# The Relationship Between Global Value Chains and Productivity

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ABSTRACT

We review the evidence linking Global Value Chains (GVCs) and productivity. GVCs are a key feature of the world economy, with production increasingly fragmented across borders. However research has uncovered that GVCs are not primarily global in nature, but focused around regional clusters of production, and services and multinationals (MNEs) play a key role in these networks. A broad literature using both industry and firm-level data has uncovered that participating in GVCs can stimulate productivity growth through a myriad of channels. These include the potential for firm specialisation in core tasks, access to imported inputs, knowledge spillovers from foreign firms and pro-competitive effects of foreign competition. However, there are many potential obstacles to seizing the opportunities for growth. The changing organisation of production across firms and countries emphasises the importance of some well-established policy levers (such as trade policy) as well as some of those previously under-explored (such as domestic service market competition). Embeddedness within GVCs may also expose firms to new sources of risk and affect resilience of economies, as a shock to one part of the supply chain can propagate throughout production networks.

Global Value Chains (GVCs) are a key feature of the world economy. Production is increasingly fragmented across country borders, with various parts of the production process, from design to distribution, segmented across different countries (Baldwin, 2012). Firms are part of complex production networks that embody diverse goods and services inputs from other domestic and foreign firms.[2] Trade flows of any firm and country embody the value-added of a myriad of different countries and suppliers further up the value chain. This article provides a brief overview of what we currently know about the links between GVCs and productivity.

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2   Richard Baldwin calls this "the second great unbundling," i.e. the end of the need to perform most production stages next to each other: because of rapidly falling communication and coordination costs, production can be sliced and diced into separate fragments that can be spread around the globe.

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GVCs reflect the segmentation of production across multiple countries.[3] Part of the literature often focuses on the outsourcing/offshoring aspect of GVCs, measured by gross trade in intermediate inputs (goods or services).[4] However, GVC participation is much wider than simply trading intermediate goods or offshoring. The availability of inter-country input-output tables has enabled different measures of GVC participation that reflect foreign value added that is both directly and indirectly embodied in trade.[5] Whilst the offshoring decision of inputs is clearly relevant, backward GVC participation also reflects indirect linkages along the whole supply chain network (such as suppliers of suppliers etc.), reflecting the ultimate sources of value-added. In addition, offshoring concerns only the sourcing of inputs, but forward GVC participation reflects the destination of value added, i.e. whether domestic value added is used in the exports of third countries (customers of customers).

The arrival of new trade in value-added metrics has uncovered that GVCs are becoming an increasingly important feature of the world economy, allowing measurement of all the sources of value-added ultimately embedded in exports. These metrics are an alternative way of expressing trade flows. Instead of being based on the source of gross trade observed at the border, these value-added metrics reflect the sources of value-added embodied in these gross flows.[6] They show that a substantial proportion of value-added comes from foreign firms and sec-

tors — the so-called measure of "GVC participation" (which may be across different unaffiliated firms-between-firm trade — or between foreign affiliates of MNEs — within-firm trade). Production is increasingly clustered in regional supply chains, and services and multinationals (MNEs) play a key role in these networks.

The evidence presented in this article derives from complementary industry and firm-level sources. A small, but growing, body of work has begun to use these newer industry-level measures to examine links between GVC participation and productivity (e.g. Contantinecu *et al.*, 2017; Kummritz, 2016; Taglioni and Winkler, 2016). These build upon earlier studies using industry-level measures of offshoring from the perspective of the offshoring country (e.g. Egger and Egger, 2006; Amiti and Wei, 2009; Winkler, 2010). In contrast, the recent availability of detailed firm-level data has allowed a deep examination of the productivity mechanisms for some aspects of GVC participation, such as firm offshoring, gross trade in goods and foreign direct investment (FDI). However, studies examining broader aspects of GVCs, such as the role of services or intangible inputs and also indirect participation in GVCs at the firm level (for example as a domestic supplier of exporters) are only recently being uncovered (e.g. Dhyne and Rubinova, 2016).

This research has uncovered that participating in GVCs can stimulate productivity growth through many possible channels, as we outline

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3    A range of related concepts have been introduced, including offshoring (Feenstra and Hanson, 1996), trade in intermediates (Antweiler and Trefler, 2002), fragmentation (Deardorff, 2001; Jones and Kierzkowski, 2001, Arndt and Kierzkowski, 2001), slicing the value chain (Krugman, 1995); trade in tasks (Grossman and Rossi Hansberg, 2008 ) and vertical specialization (Hummels, Ishii, and Yi, 2001).

4    For example, see materials offshoring measures of Feenstra and Hanson (1996, 1999) or services offshoring of Amiti and Wei (2009).

5    See for example, Johnson and Noguera, 2012, Koopman *et al.*, 2014, which build on the vertical specialization measures of Hummels *et al.*, 2001.

6    Accordingly, aggregating these different domestic and foreign sources of value-added results in gross trade itself.

in section 2. First, firms can specialise in their most productive, core activities and outsource their least productive tasks. Second, firms can gain from access to a larger variety of cheaper and/or higher quality and/or higher technology imported inputs. Third, interaction with frontier foreign (multinational) firms may facilitate knowledge spillovers through domestic supply chains. Fourth, access to larger markets and competition from foreign firms leads to the growth of more productive firms through leveraging scale economies while at the same time inducing the exit of the least productive firms.

Many of the policy lessons drawn from research on gross trade are clearly also relevant for GVCs. However, this may not be universally true, which we discuss in section 3. On the one hand, the changing organization of production across firms and countries emphasises the importance of some well-established policy levers in the context of GVCs (such as trade policy). On the other hand, some previously underexplored policy levers (such as domestic service market competition and debates about co-location of activities) may be brought to the forefront. The rise of complex supply chains therefore brings a new perspective to the policy debate.

This article is organised as follows. In the first section we highlight some key facts uncovered in recent analyses of GVCs, in particular, drawing on trade in value-added metrics. Secondly, we outline some of the salient issues for performance that have been uncovered so far. Thirdly, we illustrate some policy implications emphasised by GVCs. Finally, we discuss how embeddedness within GVCs may affect the resilience of economies to economic shocks, and conclude.

