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Knowledge flows and global value chains

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KNOWLEDGE FLOWS AND GLOBAL VALUE CHAINS

MARTA BISZTRAY AND NICLAS FREDERIC POITIERS

- The organisation of global value chains via supplier links and within business groups shapes global trade and forms a major channel through which knowledge is disseminated between countries. Global value chains are also an important channel through which economic shocks propagate.
- At the same time, knowledge seeking and knowledge protection are important determinants for multinational companies when structuring their production processes. Contract enforcement in general, and intellectual property rights protection in particular, are key institutions in this regard.
- Hierarchical ownership structures within business groups tend to be organised in the shape of an inverted pyramid, with more complex tasks located closer to the headquarters in ownership terms, facilitating stronger control. Recently, ownership structures have become 'flatter', meaning business groups have pulled key operations closer to their headquarters.
- New supply-chain relationships with key business partners are often accompanied by process and product innovation, making long-term business relationships an important driver of productivity growth. Knowledge transmission through such links not only benefits participating companies, but also leads to spillover effects.
- Import competition from high-income countries leads to investment in R&D and productivity growth in countries that have comparative advantage in capital-intensive goods. This is not the case for import competition from low-income countries, which instead makes companies downsize. Import competition also makes firms focus on their core product.
- To improve our understanding of this key aspect of globalisation, comparable micro-level data is needed on firms and firm connections across multiple countries.
- Trade and industrial policy can support productivity growth through global value chains by providing the right legal environment that supports the formation of long-term business relationships.

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Introduction

Global value chains (GVCs) form the backbone of the modern global economy. Lund *et al* (2019) estimated that 23 GVCs account for 69 percent of global output and 96 percent of global trade. Consequently, these networks shape the way in which economic production is organised and intermediate goods are traded, and also constitute one of the key channels through which knowledge and innovation is disseminated between countries. To understand the structure of trade flows and their contribution to productivity growth one needs to understand how businesses decide to structure their global production networks.

GVCs distribute production across countries either through firms connected by hierarchical control (foreign affiliates of multinational enterprises, MNEs) or through independent suppliers via contractual relationships. As Cadestin *et al* (2018) argued, the global fragmentation of production is mainly driven by MNEs.

Knowledge plays an increasingly important role in production processes, and knowledge-based investment is crucial for productivity growth (OECD, 2013). GVCs are important in facilitating cross-country knowledge flows, and thus ultimately contributing to productivity growth. At the same time, the knowledge-seeking motive influences the organisation of GVCs, which in turn has an effect on who can benefit from the knowledge flows facilitated by GVCs. Institutions that protect such knowledge from competitors, or facilitate the outsourcing of production tasks, thus have a significant impact on firms' decisions about how they structure their business networks, and ultimately also on productivity.

Both through their role facilitating and shaping global trade and their function in creating and disseminating knowledge, GVCs have for a major influence on productivity. Yet despite their importance, our understanding is still lacking on how GVCs operate and how multinational business groups decide to structure their production. In this paper, we explore the implications of a range of novel approaches to GVCs for our understanding of how they affect knowledge flow and innovation, contributing to productivity growth.

Knowledge forming the organisational structure of activities in the global economy

