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# Are Global Value Chains Really Global? Policies to Accelerate Countries' Access to International Production Networks

Antoni Estevadeordal, Juan Blyde and Kati Suominen

December 2013

E15 Expert Group on Global Value Chains:
Development Challenges and Policy Options

**Think Piece**

Co-convened with

IDB
Inter-American Development Bank

# ACKNOWLEDGMENTS

**Published by**

International Centre for Trade and Sustainable Development (ICTSD)
7 Chemin de Balexert, 1219 Geneva, Switzerland
Tel: +41 22 917 8492 – E-mail: ictsd@ictsd.ch – Website: www.ictsd.org
Publisher and Chief Executive: Ricardo Meléndez-Ortiz

World Economic Forum
91-93 route de la Capite, 1223 Cologny/Geneva, Switzerland
Tel: +41 22 869 1212 – E-mail: contact@weforum.org – Website: www.weforum.org
Co-Publisher and Managing Director: Richard Samans

**Acknowledgments**

This paper has been produced under the E15Initiative (E15). Implemented jointly by the International Centre for Trade and Sustainable Development (ICTSD) and the World Economic Forum, the E15 convenes world-class experts and institutions to generate strategic analysis and recommendations for government, business and civil society geared towards strengthening the global trade system.

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The Expert Group on Global Value Chains: Development Challenges and Policy Options is co-convened with the Inter-American Development Bank (IADB). www.iadb.org/

**With the support of:**

Schweizerische Eidgenossenschaft
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Norwegian Ministry of Foreign Affairs

**Citation**: Estevadeordal, Antoni, Juan Blyde, and Kati Suominen. *Are Global Value Chains Really Global? Policies to Accelerate Countries' Access to International Production Networks*. E15Initiative. Geneva: International Centre for Trade and Sustainable Development (ICTSD) and World Economic Forum, 2014. www.e15initiative.org/

The views expressed in this publication are those of the authors and do not necessarily reflect the views of ICTSD, World Economic Forum, the funding institutions, Inter-American Development Bank, its Board of Directors, or any of its member countries. The authors would like to thank Kun Li and Julieth Santamaria for research assistance.


ISSN 2313-3805

# ABSTRACT

The term "global value chain" (GVC) is frequently used to refer to a multi-country process in which different stages of production are carried out in specialized plants in different parts of the world. But casual evidence of this phenomenon suggests that these global linkages might be rather regional, as they seem to concentrate geographically around North America, the European Union, and East Asia, with other countries in the world remaining mostly on the sidelines. This paper seeks to document more systematically whether this is the case and if so, why. Using measures of trade in value added, we first provide evidence on the extent to which GVCs are regionally oriented. Then we ask what forces are shaping the current patterns of trade in GVCs, and, in particular, we examine the role of transport-related factors and trade policy measures. In the light of this evidence, we then assess the policy options for developing countries aiming to improve their participation in cross-border production sharing.

# CONTENTS

# LIST OF ABBREVIATIONS

| | |
|---|---|
| AD | anti-dumping |
| ADA | Anti-Dumping Agreement |
| ASCM | Agreement on Subsidies and Countervailing Measures |
| ASEAN | Association of Southeast Asian Nations |
| EU | European Union |
| FDI | foreign direct investment |
| FTA | free trade agreement |
| GATS | General Agreement on Trade in Services |
| GDP | gross domestic product |
| GVCs | global value chains |
| IP | intellectual property |
| MNCs | multinational corporations |
| NAFTA | North American Free Trade Agreement |
| PTAs | preferential trading arrangements |
| RoO | rules of origin |
| RTA | regional trade agreement |
| TPP | Trans-Pacific Partnership |
| TRIPS | Trade-Related Aspects of Intellectual Property Rights |
| US | United States |

# EXECUTIVE SUMMARY

The world economy has recently seen an increasing trend in international production fragmentation, or a geographic separation of the activities involved in producing a good or a service across two or more countries. The resulting international organization of production has substantially increased interdependencies among economies around the globe, and has translated into a fast growing trade in intermediate inputs and services.

The process of fragmentation tends to eliminate the need to gain competency in all aspects of the production of a good, and allows developing countries to enter into the network of cross-border production sharing by specializing in just one or a few stages of the production activities involved in making a final good. This type of specialization allows developing countries to participate in a finer international division of labor. In its absence, emerging economies would have to master entire production processes to become strong competitors in world markets.

However, global value chains (GVCs) have not been spread evenly across the world as the main networks concentrate around East Asia, Europe, and North America. Many developing countries in Africa and Latin America, in particular, remain at the sidelines in cross-border production sharing. Indeed, the regional bias in GVC structures means that GVCs as currently structured are not optimal. We find that the regional bias stems from high transport and logistics costs that discourage value chains spanning long distances, and from trade policies—first and foremost preferential trading arrangements (PTAs), which have often been formed among neighboring countries. While being a member of a trade agreement does not necessarily impede a country from developing supply chains with non-member countries, most PTAs have rules of origin that disincentivize the use of materials from outside the bloc.

There are a number of multilateral and regional measures to reduce distortions in GVCs and encourage developing nations' access to global production sharing.

First, while important for trade in general, the quality of logistics systems are particularly relevant for participating in cross-border production processes in which low inventory cost strategies, such as just-in-time delivery services, continue to be the norm. The WTO should pay keen attention to several other policy areas that affect transport costs in developing nations, including trade facilitation, Aid for Trade, and trade in transport services.

Second, cumulation of production across the various PTAs criss-crossing the world can be quite effective in reducing the distortive effect of rules of origin and spur cross-border production sharing. Granted, multilateral tariff and non-tariff liberalization would also reduce the bite of restrictive rules of origin—and in general encourage trade intermediates.

There is also a need for further analytical work on factors that arbitrate GVC structures. For example, more detailed evidence on how specific aspects of the logistics infrastructure (for example, port and airport efficiency, information and communication infrastructure, and customs procedures) interact with the participation of countries in a GVC is an important issue to examine further. Another important area is the optimal architecture of trade agreements—and balancing the need to curb trade deflection with the importance of keeping rules flexible enough to allow for offshoring opportunities.

# INTRODUCTION

The world economy has recently seen an increasing trend in international production fragmentation, or the geographic separation of activities involved in producing a good or a service across two or more countries. The resulting international organization of production has substantially increased interdependencies among economies around the globe, and has translated into a fast growing trade in intermediate inputs and services (Yeats 2001; Hummels et al. 2001; UNCTAD 2004). There has certainly been no shortage of names for this phenomenon, from offshoring, global value chains (GVCs), and international production networks to slicing the value added chain (Krugman 1995), disintegration of production (Feenstra 1998), delocalization (Leamer 1996), and the great unbundling (Baldwin 2006). All this reflect a rush by economists and business people alike to cope with a fast-moving trend that is changing the world's trade and production patterns.

