WPS8007

Policy Research Working Paper 8007

Economic Upgrading through Global Value Chain Participation

Which Policies Increase the Value Added Gains?

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WORLD BANK GROUP
Trade and Competitiveness Global Practice Group
March 2017

Policy Research Working Paper 8007

Abstract

The emergence of global value chains has opened up new ways to achieve development and industrialization. However, new evidence shows that not all countries have gained from participating in global value chains, and that country-specific characteristics matter for economic upgrading in global value chains. This paper uses two panel data sets of developing and industrialized countries at the sectoral level to relate global value chain participation as a buyer and seller to domestic value added. These are combined with a wide range of policy measures at the country level that can play a role in economic upgrading through global value chains, by targeting global value chain integration or the quality and conditions of input and output factors. First, the study finds that global value chain integration increases domestic value added, especially on the selling side, which holds across all income levels. Second, the results highlight the importance of policy for economic upgrading through global value chain integration. Although the study cannot claim causal evidence, all the assessed policy areas are consistently shown to mediate the effects of global value chains and magnify the gains for domestic value added. Third, a detailed analysis shows that several policy areas mediate the gains from global value chains more through integration as a seller. Finally, the study observes that many of the results are driven by high- and upper-middle-income countries.

This paper is a product of the Trade and Competitiveness Global Practice Group. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The authors may be contacted at dtaglioni@worldbank.org and dwinkler2@worldbank.org.

Economic Upgrading through Global Value Chain Participation:

Which Policies Increase the Value Added Gains?

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Key words: global value chain participation, economic upgrading, value added, role of policy, standards

JEL: F1, F2

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This paper is part of the development of a taxonomy for GVC integration and upgrading, which consists of "best practice" experiences for a representative sample of countries from each world region. The authors would like to thank Miles McKenna for his inputs on the standards literature, as well as Paulo Bastos, Dominique Bruhn, and Alexandros Ragoussis for their valuable comments on an earlier draft of the paper. The views expressed in this paper are those of the authors and should not be attributed to the World Bank, its Executive Directors or the countries they represent.

1. Introduction

The emergence of global value chains (GVCs) has opened up new ways for development and industrialization. Developing countries can now join existing supply chains instead of building complete chains domestically. This increased degree of specialization frees them from the need to develop a wide range of competitive tasks and emphasizes their respective finely defined comparative advantages. At the same time, GVCs can be a tool for industrialized countries to re-invigorate their slow growth in the absence of major innovations. Indeed, cross-country evidence and case studies show that GVC participation can on average be growth-enhancing and lead to economic and social upgrading (see, for example, UNCTAD 2013; WEF 2013). However, new evidence also shows that not all countries have gained from participating in GVCs and that the institutional and political environment of countries matters to their success in GVCs (Kummritz 2016; Taglioni and Winkler 2016).

This paper examines which national policies are crucial for successful economic upgrading in GVCs, combining two panel data sets of developing and industrialized countries at the sectoral level with a wide range of policy measures at the country level. Taglioni and Winkler (2016) differentiate between three types of economic upgrading based on a country's current tasks of comparative advantage, skills, and capabilities (Humphrey 2004; Humphrey and Schmitz 2002): (i) product upgrading, which involves moving into more sophisticated products in the existing value chain; (ii) functional upgrading, which involves increasing the value-added share (in output of the final product) in existing GVC processes by integrating or moving into more sophisticated tasks; and (iii) inter-sectoral upgrading, which involves moving into new supply chains with higher value-added shares. Therefore, in this paper, we adopt value added as our measure of economic upgrading.

These three objectives can be achieved by upgrading the production factors of labor and capital, and also by increasing total factor productivity (TFP). First, skills upgrading refers to improving the skills and know-how of the workforce. Developing skills is a key element of competitiveness, it affects the ability to participate in GVCs and to achieve economic and social upgrading within GVCs. Second, capital upgrading refers to improving the absorptive capacity and technology of firms, which requires general and industry-specific investments to upgrade technical capacity and achieve quality standards and innovation capabilities. Third, process upgrading refers to increasing TFP in existing GVC tasks that cannot be directly attributed to the production factors of labor or capital, for example, by better organizing the production or by introducing new technologies to capture efficiency gains (Taglioni and Winkler 2016).

Countries have different policy options at hand to facilitate skills, capital, and process upgrading that foster value-added gains in GVCs. We discuss and analyze a wide spectrum of areas that can play a role for GVC upgrading, either by targeting GVC entry and stronger GVC integration that increases the potential for economic upgrading in a country, or by directly targeting the quality and conditions of input and output factors. These include infrastructure, connectivity, investment and trade policy, business climate and institutions, financial development, labor market policy, education and skills, product standards and innovation, as well as labor, social, and environmental standards. We outline several paths for economic upgrading through GVC participation and highlight the complimentary role that policy plays in this development. Overall, this paper shows that countries that want to develop GVC strategies must take into account their policy environment. Bad policies can be an impediment to GVC-induced value-added gains while good policies can be a substantial facilitator.

Using two panel data sets at the sectoral level, our empirical strategy relates GVC participation as a buyer (backward GVC links) and seller (forward GVC links) to domestic value added. The measures are based on the Organisation for Economic Co-operation and Development's (OECD) Inter-Country Input-Output (ICIO) data set as well as the World Input Output database (WIOD). Both databases cover a wide range of industrialized and developing countries, manufacturing and services sectors, and years. Related streams of literature have focused on the productivity gains from international trade and investment at the sector or firm level, including the role of exporting (Bernard and Jensen 1995 and following studies), importing inputs (see, for example, early contributions by Görg and Hanley 2003 or Mann 2003), and FDI (see, for horizontal spillovers, Haddad and Harrison 1993; for vertical spillovers, Javorcik 2004a). To the best of our knowledge, Kummritz (2016) is the only other study that looked into the effects of GVC integration on economic upgrading based on international input-output measures.

The type of GVC integration is a main determinant for which policies matter. Javorcik's (2004a) seminal study on spillovers from foreign direct investment (FDI) introduced measures of backward and forward FDI links based on input-output data. The concept of backward and forward links has been used widely in the literature of FDI and, increasingly, in international trade. Overall, the literature suggests that backward and forward FDI links have a differential effect on economic upgrading (see, for example, Javorcik 2004a; Havranek and Irsova 2011), and similar results can be expected for different types of GVC integration (Kummritz 2016). Integrating as a buyer into GVCs requires a focus on building the infrastructure and strengthening connectivity to global firms in order to import world-class inputs. While GVC participation as a seller also hinges on a similar policy framework, the focus now shifts more towards increasing productivity in order to be more competitive in the global marketplace. Following Kummritz (2016), we focus on measures of backward and forward GVC links.

In a second step, we investigate whether certain policies at the national level increase the relationship between domestic value added and GVC participation, in order to guide future GVC-related policy making. There are at least two streams of literature that have emphasized the role of national policies for welfare gains: One set of studies looked at the role of country characteristics for economic growth and for escaping the middle-income trap (for recent contributions, see, for example, Eichengreen, Park, and Shin 2013; Pritchet and Summers 2014; Bulman, Eden, and Nguyen 2014; for a literature review, see Raiser 2014). Another strand of literature examined the role of policies for the productivity spillovers from FDI. For an extensive literature review, see, for example, Farole and Winkler (2014). In this paper, we include a wide range of measures at the national level in the form of interaction terms.

We also test whether the findings depend on a country's development stage by splitting the samples into three income categories. The effects of GVC integration on economic upgrading can vary depending on a country's development stage, the type of GVC integration, and its underlying transmission channels. The transmission channels include backward and forward GVC links; technology spillovers to local firms in the same or related downstream or upstream sectors; skills upgrading transferred through the training of and demand for skilled labor; investments in infrastructure that would otherwise not be profitable (minimum scale achievements); and pro-competitive market restructuring effects that are not limited to GVC participants, but also extend to nonparticipants (Taglioni and Winkler 2016). It might be possible that countries with lower income levels benefit more strongly from backward links and technology spillovers, while higher income countries show higher gains from forward links and skills upgrading.

First, we find that GVC integration significantly increases the domestic value added of our samples, especially on the selling side. The results hold across all income levels. Second, the results highlight the importance of policy for economic upgrading through GVC integration. While we cannot claim causal evidence, all assessed policy areas are consistently shown to mediate the effects of GVCs and magnify the gains for domestic value added. This holds for policies that affect the quality and conditions of input and

output factors, policies targeting investment and trade flows, and policies targeting the business climate and institutions including financial and labor markets. As a result, strategies for GVC integration must focus not just on border measures, but also on beyond-the-border measures if they are to extract the maximum benefits for the integrating country.

Third, detailed analysis shows that several policy areas mediate the gains from GVCs more through integration as a seller. This holds in particular for connectivity, education and skills, as well as for standards. We consider this a sensible result since the mechanisms behind the positive effects of GVC integration as a buyer and seller are likely to be different. For instance, backward links might generate gains through increasing the quality of inputs while forward links have a direct demand increasing effect for domestic value added. Naturally, domestic policies can influence the demand for domestic goods more than the quality of foreign inputs. Our results are in line with such an explanation.

Finally, we observe that many of our results are driven by high- and upper middle-income countries—notable exceptions are standards and the business climate and institutions; nevertheless, we consider our conclusions as highly relevant for developing economies; many high- and upper middle-income countries have higher levels of GVC integration and it is then evident that they are responsible for a significant part of our results. However, as low- and lower-middle income countries integrate more and more into GVCs, we expect that such domestic policies will play an increasing role.

The remainder of this paper is organized as follows. Section 2 reviews the literature on the impact of GVC participation on economic upgrading and discusses the relevance of policy in this context. Section 3 describes the empirical specification and introduces the data. Section 4 presents the econometric results based on the total sample of countries. Section 5 concludes and outlines areas for future research.

2. Literature Review

2.1. The Impact of GVC Participation on Economic Upgrading

Trade Openness and Efficiency Gains across Sectors

The macro-economic channels through which openness to trade enhances aggregate productivity and growth are well known. Trade openness leads to a more efficient allocation of resources across sectors within countries and thereby raises growth. Exports in Ricardo's famed two-country, two-sector, and one-factor model allow for specialization in a country's comparative advantage, which, in his model, is determined by technological differences across countries. By contrast, comparative advantage in the two-country, two-sector, two-factor model by Hecker-Ohlin-Samuelson (Heckscher 1919; Ohlin 1933; Samuelson 1948), is not determined by technological differences but by different factor endowments. The proportion of factors used in the production of different goods determines international trade.

The new trade theory à la Helpman and Krugman (1985), and generalized by Grossman and Helpman (1991), shifted the focus from static gains from trade to dynamic ones in which the increased investment, knowledge, and technology, associated with increased productivity growth can transform trade patterns and accelerate overall economic growth. Under the new theory, specialization is a result of scale and concomitant efficiencies.

Finally, New Economic Geography (NEG) models focus on the uneven distribution of economic activity and income across spaces that are determined by the interplay between transactions costs (such as trade costs) and various types of increasing returns to scale (Venables 2005). In the NEG two-region model by Krugman and Venables (1995), firms produce intermediate and final goods using labor and intermediate

inputs. Falling trade costs increase the relative benefits of clustering economic activity in a region, as the possibility of international trade enables firms to reach foreign customers via exports. When trade costs fall further, factor price differences become more important and firms start importing inputs from the lower-cost region. In sum, four forces determine the location of economic activity: factor supply and product market competition (dispersion factors), and demand and cost links (agglomeration forces).

The following sections review the literature on the relationship between GVC integration and economic upgrading. The concept of economic upgrading is largely about gaining competitiveness in higher value-added products, tasks, and sectors. While the trade models listed above emphasize the positive effects of trade openness for a country's aggregate productivity and growth, our literature review focuses specifically on productivity and value-added effects at the sector and firm levels. GVC integration is also a broad concept, which can include a variety of measures, including selling and buying in GVCs and foreign direct investment (FDI). The following is a brief literature overview of the main empirical and theoretical contributions that relate measures of GVC participation to productivity and value added, and an assessment of possible transmission channels.

Exporting and Economic Upgrading within Sectors

The export-productivity nexus has been discussed both at the macro and micro levels for a long time. While traditionally, the macro-economic channels through which export expansion enhances aggregate productivity and growth have been the focus of trade models, Melitz (2003) added firms to trade theory and showed that exporting can increase aggregate productivity by reallocating resources from less productive to more productive firms.

This development from macro to micro level started with the seminal paper by Bernard and Jensen (1995) that exporters outperform nonexporters in the same sector and country, in terms of productivity, skills, wages, technology, and capital intensity (see, for detailed literature review, Wagner 2007). Consequently, researchers started to ask whether exporters perform better because of self-selection into the exporting market and because of learning by exporting (LBE). Self-selection refers to ex ante differences across firms, while LBE refers to ex post gains of exporters versus nonexporters. Self-selection relates to the fact that exporting involves additional costs of exporting, including transportation, marketing, and distribution costs, employees with specific skills, and production costs for necessary adjustments that only more productive firms are able to absorb. LBE refers to knowledge flows that exporting firms absorb from international buyers and competitors that renders them more productive (Wagner 2007).

The wide array of existing studies tends to find that more productive firms self-select into exporting, while the positive impact of exporting on productivity is less clear-cut. The increased fragmentation of international trade in GVCs makes LBE more likely as selling to international buyers might increase firm-level productivity ex post via forward and backward links, technology spillovers, skills upgrading, and minimum scale effects.

Importing Inputs and Economic Upgrading within Sectors

Most of the studies on the effects of imported inputs on productivity focused on developed countries, as part of the offshoring literature that started in the mid-1990s, when developed countries began to assess whether importing (or offshoring) of material inputs (typically from lower-income countries) entailed positive welfare effects in the countries of origin. For instance, the seminal study by Grossman and Rossi-Hansberg (2008) showed that offshoring can entail productivity gains similar to technological progress for the offshoring nation because it lowers the average cost of inputs. Baldwin and Robert-Nicoud (2014) extended this framework and showed that offshoring can additionally shift terms of trade

in favor of the developed economy. On the developing economy's side, Li and Liu (2015) and Zi (2014) developed models in which LBE drives gains for the host countries. This relates to an older strand of literature that examined the effects of the North American Free Trade Area. Most prominently, Feenstra and Hanson (1996) showed that offshoring and host countries benefit from production fragmentation since the average skill intensity rises in both countries when the initial technology gap between the two is sufficiently large.