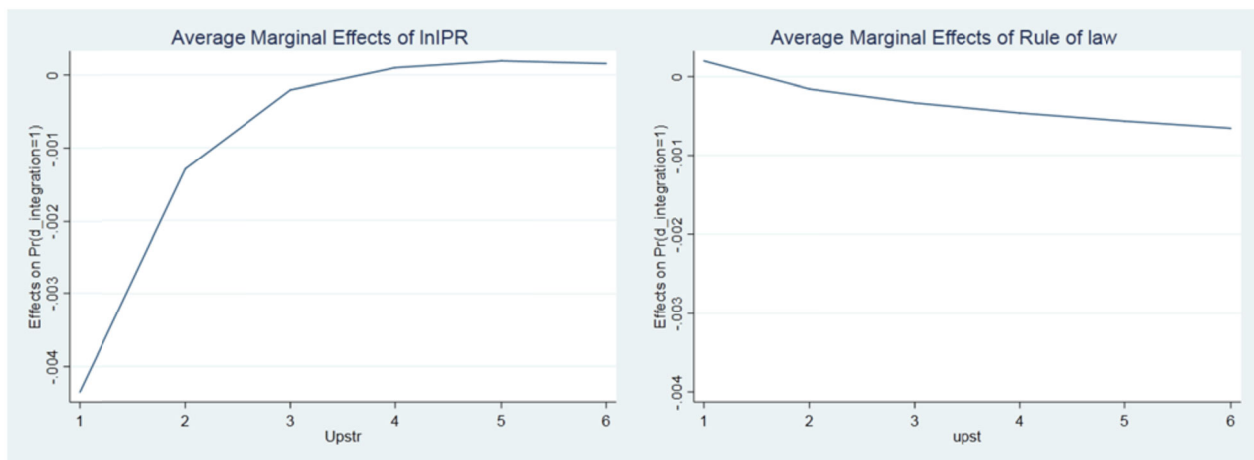
The organisation of economic activities through connections between firms and within firms, shapes the flow of knowledge in the economy. Knowledge-seeking and knowledge-protecting motives play a key role in decisions about integration or outsourcing. Supplier links serve as a major channel through

which firms can learn from each other, so it is important to study the factors that play a role in outsourcing decisions.

As transactions involve incomplete contracts, relationship-specific investments lead to a hold-up problem, decreasing the bargaining power of the investor and leading to underinvestment. The transaction cost theory (Williamson, 1971) suggests that this problem is less severe if transactions occur within the organisation. At the same time, integration induces a trade-off between increasing coordination costs and lost gains of specialisation. The property rights theory (Hart, 1990) provides an alternative explanation for the formation of organisational structures. It emphasises the role of asset ownership as the power of residual decision-making in matters that are not regulated by the contract. The hold-up problem is minimised if residual control and residual returns are connected. In both cases, institutional quality affecting contract enforceability has an impact on outsourcing decisions.

The fragmented nature of the production process in GVCs makes these considerations especially important. Since the efficient use and protection of knowledge requires long-term relationships, many of these business connections can be described as relational contracts. As intangibles and knowledge play increasingly important roles in economic activities, the non-appropriable nature of knowledge makes the protection of intellectual property rights (IPR) a crucial factor in organisational decisions. Bolatto *et al* (2019) investigated the impact on outsourcing decisions in supply chains of the quality of institutions that protect intellectual property rights. Knowledge transmission is necessary to receive customised inputs, but knowledge dissipation to competitors is disadvantageous to the firm. If the knowledge intensity of inputs is high, or intellectual property rights protection is weak, the threat of knowledge dissipation increases. Building on Antràs and Chor (2013) and Alfaro *et al* (2019), the theory suggests that with complementary investments, integrating the production of an input is more likely if intellectual property rights protection is weaker, or the relative knowledge intensity of downstream inputs is higher. Empirical evidence using firm-level data on imported inputs and foreign affiliates of Slovenian firms is in line with the predictions of the model. As Figure 1 shows, results also suggest that there are different consequences for organisational decisions in value chains depending on whether tangible (rule of law in general) or intangible (IPR protection) assets are protected.

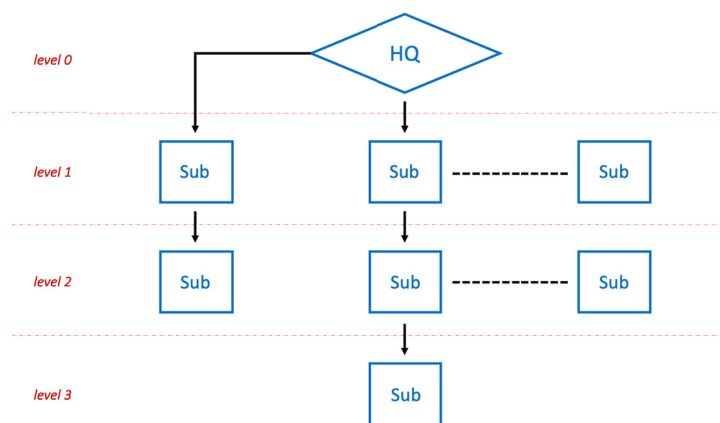
Figure 1: (Average) Marginal effects of the quality of institutions for complements with relatively more knowledge transmission upstream: IPRs (left) versus rule of law (right)



Source: Bolatto *et al* (2019), p.56.