From the point of view of developing countries, the increase in international product fragmentation provides opportunities to engage in international trade transactions that were virtually not available before. The process of fragmentation tends to eliminate the need to gain competence in all aspects of the production of a good, and allows developing countries to enter into the network of cross-border production sharing by specializing in just one or a few stages of the production activities involved in making a final good. This type of specialization allows developing countries to participate in a finer international division of labor. In its absence, they would have to master entire production processes to become strong competitors in world markets. For example, in stark contrast to the harsh development process followed by Germany and Japan in which entire supply chains were built domestically, countries such as China and Vietnam are following a different path to industrialization through entering existing international supply chains (Baldwin 2011).

But GVCs have not been spread evenly across the world as the main networks concentrate around East Asia, Europe, and North America. We find such regional biases are mostly due to trade costs and trade policies. The implication of the regional bias is that many developing countries, especially in Africa and Latin America, remain at the sidelines in cross-border production sharing, and GVCs are hardly optimized. Since participation in GVCs entails new opportunities for industrialization and development, it is important to optimize them. This paper seeks to deepen our understanding of the obstacles to optimal GVC structures and the access of countries to GVCs.

The paper is organized as follows. In Section 2, we explain the rationale for the analysis by summarizing the relevant empirical and theoretical literature. In Section 3, we present systematic evidence on the extent to which GVCs are regional. An econometric model is developed in Section 4 to measure the impact of specific drivers of production location on the regional patterns of GVCs. The section also discusses what the findings of this model imply for developing countries seeking to join GVCs. Section 5 discusses multilateral and regional policies for optimizing GVCs. Section 6 concludes by re-emphasizing the main findings.

# EMPIRICAL AND THEORETICAL BACKGROUND

Most of the evidence on GVCs consists of cases involving countries in similar regions. Examples abound, from Mexico's maquiladoras and Canadian suppliers linked to United States (US) multinational corporations (MNCs) to Japanese firms outsourcing production processes in East Asia. Even in the well-documented cases of US-designed iPods and iPhones, most of the actual manufacturing takes place "regionally" with China assembling parts and components provided by Japan, Korea, and Taiwan (Dedrick et al. 2008, 2012). The anecdotal evidence is supported by more systematic analyses such as those using micro data of MNCs. For instance, Kimura and Ando (2005) show that 80 percent of MNCs in Japan locate foreign affiliates in East Asia and more than half of all their affiliates are only located in this region. This is not to suggest the absence of truly global supply chains with firms linked across faraway regions, but existing evidence tends to support the claim that the majority of international production networks are regionally oriented.

While transport costs are the main factor that comes to mind to explain the regional character of many supply chains, casual evidence also suggests that many regional supply chains are intrinsically related to certain agreements and/or arrangements that occur across nearby countries. For instance, before the 1965 US-Canada Auto Agreement, trade in auto parts between these two countries practically did not exist. After the 1965 agreement reduced tariffs to zero, auto trade soared, igniting a successful US-Canada auto supply chain in which 60 percent of US auto exports to Canada are engines and parts, while 75 percent of Canadian auto exports to the US are finished cars and trucks (Hummels et al. 1998).

The emergence of "factory Asia" is another example in which the surge of Asian supply chains coincided with a series of actions (not always well-organized policies designed for the formation of international production networks) that were adopted regionally and may have helped spur the growth of regional cross-border production sharing in that part of the world. For example, starting in the 1970s, many countries began implementing policies for the aggressive attraction of foreign direct investment (FDI)—the backbone of many supply chains—and after the Asian currency crisis in 1997–98, the trading bloc became much more integrated (Kimura 2006), deepening trade linkages within the region, particularly in parts and components. Today, low protection levels on semi-processed products are a common factor across the Asian region (WTO IDE-Jetro 2011).

The enlargement of the EU provides additional evidence on the relationship between common regional actions and forming regional production networks. For instance, using trade data, Curran and Zignago (2012) show that the reliance of EU industry on other member states, which has been traditionally large, has only increased since enlargement. The process of enlargement, which required the new member states to apply the same common external tariffs of the bloc, triggered unprecedented flows of FDI from the old to the new members, with the main recipients being Hungary, the Czech Republic, and Poland, the three countries that have since become crucial parts of the European supply chain (Karkkainen 2008).

In the next section, using world data on trade in value added, we provide systematic evidence on the extent to which GVCs are regionally oriented. Before moving to this, however, it is useful to review the relevant literature behind the formation of GVCs to highlight some of the forces that may explain regional patterns behind the international organization of production.

During the last two decades, the literature on the so-called theory of fragmentation or offshoring has been growing rapidly. Following the work of Jones and Kierzkowski (1990), economists have been outlining models that explicitly recognize the fact that firms are increasingly fragmenting production processes into various stages or tasks and moving them to places with different location advantages (Jones and Findlay 2000, 2001; Jones and Kierkowski 1998, 2000, 2001; Deardorff 2001a, 2001b; Grossman and Rossi-Hansberg 2008). These studies examine the main forces behind the international organization of production. Most of the models

in this literature share features from the earlier literature on FDI,[1] namely that firms will fragment production across different countries to arbitrage international differences in factor prices (Helpman 1984; Helpman and Krugman 1985).[2]

The basic rationale behind the theory of fragmentation is as follows. In traditional production processes, inputs are organized and combined to generate final outputs in the same location. In the presence of many inputs, coordination is normally necessary and proximity helps keep the costs of coordination low. But if firms could separate the production process into various production blocks and relocate them in places with lower factor costs, the total cost of production could be lowered. Thus, firms may unbundle their production processes as long as the saved production costs arising from the fragmentation process compensate for the additional costs of coordinating remotely located production blocks plus the costs of moving these production blocks around.

This framework highlights the main forces behind the international unbundling of production, namely comparative advantage considerations such as differences in factor prices across countries, as well as the overall costs of coordinating activities and moving various inputs from one country to another. In this respect, trade impediments such as tariffs and costs of transportation are likely to be major factors behind the costs of moving inputs across borders.

It is then reasonable to expect that countries that are part of a regional trade agreement (RTA) are more likely to engage in cross-border production sharing, particularly because of the proportionally larger effects of lowering a tariff rate on a production process that crosses borders many times (as it is often the case in international supply chains) as opposed to a final good that crosses borders only once.[3] Additionally, due to the impact of transport costs, large distances can potentially erode the saved production costs that emanate from the fragmentation and relocation of production, limiting the range of countries that could join a given supply chain.

An additional factor that may limit the physical distance between buyers and suppliers is related to uncertainty. Uncertainty in the delivery of any single component of a supply chain can have quite disrupted impacts in the production of a final good as entire production lines might be shut down until all the necessary inputs have arrived. Companies can face this uncertainty by holding large quantities of inventory, but modern supply chain practices are increasingly moving towards low inventory holdings in an effort to cut costs, part of so-called lean production strategies. To the extent that uncertainty in delivery increases with distance, clustering would be the most likely outcome to assure timely delivery of all the components. This is indeed the prediction of a theoretical analysis by Harrigan and Venables (2006).