## Background: Some Key Facts and Trends

Economies can participate in GVCs by using imported inputs in their exports (the so-called backward linkages in GVC) or by supplying intermediates to third country exports (forward linkages). The overall participation in GVCs which is the total of backward and forward participation differs substantially across countries. Overall participation measure (measured as the sum of backward and forward linkages) reflects the importance of GVCs for an economy, with GVCs accounting for between one-third and two-thirds of gross exports (of goods and services) for OECD economies in 2011 (see summation of backward and forward linkages in Chart 1). At one extreme Luxembourg's overall participation is 71 per cent of their gross exports, whereas New Zealand's participation is 33 per cent of gross exports.
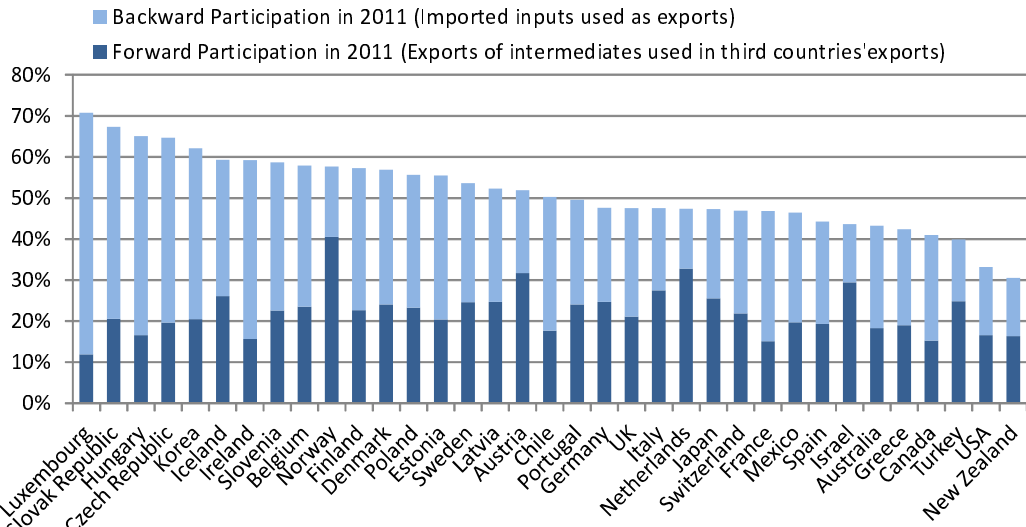
GVC participation depends on many factors. Typically, smaller, open economies that are close to large foreign markets are more integrated into GVCs (such as Luxembourg and other small European economies). Whereas larger economies (such as the US) and those that are more geographically remote (such as New Zealand) are less integrated into GVCs (OECD, 2013a)

In recent decades participation in GVCs has increased, presenting new opportunities for growth. The overall participation in GVCs has increased for every OECD member economy between 1995 and 2011 (Chart 2).[7] This presents a different picture from gross trade over the same period, with which GVC participation is only weakly correlated , and for some countries the two metrics show a very different pic-
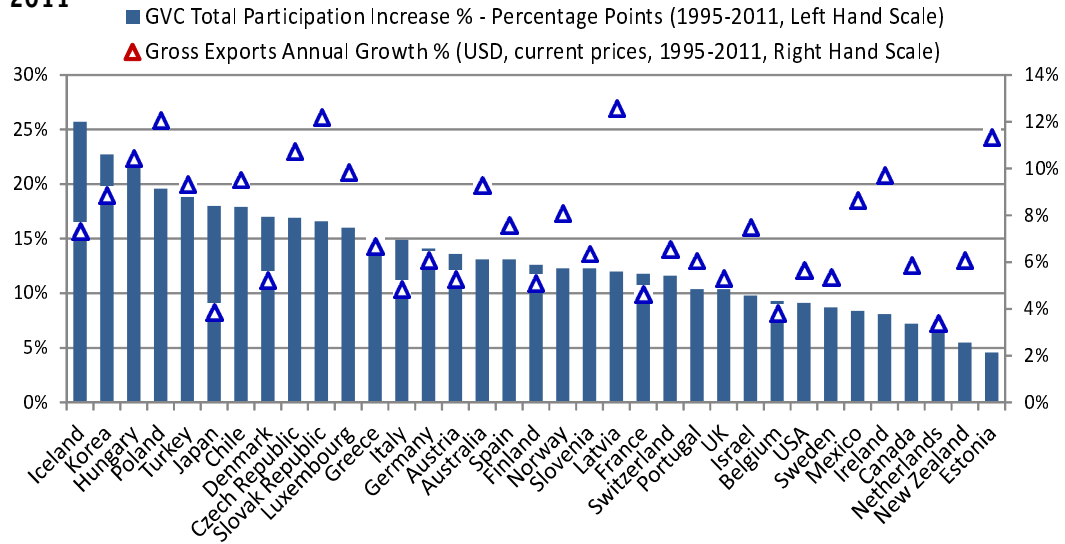
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7   In most OECD countries the increase in GVC participation in the post-crisis period has been much slower than pre-crisis. According to the authors' calculations based on the OECD-WTO TiVA Database (2015 Edition), only Eastern Europe did not experience a slowdown after the crisis: their increase in GVC participation was faster in 2008-2011 than in 2005-2008.

**Chart 1: Decomposing Overall GVC Participation into Backward and Forward Components in OECD Countries, 2011 (per cent of gross exports)**

■ Backward Participation in 2011 (Imported inputs used as exports)
■ Forward Participation in 2011 (Exports of intermediates used in third countries'exports)



Source: Authors' calculations based on OECD-WTO TiVA Database, 2015 Edition

**Chart 2: GVC Participation Increase & Gross Exports Growth in OECD Countries, 1995 - 2011**

■ GVC Total Participation Increase % - Percentage Points (1995-2011, Left Hand Scale)
△ Gross Exports Annual Growth % (USD, current prices, 1995-2011, Right Hand Scale)



Source: Authors' calculations based on OECD TiVA Database, 2015 Edition. Total GVC participation is the sum of backwards and forwards participation. Gross exports reflect both intermediate and final exports of goods and services.

**Chart 3: Aggregate Trends in Forward and Backward GVC Participation (per cent of gross exports)**
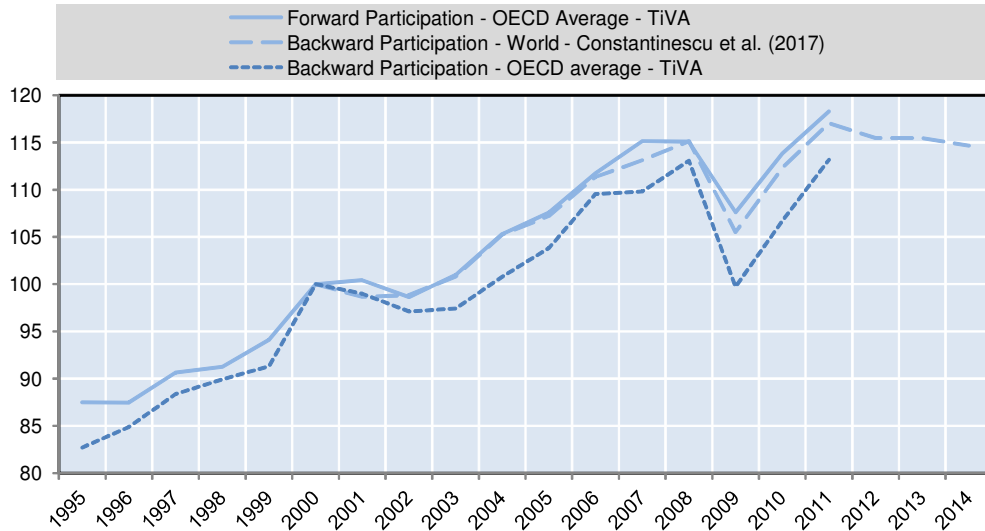


Source: Authors' calculations based on OECD-WTO TiVA Database, 2015 Edition for OECD countries and Constanintescu *et al.* (2017) using WIOD 2016 Edition for the world.
Notes: Averages are unweighted and the series have been normalised to the year 2000, such that 2000 = 100

ture.[8] Estonia's GVC participation grew the slowest within the OECD, however their gross trade grew the 3rd fastest (Chart 2). This may reflect Estonia upgrading into activities of higher (domestic) value-added, with the foreign content of ICT and electronics falling substantially as domestic value-added exports have risen (OECD and WTO, 2015a). Conversely, Korea's GVC participation grew the second fastest within the OECD over 1995-2011, however, its increase in gross trade was only the 11th fastest (Chart 2). This reflects Korea's role in the growth of Factory Asia, with China being the most important destination for Korea's intermediates (OECD and WTO, 2015b).