To understand GVCs, it is important to address business groups. These are legally independent firms connected by hierarchical control through ownership links (Figure 2), and which function as single economic entities. As Altomonte *et al* (2020) showed, many of business groups have complex structures with numerous subsidiaries organised in multiple hierarchical layers, including multiple cross-border connections (multinational enterprises).

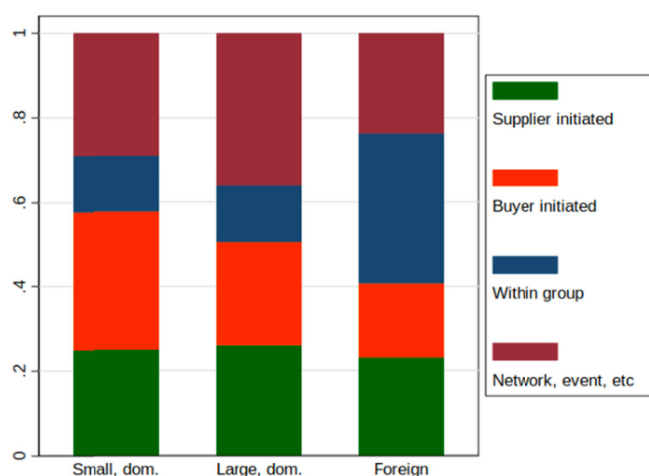
Figure 2: A business group as a hierarchy of firms



Source: Altomonte *et al* (2020), p. 32.

Business groups with cross-border connections play a crucial role in the global fragmentation of production (Cadestin *et al*, 2018). Based on the Central European Supplier Survey, Békés *et al* (2019) showed that for firms in Hungary, Romania and Slovakia, members of the same business group accounted for a large share of foreign buyers (Figure 3).

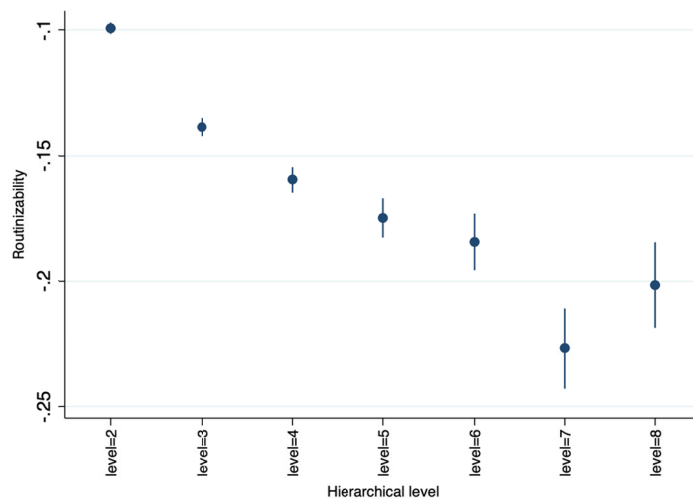
Figure 3: How do firms find customers?



Source: Békés *et al* (2019), p.26. Note: The figure shows the distribution of the answers in the Central European Supplier Survey to the question “How did the relationship start?” for key relationships (each such relationship in which the respondent is a supplier is one observation).

Instead of looking at individual decisions about integration or outsourcing along the supply chain, Altomonte *et al* (2020) considered the entire complexity of control relationships between firms. Business groups identified from ORBIS, the global ownership database of Bureau van Dyck, generally have the shape of an inverted pyramid, in which hierarchical levels closer to the headquarters consist of more subsidiaries than levels further away. Tasks carried out by subsidiaries that are closer in the hierarchy to the headquarters are also more complex than those done by remote subsidiaries, which tend to perform more routine and less knowledge-intensive tasks (Figure 4). Similarly, hierarchically more complex business groups tend to be more concentrated in terms of industry coverage. Both patterns are in line with a knowledge-based theory proposed by Altomonte *et al* (2020), which provides an explanation for the observed organisational structure of business groups. The trade-off Altomonte *et al*'s (2020) model comes from the limited ability of the headquarters to supervise the affiliates. This constraint makes headquarters choose between having many affiliates carrying out less complex tasks, which are less rewarding but which also require less supervision, or fewer affiliates doing highly complex tasks. The first corresponds to complex hierarchical structures with concentrated activities, and the second results in flat structures with a wide range of activities. The model predicts that business groups have a more complex hierarchy if the headquarters has higher-quality intangible assets, is more able to transfer knowledge (lower communication costs), and if it is easier to delegate knowledge.