There are various ways of measuring offshoring, but in most cases, it is the share of imported inputs as percentage of total inputs, value added, or output. Since these measures are typically based on input-output tables, these types of studies are often performed at the industry-level. However, the focus was more on the labor market effects. Shifting the focus on productivity growth, Egger and others (2001) found that materials offshored to Eastern European countries had a significantly positive impact in 20 Austrian manufacturing industries.

In the 2000s, this stream of literature gained momentum when the focus shifted on services offshoring and its impact on TFP or labor productivity. Several studies at the sectoral level found evidence that services offshoring significantly increases productivity, while the effect of materials offshoring is smaller or insignificant: including Amiti and Wei (2006, 2009) for U.S. manufacturing between 1992 and 2000, Crino (2008) for nine EU countries between 1990 and 2004, Winkler (2010) for German manufacturing industries covering the period 1995–2006, and Michel and Rycx (2011) for Belgian manufacturing industries between 1995 and 2004. The last study also examined the impact of inter-industry spillover effects, but only found little evidence of it. Other studies, by contrast, only found significant productivity gains from materials offshoring, including Daveri and Jona-Lasinio (2008) for Italy between 1995 and 2003 and Ito and Tanaka (2010) for Japanese manufacturing over the period 1988–2004. Focusing on low-skilled workers, Egger and Egger (2006) found a U-shaped labor productivity effect from materials offshoring in the manufacturing sectors of 12 EU countries between 1993 and 1997.

A few studies use firm-level data. Görg and Hanley (2003) analyzed the impact of services offshoring on labor productivity for Ireland using plant-level data. The effect was positive in the electronics industry between 1990 and 1995. In a more recent plant-level study, Görg and others (2008) evaluated the productivity effects of materials and services offshoring for Irish manufacturing for the period 1990–1998, differentiating between exporting and non-exporting firms. They only found a significantly positive impact of services offshoring on TFP for exporting firms.

A recent strand of literature looked at the impact of trade liberalization on productivity through improved access to foreign inputs in developing countries. Amiti and Konings (2007) found, for Indonesia, that reducing tariffs on intermediate inputs leads to a productivity gain at least twice as high as gains from reducing output tariffs. Topalova and Khandelwal (2011) confirmed this result using firm-level data from India. In addition, Crino (2012) showed for 27 transition countries that importing inputs induces skills upgrading by facilitating the production of new goods, improvement of product quality, and, to a lesser extent, research and development (R&D) and technology adoption.

FDI and Economic Upgrading within Sectors

Econometric studies of FDI spillovers usually investigate why the level or growth rate of productivity of domestic firms is higher in sectors where foreign firms are more prevalent. In the last decade, many researchers have econometrically examined the existence and direction of FDI-generated horizontal and vertical spillovers. Starting with the pioneering study by Caves (1974), early research on the topic examined the effects of horizontal spillovers using industry-level cross-sectional data, and generally found evidence for positive spillovers (see, for an overview of earlier studies, Görg and Strobl 2001). In later work, using panel data at the firm level, Haddad and Harrison (1993) found evidence for negative

spillovers in Morocco, which was attributed to possible adverse effects of increased competition offsetting positive spillovers from FDI.

Numerous studies on horizontal FDI spillovers have followed since, showing ambiguous effects of FDI on domestic productivity (see, for extensive literature reviews, Görg and Greenaway 2004; Lipsey and Sjöholm 2005; Smeets 2008, among others). In a review of 40 studies on horizontal productivity spillovers, Görg and Greenaway (2004), found that 20 studies reported statistically significant evidence of positive spillovers, while only 6 studies reported negative spillovers. However, they raised concerns over the robustness of the cross-sectional studies—almost all showed positive effects. By contrast to the 28 panel studies, only 6 studies reported positive spillovers, while 4 studies reported negative spillovers, and the large majority (18 studies) showed ambiguous results. Indeed, Paus and Gallagher (2008) concluded in their literature overview that regressions based on cross-sectional data tend to find positive spillovers, while those based on panel data are more likely to find negative spillovers.

In a seminal study using panel data for Lithuania, Javorcik (2004a) shifted the focus to vertical spillovers and introduced a measure of backward and forward spillovers based on input-output data, which has been widely used since. Besides finding positive horizontal spillovers, Javorcik (2004a) confirmed positive backward spillovers, but rejected the existence of forward spillovers. Since then, there has been a "virtual explosion of studies on vertical spillovers" (Havranek and Irsova 2011, p.1), including Blalock and Gertler's (2008) widely cited study on Indonesian manufacturing firms that confirms the positive backward spillovers. In a comprehensive meta-analysis, Havranek and Irsova (2011) took into account 3,626 estimates from 55 studies on vertical spillovers, and found evidence of positive and economically important backward spillovers from multinationals to local suppliers in upstream sectors and smaller positive effects to local customers in downstream sectors. However, the authors rejected the existence of horizontal FDI spillovers. The findings suggest that a 10-percentage-point increase in foreign presence increases productivity of local firms in upstream sectors by around 9 percent.

2.2. Transmission Channels

Expanding and strengthening a country's GVC participation may lead to higher output, productivity, value added, and jobs through a variety of channels (Taglioni and Winkler 2016).

(1) The transmission channels include *backward links*, that is, GVC-linked purchases of international inputs, spurring production and productivity in various downstream sectors via an increased availability and quality of inputs and knowledge diffusion effect; and *forward links*, that is, sales of GVC-linked local intermediates to international buyers, spurring production and productivity in various upstream sectors via the demand for more or better inputs and assistance extended to local suppliers.

(2) Second, GVC participation can translate into pro-competitive *market restructuring effects* that are not limited to GVC participants, but also extend to nonparticipants, as GVC participation increases competition for limited resources in the country, overall average productivity increases in the medium run. Moreover, knowledge and technology spillovers arise from direct imitation or reverse engineering by local firms (demonstration effect).

(3) Third, *technology spillovers* lead to improved productivity of local firms in the same or related downstream, or upstream sectors as a result of GVC production via the diffusion, availability and quality, and demonstration effects described above.

(4) Fourth, GVC participation may stimulate investments in infrastructure that would otherwise not be profitable and may spur local production and productivity in other sectors through *minimum*

scale achievements for at least two reasons: they amplify pro-competition effects and also strengthen the ability of a country to sustain GVC participation over time.

(5) GVCs also benefit *labor markets* through the training of and demand for skilled labor as well as labor turnover where knowledge embodied in the workforce of participating firms moves to other local firms.

This paper focuses on the value-added effects of forward and backward GVC integration and emphasizes the role of policy in mediating these effects. Host-country and institutional factors can influence characteristics of domestic and foreign firms in GVCs, as well as the transmission channels for knowledge diffusion to local firms. Similarly, standards can shape firms' characteristics, influence the transmission channels and thus have a mediating effect on economic upgrading through GVC integration.

Measuring a country's implementation and compliance with product, labor, social, and environmental standards can be done directly and indirectly. Direct measures include, for example, compliance with certain International Organization for Standardization (ISO) standards or certain international conventions. Indirect measures, on the other hand, focus on policies and characteristics that can be expected in countries that have implemented certain standards, including their innovation potential, and labor market, social, and environmental policies.

Causality between direct and indirect measures on standards can go two ways. On the one hand, the implementation of standards, such as higher product standards, improves a country's innovation potential, among others. On the other hand, countries put in place policies (such as minimum wages), which, in turn, help them comply with certain standards (such as labor standards). In any case, we expect a positive correlation between the direct and indirect measures of standards.

In the following section, we discuss ten types of policies that target: (i) investment and trade flows, (ii) the business climate including financial and labor markets, (iii) as well as the quality of output and input factors. While (i) and (ii) target more GVC entry and stronger GVC integration, (iii) focuses more directly on upgrading. We focus on a country's infrastructure, connectivity, investment and trade policy, business climate and institutions, financial and labor markets, education and skills, product standards and innovation, labor standards, social standards, and environmental standards. Although the focus of the literature review is on spillovers from FDI, many host-country characteristics can also be expected to lead to spillovers from GVC participation through other forms (for example, selling, buying, and nonequity modes of investment).

2.3. The Mediating Role of Policies That Target Investment and Trade Flows

Infrastructure and Connectivity

While we are unaware of studies that explicitly take into account a country's *quality of infrastructure and connectivity* when assessing FDI spillovers or broader GVC effects on economic upgrading, it can be expected to influence the predictability, reliability, and timeliness in GVCs (WEF 2013). Many countries cannot join certain stages of GVCs because of their inability to meet requirements for timely production and delivery. A day of delay in exporting has a tariff equivalent of 1 percent or more for time-sensitive products (Hummels and others 2007). Slow and unpredictable land transport keeps most of Sub-Saharan Africa out of the electronics value chain (Christ and Ferrantino 2011). Sellers are often willing to pay more for airfreight. Delays in GVCs also create uncertainty, inhibiting countries from participating in GVCs for goods such as electronics or fruits and vegetables (Arvis, Raballand, and Marteau 2010).

Regarding cost reduction, GVCs have changed the perspective on traditional barriers to trade, such as tariffs. Some recent studies suggest that reducing supply-chain barriers to trade—border administration, transport and communications infrastructure, and related services—would have greater impact on the growth of GDP and trade than the complete elimination of tariffs. Cutting supply-chain barriers to trade could increase GDP by nearly 5 percent and trade by 5 percent, against less than 1 percent and 10 percent, respectively, for complete tariff removal (WEF 2013). Developing countries would be the main benefactors of trade facilitation. Transport costs, according to developing-country suppliers, remain the main obstacle to entering, establishing, or moving up in GVCs (OECD-WTO 2013).

Policy matters for logistics performance, whether for infrastructure investment and operation or for regulatory matters, including trade facilitation at the border. Improving the quality of infrastructure and promoting international connectivity touches on several dimensions: tightening forward and backward links within GVCs by securing the flow and lowering the costs of inputs and outputs, increasing speed, and reducing uncertainty. Therefore, higher quality infrastructure and better connectivity at the border can have a positive impact on GVC integration.

Investment and Trade Policy

Investment policy and promotion mediate spillovers by helping attract foreign investment in general (the focus of most export promotion efforts), and by encouraging policies to promote spillovers (much less common). Investment promotion contributes to bringing in firms that should have higher spillover potential, given their quality and technology position (Harding and Javorcik 2012). For example, positive FDI spillovers in Chinese manufacturing are higher from foreign firms enjoying investment subsidies and exemptions from value-added taxes relative to spillovers from foreign firms that do not reap those benefits (Du, Harrison, and Jefferson 2011). Drivers of investment, particularly the protection of foreign assets, have a large influence on a country's location attractiveness for foreign investors. Those drivers affect a country's participation in GVCs, regardless of their governance structure.

Special Economic Zones (SEZs) are a special case for investor attraction, which may affect GVC spillovers. Local Chinese manufacturing firms in SEZs have smaller productivity spillovers from FDI than do nonSEZ domestic firms (Abraham, Konings, and Slootmaekers 2010). That may occur because most SEZs focus on export processing combined with a high percentage of imported inputs, which limits the potential for FDI because demand for local suppliers is constrained. Moreover, the spatial and legal structures that govern SEZs often inhibit their integration with the local economy.

A country's *trade policy* shapes the amount and type of foreign investment. Spillovers are larger in countries that are more open to trade. A country's trade policy regime is related to its capacity to attract foreign firms because foreign investors are less constrained by the size and efficiency of the local market (Crespo and Fontoura 2007). Moreover, foreign investors in an open trade setting are more integrated globally and thus tend to adopt the newest technologies. One can also argue, however, that foreign investors in an outward-oriented trade policy regime tend to focus more on international distribution and marketing and less on new technologies (Meyer and Sinani 2009).

Trade policy also affects domestic firms. In an open trade regime, domestic firms are more exposed to international competitive pressures, which will prepare them to absorb spillovers (Havranek and Irsova 2011). Moreover, a country's trade policy also affects the likelihood of domestic firms becoming exporters and LBE. Although the effect of exporting on the domestic firms' absorptive capacities is ambiguous, exporting clearly moderates the direction and extent of FDI spillovers. FDI spillovers are larger in countries that are more open to trade (Havranek and Irsova 2011, Farole and Winkler 2014). For China, horizontal and vertical spillover effects from FDI are negative when final goods and input tariffs are higher (Du, Harrison, and Jefferson 2011).

2.4. The Mediating Role of Policies That Target Business Climate

Business Climate and Institutions

A country's *business climate*—particularly the protection of foreign assets—has a large influence on a country's location attractiveness for foreign investors. Those drivers affect a country's participation in GVCs, regardless of their governance structure. The strength of intellectual property rights in a host country, for example, may help attract high-quality foreign investment initially and, therefore, create the potential for FDI spillovers (Gorodnichenko, Svejnar, and Terrell 2007; Javorcik 2004b). But some people argue that although strong intellectual property rights may help attract such investment and allow knowledge and technology to be transferred to the affiliate, they may also hinder the transmission of those advances beyond the local market (Havranek and Irsova 2011).

Competitive pressures from GVC participation might be lower if the local firm already faces a higher level of *competition* at the sectoral level. Local firms in competitive sectors might have a lower incentive to improve, resulting in lower benefits from GVC spillovers. Sinani and Meyer (2004) confirmed that more sectoral competition, both of foreign firms and of domestic firms, has a positive impact on the growth of sales on local firms in Estonia, but does not control for the interaction of competition with FDI. On the other hand, local firms could be better equipped to benefit from positive demonstration effects. Barrios and Strobl (2002) found that less sectoral competition, captured by a higher Hirschman-Herfindahl index, increases the productivity gains from FDI for Spain, pointing towards a lower incentive to improve.

Weak institutions—including corruption, red tape, intellectual property rights, and contract enforcement—are linked to protection for local firms, network-driven business practices, and inefficient markets, which, possibly, constrains foreign investors from fully exploiting their competitive advantages. That drawback may influence the type of FDI and nonequity mode of investment that is initially attracted, as well as domestic firms' absorptive capacities. Empirical evidence is mixed. Firm-level data for 17 emerging countries, during 2002–05, reveal no evidence that the degree of corruption or red tape affects the extent of FDI spillovers (Gorodnichenko, Svejnar, and Terrell 2007). Evidence also shows that a country's transparency has a U-shaped effect on FDI spillovers: countries with a medium level of transparency benefit least from FDI, whereas countries with low and high levels show stronger FDI spillovers (Meyer and Sinani 2009).