GVC participation has increased rapidly over the 1990s and the early and mid 2000s until the crisis, and following the crisis rebound quickly to pre-crisis levels. However, emerging evidence suggests that the proliferation of GVCs may have stalled since then (Chart 3). Several articles have noted that world trade, particularly in intermediate inputs, has stagnated since 2011 (Hoekman, 2015). Similarly, global participation in GVCs appears to have rebounded in the years since the crisis, 2010 and 2011, but not to have grown thereafter (e.g. using WIOD 2016 edition data see Constantinecu *et al*, 2017 or Timmer *et al*., 2016). There are several competing explanations that are at the forefront of current research. This may in part reflect macroeconomic factors such as weak demand growth, changes in the composition of demand or continued economic and policy uncertainty. However, there may also be changes in the structure of global production networks, such as China's domestic upgrading and the reorganiza-

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8    The pairwise correlation between growth in GVC participation and growth in gross exports over the period 1995-2011 is 0.29. Clearly the two metrics are related, for example, the foreign value-added component of direct exports will be reflected in both GVC participation and gross exports measures. Furthermore, some evidence suggests that joining a GVC as an indirect exporter (a domestic supplier of exporter) may facilitate learning about foreign markets that enable firms to subsequently export direct themselves (Bai *et al.*, 2017).

**Chart 4: Regional Shares in World GVC Income for all Manufactures (per cent)**

**Regional shares in value-added of manufacturing goods production**
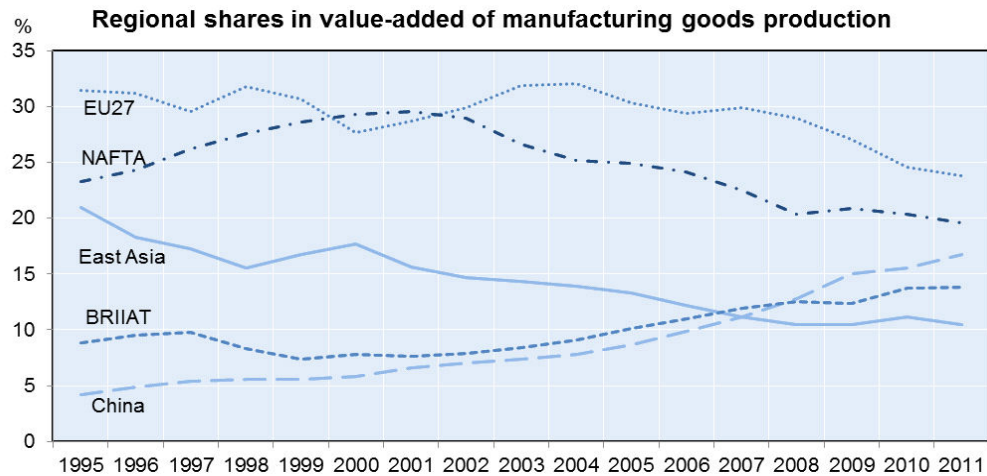


Source: Timmer *et al.* (2013)
Note: GVC income is defined as value-added in the production of final manufacturing goods. East Asia includes Japan, South Korea and Taiwan. BRIIAT includes Brazil, Russia, India, Indonesia, Australia, and Turkey. EU27 includes all European countries that have joined the European Union. NAFTA includes Canada, Mexico and the US.

**Chart 5: Services Value Added in Manufacturing Exports in OECD Countries, 1995 and 2011, (per cent of manufacturing gross exports)**
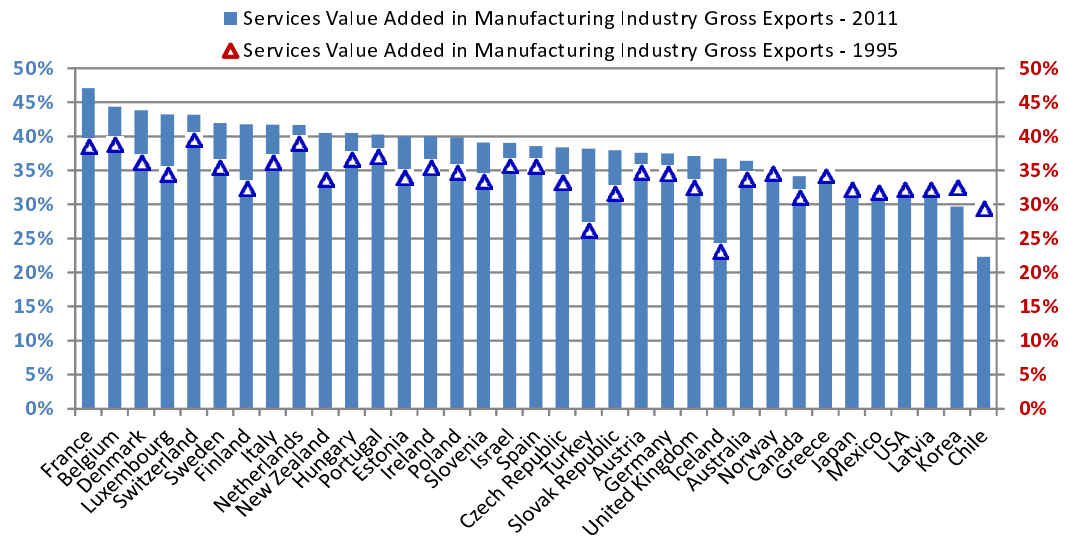


Source: Authors' calculations based on OECD TiVA Database, 2015 Edition

tion of East. Asian value chains, or the shortening of value chains to mitigate supply chain risks and rising labour costs in emerging economies. Relatedly, any link between the current productivity slowdown and GVCs is currently unclear. In particular, the productivity slowdown appears to pre-date the crisis period (OECD, 2015a)

when GVC proliferation was expanding rapidly. Investigating the different factors driving the trends in GVC participation and whether these are related to the productivity slowdown is beyond the scope of this article but is clearly an interesting direction for future research.

**Chart 6: Labour Productivity Growth in Business Services (Excl. Real Estate) in EU Countries**



■ Real value added per hour worked, percentage change at annual rate, 2009-2014
△ Real value added per hour worked, percentage change at annual rate, 2001-2007
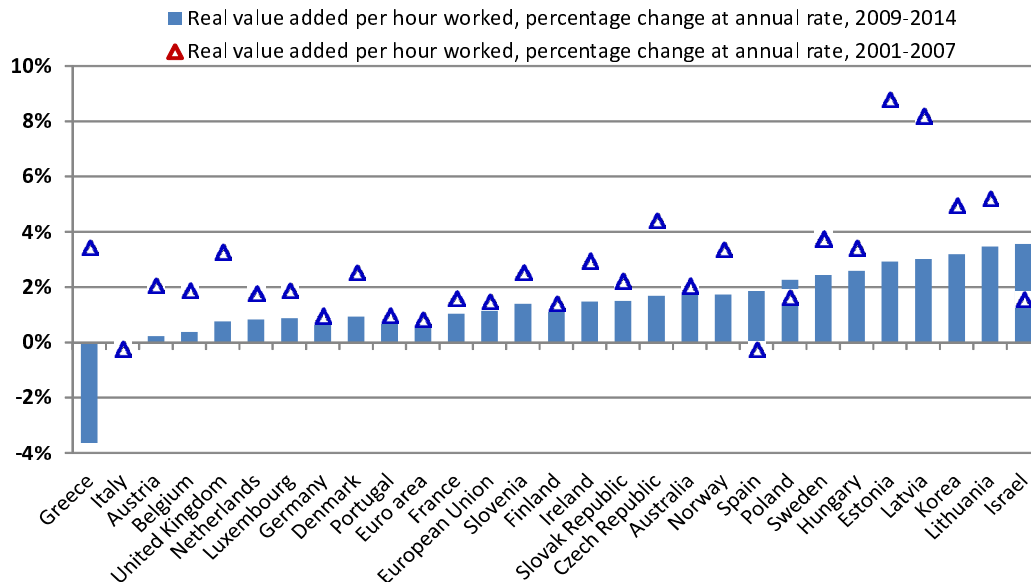
Source: OECD Compendium of Productivity Indicators 2016

