product-destination, i.e. no buyer matching. They simply identify relational contracts as processing arrangements.	The paper doesn't match buyers supplier and proxy relational contracts with processing trade.
Ghani Reed	2017	<i>Relationships, Risk and Rents: Evidence from a Market for Ice</i>	They perform a large scale data collection, interviewing ice producers, retailers and fishermen consuming ice. In this way they look at two segments of a GVC. They also use transaction data from the 5 main retailers.	The paper used self-collected data matched with transaction data which matches retailers with their suppliers. Conceptually speaking it focuses on buyer-supplier relationships and changes triggered by increased competition upstream. So rather than looking at what happens to the new ice producers entering the value chain, it looks at the effects on the actors downstream, i.e. retailers and fishermen.
Giovannetti and Marvasi	2016	<i>Food Exporters in Global Value Chains: Evidence from Italy</i>	The dataset the authors use in this paper is a survey (MET) administered by the Italy's National Institute of Statistics (ISTAT) that explicitly includes questions on firms' relationships with their buyers, which allows identifying firms that are part of a GVC.	The ISTAT data with the relevant information are part of a dataset called MET. The data include information only on the supplier's side of trade relationships. This means that it informs on how suppliers describe their trade relationships, but we do not observe every single trade relationship a supplier engages in. Also, because it relates to specific questions of 4 waves of the MET survey the paper does not provide a blue print for further research and results are hard to replicate in a different context.
Giovannetti Marvasi Sanfilippo	2015	<i>Supply Chains and Internationalization of Small Firms</i>		
Grossi Cajal	2016	<i>Searching for Trade Partners in Developing Countries : Testing Firms in the "Fast Fashion" Industry</i>	This paper focuses on the search effort buyers make looking for suppliers. The focus here is not necessarily on the relationship itself. However, buyer-supplier relationships are identified in the same way.	The paper is interesting from a methodological point of view, using administrative procedures to understand input-output relationships within the firm. Moreover, the author not only uses data on export but also information on import "all the imports by ready-made garment manufacturers into Bangladesh...exploiting an administrative procedure used for claiming duty exceptions for inputs to garment export orders, we can match specific orders to the material inputs used for producing them" (p. 7) . a further characterisation of relationships is also put forward "A relationship is sustained if, from the wake of the first trade between the two parties, exports involving the same buyer-seller pair are recorded at least in one product category once a year, for as long as the buyer has non-zero demand in the product categories in which the supplier is active." (p.8) It also provides a quality index of suppliers by looking at each firm's average deviation of the expected quantity sold conditional on price, buyer, product and time FE. Quality is here understood as a demand shift", i.e. given product, buyer, time and price, firms that manage to sell more will be providing higher quality products.

Halpern, Koren and Szeidl	2015	<i>Imported Inputs and Productivity</i>	The paper doesn't directly observe linkages between buyers and suppliers. It focuses however on the impact of import on firms' productivity, finding a strong and positive effect.	The paper is part of a very broad literature looking at the impact of importing on firm performance. Its main limitation, is that it doesn't look exactly at GVCs, but at importing more in general.
Jensen, Bernard and Schott	2009	<i>Importers, Exports and Multinationals: A Portrait of Firms in the U.S. that Trade Goods</i>	This paper puts forward a definition of most globally engage (MGE) firms that are those that import and export and for which at least one partner is a subsidiary.	This contribution uses a very narrow definition of MGE, which means that many firms that might still link into GVCs later are left out of the analysis. It also relies on very complete data that are available for the US but not for many other countries.
Kee and Tang	2015	<i>Domestic Value Added in Exports: Theory and Firm Evidence from China</i>	The Chinese data from customs provide information at the transaction level, as well as whether the exporter is a processing trade firm. The authors do not look at buyer-supplier relationships directly, instead they use a technique to compute domestic value added in export at the firm level.	The paper proposes an interesting approach to computing domestic value added in trade at the firm level. This allows to take into account firm level heterogeneity. They do so using very detailed data at the firm and transaction level, which is not commonly available.