Financial and Labor Markets

Financial markets in developing countries may also be a factor in absorption of GVC spillovers (Alfaro and others 2010). Multinationals can have an ambiguous impact on access to finance for local firms: they may ease such access by bringing in scarce capital to developing countries; but if multinationals borrow locally, they may increase local firms' financing constraints (Harrison, Love, and McMillan 2004). That, in turn, can influence local firms' absorptive capacity, and well-developed markets may facilitate domestic firms' absorptive capacity links (Aggarwal, Milner, and Riaño 2011).

Low wages may be a way for countries to enter GVCs. According to firm surveys, costs (production, labor, transport, investment) and tax incentives are major drivers of lead firms' decisions to invest or to source production in developing countries. Indeed, wage differentials have been primary drivers of the globalization of production. But costs encompass a wide range of drivers and the goal should be higher labor productivity and higher wages, allowing the country to remain cost competitive despite rising living standards (Taglioni and Winkler 2016).

Labor market regulations may influence the effect of GVC integration on domestic firms through various channels. Higher absolute and relative labor market flexibility than in the foreign investor's home

country seems to have a positive effect on the chances of securing initial foreign investment (Javorcik and Spatareanu 2005). Labor market regulations, and, in particular, wage constraints, can affect skills in a firm, hence their absorptive capacity (Hale and Long 2011). Overly rigid labor markets can reduce the likelihood of labor turnover and GVC spillovers. Conversely, overly flexible labor markets may generate frequent labor turnover, which reduces the time for domestic workers to acquire skills and knowledge from foreign firms.

2.5. The Mediating Role of Policies That Target the Quality and Conditions of Output and Input Factors

Education and Skills

Economic upgrading is often about "creating the knowledge behind the product," but a country might not be able to upgrade because of barriers in other stages of production, such as services, or skills shortages. For example, moving out of production into R&D, engineering, or marketing services requires flexibility in trading those services, including the temporary movement of service providers. It may also require establishing and enforcing intellectual property rights. Economic upgrading also requires new skills and knowledge, either by increasing the skill content of a country's activities (and thus workforce) or by developing competencies in niche market segments (Humphrey and Schmitz 2002).

Education and skills influence the share of human capital in firms and are particularly important for expanding GVC participation (Farole and Winkler 2014). Meyer and Sinani (2009) show evidence that the share of workers with tertiary education significantly affects FDI spillovers. This relationship takes a U-shaped form, that is, only below or above certain threshold levels of human capital does the extent of spillovers increase (Meyer and Sinani 2009). Tytell and Yudaeva (2007) found for Romania that productivity spillovers from FDI in manufacturing are significantly lower in regions with a low share of education.

Product Standards and Innovation

Signaling the quality of a product has become increasingly difficult for suppliers in developing countries (Mangelsdorf and others 2012). *Product standards* and certification schemes have proliferated as a means to verify quality, safety, and compatibility to buyers. However, product standards can have a dual impact on costs, and therefore trade. Complying with such standards may impose additional fixed (or even variable) costs on exporters, as they adapt production to meet one, or in some cases many, idiosyncratic market or buyer standards. Certification and auditing can generate additional costs (Portugal and others 2009). The possibility of increased costs for production and compliance has led to concerns in developing countries over technical barriers to trade, market access, and competitiveness (Henson and Jaffe 2008).

In addition, standards compliance of local suppliers could lead to lower technology spillovers through GVC participation, as their catch-up potential is smaller. This could happen in the form of reduced assistance from international buyers, reduced reliance on inputs sourced internationally with a high knowledge or technology content, or reduced competition, demonstration, training, and labor turnover effects. However, it is important to stress that the overall benefits for a country are not smaller per se, but can be attributed to both standards adoption and GVC integration.

Firms that adopt product standards can also benefit. Standards provide for technical compatibility and interoperability, allowing one country's inputs to be used in multiple markets, generating economies of scale and economies of learning in production (Tippman and Racine 2013). This should lead to growing demand via more or stronger links to international buyers and an increased location attractiveness for

foreign investors. By conveying best practices, product standards can improve the overall safety of products on the market and lead to technological upgrading and *innovation*.

In a study of the differentiated impact of standards harmonization in the electronics sector, for instance, Portugal and others (2009) found a positive and robust relationship between international harmonization and firms' trade performance. Meyer and Sinani (2009), for instance, showed evidence that innovation (an indirect measure of product standards), measured as the R&D intensity in the private sector and the number of patents per billion U.S. dollars granted to host country residents, significantly affects FDI spillovers. This relationship takes a U-shaped form, that is, only below or above certain threshold levels does the extent of spillovers increase. Yet, studies have revealed mixed results and endogeneity issues across and within sectors, providing ample evidence for a vibrant debate.

As production becomes increasingly fragmented globally, exporters face shorter time periods in which to exploit their comparative advantage. Whether through the adoption and certification of product standards or through knowledge and technology spillovers, early adopters are likely to benefit most (Rogers 1983; Francesconi and Ruben 2014). A study of the impact of U.K. supermarket standards on horticultural imports from Africa showed that success in the fresh vegetables GVC depended on meeting and exceeding regulatory requirements, and that even the most innovative of suppliers enjoyed only short-lived first-mover advantages (Dolan and Humphrey, 2000).

Labor Standards

Higher *labor standards* in a country influence GVC spillovers via forward links. On the one hand, domestic suppliers' compliance with labor standards could increase the demand for goods and services from foreign investors or international buyers whose reputation among their final clients depends on standards compliance of their suppliers; on the other hand, higher labor standards (such as minimum wages) could increase labor costs and thus the costs of inputs sold to international buyers, while not necessarily increasing the quality of those inputs, which could negatively affect a country's attractiveness. Oka (2012), for example, examined the link between labor standards and supplier competitiveness and found that better labor standard compliance increases the supplier's likelihood of retaining buyers that are reputation-conscious, but does not drive buyers' sourcing decisions. Other criteria such as price, quality, and delivery time matter more strongly.

In order to compensate for increased labor costs, local firms have two basic options: (1) they may try to save costs elsewhere, for example by sourcing inputs at lower costs internationally that they previously performed in-house. While this increases backward linkages, the type of inputs are not necessarily more technology- or knowledge-intensive, thus, positive GVC spillovers are lower. And (2) higher labor standards may force local firms to become more productive in order to compensate for the increased labor costs. Mayneris and others (2014), for instance, confirmed that minimum wages increase the productivity of high-performing firms (due to increased efforts) that may lead to the least-performing firms' exit, thus increasing overall productivity.

If certain labor standards are not the result of international conventions, the impact on GVC spillovers may be different. Researchers have for decades found that globalization is closely associated with a rise of female intensity in formal employment—especially in developing countries—mainly due to a high gender wage gap (Seguino 1997, 2000) and a more flexible female workforce that was easily employed as casual, contract or part-time labor with little or no benefits (Standing 1989). A study by Tejani and Milberg (2010), however, found a negative relationship between the growth of female intensity and that of value added per worker. The authors argue that women have, on average, attained a lower level of skills than men and thus lose out in terms of employment when economic upgrading occurs.

Social Standards

While product and labor standards have become codified, as governmental regulations in many markets and across most GVCs, suppliers had to adapt to the increasing importance of voluntary standards. In many instances, voluntary standards have become de facto mandatory obligations and a commercial imperative (Swann 2010). Their emergence reflects social concerns "unleashed by globalization" over inadequate government regulation of the social and environmental impacts of international trade (Mayer and Gereffi 2010). The governance of GVCs is increasingly determined by what the buyer requires, and not merely what a supplier can offer.

Higher *social standards* could increase the demand for goods and services from reputation-conscious foreign investors or international buyers, but also increase labor costs (for example, due to higher contributions to unemployment, pension, or health insurance), while not necessarily improving the quality of those inputs. This could have a positive or negative effect on a country's attractiveness. Higher labor costs, in turn, can trigger local firms to save costs, for example, via increased offshoring, or to raise their productivity levels. The extent of generated spillovers via GVC integration is therefore not clear.

However, a growing number of studies now show that profits, productivity, and firm survival are all positively associated with improvements in working conditions (World Bank Group 2015). Several papers have taken various approaches to try to identify the relationship between firm performance and working conditions. A discrete-time survival analysis model of 595 Cambodian garment factories by Jetha and Linsen (2015) found that increased compliance with social protection standards is associated with reduced odds of factory closure. A survey of management and laborers in the Lao People's Democratic Republic's garment sector finds that failure to increase worker well-being has led to dissatisfaction, high labor turnover, low productivity, and impaired firms' opportunities to strengthen participation in garment GVCs (World Bank 2012).

Environmental Standards

Finally, higher *environmental standards* may lead to growing demand for inputs from foreign investors or international buyers whose reputation among their final clients depends on standards compliance of their suppliers. But, while higher environmental standards compliance can raise unit costs forcing local firms to save costs elsewhere or, alternatively, to raise their productivity levels, it also improves the quality of products (for example, due to reduced pesticide usage or organic production). In this regard, the expected mediating effect of environmental standards on GVC spillovers is more similar to that of product standards.

To test this hypothesis, Prakash and Potoski (2006) employed a panel of 108 countries over seven years to investigate whether international trade encourages firms to adopt ISO 14001—the most widely adopted voluntary environmental standard. For importing countries whose own firms had high levels of adoption of ISO 14001, exporting firms from other markets showed a significantly increased rate of adoption of ISO 14001, even after controlling for firms' compliance and pollution histories, as well as addressing potential endogeneity issues. These findings point to the increasing importance of lead firms influencing organizational practices in GVCs.

Most studies in this area focused on environmental standards and their impacts in agribusiness GVCs. In 2009, the International Institute for Sustainable Development explored impacts of sustainability standards on the distribution of economic benefits along GVCs (Sexsmith and Potts 2009). The authors found standards compliance and certification often lead to producer-level price premiums for agricultural products, but less frequently for certified fisheries and forest markets. Much like product standards, the costs of certification and indirect compliance costs act as a barrier to small and resource-poor groups.

However, other producers benefit from increased market access and longer-term contracts. Certification can also lead to improved agroecological practices (Kleeman and Abdulai 2012) and increased revenues, though studies have shown wide variance, and an emphasis on measuring local context. In one randomized control trial of households producing certified organic coffee beans in Uganda, for instance, scheme participation is associated with an increase in net coffee revenue of around 75 percent on average, equivalent to 12.5 percent of mean (total) household revenue (Bolwig and Gibbon 2009).

3. Data and Empirical Specification

3.1. Empirical Specification

To capture the effect of GVC participation on the domestic economy and test if countries have been successful in economic upgrading, we estimate a standard fixed effects model for sector *s* of country *k* at time *t* of the following form:

$$\boldsymbol{dva_{s,c,t}} = \boldsymbol{\alpha} + \boldsymbol{\beta_1 x_{s,c,t}} + \boldsymbol{\beta' C_{s,c,t}} + \boldsymbol{\alpha_{s,c}} + \boldsymbol{\alpha_{s,t}} + \boldsymbol{\alpha_{c,t}} + \boldsymbol{\varepsilon_{s,c,t}}. \quad (1)$$

We use the level of domestic value added (*dva*) generated in sector *s* as our measure of economic upgrading. Since we are interested in the effects of GVC participation, we use two standard GVC indicators as proxies for $x_{s,c,t}$. The first indicator is the amount of foreign value added embodied in exports (*FVAX*), while the second indicator is the amount of domestic value added re-exported by third countries (*DVAR*). *FVAX* quantifies a country's backward links into GVCs (or GVC integration as a buyer), while *DVAR* quantifies a country's forward links into GVCs (or GVC integration as a seller). We use lagged values to minimize reverse causality concerns and allow for a delayed response of value added.

Our choice of domestic value added as measure of economic upgrading allows us to use the full sample of countries and industries covered by our databases and thus make it an optimal indicator to assess the effect of GVC related policies in developing economies. In addition, domestic value added combines the gains for firms (gross profits) and workers alike (total compensation). Finally, it combines factor productivity improvements and factor employment changes into one variable.

Alternative measures that might capture other relevant aspects of economic upgrading, such as labor productivity and TFP, focus on specific subtypes of upgrading, such as skills or process upgrading (see section 1). Moreover, they would require us to limit the sample size considerably since they are only available for high-income countries or at a much higher sectoral aggregation. Domestic value added, by contrast, reflects economic upgrading via better skills, capital, and processes, and therefore represents a comprehensive upgrading metric.

However, we have to add, there is a structural relationship between *dva* and our forward links GVC measure that might bias the results. By using the lagged relationship this bias should be reduced, though, and, most importantly, it should not affect the qualitative results obtained with the policy interaction terms as shown below in equation (2).

Our set of controls (*C*) includes the amount of foreign value added for domestic processing (*FVADP*).[4] Here, we are guided by a standard production function of the form:

$$\boldsymbol{dva_{s,c,t}} = \boldsymbol{A} * \boldsymbol{L^{\beta_2}} * \boldsymbol{K^{\beta_3}}$$

[4] Capital stock and employment data are available for the WIOD sample, which we use for robustness exercises to improve the reliability of the results. The regressions based on the OECD sample rely on the three two-dimensional fixed effects.

Combining labor with capital stock, which is dependent on a country's technology shifters (A), generates domestic value added. The technology shifter is assumed to be a function of international trade and innovation, which is consistent with the trade literature.

FVADP is a measure of final goods trade to separate a potential positive GVC effect from a simple positive effect of trade openness. For this, we calculate the amount of foreign value added processed or consumed domestically. This covers both imports of final goods and intermediate goods assembled and consumed domestically. As especially the latter part might overlap with GVC trade, we might have a downward bias in our estimates. However, not controlling for openness would prevent us from separating the effects of GVC trade and final goods trade.

Finally, we employ a set of sector-country ($\alpha_{s,c}$), country-year ($\alpha_{c,t}$), and sector-year ($\alpha_{s,t}$) fixed effects to account for potentially correlated omitted variables and take the natural logarithm of all level variables. Note that while our technology shifter does not explicitly take into account innovation (for example, R&D intensity, though, unavailable at the sectoral level for our country sample), we can assume that including three two-dimensional fixed effects picks up most of the differences in innovation.