GVCs are characterized by regional hubs, with the bulk of production activity clustered within regional supply chains (Baldwin, 2012). However, there are asymmetric growth opportunities within production networks. This is because the geography of GVCs is transforming, with a declining global share of manufacturing value-added from traditional production centres in Europe and North America and the growth of emerging economies such as China (Chart 4, and Wiebe and Yamano, forthcoming). The rising importance of China and its central role in "Factory Asia" is a well-documented feature of modern manufacturing. However, the emergence of China as a key hub has accompanied a reorganization of activities elsewhere, with some countries' industries experiencing declining importance of "peripheralization," in global value chains.

GVCs highlight the interdependencies across the production network, with the performance of input suppliers affecting productivity in output markets, which we elaborate in the next section. Peripheralization may therefore affect domestic productivity growth, both through these indirect network effects as well as through more direct channels, such as reduced productivity spillovers from GVC participants to other firms or constrained growth opportunities of the most productive domestic firms - those firms most likely to be directly engaged with GVCs. Finally, the concentration of activity in key hubs plays an important role in the transmission of shocks along GVCs and therefore affects countries' resilience, which is explored in the subsequent section.

Services are key to GVCs. Goods and services are increasingly being both joint inputs to and jointly produced by manufacturing firms. Services provide the link that helps coordinate cross-border production (such as transport, distribution, finance, communication and business services). The strong complementarity of services with global production networks, and the trend towards increasing service activities in OECD economies, "servicification," are highlighted in new measures of trade in value-added. The importance of services to GVCs is reflected

**Chart 7: Share of Intra-firm Exports in Total Exports of Affiliates Under Foreign Control, 1997 -2013**
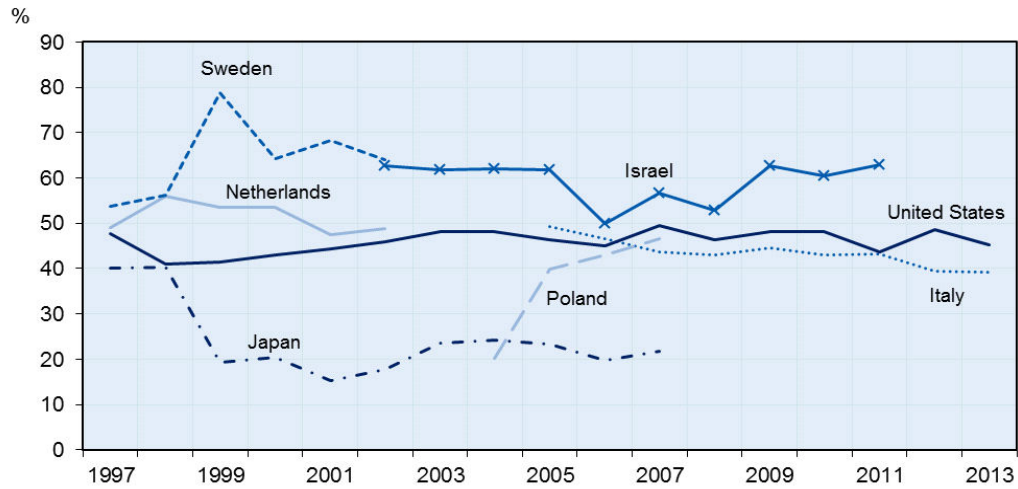


Source: Authors' calculations based on OECD Activities of Multinational Enterprises Database, May 2016

in the high proportion of upstream services value-added that is ultimately embedded in exports. This "servicification" is not only due to the growing size of service sectors in economies, but services represent a substantial portion of value-added even for manufacturing industry exports. Services comprise 37 per cent of the value-added in manufacturing exports for the OECD as a whole in 2011, and above 40 per cent for several countries including the France and Italy and the EU as a whole (Chart 5).[9]

However, in recent years, overall productivity growth in services has been sluggish (Chart 6). Emerging evidence from OECD work shows that the productivity growth slowdown is accompanied by a marked divergence in productivity performance between global frontier firms and others. The slowdown in service sector growth has not been a result of a slowdown of frontier firms, as service sector firms at the glo-

bal frontier have achieved strong productivity growth of 5 per cent per annum over the period 2001-2009. But rather it is driven by the sluggish performance of non-frontier services firms, which have shown flat growth of -0.1 per cent per annum over the same period, with the majority of the divergence appearing before the crisis (Andrews *et al.*, 2015).[10]

Multinationals (MNEs) are one of the main drivers of GVCs, which creates asymmetric growth opportunities for local firms depending upon how well they are integrated with MNEs. MNEs coordinate complex international production networks, where relationships with suppliers range from arm's-length contractual relationships to direct ownership of affiliates. Using firm-level trade data allows us to distinguish the role of MNEs from other firms within an industry. Cross-border trade between MNEs and their affiliates alone accounts for a substan-

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9   The importance of services is not reflected in gross trade flows, where goods remain more likely to be traded directly across borders than services. This serves to highlight the importance of new trade in value-added measures.

10  Of the divergence in productivity growth between frontier and non-frontier firms by 2013, three-quarters of this was revealed before the crisis - by 2007 (Andrews *et al.*, 2015). The divergence is observed using unweighted data of firms within each 2 digit sector, which comprise nonfarm non-financial business sectors excluding mining. However, the divergence is stronger for services than manufacturing.

tial portion of world trade in goods, comprising nearly half of US exports (Chart 7). Although data on MNE contribution to GVCs more broadly are not directly available, emerging research combining input-output and firm-level data estimates that MNEs and their affiliates abroad may account for one third of global production and 50-60 per cent of global exports (De Backer *et al.*, 2017).

Participating in GVCs provides an opportunity for knowledge spillovers from these multinationals to local firms for two reasons. First, MNE firms are typically the firms at the global productivity frontier (OECD, 2015a). Second, MNEs generate knowledge spillovers along the value chain through sharing knowledge with domestic suppliers and encouraging the adoption of new practices (see Alfaro, (2014) for a review of the academic literature). The mobility of workers from MNEs to other domestic firms can also be an important channel for knowledge transfers, which can lead to productivity gains for their new employers (Balsvik, 2011). However, such spillovers are unlikely to be realized universally, as only firms with sufficient absorptive capacity are likely to achieve the potentially available productivity gains; we discuss this further in the next section.

## Key Implications for Productivity

Understanding the productivity effects of GVCs is the focus of a growing literature. A large body of research has used firm-level data on trade in goods and foreign ownership to uncover links between trade participation, offshoring, or multinational status and productivity. Far less is known about the link between productivity and broader aspects of GVCs shown to be important using industry GVC participation metrics, such as indirect participation in GVCs (as a supplier of exporters) or the role of services and intangibles. However, new find-

ings are emerging using novel data on domestic supplier networks of trading firms and input linkages across industries and countries. In this section we draw on this emerging literature where possible, to highlight the pertinent performance implications of GVCs that have been uncovered so far.