Based on the above discussion, and after presenting evidence on the regional patterns of GVC participation in the next section, Section 4 points to an econometric model that examines the relationship between regional patterns of trade in GVCs and the specific drivers of GVC location.

# THE PATTERNS OF TRADE IN VALUE ADDED

One way to account for the participation of countries in GVCs is to trace the value added of each source country in a globally integrated production network. Studies like this have emerged on a case-by-case basis, from the iPod and iPhone (Dedricket al. 2008, 2012) to the less technologically intensive but still widespread multi-country production of Barbie dolls (Tempest 1996). The information in these case studies is very rich as they show which countries participate in the supply chain of a particular good and how much value they add to its production. The studies have revealed, for example, that even though China exports the iPod and the full value of this product accrues in its trade statistics, the country only contributes 3.8 percent of the value as many other countries participate in the production. This case-by-case examination of specific international supply chains is very revealing, but the approach is so data demanding that it would be unfeasible to cover the supply chain of every good that a country co-produces. This makes the technique impractical to generate aggregate measures of the participation of countries in GVCs.

Recently, however, a new literature has emerged, combining input-output tables with bilateral trade statistics to trace the value added of a country's trade flows (for example, Hummels et al. 2001; Johnson and Noguera 2012a, 2012b; Miroudot and Ragousssis 2009; Koopman et al. 2008;

1 The new models of fragmentation are generally not limited to multinationals exclusively. The main predictions of these models tend to apply to companies that fragment production internationally regardless of whether this is done within the boundaries of the firm or through independent suppliers. A more recent strand of the literature examines the more specific issue of whether the fragmentation of production occurs within the boundaries of the firm or through an independent supplier (Antras 2003; Antras and Helpman 2004, 2008). This is called the internalization decision.

2 This class of models is called the vertical model of FDI and it was developed in parallel to the horizontal model of FDI in which the objective behind the MNC is to save on the trade costs associated with exporting by setting up foreign subsidiaries producing similar goods to those produced at home (Markusen 1984; Horstmann and Markusen 1987). Later on, the knowledge-capital model was developed, simultaneously allowing horizontal and vertical FDIs (Markusen 1997)

3 This notion is formally developed by Ishii and Yi 1997. They show that tariff reductions have a proportionately greater effect on vertical trade involving goods produced sequentially in multiple countries relative to goods produced entirely in one country.

Koopman et al. 2010; De La Cruz et al. 2011). The literature has evolved rapidly and produced an array of indicators assisting in the quantification of the extent to which countries participate in cross-border production sharing.

One of the early indicators of participation in GVCs coming from this literature is based on the notion of vertical specialization. In essence, vertical specialization refers to the use of imported inputs to produce goods that are later exported, a notion that captures the idea that various countries are linked sequentially to produce a final good (see Hummels et al. 2001). More recently, the concept of foreign value added in exports has been introduced, which is a refined measure of vertical specialization where the emphasis is on the value added from other countries employed in a country's exports (Koopman et al. 2010). Foreign value added of exports is nowadays a common measure to examine the participation of a country in GVCs. This is one of the indicators that we employ. The Appendix presents the precise definition of the concepts employed as well as the data sources used to construct the indicators.

In what follows we will first examine the overall GVC participation of major regions in the world (Europe, Asia-Pacific, North America, and Latin America) and, second, analyze the regional bias of this participation, that is, the extent to which it takes place among countries of the same region versus countries from other regions. The Appendix shows in detail the list of countries included in each of the regions, which also depends on the availability of the data employed. Nevertheless, it is worth mentioning that Europe comprises the 27 members of the European Union (EU). Asia-Pacific combines the Association of Southeast Asian Nations (ASEAN) countries with the East Asian countries and also Australia and New Zealand. Finally, the separation between North America and Latin America is obvious except for Mexico. While Mexico is a Latin American country, it is much more integrated in supply chains with the US and Canada than with Latin America, and it is more natural to include it in the North America group. This is what we do in this paper.[4]

## OVERALL PARTICIPATION IN GVCS

In Figure 1, we show the foreign value added of exports for each region. More precisely this is the simple average of the foreign value added of the exports of all the countries in the particular region. It can be seen that, on an average, countries in Europe exhibit the largest foreign value added, followed by Asia-Pacific, North America, and Latin America.

One aspect that might seem puzzling at first is the relatively small value of foreign value added in North America relative to the values observed in Europe and Asia. This, however, can be explained by two factors. On the one hand, large countries such as the US or Canada usually find more factors and resources within their own borders than small countries. It is well known that this generates small values in traditional trade measures such as "openness" and generates small values on our measure of foreign value added. The second factor is that in some industrialized countries, primarily in the US, some of the value added incorporated in their imported inputs originates from that country itself. Consider the example of a US firm that exports materials to Mexico for processing, which are then re-exported back to the US and used as intermediate inputs in a final good that is later exported to other countries. The original value added from the US that is incorporated in these imported inputs from Mexico is not included in our calculation of foreign value added. This is called "reflected domestic value added" in the literature or the domestic value added that returns home (Koopman et al. 2010). In countries such as the US, where the domestic value added that returns home is large, the foreign value added tends to be relatively smaller than in other countries. But this does not mean that the country does not participate in cross-border production sharing. It only means that the participation of the US in GVCs is much more complex than the participation of other countries because it enters the supply chain at various points. In Figure 2, we add this "reflected value added" to the measure of foreign value added presented before, and we can see that the participation of the North America region increases substantially.

Another measure that is useful in assessing how countries participate in supply chains is the GVC position (see the Appendix). Koopman et al. (2010) measure GVC position as the ratio of indirect value added to foreign value added, where indirect value added is the value added of a country that is embodied in the exports of its partners. We employ the same measure here. When the GVC position is high, a country tends to participate more as a provider of value added than as a recipient of foreign value added. Therefore, the country is relatively upstream in the chain. Conversely, when this measure is small, a country tends to participate more as a recipient of value added than as provider, and it is relatively downstream in the chain. Figure 3 shows the average GVC position by regions. The Latin American region has the largest GVC position, which is not surprising. Latin American countries tend to export natural resource-intensive goods and these types of goods tend to be located upstream in the chain. Europe, on the other hand, has the smallest value, reflecting a position in GVCs much closer to the end of the production process. North America and Asia-Pacific are in the middle of the range, indicating a mix of production processes in which the participation in GVCs as providers and as recipients of value added is somewhat balanced.