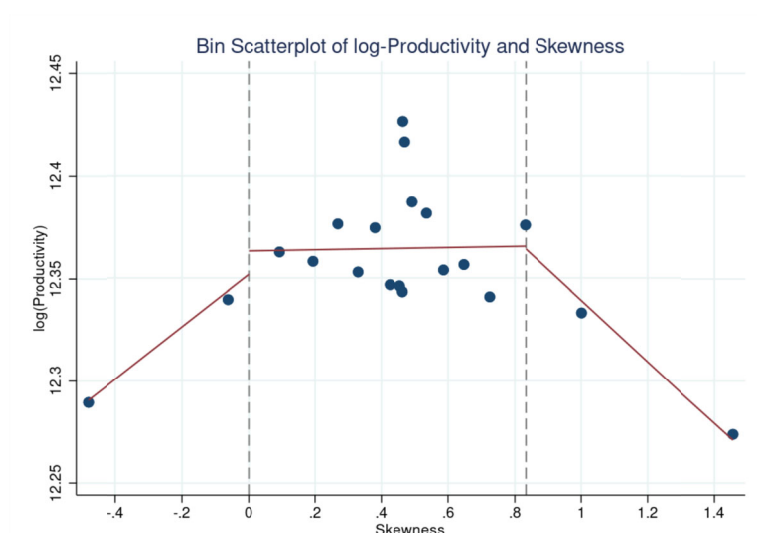
Figure 4: The share of repetitive routine tasks over hierarchies



Source: Altamonte *et al* (2020), p. 34. Note: The graph refers to 2015 data. It shows the coefficients and 95% confidence intervals obtained from a regression of the hierarchical level on the 'routinizability' index (measuring the share of repetitive routine tasks), controlling for parent fixed effects and subsidiary country fixed effects, plus robust standard errors. Note also that level = 8 represents business groups with at least 8 hierarchical levels.

There is some evidence that knowledge also plays a role in current business group restructuring trends. Altomonte *et al* (2022) looked at the evolution of business groups' hierarchical structures over time. They found that there is a tendency for incumbent business groups to become more skewed (less pyramidal) over time, and to get closer to the headquarters' core knowledge, while among new entrants, many are smaller and less skewed. Additionally, the relationship between skewedness and productivity shows an inverted U-shape (Figure 5): productivity in very extended or too-skewed business groups tends to be lower than in the middle. This pattern is in line with the hypothesis that intellectual property rights are important drivers of the restructuring of global value chains, and keeping knowledge close to the parent company is becoming increasingly important. As risks have become more prevalent because of the COVID-19 pandemic, these tendencies are also seen in current reshoring trends.

Figure 5: Productivity and skewedness



Source: Altomonte *et al* (2022). Note: The graph shows a scatter plot of the residuals of the partition regression of skewness and a proxy of productivity (ie $\log(1 + \text{turnover per employee})$) on some controls of interest: $\ln(\text{tax rate})$, $\ln(\text{current GDP p.c.})$, $\ln(\text{population})$, $\ln(\text{rule of law})$, GUO fixed effects. The data consists of all the groups for which it is available the consolidated turnover per employee and it is grouped in 20 equally sized bins.

Combining the previous two approaches, we can contrast global ownership and trade networks. Both can be important not only in the transmission of knowledge but also for the transmission of shocks. As Fontagné and Santoni (2021) showed, global demand shocks are indeed transmitted through trade networks, and ownership-networks are the main mediators of this transmission. Firms in industries and regions that are connected through overlapping networks experience an effect that is twice as great as those that are not. The effect experienced by firms that operate in industries and regions directly connected through FDI networks is three times larger. However, firms that are not directly affected also experience an indirect effect: one third of the impact of a demand shock is indirect through regions and networks.