### Specialization, Offshoring and Productivity

Specialization in tasks is an important source of GVC productivity gains. The growth of GVCs has led to increasing specialization in specific activities within value chains, with firms often no longer part of complete domestic supply chains. Reductions in trade costs and innovations in ICT have increased the scope of tasks that can be offshored in recent years (OECD and World Bank, 2015). By specializing in those core tasks most efficiently provided by the firm, and offshoring less efficient parts of the production process abroad, firms can reap productivity gains (Grossman and Rossi-Hansberg, 2008). This specialization process is linked to the ability to import cheap, additional and/or higher quality varieties of offshored inputs (which we discuss in the following section), which could be an improvement on previous in-house inputs, or from efficiency gains from the restructuring of internal processes (which we discuss in the section on growth and upscaling).

Measuring offshoring is often problematic at the firm-level, given limited information on the precise tasks previously performed in-house or intermediate inputs sourced from other domestic firms. Accordingly, firm productivity studies often employ industry-level measures of offshoring or proxies for firm offshoring, such as firm imports of materials or services. Empirically these productivity gains have been shown to extend to both the offshoring of manufacturing production processes and service functions

## Foreign Inputs

Trade in goods, services and intangible inputs is at the heart of global value chains. The bulk of trade is comprised not of final goods or services, but of trade in intermediate parts and components and intermediate services. Among OECD economies, trade in intermediate inputs accounted for 56 per cent of total goods trade and 73 per cent of services trade over the period 1995-2005 (Miroudot *et al.*, 2009). Firms can integrate into GVCs by supplying intermediate inputs for the exports of firms in other countries or as users of foreign inputs in their own exports. GVCs present a new means to access international markets: economies need no longer build complete supply chains at home; instead, they can leverage foreign inputs in their production.

The available variety and quality of foreign inputs (capital, labour and intermediates) can positively impact firm productivity. The availability of previously unobtainable varieties of imported inputs provides additional possibilities for production, allowing firms to save on costs or upgrade the quality of their inputs. Increases in the available variety and quality of imported intermediate goods and capital can therefore positively impact firm productivity. A large literature finds that productivity gains in firms that directly import these inputs (Amiti and Konings, 2007; Goldberg *et al.*, 2010; Topalova and Khandelwal, 2011; Bas and Strauss-Kahn, 2015; Halpern *et al.*, 2015).

In addition, foreign competition in the domestic input market may also lead to price reductions or quality improvements for domestic suppliers, benefiting users of domestic inputs too. These pro-competitive effects in domestic input markets can also lead to productivity gains for firms that source inputs locally (Amiti and Konings, 2007). Emerging evidence is also revealing how the liberalization of service markets, particularly the entry of new foreign service providers, can lead to substantial productivity gains in downstream manufacturing firms (Arnold *et al.*, 2011; Arnold *et al.*, 2016). However, firm-level research on how users of domestic inputs are affected is not as developed as research on firms that use foreign inputs directly.

However, imported inputs also reflect the embodiment of the skills, factors of production and technologies used to produce them. These skills, factors and technologies are embodied in all prior stages of the value chain, which highlights the importance of measurement using value-added (rather than gross) trade metrics. Whilst research on this area is at a relatively nascent stage, recent work at the OECD using industry data highlights that the jobs embodied in value-added exports are increasingly shifting towards higher levels of skill (OECD, forthcoming). Therefore imported inputs may allow access to a greater variety of human capital than is available domestically.[11] Industries that source intermediates that embody a higher R&D knowledge content tend to have higher total factor productivity in levels (Nishioka and Ripoll, 2012), suggesting embodied R&D can be a form of technology transfer to local firms.

MNEs are an important vehicle for provision of foreign knowledge and services inputs to affiliates within the firm group. In Chart 7 earlier, we saw that MNEs cross-border trade with their affiliates accounts for a substantial portion of world trade in goods. However, MNEs are also an important source of knowledge and services for their affiliates (OECD, World Bank and

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11  Note however, that local skills remain pertinent for GVC participation, particularly for knowledge-intensive activities, with ongoing OECD work directed in this area (OECD, World Bank and WTO, 2014; Jamet and Squicciarini, 2016).

WTO, 2014). Moreover, the possession of strategic assets (such as investments in knowledge, R&D and skills) can be an important motivation for foreign direct investment (FDI), in order to protect the use of these assets (see Antras and Yeaple, 2014).[12] MNEs may transfer knowledge and services embodied in intermediate goods, as highlighted above, or choose to provide direct disembodied transfers to their affiliates, which we consider in the next section (Keller and Yeaple, 2013).

### MNEs, Knowledge Spillovers and Upgrading

GVCs are a well-established vehicle for productivity spillovers to local firms. A substantial part of GVC integration is mediated through FDI, and such multinational enterprises are typically at the global frontier of productivity, innovation and technology. Exposure to the global frontier can provide an opportunity for local firms to increase productivity through learning about advanced technologies or superior organizational and managerial practices (Ciuriak, 2013, Saia et al., 2015; Guadalupe et al, 2012).

A large literature has investigated FDI spillovers and arrives at a broad consensus in favour of positive productivity spillovers to industries that supply multinationals through backward linkages (Javorcik, 2004), with little evidence through other linkages (Havránek and Iršova, 2011; Alfaro, 2014).[13] Lead firms tend to demand more or better quality inputs from suppliers and may directly share knowledge and technology and encourage the adoption of new practices to achieve this.

The literature generally uses aggregated industry-level measures of linkages and little is currently known about how spillovers are trans-mitted firm-to-firm along the value chain. Examining the diffusion of knowledge from the frontier throughout supply chains may be a fruitful application of new data on firm linkages in production networks and further research in this area would be valuable.

Knowledge acquisition is an important motive for FDI, which may increase the scope for knowledge diffusion. Firms may relocate some activities, including innovation activities, to obtain access to so-called strategic assets - skilled workers, technological expertise, or the presence of competitors and suppliers - and learn from their experience (OECD, 2008). Firms locate in leading edge countries close to the technology frontier, in order to benefit from the diffusion of advanced technologies (Griffith et al, 2004). In addition, MNE acquisition of foreign firms can lead to a relocation of innovative activities to where they are most efficiently undertaken and increase knowledge diffusion to affiliates within the group (Stiebale, 2016).

Knowledge spillovers from the frontier accrue asymmetrically, benefitting firms with sufficient absorptive capacity. A prerequisite for local firms to gain from spillovers is sufficient capacity to absorb frontier technologies. By investing in their own tacit knowledge, such as through engaging in R&D, firms can increase their ability to absorb new technologies (Griffith et al, 2004). This can pose a particular challenge for firms far from the frontier, with low absorptive capacity, as they are unlikely to benefit from exposure to frontier technologies (Saia et al., 2015). In addition, positive spillovers may be offset by MNEs crowding out some local firms, at least in the short-term following entry of MNEs (Aitken and Harrison, 1999; Kosová, 2010). The additional competition in output

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12 This is because writing and enforcing contracts over the use of strategic assets with an arm's length supplier may not be possible.

13 Less consistent evidence is found in favour of horizontal spillovers, to firms within the same industry, or through forward linkages to firms downstream (Iršova and Havránek, 2013).

markets and increased demand for inputs may lead to lower growth rates and exit of local firms far from the frontier.