As we are primarily interested in the contribution of country-specific policy variables to economic upgrading through GVCs, we include an interaction term between a set of national characteristics and our GVC indicators to equation (1):

$$\boldsymbol{dva_{s,c,t}} = \boldsymbol{\alpha} + \boldsymbol{\beta_1 x_{s,c,t}} + \boldsymbol{\beta_2 z_k} + \boldsymbol{\beta_3 x_{s,c,t} * z_c} + \boldsymbol{\beta' C_{s,c,t}} + \boldsymbol{\alpha_{s,c}} + \boldsymbol{\alpha_{s,t}} + \boldsymbol{\alpha_{c,t}} + \boldsymbol{\varepsilon_{s,c,t}}. \quad (2)$$

As measures for the national characteristics, z_c, we employ variables capturing a country's infrastructure, connectivity, investment and trade policy, business climate and institutions, financial and labor markets, skills and education, innovation and product standards, as well as labor, social, and environmental standards. Due to sometimes incomplete data and to minimize reverse causality, we use the average over the sample period.

We repeat this exercise by splitting the sample into three categories based on the World Bank's income classification. The categories are low- and lower-middle-, upper-middle-, and high-income countries. As robustness, we also split the countries into three evenly sized groups based on GDP per capita to avoid sample size issues. For a country application of the empirical model, see appendix 1.

It is important to emphasize that our empirical setting does not generate causal estimates on the role of domestic policies for economic upgrading through GVC integration, but rather provides evidence to guide future more directed work. A main advantage of this study is its comprehensive nature covering an extensive part of policy space to detect which policies should be analyzed more closely and which policies might be of second order. However, we do not claim to expose a causal relationship.

3.2. Data

GVC Indicators

To calculate our GVC indicators we rely on the OECD ICIO database, which covers 61 countries, 34 industries, and the years 1995, 2000, 2005, and 2008–11. The advantage of the database compared to other ICIOs is the extended country coverage, especially regarding low- and middle-income countries. This is especially important since it allows us to test implicitly if the role of certain policies depends on a country's stage of development. Since the average per capita income level in the OECD ICIO database is significantly below the level of, for instance, the World Input Output Database (WIOD)—a new ICIO database—differences in significance of certain variables can inform us if a policy is more relevant for either developing or industrialized countries. As robustness, we will use WIOD since it also records

employment and capital stock data. They can serve as additional controls to gauge the true effect of GVC integration.

For the estimation, we merge the industry coverage of the OECD ICIO database with the WIOD database to allow for comparability and robustness checks, which leaves us with 29 industries. In addition, we exclude nontradable industries, so that the sample consists of 20 industries, of which 2 are primary industries, 13 manufacturing industries, and 5 service industries. For a description on how the variables are constructed, see appendix 5.

Policy Variables

To get a comprehensive picture of the role that policy plays in economic upgrading through GVC participation, we analyze seven different categories. These areas can be divided into policies targeting investment and trade flows (categories 1 to 3), the business climate including financial and labor markets (categories 4 to 6), and the quality of input factors (category 7).

Infrastructure has four main dimensions: roads, ports, rail lines, and airports. We proxy for the two latter using the World Development Indicators' (WDI) *rail* line coverage (kilometers of rail lines per person)[5] and *airfreight* volume (value of air cargo as percentage of GDP); the former two are measures from the World Economic Forum's (WEF) assessment of *road* and *port* infrastructure for the Global Competitiveness Report. The report is based on business executives' perceptions of their country's port or road facilities. Data are from the WEF's Executive Opinion Survey and only available from 2006 on, but no indicators with larger country and time coverage are available. WEF scores range from 1 to 7, with 7 being the optimal value. Finally, for a subset of OECD countries in the WIOD sample, we look at investment in infrastructure (*infrainvest*) as percentage of GDP available from OECD Stat.

Connectivity looks at procedures and controls governing the movement of goods and services across and within national borders, as well as a country's ICT infrastructure. It is accounted for by three categories of the World Bank's Logistics Performance Index (LPI) (*LPI overall*, *LPI customs*, *and LPI logistics*), which ranges from 1 to 5 = best. In addition, we include *Internet* users per 100 inhabitants and the expected time for exporting (*time to export*) and importing (*time to import*) in days by the WDI as measures of connectivity. The latter two are only available from 2003.

Investment policy is measured on the investment side by an index of investment freedom by the Heritage foundation and by FDI inflows as percentage of GDP (*FDI inflows*) from the WDI. The variable *investment freedom* serves as a proxy for investment promotion. The Heritage score ranges from 0 to 100 = highest freedom, and investment freedom measures the ability of individuals and firms to move their resources in and out of specific activities both internally and across the country's borders. This variable is mainly based on official government publications of each country on capital flows and foreign investment. *Trade policy* is proxied by a country's share of exports of goods and services as percentage of GDP (*openness*) from the WDI. We also include two measures regarding services trade, namely, its share as percentage of GDP (*services trade*) from the WDI, and the Services Trade Restrictiveness Index (*STRI OECD*) from the OECD.[6] The STRI takes the value from 0 = completely open to 1 = completely closed.

Business climate and institutions are assessed using six indicators. *Property rights* (The Heritage Foundation) covers the functioning of courts. It measures the degree to which a country's laws protect private property rights and the degree to which its government enforces those laws. It also assesses the likelihood that private property will be expropriated and analyzes the independence of the judiciary, the

[5] Rail line coverage and the education variable listed below by Barro and Lee (2010) are interpolated to achieve full coverage.
[6] For the OECD sample, we use the World Bank's STRI since it has a larger country coverage.

existence of corruption within the judiciary, and the ability of individuals and businesses to enforce contracts. *Political stability* (World Governance Indicators), which ranges from -2.5 to 2.5 = best, and *corruption* (Heritage data based on Transparency International's Corruption Perceptions Index) take governance into account, while the *doing business* frontier gap (WDI, from 2004 on) and *domestic competition* and *foreign competition* estimates (WEF, from 2006 on) refer to the business climate. The former is based on the regulatory environment for the starting and operation of a local firm and takes values from 0 to 100 = best. The latter are composite indices concerned with market concentration, anti-monopolistic policies, investment incentives, and tax policy (domestic) as well as tariffs, nontariff measures, and investment promotion (foreign).[7]

Financial and labor market policy is captured on the financial side by the value of credit given to the private sector as percentage of GDP (*private credit*) from the WDI. This quantitative variable is complemented by an estimate of *financial freedom* (Heritage), which measures banking efficiency as well as independence from government control and interference in the financial sector. It relies on various underlying data sources, including from the International Monetary Fund, OECD, and official government publications of each country, among others. *Labor market policy* is examined using Heritage's *labor freedom* index that captures labor market institutions. It includes various aspects of the legal and regulatory framework of a country's labor market, such as minimum wages; laws inhibiting layoffs; severance requirements; and measurable regulatory burdens on hiring, hours, and so forth. The measure is mainly based on data from the World Bank's Doing Business study. We also use an index of unit labor costs (ULC) by the OECD that proxies for a country's cost competitiveness (base year = 2005). It measures the average cost of labor per unit of output and is calculated as the ratio of total labor costs to real output.

Education and skills are represented on the education side by the expected years of *schooling* (Barro and Lee 2013), which gives a quantitative measure of the education system. As qualitative measure, we use an index of *educational quality* provided by the WEF on the basis of their Executive Opinion Survey. Regarding skills, we look at the share of workers with a secondary degree, or higher, in the total workforce (WDI) and the WEF's index for on-the-job *training*, which is equally a qualitative survey-based indicator.

Innovation and product standards are represented on the quality side by the stock of ISO certifications related to quality management (ISO 9001, 13485, 16949, and 22000) per capita. Innovation is measured by *R&D* intensity (WDI), and the WEF's survey-based *Innovation* and *Technology adoption* indices—the former looks at private and public innovation capacities and spending while the latter measures country- and firm-level availability of new technologies.

Labor standards cover basic rights including the WDI's share of children between 7 to 14 years old in employment, *child labor*, share of *vulnerable employment*, and the share of female workers in the total workforce, *female intensity*. In addition, we cover the number of ILO's *basic conventions* (that is, fundamental and governance conventions) signed, complemented with different measures of wage inequality. We use the ILO's *wage dispersion* between the 9th and 5th wage decile, and the OECD's *minimum wage* relative to the median wage.

Social standards deal with a country's basic welfare system. We use ILO data on the share of *health* expenditure in total government spending, the share of workers contributing to a *pension* scheme, and the share of unemployed receiving regular *unemployment* benefits. Additionally, we assess the role of *total conventions* of the ILO signed.

[7] WEF's foreign competition measure could equally be grouped under trade and investment policy.

Environmental standards are our final category. Here we look at the stock of *ISO 14000* certifications per capita and the number of *UNEP* conventions signed, complemented with the Food and Agriculture Organization's data on *pesticide* use per 1000, WDI data on the share of *renewables* in electricity production and *water* withdrawals relative to internal resources, and WHO data on *air pollution* measured as particulate matter with diameter of 2.5 µm or less in urban areas.

4. Results

4.1. Overall Results

Focusing first on GVC integration, table 1 shows the results for the full sample of 61 OECD countries covering the years 1995, 2000, 2005, and 2008–11 (columns 1 and 2) and those for the full sample of 40 WIOD countries covering the period 1995–2011 (columns 3 and 4).[8] The production factors labor and capital significantly increase domestic value added. The same applies to both our trade-related variables foreign value added for domestic processing (*FVADP*) and—most importantly—our two GVC measures of backward (*FVAX*) and forward links (*DVAR*). In other words, GVC integration helps increase a country's domestic value added and thus fosters economic upgrading

Table 1. Overall impact of GVC participation on economic upgrading

	(1)	(2)	(3)	(4)
VARIABLES	*DVA*	*DVA*	*DVA*	*DVA*
	OECD		**WIOD**	
FVAX	0.0685***		0.0428***	
	(0.0091)		(0.0129)	
FVADP	0.252***	0.232***	0.124***	0.142***
	(0.0268)	(0.0257)	(0.0170)	(0.0207)
DVAR		0.217***		0.157***
		(0.0160)		(0.0377)
Employment	-	-	0.322***	0.273***
	-	-	(0.0598)	(0.0497)
Capital Stock	-	-	0.295***	0.257***
	-	-	(0.0454)	(0.0464)
Constant	5.869***	5.179***	2.663***	2.564
	(0.180)	(0.183)	(0.451)	(0.417)
Observations	7,276	7,284	10,455	10,514
R-squared	0.852	0.870	0.885	0.894

Sources: OECD ICIO database and WIOD. *** p<0.01, ** p<0.05, * p<0.1.
Notes: Robust standard errors in parentheses. *FVAX* and *DVAR* lagged. All level variables in natural logarithms. WIOD sample values in constant terms.

Focusing on the OECD sample, a 10 percent increase of GVC integration as a buyer increases domestic value added by 0.7 percent (column 1). Using the WIOD sample, we similarly observe that a 10 percent increase of GVC integration as a buyer leads to domestic value added gains of 0.4 percent (column 3). This is in line with our results in the next sections where robustness exercises using WIOD largely confirm the estimates obtained with OECD data.

GVC integration as a seller also substantially increases domestic value added (columns 2 and 4). Note that the elasticity is higher than those of all other control variables, while it was smaller when using the

[8] For the country and industry coverage of the data set, see appendixes 2 to 4.

amount of foreign value added in exports, indicating that being a seller in GVCs contributes more strongly to economic upgrading than being a buyer only.

If we split the sample into the three income groups, low- and lower middle-income, upper middle-income, and high-income, we find that our overall results are not dependent on the income level.[9] The only difference we observe is that the coefficient for GVC integration as a buyer is not significant for upper middle-income countries. However, when we split the sample into three evenly sized groups based on GDP per capita, the coefficient is significant again pointing to a sample size issue rather than the absence of an effect.

4.2. Policies That Target Investment and Trade Flows

Infrastructure

The following section focuses on policies that target investment and trade flows, in particular, their timeliness (infrastructure and connectivity), quantity, and quality (investment and trade policy). Table 2 shows the estimates of our interaction terms between the GVC participation measures and the infrastructure variables.

We find that a better airfreight infrastructure positively mediates the benefits of GVC integration as a buyer for value added (column 1). This might reflect the composition of the OECD ICIO country sample that contains many countries located far from the three major GVC hubs: Germany, Japan, and the U.S. These countries are likely to depend more strongly on air transport.

A better road network seems to equally mediate the impact of GVC integration as a buyer on domestic value added (table 2, column 4). This suggests that GVCs also require good connections to regional suppliers that enable them to link effectively into GVCs.

It is interesting to note that concerning forward GVC links, we find that the two infrastructure components that played no role for the value added gains from backward links now become significant. That is, both the port and rail networks (table 2, columns 2 and 3) increase economic upgrading through GVC integration as a seller.

For the results by income groups, we find that the estimates of GVC integration as a buyer are mainly driven by low- and high-income countries, while the results of GVC integration as a seller are mainly driven by upper middle- and high-income countries. The relatively larger significance of the results for high-income countries could be partially explained by the fact that the sample is twice as big as the low- and middle-income samples combined.

To summarize, we find that the role of infrastructure for a country's upgrading experience through GVC participation depends on the location of its partners and the type of GVC integration. For instance, if a country is highly integrated as a seller or a buyer in close geographical proximity to its partner countries, it benefits from a strong rail and road network. GVC relationships with more remote countries, on the other hand, require a sufficient port and airfreight infrastructure. To draw country-specific conclusions, one needs to determine the country's main GVC partners and their geographical distance, and also differentiate between the two types of GVC integration (that is, as a buyer or as a seller).

[9] Due to space constraints, we do not include the results by income group in the paper but they are available from the authors upon request.