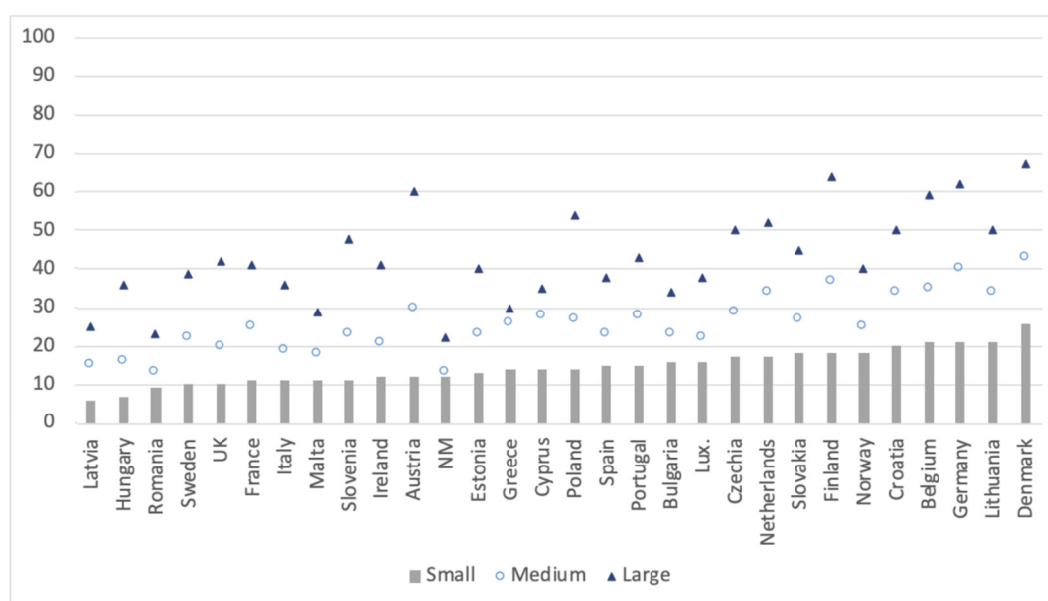
Knowledge flows in GVCs

While knowledge plays an important role in the organisation of global value chains, GVCs also serve as an important source of knowledge for connected firms, facilitating productivity growth. This productivity growth can be the result of newly introduced technology, adopted new production processes and efficient business practices, or other innovations which – as Békés *et al* (2019) showed – are a key part of the most important supplier-buyer relationships. Importantly, GVCs not only help to promote the adoption by their suppliers of efficient business practices and new technologies, but these also lead to

spillovers outside the network (Taglioni and Winkler, 2016), as suppliers can use the obtained knowledge as a base for further innovations and in their other business relationships.

In line with these patterns, using a multi-country survey covering central-eastern Europe on supplier connections between firms, Békés *et al* (2019) showed that members of business groups that sell to companies in the same business group are more productive. For Hungary's automotive industry, the findings of Bisztray (2021) suggest that firms supplying automotive MNEs are more productive and have higher levels of intangible capital than other firms in the same industry. At the same time, a positive correlation between firm productivity and GVC connections can either be the result of a productivity increase due to GVC connections, or the selection of more productive firms into GVCs. Bisztray *et al* (2021) addressed this question by looking at a specific technology which enables automated information flows between buyers and suppliers. Automated information sharing is important, as it decreases communication costs and helps information processing, which can contribute to more efficient operations. Yet, as Figure 6 suggests, it is still not widely used by firms because introduction is costly. There is significant variation between and within countries as well. Using data on transactions between firms located in Hungary, Bisztray *et al* (2021) showed that the adoption of this technology is more likely if firms have MNE buyers, which serves as suggestive evidence of the role of MNEs in technology propagation.

Figure 6: Share of firms with automated information sharing in the supply chain (%)



Source: Bisztray *et al* (2021), p. 25. Note: This figure shows the share of firms reporting information and communication technologies (ICT) allowing automated information sharing with buyers or suppliers by country and firm size group, based on Eurostat's Enterprise ICT survey in 2015. NM refers to North Macedonia.

Knowledge also plays a role in the ability of firms to integrate into GVCs. A higher level of knowledge in general and having a particular technology can help firms enter a GVC. As suggested by Bisztray *et al* (2021), firms using automated information-sharing technologies are more likely to supply MNEs or firms that already have the same technology. These patterns are in line with the complementarity between the supplier's and buyer's technology: each firm's automated information-sharing technology is more productive if the firm works with a partner that is an MNE or that has a similar technology.