Investments in knowledge based capital is an important driver of GVC upgrading and growth. Empirical evidence confirms the links between innovation, value creation and economic growth (OECD, 2010a). The value created by a GVC is unevenly distributed and depends on the ability of participants to supply sophisticated and hard-to-imitate products and services (OECD, 2013a). To upgrade the efficiency of production processes or increase the value-added of their products requires investment in organisational capital, skills and ICT to complement the necessary product/process innovations (OECD, 2013b). Value-added creation is distributed unevenly along the value chain, with the highest value-added often relating to more upstream processes (such as R&D, design) or more downstream processes (such as marketing) rather than in the middle (such as assembly). Increasingly, the bulk of the value added of products or services stem from forms of knowledge-based capital such as brands, basic R&D, design and the complex integration of software with new organisational processes (OECD, 2013b). However, there are many aspects of upgrading that are currently unknown. In particular, we know little about the extent of interdependencies between activities, for instance, whether complex manufacturing capabilities are a pre-requisite to engage in high-value added activities like R&D, design and marketing.

### Growth and Upscaling

To participate directly in GVCs requires scale. For the largest, most productive firms that are able to export, access to new customers in foreign markets can not only lead to increased learning and innovation (Crespi, Criscuolo and Haskel, 2008) but also incentivize complementary investments and the restructuring of internal processes to meet the additional demand. These may include investment in communication technology and product innovation (Lileeva and Trefler, 2010) or investments in process innovation (Bustos, 2011). In addition, expanded production can make more complex organizational structures efficient, improving decision making within firms. Evidence from Portuguese and US firms suggests that increased demand or trade liberalization leads to firms investing in additional layers of management within the firm, raising their productivity (Caliendo and Rossi-Hansberg, 2012; Caliendo *et al*., 2016).

However, small firms are often not able to build the necessary internal capabilities to meet the strict product and quality standards demanded, or overcome external barriers such as regulations and customs procedures. Building such capabilities can require substantial investment in process and product innovations, managerial and workforce skills development and adoption of modern technologies. Only firms with sufficient scale are able to incur the substantial sunk costs to develop these capabilities necessary for GVC integration. However, unlike trade in final goods, GVCs present opportunities for SMEs to become specialized in a subset of productive tasks, which may alleviate some of the barriers to SME participation. Scale requirements are likely to be a particular problem for firms operating in small, geographically isolated economies. Firm size tends to grow with market size, meaning that smaller markets are likely to have fewer firms with sufficient scale to participate directly in GVCs.[14]

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14 For European countries, the size of the domestic market is correlated almost one-for-one with the number of exporting firms (Mayer and Ottaviano, 2008).

Upscaling may yield productivity gains. The cost of many productivity-enhancing investments, including those concerning GVC participation listed above, is largely fixed. Such investments are only viable for sufficiently large firms that can spread the fixed costs over high sales volumes. Firm upscaling may therefore contribute to productive investments. Firm-level research shows correlations consistent with this narrative; larger manufacturing firms are on average more productive, across many dimensions, than smaller firms and are more likely to invest in skills, ICT and R&D (OECD, 2010b, 2013a; Gonzàlez *et al.*, 2012).

However, new trade in value-added metrics highlight the importance of indirect contributions to the value chain, not apparent in trade in final goods metrics. Indirect participation can provide a way to overcome many of the barriers to scale. Through intermediaries and international buyers, domestic producers can avoid design and marketing costs, search costs and reduce foreign market information barriers, and benefit from the transfer of knowledge from foreign firms (Artopoulos *et al.*, 2013). Many firms are indirectly connected to GVCs, for instance, as domestic suppliers of exporters, and therefore gross trade flows will understate the importance of SMEs to global supply chains. Unfortunately data on the SME contribution to GVCs are often not available and, therefore, relatively strong assumptions are required to decompose industry-level TiVA data into the contribution of SMEs and large firms.[15] Exploratory and on-going work at the OECD, using such an approach, highlights a sizeable contribution of SMEs to value-added trade flows which far exceeds their contribution to gross trade (OECD and World Bank, 2015).

Scale issues remain pertinent for indirect contributions to the value chain. Exporting firms are likely to pass down relevant product and quality standards, demanded by their foreign customers, to domestic suppliers. Accordingly, domestic suppliers have to overcome additional sunk costs to supply exporting firms, which only sufficiently large suppliers can do. Emerging evidence on domestic micro-linkages between firms is consistent with this narrative; Belgian suppliers of exporters are indeed larger and more productive than suppliers of non-exporters (Dhyne and Rubinova, 2016).

## What Does this Mean for Policy?

GVCs can provide new avenues for growth, as highlighted in previous sections. However, there are many potential barriers to deeper GVC integration and to firms' ability to seize the opportunities for growth. Many of these obstacles will be familiar to those versed in the comprehensive literature on trade in final goods and FDI. However, some of these barriers are particularly relevant for GVCs, such as trade policy, when goods cross borders multiple times. In this section, we focus on these most prominent obstacles and their policy implications.

### Trade Policy

Global value chains amplify the productivity effects of removing trade barriers relative to trade in final goods. The complex web of inter-

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15  Piacentini and Fortanier (2015) outline a preliminary disaggregation of industry-level OECD TiVA data using firm-level data from the OECD Structural and Demographic Business Statistics Database and OECD/Eurostat Trade by Enterprise Characteristics Database. The purchases of domestic inputs by SMEs and large firms are estimated from the residual between output, value-added and imports. Purchases of foreign inputs are segmented based on the share of goods imports purchased by SMEs and large firms. SME and large firm supply of inputs is assumed to be in proportion to their respective share of industry gross output. The authors highlight that their results depend heavily on these assumptions chosen to estimate the unobserved transactions between firms of different sizes.

national production networks means intermediate goods often cross borders multiple times, each time accumulating additional tariffs and other trade costs. In addition, tariffs are levied on the gross value of the good (including imported inputs and previously incurred trade costs), rather than on the value added domestically at the last production stage. Since exports often embody a substantial proportion of foreign value-added this means a low nominal tariff can translate into a high tariff on value-added trade (Miroudot *et al*., 2013a).

Global value chains increase the interdependence of trade policy, highlighting the importance of regional and multilateral trade agreements. Industries and countries are tied together through the network of forward and backward linkages. Downstream industries are affected by the whole system of trade costs incurred by their suppliers and conversely the whole network of suppliers is impacted by final goods trade costs. Accordingly, trade in value-added is affected not only by bilateral trade costs, but is also tied to third country barriers, through which intermediate inputs travel before reaching their destination (Noguera, 2012).

### Border Bottlenecks

Trade facilitation is important to achieve the gains from deeper GVC integration. The efficiency of customs and port procedures shape the global value chain, more so than trade in final goods. Customs administrative procedures and clearing processes raise the cost of accessing export markets and importing intermediates, with the costs accumulating when inputs are traded many times as in GVCs. This raises costs both in monetary terms and in time delays, the latter requiring firms to hold larger inventories and working capital. For particularly time-sensitive products or those with uncertain demand,

the effect of delays can be substantial, with each day in transit costing up to 2 per cent of the value of the good (Hummels and Schaur, 2013). Recent OECD analysis finds that a small improvement in trade facilitation performance can increase value-added imports by between 1.5 and 3.5 per cent (Moïsé and Sorescu, 2015).[16]

### Coordination of Standards

The diversity of standards has become one of the major barriers to integrating into GVCs. Technical barriers to trade cover 30 per cent of international trade and more than 60 per cent of agricultural products are affected by sanitary and phytosanitary measures in particular (Nicita and Gourdon, 2013). Whilst product quality and safety standards are needed to protect final consumers and the environment, these are far from harmonized across countries and there is little mutual recognition of alternative standards (OECD, 2013a). In addition, these standards are not always applied with the same consistency, with import refusals varying over the business cycle (Grundke and Moser, 2016). This in turn might hinder the development and the introduction of innovative products which would ultimately lead to productivity growth.