Goldberg Khandelwal Pavcnik Topalova	2016	<i>Imported Intermediate Inputs and Domestic Product Growth: Evidence from India</i>	They use matched import and export data and I-O coefficients to estimate how much of each firm import goes into each firms different export. This is needed to solve the issue of understanding the within-firm allocation of inputs across outputs. This is conceptually very similar to the concept of backward GVC participation.	The approach taken by this paper is rather different to the other papers, it doesn't look at GVC in the sense of B-S relationship but at GVC in the sense of importing in order to export. The main challenge from an I-O perspective is to resolve the within-firm allocation of different inputs across different outputs.
Macchiavello	2010	<i>Development Uncorked: Reputation Acquisition in the New Market for Chilean Wines in the UK</i>	The data has been compiled matching exporters data to each buyer, using information at both ends of the transactions. Transactions have been grouped by buyer-supplier couples which identifies a trade relationship. Here again a trade relationship is considered to break up if no transaction takes place within a year.	This is a very interesting paper for a range of reasons: (i) it looks at a specific segment of a GVCs, i.e. wine producers-retailers (ii) it provides an econometric application looking at the role of duration (iii) it provides a discussion of how to deal with FE at the buyer, supplier and relationship level.
Macchiavello and Miquel-Florensa	2017	<i>Vertical Integration and Relational Contracts: Evidence from the Costa Rica Coffee Chain</i>	This paper identifies different kinds of relationships: vertical integration (direct ownership), arm's length, and relational contracts. A mill and a buyer are considered to be in a relationship if they trade for at least four consecutive harvest seasons. Once this condition is met, the relationship duration is measured from the first transaction. The definition is forward looking but selects relationships based on success. Vertically integrated mills (almost) exclusively sell their product to their owners, the identification of ownership relationships is possible because of particular regulations of the coffee industry in Costa Rica.	This is an interesting approach, exploiting a minimum duration of relationship before considering as such. This would allow to distinguish exporting from GVC participation. All transactions that are not between B-S that have been trading for at least 4 harvest seasons are considered market transactions.
Macchiavello and Morjaria	2014	<i>The value of relational contracts : evidence from a supply shock to Kenyan flower exporters.</i>	The paper looks at relationships during a period of violence in the country, January 2008 specifically. Relationships are defined as linkages between an exporter and a foreign buyer that are active, i.e. the two parties transacted at least 20 times in the twenty weeks before the eruption of the violence.	From a methodological point of view, this paper has perhaps less to offer compared to the one above. Relationships are identified in the same way as in the rest of the literature, the treatment that is being exploited is the eruption of violence as a supply shock, rather than the linking into GVCs.
Macchiavello and Morjaria	2016	<i>Competition and Relational Contracts : Evidence from Rwanda 's Coffee Mills</i>	This paper is based on a survey on the 2012 harvest season, mixed with administrative data and GIS data on the location of each mill. The survey covers many aspects of the mill's relationship with its farmers (suppliers and allows of course to obtain information without necessarily observing the transaction between firms).	Being based on a survey this paper is of limited interest from a methodological point of view.
Monarch and Schmidt Eisenlohr	2015	<i>Learning and the Value of Relationships in International Trade</i>	The data provides unique identifiers for the exporter and the name and address of the buyer, which allows matching exporters and importers. Age (and stability) of relationships is measured as consecutive years. A supplier can be either new or familiar, i.e. has supplied a different product or was already supplying the same product.	This is a relatively interesting paper, though it uses matched import-export data to identify B-S couples and study the duration of such relationships.
Winkler and Farole	2015	<i>Global Value Chains Integration and Productivity: Evidence from Enterprise Surveys in Namibia, South Africa and Swaziland</i>	GVC participation is proxied as importing and exporting.	The Enterprise survey uses stratified samples of firms, which means that it does not allow to follow a panel of firms over time. It does have the advantage of providing a wide range of information but it is limited in the coverage of firms with respect to most administrative databases used by other contributions reviewed in this study.



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