An additional crucial factor to consider is the ability to innovate. Based on the Central European Supplier Survey conducted in Hungary, Slovakia and Romania, Békés *et al* (2019) showed that many of the key supplier-buyer relationships start with both product and process innovation. This pattern emphasises the importance of long-term and relational links between buyers and suppliers, and suggests that the ability to innovate is a key prerequisite in the formation of such links.

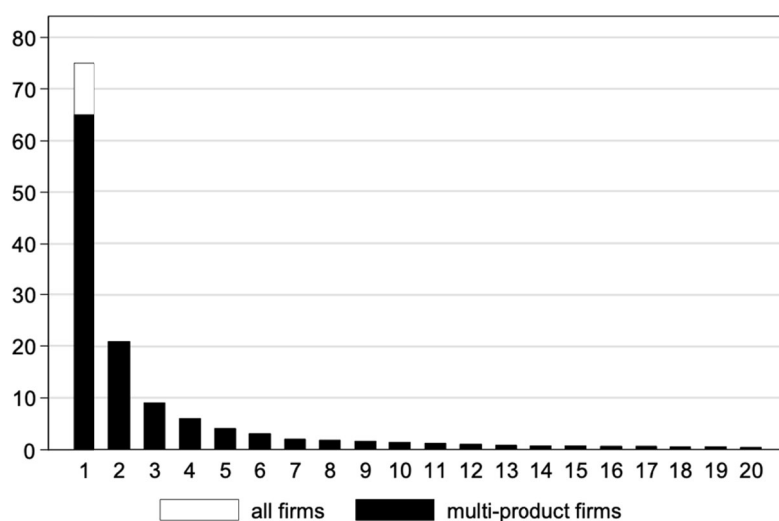
Import competition and specialisation

Beyond the direct effect of disseminating knowledge through firm connections, GVC-facilitated trade also has indirect effects on productivity through import competition and the resulting specialisation. In the political discourse, import competition has often been associated with the negative aspects of structural change, especially since the accession of China to the World Trade Organisation, also referred to as the 'China shock'. However, imports can also serve as a mean of knowledge transfer, and increased import competition itself can have positive effects on productivity.

Braeuer *et al* (2020) studied the effect import competition had on German manufacturing firms. They used panel data on German manufacturing firms between 2000 and 2014, including information about the products produced (the AFiD dataset) and combined this data with measures of import competition. This allowed them to derive the effect on the firms of increased competition from imports coming from countries with different levels of development.

They found that increased import competition from high-income countries leads to an increase in productivity, whereas import competition from middle- and low-income countries causes no such effect. They also found that import competition only increases productivity if it challenges the core product of a company. Figure 7 shows the revenue share by product of German manufacturing firms and illustrates that most companies generate most of their revenue from just one product. The incentives to defend this product if competition increases are much greater than for non-core products, on which companies can retreat from the market.

Figure 7: Revenue share by product



Source: Braeuer *et al* (2020) p. 37. Note: Revenue share by product; averages over firms. Figures do not need to add up to 100 percent, since firms have different number of products. Cut off at 20 products for convenience.

Looking at output, employment and R&D expenditures, Braeuer *et al* (2020) found a negative association with import competition from low-income countries, but no significant effect from high-income competition. Similarly, Dhyne *et al* (2021) found that firms facing international competition are focusing more on their core products. They tend to have higher technical efficiencies in these core products, meaning that the increase in import competition leads to an increase in the technical efficiency of production.

The importance of micro-level data

A common feature of the research results we have presented is the rich micro-level data they are based on. The availability of detailed data on firms and firm-to-firm connections through supplier links and ownership is crucial in investigating the links between knowledge flows and GVCs.

Data from value-added taxes is helpful to learn about firm-to-firm transactions within the country (as used by Bisztray *et al*, 2021, and Bisztray, 2021), but this data is still not available for research purposes in many countries. Firm-pair-level information on cross-border transactions is even less accessible, as standard trade data contains information only about the country and the type of the exported or imported product, though firm-to-firm links would be crucial for capturing GVC connections of individual firms. One way of addressing this issue is to make an indirect inference of GVC links based

on the exported product mix (as in Bisztray, 2021), which gives an imperfect measure. An alternative approach is using cross-country survey data on supplier-buyer links, such as the Central European Survey used in Békés *et al* (2019). However, such surveys are rare, with limited geographical coverage and time span, which makes it difficult to use them to investigate changes in patterns over time.