Table 2. The role of infrastructure in economic upgrading through GVCs

VARIABLES	(1) *DVA*	(2) *DVA*	(3) *DVA*	(4) *DVA*
Backward links				
FVAX	0.0622***	0.0456***	0.0140	0.0250
	(0.00975)	(0.0142)	(0.0398)	(0.0294)
FVADP	0.253***	0.289***	0.252***	0.252***
	(0.0269)	(0.0283)	(0.0267)	(0.0267)
*FVAX*Air freight*	1.1e+06***			
	(335,790)			
*FVAX*Rail*		2.8e-05		
		(3.11e-05)		
*FVAX*Port*			0.0119	
			(0.00826)	
*FVAX*Road*				0.0101*
				(0.0061)
Constant	5.846***	5.881***	5.935***	6.006***
	(0.183)	(0.215)	(0.182)	(0.190)
Observations	7,156	6,346	7,276	7,276
R-squared	0.855	0.877	0.852	0.852
Forward links				
DVAR	0.220***	0.190***	0.119**	0.191***
	(0.0173)	(0.0203)	(0.0503)	(0.0465)
FVADP	0.233***	0.264***	0.231***	0.232***
	(0.0259)	(0.0274)	(0.0257)	(0.0257)
DVAR*Air freight	138,451			
	(498,564)			
DVAR*Rail		0.0001**		
		(4.7e-05)		
DVAR*Port			0.0222**	
			(0.0097)	
DVAR*Road				0.0062
				(0.0091)
Constant	5.065***	5.053***	5.186***	5.152***
	(0.171)	(0.217)	(0.189)	(0.184)
Observations	7,164	6,347	7,284	7,284
R-squared	0.872	0.896	0.870	0.870

Source: OECD ICIO database. *** p<0.01, ** p<0.05, * p<0.1.
Notes: Robust standard errors in parentheses. *FVAX* and *DVAR* lagged. All level variables in natural logarithms.

Connectivity

Table 3 focuses on the role of connectivity. Remarkably, all six variables are significant with the expected positive sign when we looked at GVC integration as a seller. Better internet coverage and a higher LPI with regard to customs procedures, logistics, and overall values as well as shorter export and import times have the capacity to magnify economic upgrading through forward GVC links.

Regarding GVC integration as a buyer, however, we observe that only higher LPI customs values show a positive sign (table 3, column 3). This speaks in favor of connectivity being an important factor for competitiveness of the export sector. Timely, reliable, and efficient customs and other administration procedures benefit, in particular, domestic value added. Thus, this result highlights a further positive impact of trade facilitation agreements.

Table 3. The role of connectivity in economic upgrading through GVCs

VARIABLES	(1) *DVA*	(2) *DVA*	(3) *DVA*	(4) *DVA*	(5) *DVA*	(6) *DVA*
Backward links						
FVAX	0.0453**	0.0189	-0.0260	-0.0167	0.0903***	0.0930***
	(0.0182)	(0.0546)	(0.0491)	(0.0599)	(0.0233)	(0.0210)
FVADP	0.253***	0.273***	0.273***	0.273***	0.252***	0.252***
	(0.0269)	(0.0238)	(0.0238)	(0.0238)	(0.0270)	(0.0271)
*FVAX*Internet*	0.0008					
	(0.0005)					
*FVAX*LPI logistics*		0.0141				
		(0.0166)				
*FVAX*LPI customs*			0.0302*			
			(0.0158)			
*FVAX*LPI overall*				0.0251		
				(0.0180)		
*FVAX*Time to export*					-0.0013	
					(0.0014)	
*FVAX*Time to import*						-0.0014
						(0.0012)
Constant	5.735***	5.735***	5.863***	5.745***	5.440***	6.150***
	(0.175)	(0.168)	(0.167)	(0.167)	(0.160)	(0.190)
Observations	7,156	7,057	7,057	7,057	7,156	7,156
R-squared	0.854	0.859	0.860	0.860	0.854	0.854
Forward links						
DVAR	0.190***	0.0666	0.0638	0.0291	0.303***	0.273***
	(0.0248)	(0.0694)	(0.0638)	(0.0770)	(0.0301)	(0.0259)
FVADP	0.232***	0.251***	0.250***	0.250***	0.232***	0.231***
	(0.0259)	(0.0227)	(0.0227)	(0.0227)	(0.0258)	(0.0260)
*DVAR*Internet*	0.0010*					
	(0.0006)					
*DVAR*LPI logistics*		0.0513**				
		(0.0211)				
*DVAR*LPI customs*			0.0550***			
			(0.0204)			
*DVAR*LPI overall*				0.0621***		
				(0.0232)		
*DVAR*Time to export*					-0.0053***	
					(0.0019)	
*DVAR*Time to import*						-0.0033**
						(0.0014)
Constant	4.844***	4.671***	4.742***	4.965***	5.059***	5.029***
	(0.165)	(0.166)	(0.157)	(0.159)	(0.174)	(0.181)
Observations	7,164	7,060	7,060	7,060	7,164	7,164
R-squared	0.872	0.879	0.879	0.879	0.872	0.872

Source: OECD ICIO database. *** p<0.01, ** p<0.05, * p<0.1.
Notes: Robust standard errors in parentheses. *FVAX* and *DVAR* lagged. All level variables in natural logarithms.

Looking at the income group specific results, we observe again that upper middle and high-income countries drive these forward links results, but, overall, the results suggest that connectivity is particularly important for economies that have strong forward links. If these countries want to benefit from GVC participation, connectivity is an important policy field and must be included in GVC strategies.

Investment and Trade Policy

We now move from policies that are mainly focused on improving the timeliness of trade flows within GVCs (via better infrastructure and connectivity) to policies that target the quantity and quality of trade and investment flows in a country (via openness and promotion of trade and investment flows).

Looking at the impact of backward GVC links on economic upgrading (table 4), we find that trade and investment policies play an important mediating role. On the investment side, we find that both our qualitative measure of investment freedom (column 1) and our outcome-based measure of FDI inflows (column 3) positively moderate the effect of GVC integration on domestic value added. This supports the findings from the literature review that productivity spillovers from FDI are higher when foreign firms have been targeted by investment promotion efforts (Du, Harrison, and Jefferson 2011; Harding and Javorcik 2012).

Table 4. The role of trade and investment policies in economic upgrading through GVCs

VARIABLES	(1) *DVA*	(2) *DVA*	(3) *DVA*	(4) *DVA*	(5) *DVA*
Backward links					
FVAX	-0.0124	0.0735***	0.0537***	0.0520***	0.0249*
	(0.0347)	(0.0263)	(0.0101)	(0.0110)	(0.0142)
FVADP	0.271***	0.301***	0.252***	0.252***	0.251***
	(0.0239)	(0.0333)	(0.0270)	(0.0270)	(0.0270)
*FVAX*Investment freedom*	0.0012**				
	(0.0006)				
*FVAX*STRI WB*		-0.0005			
		(0.0008)			
*FVAX*FDI inflows*			0.0026***		
			(0.0007)		
*FVAX*Services trade*				0.0006***	
				(0.0002)	
*FVAX*Openness*					0.0004***
					(0.0001)
Constant	5.743***	5.742***	5.806***	5.904***	5.949***
	(0.165)	(0.240)	(0.190)	(0.185)	(0.192)
Observations	7,177	5,390	7,156	7,156	7,156
R-squared	0.858	0.874	0.855	0.855	0.855
Forward links					
DVAR	0.0943**	0.276***	0.212***	0.209***	0.186***
	(0.0468)	(0.0375)	(0.0180)	(0.0198)	(0.0212)
FVADP	0.249***	0.279***	0.233***	0.232***	0.231***
	(0.0227)	(0.0329)	(0.0259)	(0.0259)	(0.0259)
*DVAR*Investment freedom*	0.0020***				
	(0.0007)				
*DVAR*STRI WB*		-0.0022**			
		(0.0010)			
*DVAR*FDI inflows*			0.0013		
			(0.0010)		
*DVAR*Services trade*				0.0004	
				(0.0004)	
*DVAR*Openness*					0.0003***
					(0.0001)
Constant	4.905***	5.068***	5.008***	5.206***	5.085***
	(0.162)	(0.264)	(0.184)	(0.190)	(0.180)
Observations	7,180	5,391	7,164	7,164	7,164
R-squared	0.876	0.891	0.872	0.872	0.872

Source: OECD ICIO database. *** p<0.01, ** p<0.05, * p<0.1.
Notes: Robust standard errors in parentheses. *FVAX* and *DVAR* lagged. All level variables in natural logarithms.

Similarly, we find that a more open and competitive services sector, as measured by the extent of services trade (column 4), supports economic upgrading. This reveals that access to services inputs is important for the welfare gains from GVC integration as a buyer. In addition, the interaction term with overall trade openness shows a positive and significant coefficient (column 5), supporting the finding that more open economies experience larger value added gains from GVC integration as a buyer. This is in line with studies showing that trade openness is beneficial for FDI spillovers (Havranek and Irsova 2011, Du, Harrison, and Jefferson 2011, Farole and Winkler 2014).

Turning to forward links, we observe a similarly mediating impact of investment and trade policies. We find significant coefficients for investment freedom, STRI, and trade openness (table 4, columns 1, 2, and 5). This indicates that many of our investment and trade policy measures play a large role for both accessing foreign inputs (via backward links) and for selling abroad (via forward links).

As for policies analyzed so far, the results are primarily due to high-income countries, which represent the majority of the sample. Altogether, we find that trade and investment policy is central for GVC integration to generate value added increases, especially when targeting the openness and promotion of trade and investment flows. This policy area should be a key component of every country's GVC-integration analysis. The finding emphasizes that standard trade and investment policies remain highly relevant even in a GVC world.

Table 5 gives the estimates regarding the mediating role of the business climate and institutions. We observe that all measures are positive and significant for both types of GVC integration with the exception of political stability, which becomes insignificant for forward links (column 2). Given the relatively high weight of developing economies in this sample, we argue that these countries could considerably increase their value-added gains from GVC integration if they manage to improve their legal system (concerning contract enforcement and property rights), their governance (as represented by political stability and absence of corruption), as well as their business climate (measured by the doing business and the competition indicators). These findings support studies that find that better institutions (Javorcik 2004b, Gorodnichenko, Svejnar, and Terrell 2007) and more competition (Sinani and Meyer 2004)—are beneficial for productivity spillovers from FDI.

Interestingly, we also find that in the case of institutions, the effects are present more evenly across the three income categories. In particular, they seem to play a larger role of mediating the positive GVC effects in upper middle-income countries. This policy area should therefore receive particular attention when discussing the impact of GVC integration for development.

We conclude that business climate and quality of institutions can multiply the positive relationship between GVC integration and value added. It is therefore imperative for countries, with currently weak institutions and a less attractive business climate, to improve their conditions in order to reap the benefits from GVC participation. Here, we also see a crucial difference between the role of policy for trade in final goods and trade in value chains. The latter requires a stronger focus on previously considered policies only relevant for domestic transactions. So, despite the fact that our findings have shown that border policies—such as trade and investment facilitation—remain important, it is equally central to stress that the relevance of beyond-the-border measures has increased considerably through the rise of GVCs.

Table 5. The role of business climate and institutions for economic upgrading

VARIABLES	(1) *DVA*	(2) *DVA*	(3) *DVA*	(4) *DVA*	(5) *DVA*	(6) *DVA*
Backward links						
FVAX	0.0245	0.0623***	0.0183	-0.0330	-0.0798	-0.0854
	(0.0244)	(0.0097)	(0.0217)	(0.0551)	(0.0668)	(0.0604)
FVADP	0.271***	0.251***	0.271***	0.253***	0.252***	0.250***
	(0.0238)	(0.0268)	(0.0237)	(0.0268)	(0.0267)	(0.0269)
*FVAX*Property rights*	0.0006*					
	(0.0004)					
*FVAX*Political stability*		0.0178*				
		(0.0095)				
*FVAX*Corruption*			0.0009**			
			(0.0004)			
*FVAX*Doing business*				0.0015*		
				(0.0008)		
*FVAX*Dom. competition*					0.0330**	
					(0.0147)	
*FVAX*For. competition*						0.0327**
						(0.0127)
Constant	5.741***	5.589***	5.820***	5.780***	5.959***	5.558***
	(0.168)	(0.166)	(0.168)	(0.185)	(0.188)	(0.171)
Observations	7,177	7,276	7,177	7,156	7,276	7,276
R-squared	0.857	0.852	0.858	0.854	0.852	0.853
Forward links						
DVAR	0.154***	0.211***	0.176***	-0.0287	-0.132	-0.0733
	(0.0338)	(0.0157)	(0.0306)	(0.0664)	(0.0904)	(0.0754)
FVADP	0.249***	0.232***	0.249***	0.232***	0.232***	0.231***
	(0.0226)	(0.0258)	(0.0225)	(0.0258)	(0.0255)	(0.0257)
*DVAR*Property rights*	0.0011**					
	(0.0005)					
*DVAR*Political stability*		0.0154				
		(0.0137)				
*DVAR*Corruption*			0.0009**			
			(0.0004)			
*DVAR*Doing business*				0.0037***		
				(0.0009)		
*DVAR*Dom. competition*					0.0776***	
					(0.0195)	
*DVAR*For. competition*						0.0603***
						(0.0158)
Constant	4.958***	5.077***	4.701***	5.026***	4.962***	5.187***
	(0.159)	(0.185)	(0.152)	(0.175)	(0.181)	(0.184)
Observations	7,180	7,284	7,180	7,164	7,284	7,284
R-squared	0.876	0.870	0.876	0.873	0.871	0.871

Source: OECD ICIO database. *** p<0.01, ** p<0.05, * p<0.1.
Notes: Robust standard errors in parentheses. *FVAX* and *DVAR* lagged. All level variables in natural logarithms.

Table 6 shows that financial markets mediate economic upgrading through GVC integration as a seller in the same way. Once again, both measures are positive and significant (columns 1 and 2), which indicates that this policy area is relevant and independent of the type of GVC integration that a country pursues.

Looking at the results for the role of labor market policy, a very similar picture emerges. The estimates consistently show that, for GVC integration as a buyer, higher unit labor costs can limit economic upgrading through GVCs (table 6, column 3), supporting studies that point to wage differentials as primary drivers of the globalization of production. Labor freedom is equally positive and significant (table 6,

column 4), which indicates that a less regulated labor market can increase the effects on domestic value added. This is broadly in line with the channels discussed in section 2.1. The positive effects from flexible labor markets arise from increased labor market turnover, which facilitates spillovers from knowledge embodied in foreign value added, supporting the general findings by Javorcik and Spatareanu (2005) and Hale and Long (2011).