However, not all standards are imposed by national regulatory authorities. Multinationals and upstream buyers themselves may impose their own private quality standards on downstream suppliers (World Economic Forum, 2015). These may vary across buyers as well as markets and if these standards are more stringent and heterogeneous than those imposed by national authorities, this may reduce the effectiveness of national standard coordination and present an additional barrier to GVC integration.

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16   Specifically, an increase of 0.1 on a scale of 0 to 2 for an index of trade facilitation.

The cost of diverse standards can be amplified within GVCs, much more so than final goods trade, as the compliance needs to be coordinated at each stage of production and for each market ultimately supplied. Compliance can require firms to make costly investments in duplicate production processes, specific packaging and labelling, or to undertake multiple certification processes for the same product.[17] These compliance costs are particularly acute for SMEs and are a major obstacle to their GVC participation (OECD and World Bank, 2015; OECD, 2013c).

### Policies to Promote Competitive Domestic Markets

Fully leveraging GVCs requires efficient domestic markets and removal of internal barriers to competition. New data on trade in value-added have highlighted that service inputs are much more important to GVCs than was recognized under prior analyses of trade in final goods (Chart 5). Services are a key element in manufacturing competitiveness and are required for the coordination of complex international supply chains. Production at each stage requires a suite of complementary services, including transport and logistics, finance, communication, and other business and professional services. In addition, R&D and design services are involved in upstream stages and distribution networks, advertising and marketing services downstream. Global production networks are therefore shaped by the quality and cost of these complementary services.

Addressing the barriers to competition in local service markets and trade in services is particularly salient, given the significance of services to GVCs in particular. OECD members have few explicit barriers to services trade but there are several differences in regulation.

OECD work on Service Trade Restrictiveness Indicators reveals restrictions on foreign ownership, restrictions on the movement of people (e.g. quotas, stay duration limits), barriers to competition and regulatory transparency even amongst advanced economies. Indeed, evidence suggests services trade costs have remained persistently high over recent decades, despite substantial liberalization in goods trade (Miroudot *et al.*, 2013b). Pro-competitive domestic regulations and the liberalization of trade in services are important to ensure the efficient functioning of the supply chain, which may be particularly important for geographically isolated countries (Hallaert *et al.*, 2011) and would also improve the productivity of the domestic downstream markets which also use these services (Bourlès *et al.*, 2013).

Lifting barriers to competition in goods markets can also promote integration within GVCs, and increase innovation and productivity. Lifting product market regulations can spur productivity growth through increased competition, increasing GVC participation. Productivity growth can be achieved through several channels. First, increased competition and entry of new firms strengthens the efficiency incentives of incumbents and provides incumbents incentives to innovate to maintain their market position. In addition, by providing easier and cheaper access to inputs, reductions in red tape can also lead to gains in downstream industries utilising these intermediates (Abe, 2013).

### Policies to Bolster SME Participation

Addressing the barriers to small and mediuem-sized enterprises (SMEs) upscaling is key to encouraging GVC participation. The possibility of indirect participation in GVCs

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17 Undertaking multiple certification processes as well as repeat testing of goods already tested in other countries may also increase the administration costs to public authorities.

(through domestic supply of exporters) and task specialization, give many SMEs new opportunities, particularly relative to those in final goods trade alone (as mentioned earlier). However, GVC participation still requires additional capital, for example, through required investment in product and process innovation and working capital to finance exports, and access to finance is a particular challenge for the upscaling of SMEs. GVCs therefore highlight policies that address credit market imperfections and support development of complementary sources of exended financing, such as venture capital markets (OECD and World Bank, 2015).

The issue of SME upscaling is also intimately connected with the reallocation of resources. Policies that impede labour market flexibility and limit immigration might restrict the ability of SMEs to hire additional, skilled workers to scale-up production. Bankruptcy legislation and judicial efficiency can encourage experimentation with innovation and new technologies, if failures are not penalized too severely, and speed the reallocation of resources from exiting firms to more productive uses (Andrews and Criscuolo, 2013).

### Policies to Facilitate Innovation and Spillovers

Policies that develop absorptive capacity are key to ensuring productivity spillovers. Knowledge-based capital is a central part of GVCs, with upstream activities including R&D, design and innovation often comprising the highest share of value-added in the production chain (Baldwin, 2013). However, sufficient absorptive capacity on the part of local firms and workers is a prerequisite to benefiting from the trickle-down of spillovers. Building absorptive capacity includes developing local innovation and enhancing human capital. Given the well-known market failures affecting investment in innovation, several countries promote innovation through incentives to collaborate between firms and universities, R&D fiscal incentives and state funding of basic research. Recent OECD work (Andrews *et al.*, 2015) suggests that university-industry collaboration might play an important role in helping laggard firms benefit from knowledge spillovers from frontier firms, especially if they are SMEs.

Investment in innovation is an important driver of GVCs and is central to moving into higher value-added activities. Success in GVCs requires investment in knowledge based assets that extend far beyond R&D, for example, in capabilities for efficiently reorganizing production, in producing and commercializing more sophisticated and complex products and for successfully moving into higher-value downstream or upstream activities. Thus, innovation policies for succeeding in GVCs need to take a much broader view than just R&D. Policies that encourage stronger links between firms and research, educational and training institutions can facilitate the knowledge transfers required for upgrading in GVCs. However, GVC participation often implies a relocation of innovation to where it is most efficiently undertaken, as noted earlier, and this restructuring can lead to overall increases in innovation and greater diffusion within firms (Stiebale, 2016). This complements within-country research finding that location-specific incentives for innovation (such as state-level R&D tax credits) may simply reallocate innovation from one location to another, rather than increasing aggregate innovation (Wilson, 2009). Location-specific incentives for innovation may therefore mute one of the potential channels for gains from GVCs.

### Policies to Realize New Technology Potential

Reaping the benefits of new technologies requires policies that support complementary investments in knowledge based capital. The

rise of GVCs has been made possible by falling transport costs and advances in communication technology over the recent decades (OECD, 2013a). Many new disruptive technologies are on the horizon with the potential to transform production, for instance, through nanotechnology, 3D printing, advances in robotics or enhanced data analytics using machine-to-machine communication (OECD, 2015b).

However, adoption of new technologies, which is the focus of subsidies or tax credit policies, cannot by itself lead to substantial productivity gains, unless it is complemented by changes in the organization of work (Brynjolfsson and Hitt, 2000). What matters more than adoption, is how the technology is used within organizations. Accordingly, a large body of evidence on recent technological advances, such as ICT, highlights that the performance effects of new technologies depend on complementary firm-level investments, such as in organization structures, management capability and skills development (Draca *et al.*, 2006; Biagi, 2013).

## Shocks, Resilience and Growth

Embeddedness within a GVC affects the resilience of economies to macroeconomic shocks.[18] International trade is a key mechanism for the cross-country transmission of shocks and GVCs can intensify this propagation relative to trade in final goods alone. The international fragmentation of production means industries in different countries are connected through a complex web of intermediate input linkages. Accordingly, a shock to one part of the supply chain can propagate throughout the production network. This was as highlighted by the 2016 Kunamoto earthquake when Japanese supplier disruption led to the temporary shutdown of US auto plants and by the 2011 Tohoku earthquakes (Boehm,

Flaaen, and Pandalai-Nayar, 2015) and Thailand's great floods in the same year (Fujita, 2013).