4 It is worth noting that including Mexico in the Latin America group does not qualitatively change any of the results.

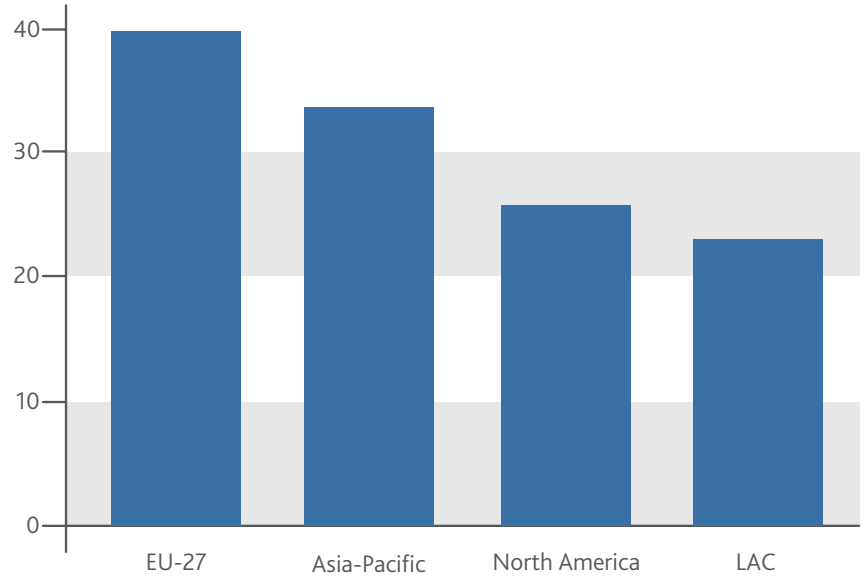


**FIGURE 1:**

Foreign Value Added (as a share of gross exports)

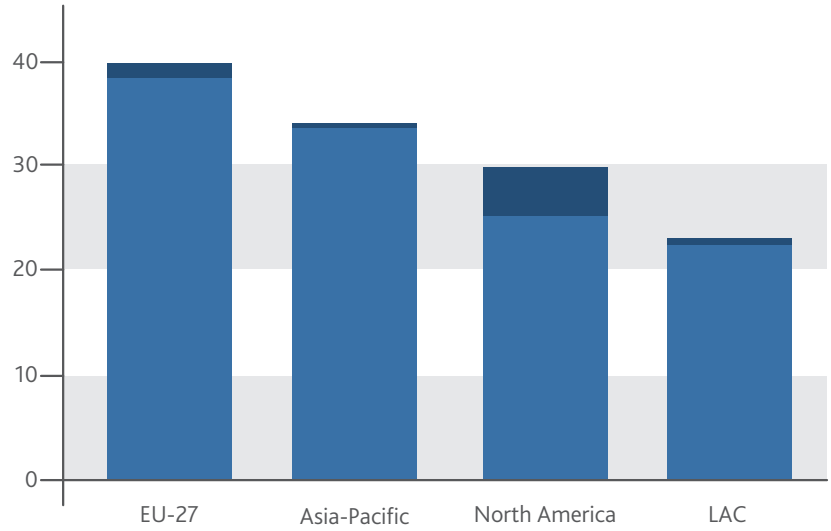


**FIGURE 2:**

Foreign Value Added and Returned Domestic Value Added (as a share of gross exports)

**LEGEND:**

Foreign value added

Returned domestic value added

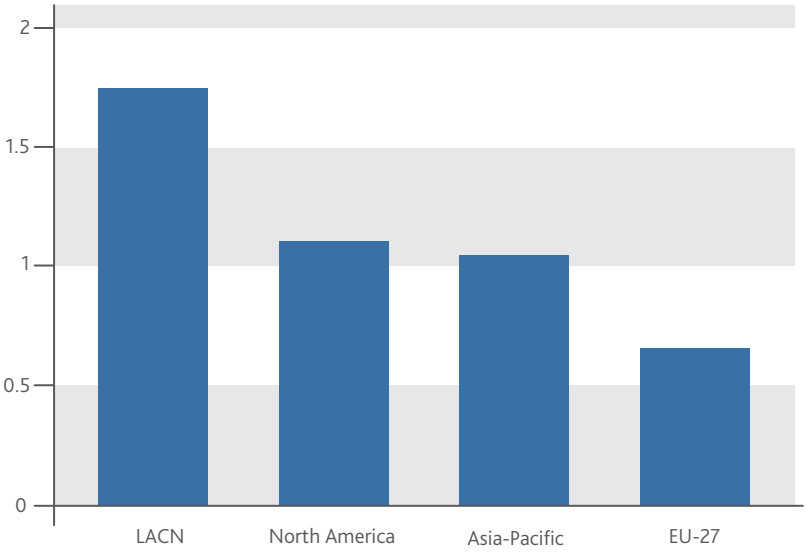


**FIGURE 3:**

GVC Position

## REGIONAL PATTERNS OF TRADE IN GVCS

The previous indicators were useful in highlighting differences across regions in terms of their overall participations and positions in GVCs. However, the indicators did not say anything about the regional bias of the involvement in GVCs. For instance, we do not know if the foreign value added of Asian exports comes mostly from countries in Asia or from other regions. The usefulness of the methodology employed in this paper, based on international input-output tables, is that we can track the origin of the foreign value added by source country/region. This allows us to move beyond the casual evidence mentioned in Section 2 and present more systematic evidence of the extent to which participation in GVCs is regionally biased. This is what we do now.

Figure 4 shows the contribution of foreign value added of each region by countries in its own region and by countries from other regions. The results unequivocally show a large regional bias in GVC participation. On average, about half of the foreign value added originates from countries in the same region. In Europe, Asia-Pacific, and North America, for example, the within-regional contribution to foreign value added is 51 percent, 47 percent, and 43 percent, respectively, and in none of these cases does the contribution from extra-regional sources reach 20 percent. Only in Latin America is the contribution of another region, North America (28 percent), practically similar to the contribution of its own region (27 percent), but even in this case the contributions of more distant regions such as Europe and Asia are smaller.

These results point to a strong role for proximity in explaining the patterns by which countries unbundle their production processes and locate them abroad. As mentioned in Section 2, there can be various mechanisms that could explain why proximity may matter, most notably the costs of shipping bundles of goods across space and the existence of RTAs among nearby countries. In the next section we present an econometric model to disentangle the role of each of these forces while controlling for other elements.