Table 6. The role of financial and labor market policies for economic upgrading through GVCs

VARIABLES	(1) *DVA*	(2) *DVA*	(3) *DVA*	(4) *DVA*
Backward links				
FVAX	-0.0033	0.0470***	0.128***	-0.0016
	(0.0366)	(0.0161)	(0.0470)	(0.0387)
FVADP	0.271***	0.252***	0.220***	0.271***
	(0.0240)	(0.0270)	0.128***	-0.0016
*FVAX*Financial freedom*	0.0011*			
	(0.0006)			
*FVAX*Private Credit*		0.0003*		
		(0.0002)		
*FVAX*ULC*			-0.0008**	
			(0.0003)	
*FVAX*Labor freedom*				0.0010*
				(0.0006)
Constant	5.748***	5.624***	5.840***	5.711***
	(0.164)	(0.169)	(0.379)	(0.161)
Observations	7,177	7,156	3,093	7,177
R-squared	0.858	0.854	0.650	0.858
Forward links				
DVAR	0.0832	0.189***	0.275***	0.0962**
	(0.0526)	(0.0265)	(0.0638)	(0.0464)
FVADP	0.249***	0.232***	0.210***	0.249***
	(0.0229)	(0.0259)	(0.0292)	(0.0225)
*DVAR*Financial freedom*	0.0023**			
	(0.0009)			
*DVAR*Private Credit*		0.0004*		
		(0.0002)		
*DVAR*ULC*			-0.0008**	
			(0.0004)	
*DVAR*Labor freedom*				0.0020***
				(0.0007)
Constant	4.874***	4.986***	5.230***	5.087***
	(0.155)	(0.173)	(0.428)	(0.166)
Observations	7,180	7,164	3,093	7,180
R-squared	0.877	0.872	0.678	0.876

Source: OECD ICIO database. *** p<0.01, ** p<0.05, * p<0.1.
Notes: Robust standard errors in parentheses. *FVAX* and *DVAR* lagged. All level variables in natural logarithms.

Regarding forward links, we find positive and significant mediating effects of lower unit labor cost, and more flexible labor markets from GVC integration as a seller in the OECD sample (table 6, columns 3 and 4). A potential explanation is that lower labor unit costs increase the competitiveness of sellers in GVCs, while higher labor market flexibility allows sellers to react faster to the changing demands of their customers in the value chain.

Income group specific results, again, suggest that financial and labor market policies work as facilitators mainly in high-income countries, but, in summary, the results suggest that financial and labor market

policies are also important factors to consider for countries trying to generate economic upgrading through GVC participation. In line with our results on business climate and institutions, such beyond-the-border policies are a vital part of successful GVC-integration strategy.

4.3. Policies That Target the Quality and Condition of Input and Output Factors

Education and Skills

Finally, we focus on policies that affect the quality and condition of input and output factors and directly focusing on economic upgrading. We start by examining the role of education and skills—a policy area that is important for absorptive capacity and competitiveness in international markets. For instance, to benefit from technology embodied in foreign value added that enters a country through backward links, the domestic workforce needs to be sufficiently trained and educated. Similarly, a skilled and educated workforce can produce more efficiently and thus makes a country more competitive for GVC integration as a seller.

Table 7 shows that competitiveness channels seem to be more relevant for economic upgrading through GVCs. Looking at backward links, we find that only educational quality seem to have a mediating impact (column 3), while the remaining variables are positive but not statistically significant.

The picture for GVC integration, as a seller, is quite different. Here, all variables show a facilitating effect on domestic value added. This supportive role of education confirms the findings by various studies on FDI spillovers (Tytell and Yudaeva 2007, Meyer and Sinani 2009, Farole and Winkler 2014), though the results are significant, as usual, primarily for high-income countries.

Nevertheless, we can conclude that this policy area is a relevant mediator for economic upgrading. Even if the gains from improvements in this field might mainly accrue through one type of GVC integration, countries need to take education and skills into consideration when reviewing their GVC strategies.

Product Standards and Innovation

Looking at quality and innovation, we observe a very similar pattern to education and skills. The results in table 8 show that this policy area is particularly relevant for economic upgrading through GVC integration as a seller. All four proxies are positive and significant, emphasizing the impact on competitiveness, and supporting the findings of Portugal and others (2009) and Meyer and Sinani (2009). An additional channel to explain the special relevance of forward links that arises with respect to our measure of quality certifications could be signaling. Foreign customers may rely on internationally normed standards to assess a product's quality. This removes uncertainty and makes products more attractive internationally, which reflects in the strong and consistent results for forward links.

Technology adoption and a country's overall innovative environment are also positively associated with economic upgrading through backward links (table 8, columns 3 and 4). This emphasizes that the importance of absorptive capacity for GVC-related spillovers should never be underestimated. Only if countries are able to adequately use and exploit technology embedded in foreign value added, they may fully reap the gains from GVC integration.

Interestingly, here we observe that the upper middle-income category causes the mediating effect for GVC integration as a buyer. This means innovation as a second major area—apart from the business climate and institutions—matters for developing economies, even if it mainly applies to wealthier developing economies.

Table 7. The role of education and skills for economic upgrading through GVCs

VARIABLES	(1) *DVA*	(2) *DVA*	(3) *DVA*	(4) *DVA*
Backward links				
FVAX	0.0411	0.0235	-0.0313	-0.0118
	(0.0346)	(0.0298)	(0.0506)	(0.0542)
FVADP	0.252***	0.273***	0.2510***	0.2523***
	(0.0268)	(0.0265)	(0.0267)	(0.0268)
*FVAX*Schooling*	0.0033			
	(0.0039)			
*FVAX*Secondary degree*		0.0006		
		(0.0004)		
*FVAX*Educ. Quality*			0.0223**	
			(0.0110)	
*FVAX*Training*				0.0185
				(0.0121)
Constant	6.135***	5.603***	5.9181***	5.8125***
	(0.189)	(0.182)	(0.1819)	(0.1847)
Observations	7,276	6,819	7,276	7,276
R-squared	0.852	0.850	0.853	0.852
Forward links				
DVAR	0.0888**	0.106***	0.0436	0.0777
	(0.0437)	(0.0387)	(0.0630)	(0.0804)
FVADP	0.232***	0.247***	0.2313***	0.2329***
	(0.0258)	(0.0256)	(0.0257)	(0.0257)
*DVAR*Schooling*	0.0152***			
	(0.0053)			
*DVAR*Secondary degree*		0.0020***		
		(0.0006)		
*DVAR*Educ. Quality*			0.0387***	
			(0.0139)	
DVAR Training*				0.0319*
				(0.0180)
Constant	4.974***	4.828***	4.9067***	5.0618***
	(0.177)	(0.190)	(0.1821)	(0.1825)
Observations	7,284	6,822	7,284	7,284
R-squared	0.870	0.871	0.870	0.870

Source: OECD ICIO database. *** p<0.01, ** p<0.05, * p<0.1.
Notes: Robust standard errors in parentheses. *FVAX* and *DVAR* lagged. All level variables in natural logarithms.

Labor Standards

For our last three policy measures, we focus exclusively on the condition of inputs and output factors. This means we look at indicators that differentiate a country's products based on specific standards in production. As a result, we expect on the one hand that the absorptive capacity channel is likely to become less prominent since our indicators do not necessarily look at the quality of input factors, as was done in the previous section. On the other hand, we expect these policy areas to matter much more for forward links through signaling effects.

Table 9 on the role of labor standards confirms this hypothesis. Such standards do not seem to affect economic upgrading through GVC integration as a buyer. This might in fact be an interesting result in itself. It shows that, despite their often cost-increasing nature, there is no evidence on an upgrading-preventing effect either. Therefore, a race to the bottom in terms of labor standards is not justified from a GVC perspective.

Table 8. The role of quality and innovation for economic upgrading through GVCs

VARIABLES	(1) *DVA*	(2) *DVA*	(3) *DVA*	(4) *DVA*
Backward links				
FVAX	0.0595***	0.0603***	-0.0684	0.0029
	(0.0123)	(0.0129)	(0.0759)	(0.0400)
FVADP	0.252***	0.253***	0.252***	0.252***
	(0.0269)	(0.0268)	(0.0268)	(0.0268)
*FVAX*Quality ISOs*	4.5e-06			
	(3.7e-06)			
*FVAX*R&D intensity*		0.0086		
		(0.0083)		
*FVAX*Technology adoption*			0.0265*	
			(0.0145)	
*FVAX*Innovation index*				0.0176*
				(0.0101)
Constant	5.843***	5.775***	5.612***	5.847***
	(0.178)	(0.180)	(0.177)	(0.185)
Observations	7,276	7,276	7,276	7,276
R-squared	0.852	0.852	0.852	0.852
Forward links				
DVAR	0.183***	0.191***	-0.0062	0.113**
	(0.0177)	(0.0200)	(0.111)	(0.0571)
FVADP	0.232***	0.233***	0.233***	0.233***
	(0.0258)	(0.0257)	(0.0257)	(0.0257)
*DVAR*Quality ISOs*	1.7e-05***			
	(5.3e-06)			
*DVAR*R&D intensity*		0.0268**		
		(0.0117)		
*DVAR*Technology adoption*			0.0427**	
			(0.0210)	
*DVAR*Innovation index*				0.0280*
				(0.0143)
Constant	4.904***	5.070***	4.923***	4.957***
	(0.170)	(0.182)	(0.176)	(0.179)
Observations	7,284	7,284	7,284	7,284
R-squared	0.870	0.870	0.870	0.870

Source: OECD ICIO database. *** p<0.01, ** p<0.05, * p<0.1.
Notes: Robust standard errors in parentheses. *FVAX* and *DVAR* lagged. All level variables in natural logarithms.

In fact, the evidence suggests a contrary strategy since it shows that labor standards thus promote economic upgrading through GVC integration as a seller. All six indicators have the expected sign and four are statistically significant (Basic ILO conventions, vulnerable employment, child labor, and wage dispersion). Minimum wages in our sample show no mediating effect, thereby rejecting the positive impact hypothesized by Mayneris and others (2014). Similarly, female intensity in our sample has no moderating effect, opposing the negative relationship hypothesized by Tejani and Milberg (2010). Finally, we conclude that raising labor standards is a sound and recommendable strategy for countries that are engaged in GVCs. Furthermore, the income group specific results show that, not only high, but also upper middle-income countries benefit from such standards, indicating that their facilitating potential is not dependent on the stage of development.

Table 9. The role of labor standards for economic upgrading

VARIABLES	(1) *DVA*	(2) *DVA*	(3) *DVA*	(4) *DVA*	(5) *DVA*	(6) *DVA*
Backward links						
FVAX	0.0877***	0.0734***	0.0627***	0.00286	0.0726	0.0513***
	(0.0303)	(0.0142)	(0.0138)	(0.0439)	(0.0835)	(0.0172)
FVADP	0.259***	0.272***	0.282***	0.254***	0.268***	0.280***
	(0.0276)	(0.0243)	(0.0285)	(0.0269)	(0.0342)	(0.0260)
*FVAX*Basic ILO conv.*	-0.0023					
	(0.0031)					
*FVAX*Vulnerable Empl.*		-0.0003				
		(0.0004)				
*FVAX*Child labor*			-0.0002			
			(0.0010)			
*FVAX*Female workforce*				0.0016		
				(0.0011)		
*FVAX*Wage dispersion*					-0.0095	
					(0.0400)	
*FVAX*Minimum wage*						2.3e-05
						(2.1e-05)
Constant	5.733***	5.532***	5.778***	5.844***	5.676***	5.641***
	(0.179)	(0.160)	(0.208)	(0.181)	(0.234)	(0.175)
Observations	7,037	6,578	5,147	7,156	2,995	5,502
R-squared	0.858	0.855	0.840	0.854	0.870	0.867
Forward links						
DVAR	0.102*	0.252***	0.232***	0.156*	0.473***	0.208***
	(0.0610)	(0.0231)	(0.0238)	(0.0824)	(0.128)	(0.0271)
FVADP	0.239***	0.250***	0.264***	0.233***	0.235***	0.259***
	(0.0261)	(0.0234)	(0.0275)	(0.0259)	(0.0298)	(0.0247)
*DVAR*Basic ILO conv.*	0.0115*					
	(0.0061)					
*DVAR*Vulnerable Empl.*		-0.0010*				
		(0.0005)				
*DVAR*Child labor*			-0.0027**			
			(0.0012)			
*DVAR*Female workforce*				0.0016		
				(0.0020)		
*DVAR*Wage dispersion*					-0.1200**	
					(0.0554)	
*DVAR*Minimum wage*						3.2e-05
						(2.8e-05)
Constant	4.899***	4.715***	5.071***	5.162***	4.886***	4.980***
	(0.180)	(0.155)	(0.212)	(0.184)	(0.222)	(0.180)
Observations	7,045	6,580	5,149	7,164	2,997	5,502
R-squared	0.875	0.875	0.861	0.872	0.886	0.886

Source: OECD ICIO database. *** p<0.01, ** p<0.05, * p<0.1.
Notes: Robust standard errors in parentheses. *FVAX* and *DVAR* lagged. All level variables in natural logarithms.

Social Standards

The identical intuition holds for social standards; table 10 shows that the empirical evidence is in line with the evidence for labor standards. A basic welfare system, measured through pension and unemployment insurance proxies, facilitates the positive effects of GVC integration as a seller on domestic value added (columns 2 and 3); and these effects are not driven by any particular income group. The positive mediating effect on the selling side supports the findings by Jetha and Linsen (2015) and the World Bank (2012).

Similarly, the positive effects of GVC integration as a buyer are not associated with social standards. Therefore, the conclusion remains the same here—economic and social upgrading through GVC participation can move hand in hand. In fact, deteriorating social standards can be a stumbling block for economic upgrading and should be prevented.

Table 10. The role of social standards for economic upgrading through GVCs

VARIABLES	(1) *DVA*	(2) *DVA*	(3) *DVA*	(4) *DVA*
Backward links				
FVAX	0.0687***	0.0677***	0.0540***	0.0683***
	(0.0149)	(0.0130)	(0.0197)	(0.0262)
FVADP	0.259***	0.246***	0.275***	0.261***
	(0.0276)	(0.0261)	(0.0243)	(0.0278)
*FVAX*Technical ILO conv.*	-8.6e-05			
	(0.0003)			
*FVAX*Unempl. insurance*		0.0001		
		(0.0003)		
*FVAX*Pension insurance*			0.0002	
			(0.0003)	
*FVAX*Health expenditure*				-0.0003
				(0.0022)
Constant	5.558***	5.781***	5.485***	5.632***
	(0.171)	(0.168)	(0.167)	(0.178)
Observations	7,037	6,918	6,697	6,917
R-squared	0.858	0.858	0.858	0.858
Forward links				
DVAR	0.185***	0.186***	0.166***	0.236***
	(0.0246)	(0.0207)	(0.0262)	(0.0394)
FVADP	0.239***	0.223***	0.253***	0.240***
	(0.0264)	(0.0240)	(0.0233)	(0.0267)
*DVAR*Technical ILO conv.*	-0.0026			
	(0.0018)			
*DVAR*Unempl. insurance*		0.0012**		
		(0.0005)		
*DVAR*Pension insurance*			0.0008**	
			(0.0004)	
*DVAR*Health expenditure*				-0.0019
				(0.0031)
Constant	4.822***	4.990***	4.617***	5.012***
	(0.173)	(0.161)	(0.166)	(0.185)
Observations	7,045	6,926	6,700	6,925
R-squared	0.875	0.874	0.876	0.875

Source: OECD ICIO database. *** p<0.01, ** p<0.05, * p<0.1.
Notes: Robust standard errors in parentheses. FVAX and DVAR lagged. All level variables in natural logarithms.