Understanding the organisation of business groups and their roles in transmitting knowledge or shocks requires cross-country data on ownership links between firms. So far, only commercial datasets such as ORBIS by Bureau van Dijk can be used for that purpose (as in Altomonte *et al*, 2020; Altomonte *et al*, 2022; and Fontagné and Santoni, 2021). Another way of addressing questions about the structure of GVCs is to look at integration and outsourcing decisions by combining information on imported products and on the activity of foreign affiliates of firms (as in Bolatto *et al*, 2019). While this data is available in many countries, it is difficult to make a comparable analysis using similar data from multiple countries at the same time.

To further deepen our understanding about the links between knowledge and GVCs, it is crucial to access comparable micro-level data in multiple countries, not only at the firm-level, but also on firm-to-firm connections, including cross-country ownership and supplier-buyer links.

Policy implications

The new approaches and datasets we have described all emphasise the importance of GVCs for trade and productivity. The institutional arrangements that facilitate – or impede – such value chain formation thus have direct consequences for productivity growth. The organisation of business groups is not only affected by the availability of skilled labour and capital, but also by the quality of property rights and contract enforcement.

Trade policy can play an important role in shaping such organisation. By opening new markets and creating certain legal environments, it can help MNEs expand into new markets and form new business relationships. This can then lead to knowledge spillovers, or even direct innovation when the new relationships are formed (as described by Békés *et al*, 2019). Long-run relationships are especially productive in this regard. Many of the most productive relationships are formed within business groups. To establish such productive relationships, stable business environments that allow relationships to form and thrive are crucial. Trade policy can contribute to building such stable environments by providing a framework that ensures both smooth and cost-effective cross-border trade between entities in different countries, and by providing legal certainty for investors and managers.

Furthermore, common standards can facilitate expansion and deepening into new markets. Bisztray *et al* (2021) provided evidence about how use of the same technologies can drive decisions on the formation of supply-chain relationships. This means that engagement in international standard-setting bodies, as well as the strategic use of the 'Brussels effect' (ie the external application of EU regulation due to the size of the European market) can lead to economic benefits in terms of deeper economic integration with other markets. Cross-country links established through GVCs also mean that policy measures implemented in one jurisdiction can have cross-border effects, as they affect the way in which business groups structure their operations.

Property rights and contract enforcement play crucial roles in the decisions of MNEs about how to structure their GVC networks. As Bolatto *et al* (2019) discussed, knowledge transfers through outsourcing are more costly if intellectual property might leak to competitors. In such cases, MNEs might prefer to integrate the production of an intermediate good rather than outsource it. As Altamonte *et al* (2022) showed, such a dynamic has led to MNEs pulling their core competencies closer to the headquarters. This has major implications in the debate over forced technology transfers in China. It suggests that, in the absence of an effective policy response, companies themselves will react by readjusting their value chains. Furthermore, policies that shape the way in which business groups are structured also affect the propagation of knowledge and technologies through GVCs.

Conclusion

GVCs are the current drivers of global trade. The connections formed through GVCs lead to the flow of knowledge and create innovation and can be drivers for productivity and ultimately economic growth. Import competition can also contribute to productivity, by forcing companies to invest in R&D and focus on their core products where they are most productive.

The way in which GVCs are structured is shaped by the institutional environment. Contract enforcement and protection of intellectual property rights are the main drivers of firms' decisions about where to outsource and how to structure their business groups. Long-term relationships are crucial to realise these benefits of GVCs. Trade policy can facilitate such productive connections by providing a stable environment and by opening new markets for GVC operations. On the flip-side, in light of the current uncertainty regarding the business environment, MNEs are already adjusting by pulling their core competencies closer to their headquarters.

Given their centrality in the global economy and in facilitating knowledge growth and innovation, a better understanding of the way GVCs function is crucial to solving the productivity puzzle. Better microdata is fundamental to building this knowledge.

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