# DETERMINANTS BEHIND REGIONAL PATTERNS OF GVCS

In this section, we estimate an empirical model to isolate the impact of specific drivers behind the regional patterns of GVCs. The model is based on a gravity equation, the workhorse of empirical international trade. Gravity equations, which have been shown to have theoretical underpinnings,[5] are typically estimated using gross trade flows. More recently, however, they have also been employed to examine trade in value added (Johnson and Noguera 2012b). The specific gravity model that we employ takes the following form:

$$Y_{ij}=\theta+\alpha D_i+\beta D_j+\delta X_{ij}+\phi PTA_{ij}+\varepsilon_{ijk} \quad (1)$$

where $Y_{ij}$ is the foreign value added from country jin the exports of country i; $D_i$ and $D_j$ are fixed effects for country i and country j, respectively, $X_{ij}$ is a vector of bilateral variables, and $PTA_{ij}$ is a variable that captures PTAs. The formulation follows others in using individual country fixed effects to estimate trade equations (Feenstra 2004; Eaton

5 See Anderson and van Wincoop 2003; Eaton and Kortum 2002.

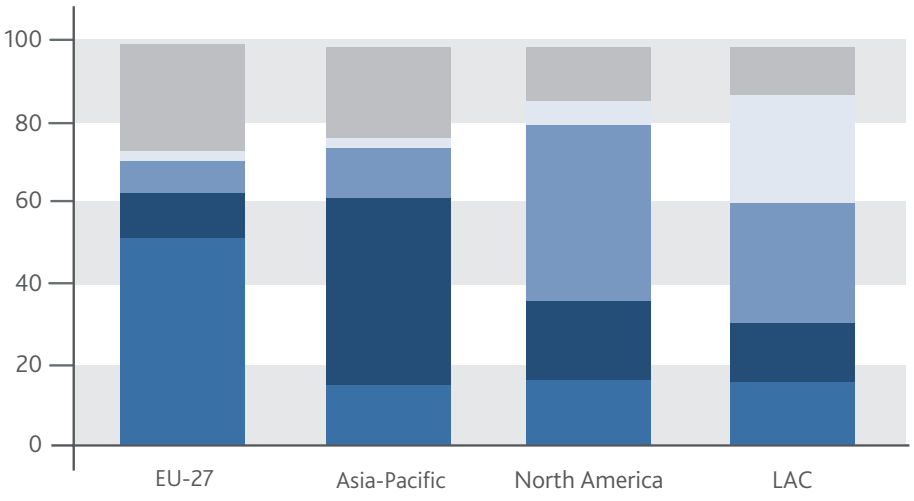


FIGURE 4:

Regional Contribution to Value Added

LEGEND:

EU
North America
Other
Asia-Pacific
LAC

and Kortum 2001, 2002).[6] More specifically, the vector $X_{ij}$ comprises a series of variables that are standard in gravity models. These variables are the bilateral distance between both countries and dummy variables for the same border, same language, and same colonial ties. The dummy variable $PTA_{ij}$ is equal to one if the countries are part of the same PTA and zero otherwise.

In this paper, we are particularly interested in the coefficients for distance and for the trade agreement variables. Note that in our specification the fixed effects $D_i$ and $D_j$ will control for any country characteristics such as size (for example, gross domestic product [GDP], population, and area) or level of development (for example, GDP per capita) that may also affect the extent to which countries use foreign value added.

The results of our baseline estimation are in Table 1. As noted in columns 1 and 2, countries that share the same border, language, and colonial ties are more likely to engage in cross-border production sharing. More importantly, the results show that physical distance substantially decreases foreign value added. In column 2, for example, the results imply that an increase of 10 percent in distance reduces foreign value added, on an average, by around 67 percent. Physical distance is a proxy for the costs of transportation, and the finding supports the notion mentioned in Section 2 that if these costs are large they can erode the saved costs from locating blocks of production in other countries, particularly if they are far away.

Another finding from column 2 is that even after controlling for the effect of distance, foreign value added is positively and significantly related to PTAs. Membership in the same PTA increases foreign value added, on an average, by around 15 percent. In other words, countries will source 15 percent more of their foreign value added from members of the same PTA than from non-members. Therefore, the fact that trading across borders in the same PTA does not add extra duties creates an incentive to source part of the production process from countries that share the same trade agreement.

It is worth mentioning that while the role of distance is clear in explaining the regional bias of GVC participation, the role of PTAs is less obvious; after all, PTAs have been signed between countries as distant as the US and Bahrain. More often than not, however, PTAs are signed between nearby countries or among countries in similar regions. Therefore, sharing a trade agreement often represents an incentive to source materials from proximate countries in addition to the incentives offered by transportation costs savings.

6 These individual country-fixed effects play the same role as the multilateral resistance index introduced by Anderson and van Wincoop 2003. Additionally, potential econometric problems related to exogeneity and omitted variables are largely reduced by using these fixed effects (Anderson and Yotov 2012).

TABLE 1:

Baseline Estimation

Note: ***;**; * significant at the 1 percent, 5 percent, and 10 percent levels respectively.

| Regressor | 1 | 2 |
|---|---|---|
| Contiguity | 0.9059*** | 0.8989*** |
| | (0.0443) | (0.0442) |
| Common language | 0.2355*** | 0.2334*** |
| | (0.0249) | (0.0248) |
| Colonial ties | 0.2569*** | 0.2652*** |
| | (0.0531) | (0.0529) |
| Distance | -0.7088*** | -0.6667*** |
| | (0.0109) | (0.0121) |
| PTA | | 0.1475*** |
| | | (0.0186) |
| Importing country fixed effect | Yes | Yes |
| Exporting country fixed effect | Yes | Yes |
| Observations | 11,740 | 11,740 |
| $R^2$ | 0.91 | 0.91 |

## DISCUSSION AND FURTHER EVIDENCE

The econometric evidence shows that proximity matters. Global supply chains are less likely to flourish if the participating countries are at a distance. This opens up some questions on the options for many developing countries that are not close to major GVC regions but are aiming to improve their participation in them, such as countries in Latin America and the Caribbean (LAC). At least three issues are worth mentioning about this. First, a remote country/region is not entirely forbidden to join an international supply chain because of long distance. However, the results imply that some form of compensation for high transportation costs would probably be required. Most likely this compensation will take place with savings in production costs arising from strong comparative advantages. Therefore, for many developing countries, like in LAC, accessing GVCs in other regions is likely to take place, at least initially, in sectors where comparative advantages are the strongest. Second, transport costs are not solely determined by distance. The costs of transportation also depend on issues such as volume, the level of containerization, the degree of competition among shipping companies, and the quality of the transport-related infrastructure, among others. It has been shown, for example, that around 30 percent of the larger freight rates of LAC's exports to the US relative to those from Europe can be explained by differences in port efficiency (see Moreira et al. 2008). What the results then imply is that for faraway countries to join GVCs, issues such as improving port or airport efficiency are likely to be more important to offset the impact of distance than for nearby countries. Finally, countries away from major GVC regions can seek to develop their own regional value chains. This could be the case, for instance, across countries in LAC in which some regional value chains already exist. But even if these are the type of supply chains that are more likely to emerge in LAC, it is still important to be aware of the differences that exist in terms of distance across countries there versus the distances across countries in other regions. For example, the average bilateral distance across all the East Asian and ASEAN countries is around 2,400 kilometres while the average distance across countries in LAC is 3,000 km. If we include the US and Canada, the distance across the Americas is 3,200 km, or 30 percent more than in Asia.[7] Therefore, even for the prospects of intra-regional supply chains in the Americas, the vast distances of the continent impose a challenge. In addition, because of the geography, most of the shipments across countries in Asia take place by sea while within LAC, many shipments take place by land, a mode with lower economies of scale and thus higher per unit freight costs. True, land transportation is the main shipping mode within Europe but the distances are much smaller. The average bilateral distance among all 27 European countries is 1,400 km, which is less than half the average distance across the Americas. Again, the issue of long distances does not necessarily mean that the prospects for the creation of regional supply chains are doomed to fail. It means that everything about connectivity, including the efficiency of port and airport infrastructure, and the quality of internal road networks, is relatively more important for LAC than for countries in other regions that are closer to each other.