Environmental Standards

The final policy area we look at considers environmental standards. Here we find a slightly more differentiated picture. Regarding country-level policies, table 11 indicates a mediating effect for both GVC integration as a seller and a buyer. High air pollution and extensive water usage have negative and significant coefficients for backward links (columns 5 and 6); and heavy pesticide use has a negative and significant coefficient for forward links (column 4). While our firm-level indicator for the stock of ISO certifications related to environmental protection has the positive and significant sign, only for GVC integration as a seller. This is in line with what we found for the previous standards and fits the signaling channel as dominant transmission mechanism between standards and GVC-induced upgrading.

Finally, as with labor and social standards, the estimates are not due to a specific income group, but do apply to all. An outlier for the overall results is the negative and significant coefficient for the share of renewables in electricity generation (column 3). It does not fit the generally mediating role of standards for economic upgrading through GVCs and, therefore, does not affect the overall very positive conclusion we can draw with respect to standards.

Table 11. The role of environmental standards for economic upgrading

VARIABLES	(1) *DVA*	(2) *DVA*	(3) *DVA*	(4) *DVA*	(5) *DVA*	(6) *DVA*
Backward links						
FVAX	0.0555***	0.118**	0.0678***	0.0638***	0.146***	0.0699***
	(0.0114)	(0.0504)	(0.0104)	(0.0124)	(0.0515)	(0.00985)
FVADP	0.258***	0.254***	0.254***	0.265***	0.252***	0.259***
	(0.0276)	(0.0269)	(0.0269)	(0.0237)	(0.0352)	(0.0275)
*FVAX*Environm. ISOs*	4.6e-05					
	(2.9e-05)					
*FVAX*UNEP conventions*		-0.0060				
		(0.0060)				
*FVAX*Renewables*			0.0005			
			(0.0017)			
*FVAX*Pesticides*				-0.0008		
				(0.0019)		
*FVAX*Air pollution*					-0.0055**	
					(0.0027)	
*FVAX*Water use*						-7.2e-05***
						(2.6e-05)
Constant	5.651***	5.937***	5.895***	5.875***	6.131***	5.870***
	(0.176)	(0.188)	(0.187)	(0.178)	(0.284)	(0.189)
Observations	7,037	7,156	7,156	6,461	3,356	7,037
R-squared	0.858	0.854	0.854	0.865	0.850	0.858
Forward links						
DVAR	0.187***	0.0914	0.238***	0.264***	0.280***	0.220***
	(0.0167)	(0.0823)	(0.0187)	(0.0205)	(0.0575)	(0.0174)
FVADP	0.237***	0.234***	0.231***	0.245***	0.226***	0.238***
	(0.0266)	(0.0256)	(0.0258)	(0.0228)	(0.0304)	(0.0266)
*DVAR*Environm. ISOs*	0.0001***					
	(4.2e-05)					
*DVAR*UNEP conventions*		0.0157				
		(0.0098)				
*DVAR*Renewables*			-0.0049**			
			(0.0022)			
*DVAR*Pesticides*				-0.0065***		
				(0.0020)		
*DVAR*Air pollution*					-0.0015	
					(0.0029)	
*DVAR*Water use*						-9.5e-05
						(8.7e-05)
Constant	5.314***	5.080***	5.255***	5.030***	5.170***	5.322***
	(0.198)	(0.182)	(0.189)	(0.161)	(0.273)	(0.199)
Observations	7,045	7,164	7,164	6,464	3,356	7,045
R-squared	0.876	0.872	0.872	0.883	0.873	0.875

Source: OECD ICIO database. *** p<0.01, ** p<0.05, * p<0.1.
Notes: Robust standard errors in parentheses. *FVAX* and *DVAR* lagged. All level variables in natural logarithms.

4.4. Summary

Overall, our results highlight the importance of policy for economic upgrading through GVC integration. While we cannot claim causal evidence, all assessed policy areas consistently show mediating effects of GVCs and magnify the gains for domestic value added. This holds for policies that affect the quality and conditions of input and output factors, policies targeting investment and trade flows, and policies targeting the business climate and institutions, including financial and labor markets. As a result, strategies for GVC integration need to focus, not only on border measures, but also increasingly on beyond-the-border measures—if they are to extract the maximum benefits for the integrating country.

A more detailed analysis shows that several policy areas mediate the gains from GVCs more through integration as a seller. This holds in particular for connectivity, education, and skills, as well as for standards. We consider this as a sensible result since the mechanisms behind the positive effects of GVC integration as a buyer and seller are likely to be different. For instance, backward links might generate gains by increasing the quality of inputs, while forward links have a direct demand increasing effect for domestic value added. Naturally, domestic policies can influence the demand for domestic goods more than the quality of foreign inputs. Our results are in line with such an explanation.

Finally, we observe that high- and upper middle-income countries drive many of our results. (Notable exceptions are standards and the business climate and institutions.) We consider the conclusions, nevertheless, are highly relevant for developing economies. Many high- and upper middle-income countries have higher levels of GVC integration and it is then evident that they are responsible for a significant part of our results. However, as low- and lower-middle income countries integrate more and more into GVCs, we expect that such domestic policies will play an increasing role.

5. Conclusion

GVCs changed the way we think about trade and its role for development. Initial work on the topic outlined several ways how GVCs can raise growth and value added through increased specialization, knowledge spillovers, or terms of trade effects. However, initial comprehensive empirical tests of the relationship have shown that gains from GVC participation are not self-evident, instead, the effects seem to be dependent on a set of country- and industry-specific characteristics.

Our econometric results confirm that GVC integration—both as a buyer and seller—increases domestic value added, using a large database covering up to 61 countries, 34 industries, and the time period from 1995 to 2011. Interestingly, the results indicate that being a seller (forward links) in GVCs contributes more strongly to economic upgrading than being a buyer (backward links) only.

In a second step, we specifically examined the role of national policies, institutions, and standards for the GVC integration-economic upgrading nexus. We find that the domestic policy environment is indeed a major catalyst for the effects of GVC participation on domestic value added. It can act as either an obstacle or a facilitator for economic upgrading in GVCs and should be a key element of a country's GVC strategy.

A more detailed analysis shows that several policy areas mediate the gains from GVCs more through integration as a seller, which holds in particular for connectivity, education, and skills, as well as for standards. We consider this as a sensible result since the mechanisms behind the positive effects of GVC integration as a buyer and seller are likely to be different. For instance, backward links might generate gains through increasing the quality of inputs, while forward links have a direct-demand increasing effect for domestic value added. Naturally, domestic policies can influence the demand for domestic goods more than the quality of foreign inputs—our results are in line with such an explanation.

Finally, we observe that many of our results are driven by high- and upper-middle-income countries. Notable exceptions are standards and business climate and institutions. In any case, we consider that the conclusions are highly relevant for developing economies nonetheless. Many high- and upper-middle-income countries have higher levels of GVC integration and it is then evident that they are responsible for a significant part of our results. However, as low- and lower-middle-income countries integrate more and more into GVCs, we expect that such domestic policies will play an increasing role.

This source of heterogeneity represents an important area for further research. A better understanding of the role the type of GVC integration plays allows for the design of more accurate country-specific GVC strategies. In addition, other sources of heterogeneity should be examined in more detail. For instance, differences in effects that depend on the stage of development or a country's proximity could be highly relevant. Finally, it would be important to complement this work with a narrower analysis that assesses the role and the transmission channels of each of these policies. While we shed some light on these issues, more detailed research would be welcome.

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Appendix 1: Country application of the empirical model

We can apply our model to selected countries and their respective peers to exemplify successful upgrading experiences and the role policy played in them. We therefore add a third interaction term to equation (2) to separate country-specific experiences:

$$\boldsymbol{dva_{s,c,t}} = \boldsymbol{\alpha} + \boldsymbol{\beta_1 x_{s,c,t}} + \boldsymbol{\beta_2}\, \boldsymbol{x_{s,c,t}} * \boldsymbol{z_c} + \boldsymbol{\beta_3}\, \boldsymbol{x_{s,c,t}} * \boldsymbol{ctry_c} + \boldsymbol{\beta_4}\, \boldsymbol{x_{s,c,t}} * \boldsymbol{z_c} * \boldsymbol{peers_c} + \boldsymbol{\beta'} \boldsymbol{C_{s,c,t}} + \boldsymbol{\alpha_{s,c}} + \boldsymbol{\alpha_{s,t}} + \boldsymbol{\alpha_{c,t}} + \boldsymbol{\varepsilon_{s,c,t}} \quad (3)$$

here, *peers* represents a dummy that is equal to one for a selected country and its peers and zero otherwise. Peers are countries with a similar income-level or within geographical proximity.

We can finalize the assessment by testing whether the examined country itself is different from its peers by reducing the sample to the peer countries and replacing the *peers* dummy by a dummy equal to one only for the country under examination (*ctry*). To avoid multi-collinearity, we use time-varying policy proxies in this specification:

$$\boldsymbol{dva_{s,c,t}} = \boldsymbol{\alpha} + \boldsymbol{\beta_1 x_{s,c,t}} + \boldsymbol{\beta_2}\, \boldsymbol{x_{s,c,t}} * \boldsymbol{z_{c,t}} + \boldsymbol{\beta_3}\, \boldsymbol{x_{s,c,t}} * \boldsymbol{ctry_c} + \boldsymbol{\beta_4}\, \boldsymbol{x_{s,c,t}} * \boldsymbol{z_{c,t}} * \boldsymbol{ctry_c} + \boldsymbol{\beta'} \boldsymbol{C_{s,c,t}} + \boldsymbol{\alpha_{s,c}} + \boldsymbol{\alpha_{s,t}} + \boldsymbol{\alpha_{c,t}} + \boldsymbol{\varepsilon_{s,c,t}} \quad (4)$$

Appendix 2: Sources, definitions, and coverage of policy variables

Variable	Source	Definition	Category	Years	Country coverage
Infrainvest	OECD	Total infrastructure investment (% of GDP)	infrastructure	1995-2011	AUS, AUT, BEL, BGR, CAN, CHE, CZE, DEU, DNK, ESP, EST, FIN, FRA, GBR, GRC, HRV, HUN, IND, IRL, ISL, ITA, JPN, KOR, LTU, LUX, LVA, MEX, MLT, NLD, NOR, NZL, POL, PRT, ROU, RUS, SVK, SVN, SWE, TUR & USA
Air freight	WDI	Air transport, freight (million ton-km normalized by GDP)	infrastructure	1995-2011	Full except TWN
Rail	WDI	Rail lines (total route-km normalized by population and intrapolated)	infrastructure	1995-2011	Full except TWN, BRN, CRI, CYP, HKG, ISL, MLT, SGP
Port	WEF	Quality of port infrastructure, 1-7 (best)	infrastructure	2006-2011	Full
Road	WEF	Quality of roads, 1-7 (best)	infrastructure	2006-2011	Full
Internet	WDI	Internet users (per 100 people)	connectivity	1995-2011	Full except TWN
LPI logistics	LPI	Competence and quality of logistics services (1-5=high)	connectivity	2007/10	Full except TWN & BRN
LPI customs	LPI	Efficiency of customs clearance process (1-5=high)	connectivity	2007/10	Full except TWN & BRN
LPI overall	LPI	Overall (1-5=high)	connectivity	2007/2010	Full except TWN & BRN
Export time	WDI	Time to export (days)	connectivity	2005-2011	Full except TWN
Import time	WDI	Time to import (days)	connectivity	2005-2011	Full except TWN
Investment freedom	Heritage foundation	Restrictions imposed on investment (100=best)	investment & trade policy	1995-2011	Full except BRN
STRI WB	Borchert, Gootiz, and Mattoo (2012)	Services trade restrictiveness index, simple mean	investment & trade policy	2008/09/10	Full except TWN, BRN, CHE, CYP, EST, HKG, HRV, ISL, ISR, LUX, LVA, MLT, NOR, SVK, SVN, SGP
FDI inflows	WDI	Foreign direct investment, net inflows (% of GDP)	investment & trade policy	1995-2011	Full except TWN
Services trade	WDI	Exports and imports of services (% of GDP)	investment & trade policy	2005-2011	Full except TWN
Openness	WDI	Exports and imports of goods and services (% of GDP)	investment & trade policy	1995-2011	Full except TWN
Political stability	WGI	Perceptions on political stability and absence of violence/terrorism (2.5=best)	business clim. & institutions	1996-2011	Full
Corruption	Heritage foundation	Freedom from corruption (100=best)	business clim. & institutions	1995-2011	Full except BRN
Property rights	Heritage foundation	Degree to which a country's laws protect private property rights and to which its government and judiciary enforce those laws (100=best)	business clim. & institutions	1995-2011	Full except BRN
Doing business	WDI	Ease of doing business distance to frontier (100=best)	business clim. & institutions	2004-2011	Full except TWN
Dom. competition	WEF	Domestic competition, 1-7 (best)	business clim. & institutions	2006-2011	Full
For. competition	WEF	Foreign competition, 1-7 (best)	business clim. & institutions	2006-2011	Full
Financial freedom	Heritage foundation	Banking efficiency and independence from government control / interference (100=best)	financial development	1995-2011	Full except BRN
Private credit	WDI	Domestic credit to private sector (% of GDP)	financial development	1995-2011	Full except TWN
Labor freedom	Heritage foundation	Legal and regulatory framework of a country's labor market (100=best)	labor markets	1995-2011	Full except BRN