Through these interconnections, firms are potentially exposed to a myriad of risks, including geopolitical risks (such as political violence), infrastructure risks (such as the 2010 Icelandic volcano eruption and disrupted air travel), and financial risks (such as the recent economic crisis) (OECD, 2013a). In the aggregate, growing evidence supports the role of GVCs as a conduit for shocks, with strong correlations between countries' GVC links and business cycle co-movement (Burstein *et al.*, 2008; Bergin *et al.*, 2009; Ng, 2010).

Mitigating supply chain risks implies a productivity trade-off. The small margin of error that firms typically build into value chains in order to reduce costs considerably increases risks (OECD, 2013a). Firms can mitigate their vulnerability to (supply) shocks through holding additional input inventories (Kahn, 1987; Alessandria, Kaboski and Midrigan, 2011) or diversifying their range of input suppliers (OECD, 2013a). However, holding additional inventories is costly to the firm as it ties up working capital. Supplier diversification may increase input costs through purchasing in smaller quantities (per supplier), sourcing from more expensive suppliers and the costs of transacting with more firms or countries. Therefore, in an effort to mitigate supply shocks, firms may incur higher production costs and reduce their productivity even during normal times.

Resilience is also determined by position within a GVC. Evidence for the United States suggests that industry growth is more strongly determined by industries that are directly linked (as customers or suppliers) and less correlated with indirect links (e.g. with the suppliers of their suppliers) (Carvalho, 2014 and OECD,

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18  See OECD, 2013a: Chapter 8 for an extensive discussion of resilience.

2013a). In addition, position within a GVC determines resilience to different types of shocks. Downstream industries are relatively more vulnerable to supply shocks higher up the value chain.

GVC position (and hence resilience) is determined by productive investments. Firms can reduce their vulnerability to supply shocks by moving up the value chain and specializing in upstream activities such as design, R&D and innovation. Firms can also move up the value chain by improving efficiency or increasing the value-added of their products; either by upgrading their existing product mix, adding new products or moving into new value chains (OECD, 2013a). These often require substantial productive investments. However, moving up the value chain does not immunize firms to GVC shocks. Rather, their position determines the type of shocks a firm is more exposed to. Upstream industries further from the final consumers are more exposed to demand shocks (Acemoglu *et al.*, 2015).

Increasing task specialization may also impact the resilience to shocks. The unbundling of the supply chains has permitted specialization in activities for which there is a comparative advantage. Firms can join a production network, specialising in a small part of the value chain, and at an aggregate level, developed economies are increasingly specialising in specific upstream or downstream activities (such as R&D, marketing, design). Indeed, the specialization in productive tasks is one of the oft-cited mechanisms through which productivity gains of GVCs are realised (e.g. OECD, World Bank and WTO, 2014). However, specialization can reduce resilience to shocks, particularly in the production of complex goods, where many countries and suppliers perform highly specialized tasks. Risks increase with the customization of the task and the greater number of countries linked through production networks (Taglioni and Winkler, 2016).

Conversely, the micro-structure of GVC supply chain networks can also generate macroeconomic shocks. Linkages between firms and industries are not evenly distributed; instead, a minority of multinational firms are the drivers of GVCs and production networks are disproportionately dependent on a minority of input suppliers. This is true within domestic production networks, such as the United States (Carvalho, 2014), and emerging evidence finds similar results for global supply chains (Cerina *et al.*, 2015). These key hubs can propagate disruptions to many other sectors, amplifying microeconomic fluctuations in one part of the economy into a macroeconomic shock. Evidence for the US suggests that fluctuations in these key sectors are highly correlated with aggregate manufacturing growth since the 1960s (Acemoglu *et al.*, 2012; Carvalho, 2014). MNEs may also play an important role in propagation of shocks, with emerging evidence suggesting intra-firm trade exhibited greater volatility than arm's length trade during the recent economic crisis (Altomonte *et al.*, 2012).

Evidence on resilience to shocks is only starting to emerge. However, structural policies that facilitate the flexible operation of markets appear to be important (Canova *et al.*, 2012; Caldera Sanchez *et al.*, 2015). This complements a wide breadth of recent research concerning preventing shocks, and monetary and macro-prudential policy prescriptions. Flexible labour and product market policies increase the scope for firms to adjust in response to shocks across many dimensions, with policies found to be more important for firms in volatile sectors (e.g. Calvino *et al.*, 2016). First, increased competition in goods and factor markets may increase the flexibility of wages and prices, enabling firms to absorb such shocks. Second, flexible labour and product market policies may accelerate the exit of the least productive firms and the reallocation of factors more generally to

more productive activities across firms. Third, such policies may ease the reorganization of activities and reallocation of factors within firms to mitigate the effect of shocks. For example, evidence from trade shocks suggest firms respond by transitioning from traditional manufacturing activities into provision of services (Breinlich *et al.*, 2014), product upgrading (Amiti and Khandelwal, 2013) or through investment in innovation.[19] However, there may be an important distinction in short and medium term effects of such policies. For example, stringent labour market policies may cushion the initial impact of shocks but stifle the reallocation and recovery process, extending the impact of the shock (Caldera Sanchez *et al.*, 2015).

## Conclusion

Recent decades have witnessed the widespread growth of GVCs across many developed and emerging economies. The unbundling of production across complex networks, involving the inputs of goods, services and intangibles from many firms and many countries, has presented new channels for growth. The recent availability of detailed firm-level data, combined with new trade in value-added metrics have uncovered many of these mechanisms. However, the rise of complex GVCs presents some additional policy complexities, such as the importance of domestic competitiveness in services and facilitating firms to join domestic supply chains of exporters.

GVCs are not primarily global in nature, but focused around regional clusters of production. The geography of GVCs has changed significantly in the last decades with some countries and industries having become key hubs in regional production (such as China's emergence onto the world stage). Eastern European countries have become increasingly connected to European value chains, whilst other regions have remained relatively peripheral (e.g. South America or New Zealand). Therefore the productivity effects of GVCs are likely to be heterogeneous across countries, as well as firms and workers. Further research is warranted to examine how the changes in the geography and structure of GVCs (such as becoming a key hub or peripheral) affect productivity.

However, emerging evidence suggests that the fragmentation of production may have stagnated since 2011, raising the question of the extent to which further productivity gains from GVCs can be realized going forward. On the horizon there are many structural and technological factors that are likely to influence GVCs, leading to further reorganization of production networks. These include rising demand and labour costs in emerging economies, an uncertain policy environment and the arrival of new digital and production technologies such as 3D printing, advances in robotics or enhanced data analytics using machine-to-machine communication. Some of these advances may lead to a reorganization of some activities closer to sources of demand (e.g. 3D printing, rising emerging economy labour costs), whilst others may lead to increasing complexity of production networks (e.g. advances in communication technologies, services liberalization). Further research is needed to uncover whether these factors will reverse the recent stagnation of production fragmentation and their effects on productivity.

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19  It is somewhat unclear precisely how innovation investments respond to shocks. Bloom *et al.* (2016) and Hombert and Matray (2016) suggest increasing innovation in response to trade shocks; although Autor *et al.* (2016) find the reverse.

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