The role of trade agreements is another issue emerging from the econometric results that is worth discussing further. As mentioned, the fact that many trade agreement occurs between countries in similar regions imply that sharing a trade agreement adds an additional layer of incentives, beyond transport costs, to co-locate production in nearby countries. So what does this imply for the prospects of countries that are not members of PTAs? In principle, being a member of a PTA does not necessarily impede a country from developing supply chains with non-member countries, particularly if tariff rates between them are not very large. However, most PTAs have rules, in the form of rules of origin (RoO) that disincentivize the use of materials from outside the bloc, particularly if they are employed to produce final goods that are later exported to other members of the PTA. In some cases, however, the RoO are flexible enough for countries to engage in cross-border production sharing even with members outside the PTA. Therefore, it is worth examining the issue of RoO in more detail.

RoO are critical parts of PTAs because they establish the conditions that a product must satisfy to be deemed as originating from the country seeking preferential access (Estevadeordal and Suominen 2006). They are primarily used to prevent trade deflection—that is, to avoid products from non-participating countries reaching a high-tariff PTA partner via transshipment through a low-tariff PTA member. But depending on how they are designed, RoO can have quite important implications on the way firms choose a location to fragment production.

The most obvious implication, as mentioned, is that RoO restrict outsourcing from countries outside a PTA. Take, for instance, a firm producing a good entirely in country A and selling it tariff free to country B within the same PTA. If the firm decides to use inputs from country C outside the PTA, depending on the RoO of the agreement, the final good that it is exported from A to B will now pay import duties. Therefore, the RoO can disincentivize outsourcing from outside the PTA, especially if the final destination of the good is within the PTA.

RoO can also limit the outsourcing of production processes among countries that have parallel or overlapping PTAs. Consider the example of country A that has separate PTAs with two countries B and C. Any final good produced in B or C would have tariff-free access to country A. However, a good produced in B using inputs from C and exported to A would not. In this case, RoO create disincentives for firms in country B to outsource part of the production process to country C even if it makes economic sense to do so.

Finally, RoO can even limit the outsourcing possibilities among countries in the same PTA. Take, for instance, the

7 | We use great-circle distances between the capitals of the countries.

case of the North American Free Trade Agreement (NAFTA). In this agreement, the relevant RoO implies that a final good produced in the US with inputs from Canada can be exported to Canada with zero import duties in the same way as if the good was entirely produced in the US. However, if the inputs used in the US come from Mexico—another NAFTA country—the final good exported to Canada will have to pay an import duty. Again, this creates disincentives to relocate part of the production process from the US to Mexico.

While RoO can impose limits on the range of countries that can participate in the international fragmentation of production, it is also possible to reduce these limits through various instruments, for instance, with flexible cumulation rules (such as diagonal cumulation), with higher de minimis levels, or by allowing for duty drawbacks. Cumulation in general means that inputs from trading partners can be used in the production of a final good without undermining the origin of the product. In the case of diagonal cumulation, inputs from, say, a non-member country can be used for exports geared towards members of the agreement without paying extra duties. De minimis rules allow a specified percentage of non-originating products to be used in the production process without affecting the origin status of the final product. A duty drawback can be used to return the payment of duties applicable to the non-originating material employed in the production of a final product that is subsequently exported to other members of the agreement.

It is important to note that because RoOs can restrict the fragmentation of production even within the same PTA. Depending on how they are crafted, the mechanisms mentioned above (cumulation, de minimis, duty drawbacks) can act as incentives to encourage more cross-border production sharing among the countries of the same PTA and/or between them and non-PTA countries.

It is worth noting, however, that the capacity of these mechanisms to incentivize trade in general, particularly trade in inputs, has not been analyzed empirically before. From the results in Table 1, for example, we know that a country is more likely to obtain foreign value added from a member of its PTA, but we do not know what extra incentives mechanisms such as diagonal cumulation can create to encourage the participation of a country in GVCs. This is an issue that we explore now.

To gain some perspective before we proceed with an econometric analysis, let us consider the following example. China is a country that has 10 PTAs, including one with Chile. None of the PTAs that China has with countries other than Chile allows diagonal cumulation with Chile. This means that an export from China to any of its PTAs will enter with zero tariff if it is produced entirely in China but will pay a duty if it uses materials from Chile. This situation implies the following. On the one hand, the agreement with Chile means that when China sources imported inputs to be employed for domestic final demand or for exports to countries that are not part of its PTAs, it has more incentives to trade with Chile than, say, with Bolivia, a country with which it does not have a trade agreement. This effect is captured by the PTA dummy that we include in the gravity model in equation (1) and it is also the typically bilateral effect that is analyzed in the empirical literature on free trade agreements (FTAs) and trade. However, when it comes to importing goods that will be subsequently used in the exports of China to members of its PTAs, China does not have more of an incentive to import from Chile than from Bolivia, even though it has an agreement with Chile. This is because none of China's PTAs allow cumulation from Chile or, by the same token, from Bolivia. In other words, China's exports to other members of its PTAs will need to pay the same extra duties for using non-originating inputs from Chile or Bolivia. Therefore, beyond the incentives created by the preferences that China grants to Chile with its own bilateral PTA, China does not have any additional incentives to source inputs from Chile relative to Bolivia. Now, let us complete the example by introducing another country, Thailand. Thailand is a member of the ASEAN, with which China has a PTA. It is also the case that diagonal cumulation is allowed between ASEAN countries and China. This implies the following. First, when China sources imported inputs to be employed for domestic final demand or for exports to countries that are not part of China's PTAs, it has more incentives to trade with Thailand than with Bolivia because of the trade agreement. This is similar to the additional incentive that China has to trade with Chile than with Bolivia. Again, this is the bilateral impact captured by the PTA dummy in the gravity equation. The second effect now implies that when it comes to importing goods that will be subsequently used in China's exports to other members of its PTAs, China has more of an incentive to import from Thailand than from Chile or Bolivia because it can cumulate materials from Thailand to export to other ASEAN countries while it cannot do so from Chile or Bolivia. Therefore, the diagonal cumulation gives an extra incentive to imports from Thailand. Note that this incentive can take place regardless of whether there is an FTA between Thailand and China.