ULC	OECD	Unit labor cost index (2005=100)	labor markets	2001-2011	AUS, AUT, BEL, CAN, CZE, DEU, DNK, ESP, EST, FIN, FRA, GBR, GRC, HUN, IRL, ISR, ITA, JPN, KOR, LTU, LUX, MEX, NLD, NOR, NZL, POL, PRT, SVK, SVN, SWE & USA
Female labor	WDI	Share of females in the workforce	labor markets	1995-2011	Full except TWN
Education	Barro and Lee (2010)	Expected Years of Schooling (intrapolated)	education and skills	1995-2010	Full
Secondary degree	WDI	Share of workers with secondary degree or higher in the workforce	education and skills	1995-2011	Full except TWN, BRN, VNM & CHN
Educational Quality	WEF	Survey-based index of educational quality, 1-7(best)	education and skills	2006-2011	Full
On-the-job training	WEF	Survey-based index of availability and quality of on-the-job training, 1-7(best)	education and skills	2006-2011	Full
Quality ISOs	ISO	Stock of reported ISO certifications related to quality management per capita	quality and innovation	1995-2011	Full
R&D	WDI	Research and development expenditure (% of GDP)	quality and innovation	1995-2011	Full except BRN, KHM & VNM
Technology adoption	WEF	Index on technology adoption, 1-7 (best)	quality and innovation	2006-2011	Full
Innovation	WEF	Index on innovation environment, 1-7(best)	quality and innovation	2006-2011	Full
Child labor	WDI	Children 7-14 in employment/Children 7-14	labor standards	1995-2011	Full except TWN
Vulnerable employment	WDI	Vulnerable employment, % of total employment	labor standards	1995-2011	Full except TWN
Basic ILO conventions	ILO	Fundamental and governance ILO conventions signed	labor standards	1995-2011	Full
Female workforce	WDI	Share of females in the workforce	labor standards	1995-2011	Full except TWN
Minimum wage	OECD	Minimum relative to median wage of full-time workers	labor standards	1995-2011	28 middle- and high-income countries
Wage dispersion	ILO	Earnings dispersion among employees (Decile 9/Decile 5)	labor standards	One year	25 countries across all income levels
Total ILO conventions	ILO	Total ILO conventions signed	social standards	1995-2011	Full
Health	ILO	Public health expenditure/General government expenditure	social standards	2000-2011	Full except TWN, BRN
Pension	ILO	Active contributors to a pension scheme/labor force	social standards	One year	56 countries
Unemploy-ment	ILO	Share of unemployed receiving regular unemployment benefits	social standards	One year	Full except TWN, BRN
Environ-mental ISOs	ISO	ISO 14000 certifications per capita	environmental standards	1995-2011	Full
UNEP conventions	UNEP	Number of elementary Unep conventions signed (0-11)	environmental standards	1995-2011	Full
Pesticides	FAO	Pesticide use in Arable Land & Permanent Crops (tonnes per 1000 Ha)	environmental standards	One year	54 countries
Air pollution	WHO	Particulate matter with diameter of 2.5 μm or less in urban areas	environmental standards	One year	28 low- and middle-income countries
Renewables	WDI	Electricity production from renewables excl. hydro (% of total)	environmental standards	1995-2011	Full except TWN
Water	WDI	Annual freshwater withdrawals, % of internal resources	environmental standards	One year	Full except TWN

Note: LPI = Logistics Performance Index, WDI = World Development Indicators, WEF = World Economic Forum, WGI = World Governance Indicators.

Appendix 3: Country coverage

ISO	Country	Income group	Income group
aus	Australia	HI: OECD	HI: OECD
aut	Austria	HI: OECD	HI: OECD
bel	Belgium	HI: OECD	HI: OECD
can	Canada	HI: OECD	HI: OECD
che	Switzerland	HI: OECD	HI: OECD
cze	Czech Republic	HI: OECD	HI: OECD
deu	Germany	HI: OECD	HI: OECD
dnk	Denmark	HI: OECD	HI: OECD
esp	Spain	HI: OECD	HI: OECD
fin	Finland	HI: OECD	HI: OECD
fra	France	HI: OECD	HI: OECD
gbr	United Kingdom	HI: OECD	HI: OECD
grc	Greece	HI: OECD	HI: OECD
irl	Ireland	HI: OECD	HI: OECD
isl	Iceland	HI: OECD	HI: OECD
isr	Israel	HI: OECD	HI: OECD
ita	Italy	HI: OECD	HI: OECD
jpn	Japan	HI: OECD	HI: OECD
kor	Korea, Rep.	HI: OECD	HI: OECD
lux	Luxembourg	HI: OECD	HI: OECD
nld	Netherlands	HI: OECD	HI: OECD
nor	Norway	HI: OECD	HI: OECD
nzl	New Zealand	HI: OECD	HI: OECD
prt	Portugal	HI: OECD	HI: OECD
svn	Slovenia	HI: OECD	HI: OECD
swe	Sweden	HI: OECD	HI: OECD
usa	United States	HI: OECD	HI: OECD
brn	Brunei Darussalam	HI: nonOECD	HI: nonOECD
cyp	Cyprus	HI: nonOECD	HI: nonOECD
hkg	Hong Kong SAR, China	HI: nonOECD	HI: nonOECD
mlt	Malta	HI: nonOECD	HI: nonOECD

ISO	Country	Income group 2011	Income
sau	Saudi Arabia	HI: nonOECD	High
sgp	Singapore	HI: nonOECD	High
twn	Taiwan, China	HI: nonOECD	High
hrv	Croatia	HI: nonOECD	Upper
ltu	Lithuania	HI: nonOECD	Upper
lva	Latvia	HI: nonOECD	Upper
rus	Russian Federation	HI: nonOECD	Upper
chl	Chile	HI: OECD	Upper
est	Estonia	HI: OECD	Upper
pol	Poland	HI: OECD	Upper
svk	Slovak Republic	HI: OECD	Upper
arg	Argentina	UMI	UMI
bra	Brazil	UMI	UMI
col	Colombia	UMI	UMI
cri	Costa Rica	UMI	UMI
hun	Hungary	UMI	UMI
mex	Mexico	UMI	UMI
mys	Malaysia	UMI	UMI
rou	Romania	UMI	UMI
tur	Turkey	UMI	UMI
zaf	South Africa	UMI	UMI
bgr	Bulgaria	UMI	LMI
chn	China	UMI	LMI
tha	Thailand	UMI	LMI
tun	Tunisia	UMI	LMI
idn	Indonesia	LMI	LMI
phl	Philippines	LMI	LMI
ind	India	LMI	LI
vnm	Vietnam	LMI	LI
khm	Cambodia	LI	LI

Note: HI = high income, UMI = upper middle income, LMI = lower middle income, LI = low income.

Appendix 4: Industry coverage (bold industries excluded due to non-tradability)

ISIC 3	Industry (WIOD)
01t05	Agriculture
10t14	Mining and quarrying
15t16	Food and tobacco
17t18	Textiles and apparel
19	Leather
20	Wood
21t22	Paper and print
23	Refined petroleum
24	Chemicals
25	Rubber and plastics
26	Non-metallic mineral products
27t28	Basic and fabricated metals
29	Machinery and equipment n.e.c.
30t33	Electrical and optical equipment
34t35	Motor and transport equipment
36t37	Other manufactures and
40t41	Electricity, gas and water supply
45	Construction
50	Sale, maintenance and repair of
51	Wholesale trade
52	Retail trade
55	Hotels and restaurants
60	Land transport
61	Water transport
62	Air transport
63	Supporting and auxiliary
64	Post and telecommunications
65t67	Financial intermediation
70	Real estate activities
71t74	Renting and business activities
75	Public administration and defence
80	Education
85	Health and social work
90t93	Other services
95	Private households with employed persons

ISIC 3	Industry (OECD)
01t05	Agriculture
10t14	Mining and quarrying
15t16	Food and tobacco
17t19	Textiles, apparel, and leather
20	Wood
21t22	Paper and print
23	Refined petroleum
24	Chemicals
25	Rubber and plastics
26	Non-metallic mineral products
27	Basic metals
28	Fabricated metals
29	Machinery and equipment
303233	Electrical and optical
31	Electrical machinery and
34	Motor vehicles
35	Other transport equipment
36t37	Other manufactures and
40t41	Electricity, gas and water
45	Construction
50t52	Wholesale and retail trade;
55	Hotels and restaurants
60t63	Transport and storage
64	Post and telecommunications
65t67	Financial intermediation
70	Real estate activities
71	Renting of machinery and
72	Computer and related
73t74	R&D and other business
75	Public administration and defence
80	Education
85	Health and social work
90t93	Other services
95	Private households with employed persons

ISIC 3	Industry (Sample)
01t05	Agriculture
10t14	Mining and quarrying
15t16	Food and tobacco
17t19	Textiles, apparel, and leather
20	Wood
21t22	Paper and print
23	Refined petroleum
24	Chemicals
25	Rubber and plastics
26	Non-metallic mineral products
27t28	Basic and fabricated metals
29	Machinery and equipment
30t33	Electrical and optical
34t35	Motor and transport
36t37	Other manufactures and
40t41	**Electricity, gas and water**
45	**Construction**
50t52	Wholesale and retail trade;
55	**Hotels and restaurants**
60t63	Transport and storage
64	Post and telecommunications
65t67	Financial intermediation
70	**Real estate activities**
71t74	Renting and business activities
75	**Public administration and defence**
80	**Education**
85	**Health and social work**
90t93	**Other services**
95	**Private households with employed persons**

Appendix 5: Derivation of GVC indicators

This derivation is based on Hummels and others (2001) and follows the exposition of Kummritz (2016). To derive the indicators for the analysis, Hummels and others (2001) suggested applying the standard Leontief's (1936) insight to ICIOs and in order to derive a decomposition of gross exports into value added along the four dimensions: source country, source industry, using country, and using industry. This means in a simple example for a given year with two countries, *k* and *l,* and two industries, *i* and *j*, that we multiply the value-added multiplier, $V\ (I\text{-}A)^{-1}$, with country-industry-level gross exports, E, to deduce their value-added origins[10]:

$$V\ (I-A)^{-1}\ E = \begin{pmatrix} v_k^i & 0 & 0 & 0 \\ 0 & v_k^j & 0 & 0 \\ 0 & 0 & v_l^i & 0 \\ 0 & 0 & 0 & v_l^j \end{pmatrix} \begin{pmatrix} b_{kk}^{ii} & b_{kk}^{ij} & b_{kl}^{ii} & b_{kl}^{ij} \\ b_{kk}^{ji} & b_{kk}^{jj} & b_{kl}^{ji} & b_{kl}^{jj} \\ b_{lk}^{ii} & b_{lk}^{ij} & b_{ll}^{ii} & b_{ll}^{ij} \\ b_{lk}^{ji} & b_{lk}^{jj} & b_{ll}^{ji} & b_{ll}^{jj} \end{pmatrix} \begin{pmatrix} e_k^i & 0 & 0 & 0 \\ 0 & e_k^j & 0 & 0 \\ 0 & 0 & e_l^i & 0 \\ 0 & 0 & 0 & e_l^j \end{pmatrix} =$$

$$\begin{pmatrix} v_k^i b_{kk}^{ii} e_k^i & v_k^i b_{kk}^{ij} e_k^j & v_k^i b_{kl}^{ii} e_l^i & v_k^i b_{kl}^{ij} e_l^j \\ v_k^j b_{kk}^{ji} e_k^i & v_k^j b_{kk}^{jj} e_k^j & v_k^j b_{kl}^{ji} e_l^i & v_k^j b_{kl}^{jj} e_l^j \\ v_l^i b_{lk}^{ii} e_k^i & v_l^i b_{lk}^{ij} e_k^j & v_l^i b_{ll}^{ii} e_l^i & v_l^i b_{ll}^{ij} e_l^j \\ v_l^j b_{lk}^{ji} e_k^i & v_l^j b_{lk}^{jj} e_k^j & v_l^j b_{ll}^{ji} e_l^i & v_l^j b_{ll}^{jj} e_l^j \end{pmatrix} = \begin{pmatrix} va_{kk}^{ii} & va_{kk}^{ij} & va_{kl}^{ii} & va_{kl}^{ij} \\ va_{kk}^{ji} & va_{kk}^{jj} & va_{kl}^{ji} & va_{kl}^{jj} \\ va_{lk}^{ii} & va_{lk}^{ij} & va_{ll}^{ii} & va_{ll}^{ij} \\ va_{lk}^{ji} & va_{lk}^{jj} & va_{ll}^{ji} & va_{ll}^{jj} \end{pmatrix},$$

with $$v_c^s = {dva_c^s}\Big/{y_c^s} = 1 - \sum_d^2 a_{kc}^{ds} - \sum_d^2 a_{lc}^{ds} \qquad (c \in k,l \qquad s \in i,k),$$

$$\begin{pmatrix} b_{kk}^{ii} & b_{kk}^{ij} & b_{kl}^{ii} & b_{kl}^{ij} \\ b_{kk}^{ji} & b_{kk}^{jj} & b_{kl}^{ji} & b_{kl}^{jj} \\ b_{lk}^{ii} & b_{lk}^{ij} & b_{ll}^{ii} & b_{ll}^{ij} \\ b_{lk}^{ji} & b_{lk}^{jj} & b_{ll}^{ji} & b_{ll}^{jj} \end{pmatrix} = \begin{pmatrix} 1-a_{kk}^{ii} & -a_{kk}^{ij} & -a_{kl}^{ii} & -a_{kl}^{ij} \\ -a_{kk}^{ji} & 1-a_{kk}^{jj} & -a_{kl}^{ji} & -a_{kl}^{jj} \\ -a_{lk}^{ii} & -a_{lk}^{ij} & 1-a_{ll}^{ii} & -a_{ll}^{ij} \\ -a_{lk}^{ji} & -a_{lk}^{jj} & -a_{ll}^{ji} & 1-a_{ll}^{jj} \end{pmatrix}^{-1},$$

and $$a_{cf}^{su} = {inp_{cf}^{su}}\Big/{y_f^u} \qquad (c,f \in k,l \qquad s,u \in i,k),$$

where v_c^s gives the share of domestic value added, dva_c^s, in output, y_c^s, and e_k^i indicates gross exports. Finally, a_{cf}^{su} denotes the share of inputs, inp_{cf}^{su} , in output. Accordingly, the elements of the $V\ (I-A)^{-1}\ E$ matrix are estimates for the industry-level value-added origins of each industry's exports. These estimates can be summed to get industry-country totals for *FVAX* and *DVAR*. Note that for *FVAX* we exclude sourcing from the mining sector to avoid spurious effects driven by variations in raw material prices such as oil.

[10] The decomposition was technically implemented using the R package *decompr* described in Quast and Kummritz (2015), which automates the calculation of GVC indicators.