In what follows, we present an empirical exercise that examines the role of diagonal cumulation on cross-border production sharing. The exercise consists of augmenting the gravity model in equation (1) as follows:

$$Y_{ij}=\theta+\alpha D_i+\beta D_j+\delta X_{ij}+\phi PTA_{ij}+\gamma CUM_{ij}+\varepsilon_{ijk} \quad (2)$$

where $CUM_{ij}$ is equal to 1 if the importing country i has a trade agreement with third countries that permit cumulation with country j and zero otherwise, and the rest of the variables are the same as before. Note that the traditional bilateral effect of having a trade agreement will still be captured by the PTA variable. In other words, the PTA variable will still measure the incentives for country i to source inputs from country j because they share a trade agreement. But in addition to this effect, now the CUM variable will capture the additional impact that involves a relationship between three parties. That is, CUM will measure the incentives for country i to source inputs from country j because country i can cumulate these inputs to export goods to third countries. Note that this modeling can encompass many different situations. For instance, country i

and j might have a PTA, and this PTA might be the same as the PTA that country i has with third countries. It can also be the case that the PTA between countries i and j is different from the PTA that country i has with third countries. Finally, it is also possible that country i and j do not share a PTA. In all these situations, CUM will be equal to 1 if country i has a PTA with third countries that permit cumulation from country j.

Constructing the cumulation dummy is not an easy task. It involves, for each country i, analyzing each of its PTAs and identifying whether it permits cumulation with each of the countries in the sample. Accordingly, we restrict this exercise to a smaller set of countries. In particular, we examine the country members of the ASEAN FTA (AFTA; Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam), the ASEAN-China FTA (ACFTA; ASEAN countries and China), the ASEAN-Korea FTA (AKFTA; ASEAN countries and Korea), and the Trans-Pacific Partnership (TPP; Brunei, New Zealand, Chile, and Singapore). More specifically, the sample of country i will be restricted to the countries in these agreements while the sample of country j includes all the countries as before. Note that the countries in each of these agreements are allowed to engage in diagonal cumulation among themselves. Note also that because any pair of countries could share the same PTA and also be allowed to cumulate with other members of the agreement, the variables PTA and CUM will be equal to 1 among all the country pairs of each of these agreements. The identification of the effect on cumulation comes from that many of these countries have PTAs with other nations with whom they cannot cumulate. In those cases, the PTA dummy is equal to 1 while the CUM dummy is equal to zero.[8]

The results of this exercise are shown in Table 2. Columns 1 and 2 depict similar specifications as columns 1 and 2 of Table 1; that is, without including the variable CUM. Note from these columns that the PTA dummy again has a positive and significant impact on foreign value added with a coefficient that is comparable to the results in Table 1. In column 3 we add the variable to capture the effect of cumulation. The results in this column indicate that the PTA variable is still

8 It is also the case that the countries in these agreements do not have PTAs with many other countries in the sample.

TABLE 2:

The Role of Diagonal Cumulation

Note: ***;**; * significant at the 1 percent, 5 percent, and 10 percent levels respectively.

| Regressor | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Contiguity | 0.8620*** | 0.8454*** | 0.8295*** | 0.8295*** |
| | (0.1092) | (0.1094) | (0.1096) | (0.1096) |
| Common language | 0.0331 | 0.0245 | 0.0316 | 0.0316 |
| | (0.0639) | (0.0640) | (0.0640) | (0.0640) |
| Colonial ties | 0.3439* | 0.3657** | 0.3668** | 0.3668** |
| | (0.1807) | (0.1808) | (0.1807) | (0.1807) |
| Distance | -0.6488*** | -0.6448*** | -0.6290*** | -0.6290*** |
| | (0.0426) | (0.0426) | (0.0435) | (0.0435) |
| PTA | | 0.1116** | 0.0977* | |
| | | (0.0560) | (0.0565) | |
| CUM | | | 0.2079* | |
| | | | (0.0186) | |
| PTA - No cumulation | | | | 0.0977* |
| | | | | (0.0565) |
| PTA - Cumulation | | | | 0.3056** |
| | | | | (0.1222) |
| Importing country fixed effect | Yes | Yes | Yes | Yes |
| Exporting country fixed effect | Yes | Yes | Yes | Yes |
| Observations | 1,480 | 1,480 | 1,480 | 1,480 |
| $R^2$ | 0.93 | 0.93 | 0.93 | 0.93 |

positive and significant with a coefficient that decreases only slightly relative to column 2. Most importantly, there is this additional impact from the cumulation mechanism that is also positive and significant. The results imply that countries will source 9 percent more of their foreign value added from members of the same PTA and an additional 20 percent if cumulation is possible.

Column 4 presents an alternative specification to examine the same issue. Specifically, we include a PTA dummy that is equal to 1 if country i has a PTA with country j but no cumulation is possible (PTA – No cumulation), and another PTA dummy that is equal to 1 if country i has a PTA with country j but cumulation is possible (PTA – Cumulation). In essence, this specification presents the differential impact of PTAs that allow cumulation from those that do not allow cumulation more clearly. According to the results, countries will source 9 percent more of their foreign value added from members of the same agreement if the PTA does not allow cumulation, while they will source 30 percent more from members of the same agreement if the PTA allows cumulation. This result is equivalent to the one in column 3. Both results support the notion that the capacity to cumulate adds extra incentives to trade, especially to engage in cross-border production sharing.

Obviously, because the diagonal cumulation mechanism only takes places among countries of the same PTA in this exercise, the findings support the notion that it significantly encourages cross-border production sharing across PTA countries. But, in general terms, the results suggest that allowing diagonal cumulation can be an important mechanism to promote international linkages between PTA members and non-PTA members. The general idea is that even though a country is not part of a PTA, allowing cumulation with that country can go a long way in integrating it into regional supply chains. This is then one mechanism by which developing countries that are not members of certain PTAs could benefit as it improves their chances of accessing international/regional production networks.

# IMPLICATIONS FOR THE WTO

GVCs are mostly regional. This is due primarily to transportation costs that rise with distance, and trade agreements, which have first and foremost been forged among neighboring countries. This regional bias in GVCs has two implications.

First, some countries (typically developing countries in Latin America and Africa) have remained at the periphery of GVCs. They are distant from the main GVC clusters and do not necessarily share trade agreements with "GVC hub regions."

Second, some of the regional clustering of GVCs is due to geographic factors that cannot be altered, but much is due to trade policy and transportation costs, which can be changed. Granted, these variables will likely evolve with changes in energy costs (which, if increasing, can incentivize shorter value chains); education and information technology (which, if improving, can obliterate distances); and new trade agreements (which are increasingly struck across continents). However, an optimal scenario where GVCs are unconstrained by trade or transportation barriers has yet to be reached.

Only a multilateral approach can effectively encourage globalization of value chains. There is unique value in a multilateral approach that includes all regions, and in a comprehensive approach across trade disciplines. This is something only the WTO can accomplish. To optimize GVCs by reducing transportation costs and trade barriers, work has to be done in at least six major areas.

- **Trade facilitation**: Trade facilitation is key to fluid trade in intermediate products and particularly critical for developing nations, which stand to gain considerably from policies and measures that help fuel trade. Trade facilitation is also a central issue in the Doha Round. However, the negotiations have been quite narrow in scope and implementing their outcome will take a long time. In the light of the urgency of trade facilitation to WTO Members, particularly developing nations, they should agree to implement the Trade Facilitation Agreement, possibly as a plurilateral agreement not requiring a formal conclusion of the Single Undertaking.

- **Aid for Trade**: To a large extent purported to catalyze investments in infrastructure improvements, the global Aid for Trade agenda, an integral part of the Doha Round, is an important complement to trade facilitation agreements in helping developing countries access GVCs.

- **Barriers to intermediate imports**: Protectionist reactions crept up in the wake of the Great Recession, and some nations have supported tariff and non-tariff measures, such as "buy local" provisions for replacing input imports with domestically made goods, generally to encourage production and job creation at home. Policies to keep imports out and production in are, however, ultimately self-defeating. They curb access to the most efficient intermediate goods for production of exports; undermine opportunities to absorb foreign technologies, and erode participation in GVCs (which would help create jobs). Non-tariff barriers such as regulations and standards can significantly limit trade in intermediates and must be dealt with rigorously at the multilateral level.

- **Services liberalization**: Quality of transportation services affects trade costs and is a major determinant of how GVCs are structured. Transport, communications, and distribution are key services sectors and closely linked to trade costs. Yet barriers to trade in services remain very steep, particularly in developing nations.

Liberalization of transportation services could significantly enhance these countries' access to GVCs. Granted, PTAs have progressed well beyond the WTO and the General Agreement on Trade in Services (GATS) in services liberalization; for the WTO to catch up, Members may be well advised to seek a plurilateral agreement among a substantial coalition of the willing.

- **Cumulation across PTAs**: PTAs reduce trade policy barriers that otherwise may discourage value chains among the parties; however, PTAs' RoO can undermine their members' incentives and ability to participate in GVCs. Such problems can be reduced through further multilateral tariff liberalization (which reduces the attraction of PTA preferences and thus the need to comply with RoO), and cumulation across several RTAs into larger trade areas. This happened in Europe in the late 1990s, and is set to happen in the Asia-Pacific through the TPP negotiations and in Latin America through the Pacific Alliance.

- **Intellectual property**: Outsourcing and "slicing" the production chain requires the sharing of a wide array of proprietary knowledge. Inadequate intellectual property (IP) protections erode innovators' profit margins and businesses' incentives to extend value chains to third countries for fear of IP theft. Concerns about IP have increased with recent efforts to incentivize technology transfer to certain nations through compulsory licensing of patents and "indigenous innovation" policies. China, for example, has established a preference in government procurement to products whose IP is owned and originally trademarked in China—which essentially means exchanging market access to foreign firms for technology transfer to China. This disadvantages foreign property rights holders across the world and discourages production sharing. The immediate priority at the multilateral level is to ensure effective enforcement of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS).

# CONCLUSIONS

Rapid technical progress allowing the physical fragmentation of production in various bundles, combined with a general decline in transport costs and the improved capacity of communication and information systems, have allowed firms to separate production processes to take advantage of differences in relative prices across the world. While the importance of proximity has declined, it has not disappeared completely—international production networks continue to exist across nearby countries or in similar regions.

The regional bias in forming GVCs poses a challenge for developing countries that want to participate in GVCs but are far away from these industrial clusters. This paper shows that high transport costs accrued by long distances are a major determinant of countries' ability to participate in GVCs. This is no reason for fatalism—transport costs are not only about distance, but also about the quality of transport-related infrastructure, which includes aspects like the capacity of a port to move merchandise in and out without uncertainty, delays, and/or damages. While important for trade in general, the quality of logistics systems are particularly relevant for participating in cross-border production processes where low inventory cost strategies, such as just-in-time delivery services, continue to be the norm. More detailed evidence on how specific aspects of the logistics infrastructure (for example, port and airport efficiency, information and communication infrastructure, custom procedures) interact with the participation of countries in GVCs is an important issue to examine further. The WTO should pay attention to several other policy areas that affect transport costs, including trade facilitation, Aid for Trade, and trade in transport services.

We also show in this paper that the regional bias in GVCs stems from trade and other agreements among neighboring countries. While being a member of a trade agreement does not necessarily impede a country from developing supply chains with non-member countries, most PTAs have RoOs that disincentivize the use of materials from outside the bloc. This paper shows that RoOs have quite important implications in the way firms choose the location in which they fragment production, typically restricting outsourcing even from countries of the same PTA. Specifically, we provide some preliminary evidence showing that instruments like diagonal cumulation can be quite effective in reducing the strictness of these rules and spur cross-border production sharing among PTA members. Granted, multilateral tariff and non-tariff liberalization would also reduce the bite of restrictive RoOs—and in general encourage trade intermediates. Additional analysis on this area should be welcomed to further illuminate the extent to which this and other mechanisms can encourage production linkages between PTA members and non-members. More generally, the results of this paper suggest that another important area for further discussion is the optimal architecture of trade agreements, and the need to balance curbing trade deflection with rules flexible enough to allow for potential offshoring opportunities.

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# APPENDIX

## MEASURES OF TRADE IN VALUE-ADDED

*Foreign value-added of country s (FVA):* the value-added embodied in the exports of country s that comes from all the other countries. This is a measure of the extent to which imported inputs are used in the exports of countrys.

*Indirect value-added of country s (IVA):* the value-added of country s that is embodied in the exports of all the other countries. This is a measure of the extent to which the exports of country s are used as inputs in the exports of other countries.

*GVC position of country s:* Ratio of IVA and FVA. If this ratio is high, the country tends to participate more as a provider of value added to other countries than as a recipient of foreign value added; therefore, the country is relatively upstream in the chain.

Conversely, if this ratio is low, the country tends to participate more as a recipient of foreign value added than as a provider of value added to other countries; therefore, the country is relatively downstream in the chain

## DATA SOURCES

All the measures are constructed using the GTAP (Global Trade Analysis Project) data which include bilateral trade statistics and I-O tables for many countries around the world. We employ GTAP versions 7 and 8, covering a total of 129 countries (regions) and 57 sectors for the years 2004 and 2007.

## COUNTRY GROUPINGS

*EU-27:*
Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherland, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, UK

*Asia-Pacific:*
Australia, Cambodia, China, Hong Kong, Indonesia, Japan, Korea, Lao, Malaysia, Mongolia, Myanmar, New Zealand, Philippines, Singapore, Taiwan, Thailand, Vietnam

*North America:*
Canada, USA, Mexico

*LAC:*
Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Paraguay, Peru, Uruguay, Venezuela

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